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A theorem on the methodology of positive economics

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Abstract: It has long been recognized that the Milton Friedman's 1953 essay on economic methodology (or F53, for short) displays open-ended unclarities. For example, the notion of "unrealistic assumption" plays a role of absolutely fundamental importance in his methodological framework, but the term itself was never unambiguously defined in any of the Friedman's contributions to the economics discipline. As a result, F53 is appealing and liberating because the choice of premises in economic theorizing is not subject to any constraints concerning the degree of realism (or unrealism) of the assumptions. The question: "Does the methodology of positive economics prevent the overlapping between economics and science fiction?" comes very naturally, indeed. In this paper, we show the following theorem: the Friedman's methodology of positive economics does not exclude science fiction. This theorem is a positive statement, and consequently, it does not involve value judgements. However, it throws a wrench on the formulation of economic policy based on surreal models.

Subjects: Economics; Finance; History of Economic Thought; Social Sciences

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ABOUT THE AUTHOR

My complete name is Jorge Eduardo Fernandez-Pol. I firmly believe that the growth of genuine knowledge is the prime mover of human progress. There are many activities carried out by humans that contribute to the growth of knowledge. These include research and teaching. I define myself as a social scientist whose specialization is economics. I have always had a passion for research and teaching. My main research interests focus on three areas: economic methodology, causality in economics and innovation as an economic activity. The research reported in this paper is in line with my permanent interest in making the economics discipline rigorous and transparent.

PUBLIC INTEREST STATEMENT

It is generally accepted that idealized models have a role to play in economics. However, university students and the public in general seem to perceive an element of bizarreness in some of the assumptions underpinning these models. Sometimes, the content of the assumptions are reminiscent of science fiction. For example, the assumption that an economy is populated by individuals with surpassingly rare attributes such as *automatic* understanding of any piece of information publicly available is preposterous. Under this assumption, the disastrous 2008 financial crisis could not have happened. It appears that concerns about the economics discipline going astray are gaining momentum. The movement "Rethinking Economics"—an international network of students, thinkers, and citizens who seek to demystify and diversify economics—materializes these concerns. Krugman (2014) has lent the weight of his authority to the view that "Rethinking Economics" has value.

1. Introduction

In economics, it is customary to develop formal models of imaginary worlds based on assumptions that may have remote connection with the economic reality. It is not unusual to hear, for example, in a seminar presentation that “My model is not intended to be realistic, but only to demonstrate the potential for a particular outcome”. When someone suggests that an economic assumption within the model is absurd, they are told that they do not understand economics. “Have you ever read Friedman’s essay on positive economics?” the model builder would ask. “Well, if you do, you will understand that the realism of an assumption does not matter”. This intellectual attitude illustrates the typical reaction of the rational expectations economists when confronted with questions about the empirical existence of omniscient economic agents.

In his famous essay, “The methodology of positive economics”, Friedman (1953) conveyed an influential message to the economics profession: the existence of unrealistic assumptions within a model is not a valid reason for the rejection of the model. It has long been recognized that the Friedman’s (1953) essay on economic methodology (or F53, for short) displays open-ended unclarities. For example, the notion of “unrealistic assumption” plays a role of absolutely fundamental importance in his methodological framework, but the term itself was never unambiguously defined in any of the Friedman’s contributions to the economics discipline.¹ As a result, Friedman’s methodology of positive economics is appealing and liberating because the choice of premises in economic theorizing is not subject to any constraints concerning the degree of realism (or unrealism) of the assumptions.

Concerns about the use of unrealistic assumptions are not new. Well before the publication of F53, Fredrick A. Hayek emphasized that “to assume all the knowledge to be given to a single mind ... is to assume the problem away and to disregard everything that is important and significant in the real world” (Hayek, 1945, p. 530). The early 1970s witnessed criticisms on F53 from several prominent economists, including Frisch (1970), Leontief (1970) and Brown (1972). Or, to add one more example which by no means exhausts the list of early criticisms, James Tobin expressed that the Friedman’s methodology of positive economics “has done great damage” (Klamer, 1984, p. 105). It is true that Tobin’s reaction against Friedman’s methodology was unambiguous: “My reaction is that we are not so good at testing hypotheses so that we can give up any information we have at whatever stage of the argument. The realism of the assumptions does matter. Any evidence you have on that, either casual or empirical, is relevant” (Klamer, 1984, p. 106). But, it is true also that Tobin did not articulate any convincing criticism of the Friedman’s methodology.

