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The theory of reflexivity – a non-stochastic randomness theory for business schools only?

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The theory of reflexivity – a non-stochastic randomness theory for business schools only?

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Abstract:

„The Alchemy of Finance", a book written by George Soros (1987) on the workings of financial markets, „has found a place in the reading lists of business schools as distinct from economics departments", according to the author (2003, 4). His theory of reflexivity, which is at the center of the book, states that interdependence exists between the cognitive and manipulative functions of market participants. While Soros claims that imperfect knowledge rules on financial markets, academic orthodoxy assumes perfect knowledge and hence displays – in the absence of external shocks – financial markets as efficient.

We review the work of Soros on reflexivity and follow up his claim that it can be used to attack the efficient market hypothesis. Both are discussed and then the ideas of Soros are compared to those of Post-Keynesian economics. We argue that Soros' book is mainly ignored by neo-classical economists because they disagree with his axioms, and by heterodox economists because his ideas are not new.

JEL classifications: B26, D8

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> But for the very reason that we are unable to have directly complete knowledge of reality, there is nothing for us but arbitrarily to construct a reality, to suppose that things are happening after a certain fashion. This provides us with an outline, a concept or framework of concepts.
>
> *Ortega y Gasset (1932[1930], 93)*

1. Introduction

The creation of money out of nothing has led market participants like George Soros to speak of the alchemy of finance. Every once in a while, a financial disturbance threatens the markets, both real and financial. Toporowski (2005, 2) divides academic explanations of finance into three categories. There is equilibrium finance, in which the "financial system is a state of static, mutually determined equilibrium" (ibid.), as in Samuelson's efficient market hypothesis (1965) or Tobin's "q" (1969). Then there is reflective finance, in which the real economy determines the conditions in the financial sector. The third approach is called critical finance because it shows that finance may disturb the functioning of the economy. It is probably here where the theory of reflexivity would be integrated into Toporowski's classification.

The aim of this paper is to examine the theory of reflexivity and its relation to other theories of financial disturbances. We first present a summary of the theory of reflexivity and its evolution. We proceed to carve out its contribution, as Soros himself sees it, and proceed to contrast it with the ruling paradigm in economics, defined by the efficient market hypothesis and the rational expectations hypothesis. This is followed by a section on Post-Keynesian explanations, namely the contributions of Keynes (1936) and Minsky (1975, 1982, 1986). The conclusion sums up reasons why the theory of reflexivity is and is not taught at business schools and economics departments respectively.

2. Soros' theory of reflexivity

George Soros developed his theory of reflexivity when he was an investor, not an academic, which of course does not disqualify his work. Nevertheless, his prose is not easy to digest. He does not rigorously connect his own ideas to those of others – neither those that he builds on nor those that he attacks – and at times does not even try to understand other's ideas, which makes it difficult to evaluate his work.[1] Over time Soros has amended his theory of reflexivity. Here is his own original definition of reflexivity (2003, 2):[2]

> In situations that have thinking participants, there is a two-way interaction between the participants' thinking and the situation in which they participate. On the one hand, participants seek to understand reality; on the other, they seek to bring about a desired outcome. The two functions work in opposite directions: in the cognitive function reality is the given; in the participating function, the participants' understanding is the constant. The two functions can interfere with each other by rendering what is supposed to be constant, contingent. I call the interference between the two functions "reflexivity". I envision reflexivity as a feedback loop between the participants' understanding and the situation in which they participate…

Some definitions and an example should help to clarify this paragraph. It starts with the entities "situations" and "thinking participants". We add the two functions – cognitive and manipulative – and end up with the graphical representation below (see Figure 1). The arrow from situation (s) to each participant (p) is indicative of the cognitive function, the reverse arrow of the manipulative function. Over time, a change of the situation through a change of thinking of any of the participants leads to changes in that of other participants and, possibly, to feedback loops. How are the two entities defined? One example of a situation is where "the market price at the termination of the experiment serves as a criterion by which the experiment can be judged" (2003, 325-6). The thinking participants, obviously, would then be investors trying to maximize profits (or minimize losses or hedge risk, etc.).

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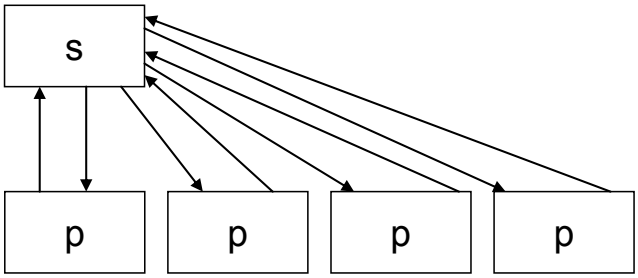
1 Soros (2003, 4) claims that he is not familiar with the theories of rational expectations and efficient markets because „as a

2 In the following our focus is on the new 2003 edition which is meant to clarify some issues from the original 1987 edition. Soros (2008, 3) calls the participating function manipulative function.