As the foregoing illustrates, the economics discipline has some methodological tensions conducive to strong disagreements between economists of high reputation. Unfortunately, the disputes of earlier decades about the realism of the assumptions in economics have not been completely resolved. This can be easily verified by inspection of the papers in the book edited by Mäki (2009a). The debate on Friedman’s methodology and the methodology of F53 is far from over.²

An obvious point to make is as follows. The methodology of F53 maintains that the realism of the assumptions is irrelevant, but it does not offer an operational definition of either realistic or unrealistic assumption. Consequently, it is not nonsensical to infer that this methodological stance allows assumptions involving economic agents endowed with attributes that cannot be found in any real human being. A case in point is the conventional assuming of omniscient economic agents. The agents in question are able to instantaneously understand the available information, and for them, all the implications of any propositions are obvious. This brings us naturally to an awkward theme: the line of separation between economics and science fiction.

Science fiction is a field of imaginary enquiry that covers several disparate subfields. A grand view on this vast intellectual field can be found in Sterling (2013). For the sake of concreteness, we confine attention to a proper subfield, namely scientific or technological narrative based on imaginary worlds that do not exist but they render impossible things possible. The essential distinguishing feature of this subfield is the formulation of assumptions hypothesizing entities that cannot possibly

exist at the time the story is imagined. Examples of fictional elements included in this form of narrative abound: humans travelling close to the speed of light, teleportation, androids with conscious and purchase of desirable memories are a few.

Logical inference is typically used in science fiction to answer formidable questions—such as time travelling—but other forms of creative thinking (e.g. lateral thinking, imaginary thinking and sophisms) are not excluded. For example, the physicist and cosmologist Hawking (2010) asks: Is time travel to the future possible within the laws of nature? To answer this, question Hawking postulates the existence of a super-fast train able to travel close to the speed of light (186,000 miles per second) and circling the Earth over and over again. Then, using logical inference, Hawking shows that one week in the super-fast train implies a hundred years into the future. Not surprisingly, Hawking points out that there is no train on Earth that could reach such a speed.

In reviewing the literature on the realism of the assumptions, we have uncovered a significant work that tacitly suggests a possible point of contact between economics and science fiction: *Facts and Fiction in Economics*, edited by Mäki (2002a). However, the question, “Is the intersection between the economics discipline and science fiction empty?” is never asked. It is not difficult to offer tentative reasons for this neglect. For example, the economics profession in general is not interested in the answer; or the question seems whimsical; or there is no universally accepted definition of science fiction and so on.

It should hardly be necessary to mention that the use of models of imaginary worlds involving unrealistic assumptions does not of itself prove that there exists a non-empty intersection between economics and science fiction. Economic models are designed to abstract essential features of complex reality, and thereby, they deal with simplified, imaginary worlds. Notwithstanding, the question “Does the methodology of positive economics prevent the overlapping between economics and science fiction?” comes very naturally.

In this paper, we show the following theorem: The methodology of positive economics does not exclude science fiction. This theorem is a positive statement, and consequently, it does not involve value judgements. However, it throws a wrench on the formulation of economic policy based on surreal models.

The paper is organized as follows. In Section 2, we briefly mention the existence of different interpretations of F53. Section 3 gives a precise definition of the notion of surreal economic model. Section 4 proves a logical conclusion emerging from the methodology of F53, illustrates the result and points out a riddle concerning the use of surreal models for practical policy purposes. Section 5 proffers a solution to eliminate a possible point of contact between economics and science fiction. Section 6 offers summary and concluding remarks.

2. The Friedman tenet

The first essay written by Milton Friedman on economic methodology was a critical review of Oskar Lange’s *Price Flexibility and Employment*. Friedman (1946) emphasized the crucial role of prediction in economic theorizing:

The basic sources of the defects in Lange’s theoretical analysis are the emphasis on formal structure; the attempt to generalize without first specifying in detail the facts to be generalized; and the failure to recognize that the ultimate test of the validity of a theory is not conformity to the canons of formal logic but the ability to deduce facts that have not yet been observed, that are capable of being contradicted by observation, and that subsequent observation does not contradict. In consequence, these defects are found in much economic theorizing that is not taxonomic in character. They are, however, especially likely to arise when the taxonomic approach is adopted, as their presence in the writings of so able and careful a theorist as Lange testifies. (Friedman, 1946, p. 631)

Seven years later, Friedman published the most influential—and controversial—essay on economic methodology ever: “The Methodology of Positive Economics”. The essential distinguishing feature of F53 is the following *test by implications*: the only relevant test for the validity of an economic model is the comparison of its predictions with experience. In Friedman’s own words, “theory is to be judged by its predictive power for the class of phenomena which it is intended to ‘explain’” (Friedman, 1953, p. 8). What about the view that the conformity of the assumptions to reality is a valid test of a model different from or additional to the test by implications? “This widely held view is wrong and productive of much mischief” (Friedman, 1953, p. 14).