Figure 1: Soros (2003) - a situation (s) and participants (p)



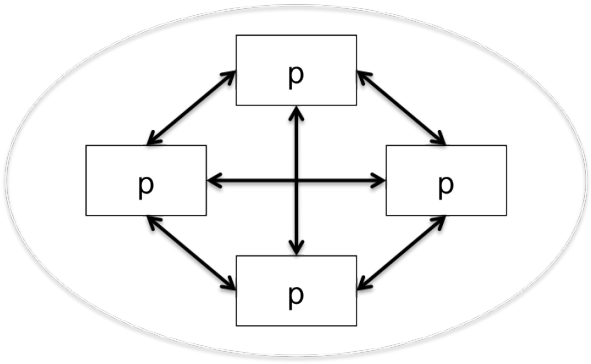
Soros (2003, 3) notes that there is a problem with defining thinking participants and situation – which produces facts – as different entities:

> The traditional correspondence theory of truth sees knowledge as being expressed by true statements. The statement X is true if, and only if, the fact described by X actually happens. Facts have to be independent of statements that refer to them in order to constitute a reliable criterion. But the participants' decisions relate to the future, and the future is contingent on the participants' decision in the present. Therefore, facts do not constitute an independent criterion by which the current thinking of participants could be qualified as knowledge.

What is important for Soros is the uncertainty of the future.[3] Soros (2003, 373 f.) recognizes towards the end of the book that "[i]t is a mistake to think that there are two separate entities [individuals and society] involved: the relationship is between a part and the whole". Only later it occurred to him that thinking is part of reality, or in other terms, participants are part of the situation (2008, 28). Correcting his theory, Soros (2008, 28) describes the direct interpersonal relations of participants so that the arrows connect all participants with each other in real time (see Figure 2). There are several reflexive processes going on at the same time (2008, 73). Soros envisions a feedback loop in which participants are reflecting on the situation, which they – partly – constitute. It is the ability to reflect that turns the passive participants with no control over the situation into thinking participants with some control.

[3] It seems that Soros does not understand the correspondence theory. Statements correspond to facts, hence the name. Facts are not in that sense independent of statements and they are not supposed to be. Statements about future "facts" cannot be true today.

Figure 2: Soros (2008) - a situation (gray circle) with thinking participants (p)



Soros (2008, 26) adds the idea of fallibility, which governs situations in which knowledge is not and cannot be sufficient to guide action. People's understanding of reality is inherently imperfect because a part cannot fully comprehend the whole. The capacity of the human brain is limited, and therefore the information that is available must be reduced. Techniques are generalizations, metaphors, habits, etc.. The fact that knowledge is imperfect does not and should not discourage people, as so-called fertile fallacies can "flourish and produce positive results before their deficiencies are discovered" (2008, 34). It is when knowledge is overexploited that these deficiencies are finally discovered and a new idea is called for.

In consequence, Soros postulates radical fallibility as the idea that "the ultimate truth is beyond the reach of the human intellect" (2008, 47). According to Soros the causality runs from limited brain capacity to imperfect information. Transferring these thoughts back into the philosophical realm we wonder how these thoughts fit with the correspondence theory of truth. Soros seems to imply that you can find a truth, but it is destroyed by making public the statement that describes it. Therefore he takes a middle position between those who think that truth can and those who think that truth cannot be found. When Soros writes that a part cannot understand the whole, he is outside the correspondence theory of truth: the whole is the sum of all facts. Soros is still outside the correspondence theory with his fruitful "fallacies". They are neither facts nor statements and therefore cannot be "true". The same goes for the idea of "ultimate truth".

The idea that there is too much information to apprehend has been recognized by

academics some time ago. The literature on bounded rationality focuses on some of these aspects, as in Gigerenzer (2002). Behavioral economics provides a different view (see Kahneman 2011). The fundamental argument of our limitations to accumulate and store knowledge was made by Hayek (1952, 185) and according to Popper (1972[1963], 191) "the world as we know it is our interpretation of the observable facts in the light of the theories that we ourselves invent." The causality that Soros sees from limited brain capacity to imperfect information has been disputed by anthropologists in the 1980s. Instead of processing factual information, Dunbar (1998) argues that we use our brain to create and participate in social systems.

Social scientists have expressed the imperfect character of knowledge once and again. Whatever the cause is for imperfect knowledge, according to Soros it puts the theory of reflexivity up against the reigning paradigm in economics that is based on the idea of perfect knowledge, which is inherent to both the efficient market and the rational expectations hypothesis. For instance, Malkiel (2003, 60) writes in the Journal of Economic Perspectives: „I conclude that our stock markets are far more efficient and far less predictable than some recent academic papers would have us believe". At the time of writing, it seems that contrary to his fears Soros has not been flogging a dead horse.

Soros attacks the reigning paradigm using methodological arguments. He argues that, in a nutshell, his theory states that in the social sciences the observer's ideas about the world influence the actions in the world. Therefore, the distinction between theories, like the theory of gravity, and facts, like data from experiments, that has proven to be so successful for natural sciences, does not exist in social sciences. Observers are always part of the experiment and they do influence it. Social structures are fundamentally defined by human interaction. It is not possible to falsify a social theory in the sense of Popper (1934) because there is no unique outcome of experiments.[4]

All this, according to Soros, has huge implications for social science. Perhaps the most important for the study of economics, according to Soros, is that knowledge is

4 Whether this is correct is open to debate.

and can only be imperfect. Consequently, Soros (2003, 5) concludes that the prevailing paradigm in economics, which according to him builds on rational expectations and the efficient market hypothesis, should be rejected.

3. Life in a world where prices are „properly anticipated“

Today's mainstream economics, in particular neoclassical economics, has been built on a theoretical foundation borrowing freely from normative (as opposed to descriptive) decision theory as discussed for instance by French (1988):

> Our study, by and large, will concentrate on normative theories of decision. In order that we might consider rational choice per se, without being confused by our human limitations, we shall assume that our rational decision maker will have powers of infinite discrimination. (p. 64)
>
> Empirically, indifference is often observed to be intransitive and it is not uncommon to observe intransitive strict preferences. So it is hardly likely that ordinal value functions would provide descriptive models that closely fit the data. Descriptive models of choice are likely to be, and indeed are, different from the normative models that are our main interest. (p. 94)

Such an approach is perhaps to be expected from a mathematician, but the same disregard for empirical input about the actual decision-making behaviour of actual humans is common among economists, disturbingly so for what purports to be a social science.

One aspect of this theoretical foundation is stochastic randomness. By this we mean the assumption that possible future events can be enumerated and can be assigned a probability distribution. For instance, Samuelson (1965, 42), on his way to defining the efficient market hypothesis, writes:

> Suppose there is at best a probability distribution for any future price, whose form depends solely on the number of periods ahead over which we are trying to forecast prices ...

The existence of a probability distribution for future events may seem like an innocuous assumption, but even Kolmogorov (1983, 515), the formalizer of modern mathematical probability theory, rejected it in general:

> In everyday language we call random these phenomena where we cannot find a regularity allowing us to predict precisely their results. Generally speaking

> there is no ground to believe that a random phenomenon should possess any definite probability. Therefore, we should have distinguished between randomness proper (as absence of any regularity) and stochastic randomness (which is the subject of probability theory).

Several prominent economists also reject this assumption in general. Frank Knight (1921, 197 ff.) famously distinguished between risk – that is, quantifiable randomness – and uncertainty, when probabilities cannot be assigned. He also mentions "true uncertainty" (1921, 232) as the main obstacle to perfect competition. Hicks (1979) also distinguished a notion of "true uncertainty".[5] A preoccupation with "true uncertainty" is found in the Post-Keynesian school in particular, for instance in Davidson (1991) and Lavoie (1992).

Not all of neoclassical or mainstream economics assumes a given probability distribution, but at the very least the knowledge of the possible outcomes facing economic agents. The latter clearly encompasses not just deterministic game theory and "objective" probabilities, but also "subjective" probabilities as well as "rational" state preferences. Again quoting French (ibid.):

> I can think of no real problems which cannot be modelled satisfactorily in one of these formats. I am unaware of anything essential being lost when I gather together the real alternatives facing me and structure them in either a table or a tree. (p. 345)

But the possibility that economic actors may not be able to enumerate all the possible "real alternatives facing them" (Hicksian "true uncertainty") is excluded. Descriptive decision theories, by contrast, would encompass the findings of behavioural economics or behavioural finance, on which Samuelson, interviewed by Bernstein (2007, 39), had the following to say in relation with the efficient market assumption (italics added by Bernstein):

> Samuelson admires Kahneman but considers much of the work in the area as "a lot of noise." He believes the ultimate judgement of Behavioral Finance is whether you make money out of it. In a masterful statement that reveals Samuelson's keen grasp of the real world of investing, he points out that most investors "do not even understand how to capitalize on the behavioral anomalies, even if they are skeptics about efficiency and fans of behavioral

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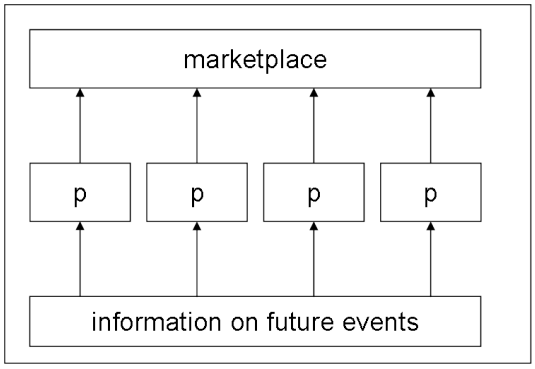
5 In endnote [v] of Davidson (2007), Hicksian „true uncertainty" is characterised as follows: "*v. True uncertainty occurs whenever an individual cannot specify and/or order a complete set of prospects regarding the future, either because: 1) the decision maker cannot conceive of a complete list of consequences that will occur in the future; or, ii) the decision maker cannot assign probabilities to all consequences because "the evidence is insufficient to establish a probability" so that possible consequences "are not even orderable" (Hicks, 1979, p.113, 115). In such cases ordering is not possible.*"

> theories. Indeed, *part of their own irrationality is their unwillingness to accept the volatility and kinds of risks that do average out to be profitable."*

The efficient market hypothesis was originally stated and elaborated by Samuelson (1965, 1973).[6] In the 1965 article, Samuelson attempts to make precise the idea that "what can be perceived about the future must already be 'discounted' in current price quotations" (p. 41). He then concludes that there can be no expected gain in investing. Arguing that "we would expect people in the market place, in pursuit of avid and intelligent self-interest, to take account of those elements of future events that in a probability sense may be discerned to be casting there shadows before them" (p. 44), Samuelson assumes the existence of an unspecified probability distribution for future spot prices, and also that current forward prices are expected values of future spot prices with respect to that same probability distribution. He then deduces that forward prices for a given delivery date are "fair games" (technically, "martingales") so that there is no expected gain from entering into a forward contract.[7]

Figure 3: A market place, participants (p) and information on future events



This structure follows from the mathematical properties of the model Samuelson develops. From his assumption of perfect information – that market participants take account of the 'shadow' that future events may be casting on the present – he concludes "that there is at best a probability distribution for any future price", but not more. This is noteworthy for two reasons. First, Samuelson does not assume that

6 It was aso independenty stated by Euene Fama (1970). We focus on Samuelson who, before the award of The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 2013 to Fama, was the more prominent target of Postkeynesian criticism of neoclassical economics as a proponent of the efficient market hypothesis.

7 One can define a 'fair game' as one in which the price of joining the game equals the expected payoff from it. This concept is formally generalised in probability theory as a 'martingale', which is a random process such that its expected value given the history up to some time equals the value of the process at that time. The term 'martingale' is borrowed from certain betting strategies popular in France in the 18th century.

perfect information leads to predictability. On the other hand, his unpredictability is not Hicksian "true uncertainty" but probabilistic risk.

The 1973 paper extends the analysis from futures to stock prices. He again *assumes* "some known stochastic process generating" financial variables such as dividends, and *assumes* that "the market capitalizes the stock at the expected value" of the "present discounted value" of future dividends, after what he calls the classical Fisher rule. Figure 3 compares the setup of Samuelson with that of Soros. As in the original statement of the theory of reflexivity, the participants are taken out of and are isolated from the marketplace. Information on future events is independent from both the participants and the marketplace. Last but not least it is assumed that the different pieces of information, participants and prices in the market place do not influence each other or parts of other entities.

Samuelson recognizes the shaky foundations of his hypothesis. In the conclusion of his article, he warns against reading too much significance into his premise or conclusion. On the premise, he writes in the concluding paragraph of the article (1965, 48 f.):

> I have not here discussed where the basic probabilities are supposed to come from. In whose minds are they *ex ante?* Is there any *ex post* validation of them? Are they supposed to belong to the market as a whole? And what does that mean? Are they supposed to belong to the representative individual and who is he? Are they some defensible or necessitous compromise of divergent expectation patterns? Do price quotations somehow produce a Pareto-optimal configuration of *ex ante* subjective probabilities? This paper has not attempted to pronounce on these interesting questions.

In his earlier 1965 paper Samuelson is even ambiguous about the meaning of "properly anticipated prices" in a competitive market: in addition to deducing the "fair game" property of forward prices assumed to be expected future spot prices, Samuelson generalizes the result by assuming that forward prices are expected future spot prices, discounted by the prevailing interest rates, to account for investor risk aversion and/or opportunity cost.[8] In that case, Samuelson proves that forward prices grow, on average, at the short-term interest rate. So, what constitutes "properly anticipated prices" begs the question of the appropriate discount rate.

[8] This is a generalization because it reduces to the previous case when the interest rate is zero.

However, in the 1973 paper Samuelson is more self-assured and assumes that stock prices are expectations of discounted present values of future dividends without any questioning of the appropriate discount factors. In addition, the question of where the assumed probabilities come from has also vanished. He assumes the stochastic process is "known" but he also allows for the possibility that "one person, too small to affect market prices appreciably could make systematic speculative gains if he had more or better information" (than "the market," presumably). Samuelson thinks it possible to have conditional probabilities conditioned on "more or better" information than "the market", so that the originally assumed conditional probabilities can be obtained from the private ones by "integrating out" the additional information. Thus "if this private knowledge becomes widespread" the conditional probabilities, with respect to which market prices are expectation values, would become the private conditional probabilities, and the prices would change accordingly.

When in 1965 Samuelson wonders whether "price quotations somehow produce a Pareto-optimal configuration of ex ante subjective probabilities", he's foreshadowing the modern theory of asset pricing, in which the assumption of complete competitive markets allows "market-implied probabilities" to emerge from current prices in such a way that current prices are expected discounted future values. As expected values are martingales by probability-theoretical "abstract nonsense", prices are martingales with respect to the "market probabilities" by construction, so consistency is enforced.[9] However, the theory makes no claims that market probabilities are estimates of "physical" probabilities. Indeed, Baxter et al. (1996) spend their preface and first chapter of their textbook on derivative pricing disabusing the reader of the notion that derivative prices are expectations: they are enforced by arbitrage, and the use of expectations and martingales is in the nature of mathematical representation techniques allowing the construction of arbitrage strategies. Within these representation techniques, however, "tradeables are martingales and martingales are tradeables" (ibid., 116-117).

9 That random variables defined as expectations are martingales is a straightforward application of the so-called „law of iterated expectation", which is a corollary of „Fubini's theorem", allowing the order of integration in multiple integrals to be permuted. Samuelson's paper (1965) essentially proves two versions of the law of iterated expectation by permuting the order of integration.

In 1965 Samuelson is pricing forwards which are derivatives, but in the 1973 paper he turns to pricing shares by the same techniques. Contemporaneously with Samuelson, Merton (1973) provides an equity pricing model where shares are priced as derivatives because they are options on the future credit solvency of a firm. Finally, Sharpe's (1964) CAPM (Capital Asset Pricing Model), which is also based on an assumption of "market efficiency", makes it possible to connect "market expectations" of discounted values with "physical expectations", but where the discount rate is risk-adjusted. On the empirical front, with a focus on derivatives rather than stocks, it is known that forward prices are not good empirical estimators of future spot prices, neither in commodities nor in currency markets.[10] This is because of the appearance of "risk premia" in the prices when evaluated in terms of "physical probabilities" as opposed to "market probabilities".

In the penultimate paragraph of his 1965 paper, Samuelson (1965, 48 f.) warns the reader of too much enthusiasm:

> One should not read too much into the established theorem. It does not prove that actual competitive markets work well. It does not say that speculation is a good thing or that randomness of price changes would be a good thing. It does not prove that anyone who makes money in speculation is ipso facto deserving of the gain or even that he has accomplished something good for society or for anyone but himself.

The last sentence, one can imagine, is not what Soros likes to hear. Soros states that he works with a different model and the fact that he was successful would make nonsense of efficient market and rational expectations hypothesis. The rational expectations hypothesis goes back to Muth, who summarizes it as follows (1961, 316):

> The hypothesis can be rephrased a little more precisely as follows: that expectations of firms (or, more generally, the subjective probability distribution of outcomes) tend to be distributed, for the same information set, about the prediction of the theory (or the "objective" probability distributions of outcomes).

This says that the ex-ante expectations are always validated ex-post, which is denied by Soros, who assumes that the prevailing bias can change the fundamentals. Coming back to the efficient market hypothesis and the theory of reflexivity, it is interesting

[10] See Chernenko et al. (2004) for a discussion of a range of future and forward rates.

that the conclusions seem to be very similar. Lo (2008, 4)[11] in his article on the efficient market hypothesis in Palgrave's Dictionary of Economics states:

> Such compelling motivation for randomness is unique among the social sciences and is reminiscent of the role that uncertainty plays in quantum mechanics. Just as Heisenberg's uncertainty principle places a limit on what we can know about an electron's position and momentum if quantum mechanics holds, this version of the EMH places a limit on what we can know about future price changes if the forces of economic self-interest hold.

We find Samuelson's efficient market hypothesis less than compelling a „motivation for randomness" in social science. In the 1965 paper Samuelson *assumes* future spot prices are random and deduces not that current spot prices are random martingales (his examples, such as an autoregressive process, are not) but that current forward prices are; similarly, in the 1973 paper he *assumes* that future dividends are random, and deduces not that dividends themselves are martingales, but that discounted stock prices are martingales. In the asset pricing theory developed by Samuelson's successors, „the forces of economic self-interest", interpreted as *the absence of arbitrage opportunities in a competitive market*, only enforce price linearity and imply the existence of a "stochastic discount factor" such that discounted asset prices are "fair" (i.e., martingales). However, linearity and no-arbitrage consistency could equally well apply to deterministic prices and the discount factor could itself be deterministic: but the randomness of prices is an empirical input into the theory and neither explained nor motivated by it.

The idea that future price changes are uncertain under the given circumstances seems to be compatible with the theory of reflexivity. Soros (2003, 6 f.) under the heading of "The Human Uncertainty Principle" coincidentally also invokes Heisenberg's idea:[12]

> That principle holds that people's understanding of the world in which they live cannot correspond to the facts and be complete and coherent at the same time. Insofar as people's thinking is confined to the facts, it is not sufficient to reach decisions; and insofar it serves as the basis of decisions, it cannot be confined to the facts. It [...] introduces an element of genuine uncertainty – as distinct from randomness – into the course of events.

Apart from the vocabulary – what is a random walk to Samuelson is genuine

11 This is page 4 of the article in the dictionary.

12 It seems that name-dropping of famous theories in physics when making an analogy is very popular in economics. We do not examine whether these analogies are justified. Eriksson (2012) shows that in general more mathematical contents increase the respectability of writings in economics.

uncertainty for Soros – the two statements agree on the main issue: you cannot predict the future. It seems that the theory of reflexivity and the efficient market hypothesis are competitors to explain the unpredictability of the future. Their conclusions for financial markets are very different. Samuelson believes that you can predict the future if you are lucky, but nobody will be lucky his whole life and therefore you cannot consistently beat the market. Soros believes that you cannot predict the future because your guess will influence it and because your knowledge of the future is limited, but that does not mean that a single investor cannot outsmart the average investor over his life. He claims that he himself has been aware of the reflexivity underlying the financial market and that this would explain his financial success. To examine whether this statement holds any truth is outside the scope of this paper. Having discussed the efficient market hypothesis, we turn to (Post-)Keynesian ideas to see how they compare to Soros' theory of reflexivity.

4. Life in a World of Financial Disturbances

Some aspects of the theory of reflexivity have been identified by Post-Keynesian authors. Soros' idea of the impossibility to divide the whole from the part had been mentioned in ontological discussions of economics. Lawson (1997, 32) writes:

> Human agency and social structure then presuppose each other. Neither can be reduced to, identified with, or explained completely in terms of the other, for each requires the other. Now the significant point here is that because social structure is human-agent dependent it is only ever manifest in human activity. Thus, given the open nature of human action – the fact that each person could always have acted otherwise – it follows that social structure can *only* ever be present in an open system.

In Soros' theory, the situation assumes the existence of a market, which is a social structure in Lawson's terms. The thinking participants are what Lawson calls human agents. Thus it can be argued that Soros and Lawson say the same thing. Soros first accepted the false dichotomy of market and participants, but the dynamic interaction as he saw it lead him to discard it later on. His argument is now the same as that of Lawson: the two entities are not independent from each other. This would constitute what Lawson calls an open system. In other social sciences the concept of reflexivity is also well-known. In psychology, Flanagan (1981) recognized that it is reflexivity

which makes human sciences unique. In sociology, the literature is large and well-known in the field.[13]

Economists like Keynes (1936, 144) and Minsky (1957, 185) have also emphasized the role of risk in financial markets. Both distinguish borrower's risk and lender's risk. They explicitly stress uncertainty resulting from, among other things, interdependence of investment and portfolio allocation decisions. Investors' willingness to hold a stock of risky assets depends on their perception of risk. Alternatively, a pessimistic mood in the real economy might lead to below average loan demand, restricting the flow of new financial assets.

In the Keynesian IS/LM model, developed by Hicks (1937), the liquidity demand derived from speculative holdings of cash depends on the yield, which itself depends on bond prices. If bond market prices are high, then effective interest rates are low. People expect prices to come back to average and therefore start hoarding money instead of investing in bonds. Bond prices and – if the model would feature other financial assets – prices of financial assets in general are important factors in determining the willingness to finance the production of new investment goods. Real assets can serve as collateral and the higher their expected value the more likely it is that their production gets financed.

Hicks (1980, 153) notes that the willingness to finance the production of investment goods cannot be approximated by the interest rate only:

> We now know that it is not enough to think of the rate of interest as the single link between the financial and industrial sectors of the economy; for that really implies that a borrower can borrow as much as he likes at the rate of interest charged, no attention being paid to the security offered. As soon as one attends to questions of security, and to the financial intermediation that arises out of them, it becomes apparent that the dichotomy between the two curves of the IS-LM diagram must not be pressed too hard.

Financial asset prices and characteristics – like maturity, seniority, etc. – become important determinants of the "link between the financial and industrial sectors of the economy". Hence financial assets should be included in macroeconomic models. To

13 Notable authors include Mead (1913), Giddens (1991) and Luhmann (1985).

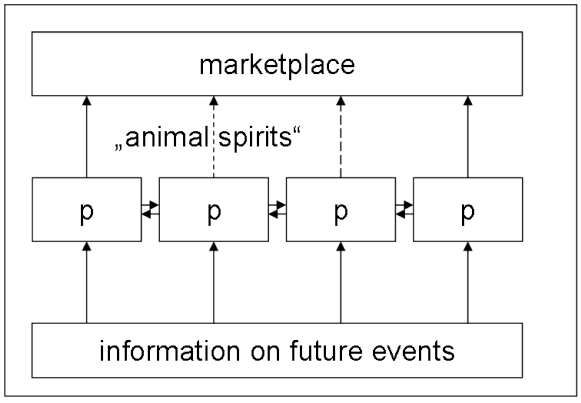
complete the picture, the importance of the liability side has been stressed by Minsky (1975, 1982, 1986). He focussed on firms using internal or external finance. In a nutshell, firms that finance investment out of profits are financially healthy while firms that borrow depend on financial markets. Perhaps his greatest idea was that over time financial stability would create the conditions for financial instability. Minsky (1982, 92) derives the following "big theorem" from his financial instability hypothesis:

> [A] capitalist economy with sophisticated financial institutions is capable of a number of modes of behavior and the mode that actually rules at any time depends upon institutional relations, the structure of financial linkages, and the history of the economy.

Minsky acknowledges that the economy can be driven by more than one mode of behaviour – by which very probably he meant profit maximization – and that the future therefore cannot be predicted by looking at the past. The contributions of Keynes himself seem to be somewhat similar to those of both Minsky and Soros. Interacting participants driving a situation seems to be what Keynes had in mind with his popular phrase "animal spirits". This is the full quote from Keynes (1936, 161-162):

> Even apart from the instability due to speculation, there is the instability due to the characteristic of human nature that a large proportion of our positive activities depend on spontaneous optimism rather than mathematical expectations, whether moral or hedonistic or economic. Most, probably, of our decisions to do something positive, the full consequences of which will be drawn out over many days to come, can only be taken as the result of animal spirits – a spontaneous urge to action rather than inaction, and not as the outcome of a weighted average of quantitative benefits multiplied by quantitative probabilities.

Figure 4: animal spirits and the beauty contest



Clearly, this paragraph shows that Keynes was well aware of the problems of calculating the outcomes of games and of the peculiarities of speculation. Figure 4 shows this as some speculators act differently on new information than others (dotted and solid lines). His "beauty contest" metaphor (1936, 156), which describes the instability of speculation, is another case in point. Instead of guessing fundamentals, speculators engage in outguessing each other: what will other speculators think about what other speculators think? The investors, having lost contact to fundamentals completely, might succumb to herd behaviour. This is shown in figure 4 as additional arrows among the investors.[14] However, the idea that probabilities of events have something to do with prices in markets is something that Keynes outright rejected in his Treatise on Probability where he argues (1921, 23):

> These merchants, moreover, may be wise to insure even if the quotations are partly arbitrary; for they may run the risk of insolvency unless their possible loss is thus limited. That the transaction is in principle one of bookmaking is shown by the fact that, if there is a specially large demand for insurance against one of the possibilities, the rate rises; – the probability has not changed, but the "book" is in danger of being upset.

Applying this logic to a die roll, we assume that the bookmaker insures the merchants against loss if the result is an odd number. The probability of this to happen is 50%. The bookmaker, one might assume, would be willing to insure this result by pricing the policy at slightly above 50% of the sum insured. If demand for this insurance goes up and the bookmaker sells more of the same insurance without finding counterparties that take the opposite position, the "book" is in danger of being upset, as Keynes put it, and therefore the insurer will charge higher rates in order to drive business away from him. This leads Keynes to believe that the price of insurance is not directly related to the probability of the underlying event. Keynes (1921, 23 f.) writes:

> In fact underwriters themselves distinguish between risks which are properly insurable, either because their probability can be estimated between comparatively narrow numerical limits or because it is possible to make a "book" which covers all possibilities, and other risks which cannot be dealt with in this way and which cannot form the basis of a regular business of insurance, – although an occasional gamble may be indulged in. I believe, therefore, that the practice of underwriters weakens rather than supports the contention that all probabilities can be measured and estimated numerically.

The theory of reflexivity, it seems, does not add much to Keynesian economic

[14] Not all arrows are drawn to keep the graph readable.

thought. The writings of Keynes are full of insights that predate those of Soros as expressed in the original statement of his theory, when it comes to actors observing ("beauty contest") and influencing each other ("animal spirits"). The later restatement of the theory of reflexivity strongly resembles the ideas of Lawson. Other insights, like those of Keynes (1921) on probabilities, are not part of the theory of reflexivity as applied to financial markets.

5. The Great Financial Crisis

In the preceding sections we have established two opposing views of the world. According to the efficient market hypothesis view of a stochastic world, market participants have perfect knowledge, which means that they can perfectly handle risks. There is not much scope for government intervention. The opposing view denies the existence of perfect knowledge and this introduces fundamental uncertainty in a non-stochastic world, which potentially gives a role to government intervention. The dividing line about the nature of the world is that only in a non-stochastic world unforeseen – and not improbable – things can happen.

All of this matters a great deal when it comes to pricing financial assets. In the following, Soros' own idea of what happened during the very beginning of the Great Financial Crisis is contrasted with the thinking of mainstream and Post-Keynesian economics.[15] Chairman of the Federal Reserve Alan Greenspan said in a speech in 2005:[16]

> To be sure, the benefits of derivatives, both to individual institutions and to the financial system and the economy as a whole, could be diminished, and financial instability could result, if the risks associated with their use are not managed effectively. Of particular importance is the management of counterparty credit risks.

The most notorious derivative in the Great Financial Crisis has been the credit default swap (CDS). One party insures the other against the risk of credit default, which is swapped from one party to the other. This issue was right at the heart of the Great

[15] Another topic that would produce quite similar insights would be he rise and fall of Long Term Capital Management (LTCM) in the 1990s, which was advised by mainstream economists who won The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel while being active in the firm. See DeMartino (2011, 5 ff.).

[16] According to Blinder (2005, 9 ff.) the approach of Greenspan to reality was more complicated.

Financial Crisis, which started with the US sub-prime crisis. In an article in the Wall Street Journal, Soros (2012 [2009], 43-46) explains that CDS were a central element of the market downturn. At the centre is an asymmetry in profit and loss possibilities. To see this, recall that shares can be sold short or held long. Payoffs are asymmetric since, when losses occur, these are limited to the original share price for long positions, while for short positions they are unlimited. There is hence a safety incentive to going long. With CDS, it is the opposite.

For the seller of CDS, the potential profits are relatively small compared to the potential losses. Once losses start accumulating, things can get much worse as more defaults of the underlying collateralized debt obligations (CDOs) are possible.[17] On the other side, the buyers of CDS pay an insurance premium and from there things can only get better. No more money can be lost, though a lot of money can be gained. Soros (2012 (2009), 45) writes:[18]

> AIG thought it was selling insurance on bonds, and as such, they considered CDS outrageously overpriced. In fact, it was selling bear-market warrants and it severely underestimated the risk.[19]

The risk models of financial firms, including AIG, were indirectly based on the efficient market hypothesis and rational expectations, on which the assumptions of arbitrage pricing principles and unlimited liquidity rest. When the sub-prime crisis hit, some markets were left without buyers since nobody knew how to price some of the quite complex financial assets. For instance, the market for asset-backed commercial paper "froze" when two Bear Stearns hedge funds invested in sub-prime assets filed for bankruptcy and subsequently similar financial structures were shunned by the investors (Acharya et al. 2010, 3). As Bloomberg (2007) reported, some banks could not find any buyers for a range of assets – there were no bids.

The conclusion for Soros (2012[2009]) is that only those who own the underlying bonds ought to be allowed to buy CDS. This is contradicted by Lewis (2010, 77), who quotes a former Goldman Sachs derivatives trader saying that tranches of CDO were

17 CDOs are structured into tranches (parts) which are synthetic bonds.

18 The same argument can be found in chapter 6 of Davidson (2009).

19 Henderson (2009) claims that CDS are derivatives, not insurance. We agree with his view while we disagree with his conclusion that, as a result, CDS should be regulated more lightly.

paired with the respective CDS and moved off-balance sheet as essentially risk-free. Whether this is true we are not able to judge. What remains is the fact that AIG learned the lesson about letting rates rise if there is "a specially large demand" for insurance in order to protect the book from the danger of being upset the hard way. As Taleb (2013) points out, it does not matter that the probability of losses is small.

One reason why AIG did not follow Keynes' advice might have been Li's (2000) Gaussian copula formula, which Salmon (2009) described as "the formula that killed Wall Street". It can be used to measure the correlation of two events. What is ingenious is that the correlation of two events is imputed by using historical price data instead of historical data on the occurrence of events. In the early 2000s the formula gained widespread acceptance in pricing CDOs. The reason seems to have been that the leading investment bank in the derivatives market – J. P. Morgan – started using Gaussian copulas and was selling services based on the software that was developed around them.[20] Investors knew about the problems of the formula, but in a competitive environment other firms copied the software so that it became a standard. Users struggled to find the correlation of market values of two companies' assets, so they used share prices instead.

The introduction of Li's formula into financial firms offered a cheap way of pricing CDOs. According to SIMFA (2013), global CDO issuance went from $68 billion in 2000 to $520 billion in 2006 and then down to $4.3 billion in 2009. Although it seems that Soros himself has not recognized it, the question of why markets rise is as important as why they fall or fail. The use of markets means that participants pay transaction costs, among other things, for trying to estimate the value of the financial assets on offer. This is what Soros calls the cognitive function. A software tool for valuation of financial assets can help participants to understand the market and manipulate it, and this is what the Li formula did. The acceptance of the model meant that money would be made available by the market participants' respective firm for investment in that specific market. Competition among firms led to a race which single firms could not afford to stay away from. Those that did missed out on a $520

[20] See MacKenzie et al. (2012, 33).

billion market generating fees for the participating firms.[21] It is in this context that the idea of fallibility seems to hold explanatory power.

The inventors of the efficient market hypothesis have also expressed their views on the Great Financial Crisis. Fama is quoted in Cassidy (2010, 30) on the Great Financial Crisis:

> Stock prices typically decline prior to a recession and in a state of recession. This was a particularly severe recession. Prices started to decline in advance of when people recognized that it was a recession and then continued to decline. That was exactly what you would expect if markets are efficient.

It is the efficiency with which new information is incorporated into the price that is explained by the theory, not the efficiency of the market itself. The theory says nothing on the question of whether those prices have been fundamentally correct or have been inflated.[22]

6. Conclusion

Economics as a social science is a difficult subject. The discipline has evolved from political economy, which itself evolved from philosophy. The latest stage builds largely on the epistemological ideas of Samuelson (1976, 7):[23]

> The first task of modern political economy is to describe, to analyze, to explain, and to correlate the behaviour of production, unemployment, prices and similar phenomena [..] To be significant, descriptions must be more than a series of disconnected narratives. They must be fitted into a systematic pattern – i.e., constitute true analysis.

According to Samuelson, economics has to follow the natural sciences and build on mathematics in order to become a science. Only if math "works" in economics as in natural sciences we would expect this to be a promising road to go down. Wigner (1960, 14), among others, disputes this. He thinks that the "miracle of the appropriateness of the language of mathematics for the formulation of the laws of physics is a wonderful gift which we neither understand nor deserve". It is therefore

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21 This includes mostly real estate dealers, investment bankers, lawyers, and analysts in rating agencies.

22 Fama in the same article appears to be angry, commenting that he does not understand what "bubble" is supposed to mean.

23 We recommend to re-read the introductory quote of this article before reading the following quote.

doubtful that the economics of Samuelson is standing on firm ground.

In a nutshell, the theory of reflexivity states the following. We cannot predict the future with certainty. Actions that influence the future will lead to uncertain outcomes. Nevertheless, predicting the future is part of the economic process, and our predictions will change this process and hence future outcomes. It happens because society is an open system. If you understand this you can make a profit.[24] Soros sees his theory of reflexivity as a new paradigm that should substitute the reigning efficient market hypothesis. We think that the idea that the latter would constitute a paradigm is misguided. Perhaps Fama (1970) has claimed that markets are efficient, but by now he is back at Samuelson's (1965) line. In an interview in Fama et al. (2012, 15) Fama himself says: "As the market efficiency ideas took shape, it dawned on me that the reason the trading rules I'd developed earlier didn't work out of sample was because price changes were random, which at that point was what people thought an efficient market meant. We know now it doesn't." The efficient market hypothesis should be renamed the random walk hypothesis, since in its weak form it only states that an investor cannot beat the market over a longer time frame. That is a valid empirical claim which can be refined to make it falsifiable.

The theory of reflexivity is compatible with both the work of Keynes and the work of Post-Keynesians. Keynes had a more advanced understanding of financial markets than Soros when it comes to probabilities in the real and financial world. Breaking the link between probability and the real world is a crucial argument against calculating any future price and leaves us with fundamental uncertainty. This became clear when AIG went bankrupt in the early stages of the Great Financial Crisis.

So, should the theory of reflexivity be taught in economics departments? Currently, it seems that the neo-classical axioms are so defined that the theory of reflexivity is not inside the paradigm. On the other hand, Post-Keynesians neglect it because they use the same ideas, but trace them back to others inside and outside the discipline. Nevertheless, we think that theories building on non-stochastic randomness deserve

[24] If one is interested to improve the theory of reflexivity, it is this gap which must be filled. Given that knowledge is imperfect because of a reflexive process, exactly how do you use this insight to make profit?

more attention in economics and that the current teaching of theories building on stochastic randomness and not much else is mistaken. Understanding the real world as it is will help us to manipulate it and understand how others do the same, keeping in mind the fallibility of the whole process. Therefore, one should be able and willing to criticize everything. This is what universities and business schools are for.

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