In a nutshell, according to F53 an economic model is to be judged by its predicted power, not by the “realism” of its assumptions. A corollary consistent with the methodology of F53 is that the realism of the assumptions in economics is immaterial to assess economic models. In at least this respect Friedman’s position is unique. Henceforth, this corollary will be called the *Friedman tenet*.

Most specialists in economic methodology have found that the methodology of economic theorizing presented by Friedman half a century ago is problematic. Methodological research has shown that the Friedman tenet is a very complex and highly ambiguous claim, and the methodology of F53 is therefore open to multiple interpretations. Indeed, it was clear after the publication of Mäki (1986) that there is no unambiguous doctrine presented in Friedman’s (1953) essay on economic methodology.

Summarizing the myriad of problems emerging from F53 would take us too far afield.³ We mention only two competing interpretations. Boland (1979) claimed that Friedman was an instrumentalist, that is Friedman was not interested in the truth value of theories but more about their utility in devising solutions to practical problems. Mäki (1986) rejected Boland’s view that (1) there is just one coherent position in Friedman’s essay and (2) only an instrumentalist reading makes sense of it. More recently, Mäki (2009c) has “rewritten” Friedman’s (1953) essay in order to remove some unnecessary confusions and ambiguities. He has shown that F53 can be interpreted as a socially constructivist fallibilist and realist statement—in contrast with the received instrumentalist interpretation (Mäki, 2009c).

Reading about methodological disputes in economics tends to be puzzling and frustrating for practising economists. In fact, sometimes it feels like grasping at air. As an illustration of this awkward situation, consider a small sample of representative assessment of the economics discipline. Ronald Coase’s attack on what he called “blackboard economics” was that “What is studied is a system which lives in the minds of the economists but not on earth. I have called the result ‘blackboard economics’” (Coase, 1992, p. 714). This appears to suggest that the problem with the economics discipline is that economics has ceased to make any claims about the economy. However, many economists, including Baumol (2000), Dasgupta (2002), Kreps (1997), and Solow (1997), claimed that economics has become more rather than less empirical. “The clear picture that emerges is that there is no clear picture” (Mäki, 2002b, p. 8).

We believe that the problem is not that economists have lost interest in real-world issues. On the contrary, practising economists today are more interested than ever in empirically understanding the real economy. The root problem lies in the formulation of assumptions which have no links with concrete facts, not the lack of connection of the model as a whole with the real world. It is always possible to make contact (perhaps arbitrarily) with the economic reality, even with a model which “lives in the minds of the economists but not on earth”.

There can be little doubt that F53 left the most important issue for practising economists and policy-makers unexplained. In fact, it is not clear what Friedman means by the term “unrealistic”. Sometimes he means “not descriptively complete”. At other times, he calls an assumption unrealistic when it is not true, perhaps not even approximately true, of the phenomena to which the model

is applied. There can be equally little doubt that, because of this unclarity, Friedman's essay has led to a disquieting state of affairs. We all talk about the same thing, namely "unrealistic assumptions", but we have not yet agreed what it is we are talking about.

The first time that Milton Friedman publicly commented about what others have written about his essay was after half a century of silence. Uskali Mäki invited Milton Friedman to a conference on his essay that was held at Erasmus University of Rotterdam in December 2003, but at the age of 91, Friedman decided not to travel. However, he agreed to write the final comment for the volume Mäki (2009a) upon having read the other contributions to the conference in question. Friedman's final comment was laconic, to say the least (just one page!). His feelings were ambiguous:

I have somewhat mix feelings about the splendid conference that Uskali Mäki organized on my ancient methodology article. On the one hand, it is a source of great satisfaction that an article I wrote more than fifty years ago should still be regarded as worth extensive scholarly discussion. On the other hand, that very fact is a severe condemnation of the essay. Surely, if the essay had been really lucid, scholars should not today still be having different opinions about what it says. (Friedman, 2009, p. 355)

Inspection of the papers included in Mäki (2009a) confirms that a single coherent economic methodology cannot be found in F53. Furthermore, Friedman's beliefs and intentions were far from clear. In this connection, Mäki (2009b, p. 114) recognizes two possibilities: either Friedman did not have a coherent economic methodology in mind or he had a coherent methodology in mind but failed to convey it due to flaws in textual production. We will never know. What we do know, however, is that some economic theoreticians have interpreted the message of F53 as a maxim: "concerning the realism of the economic assumptions, anything goes".

3. Fictional assumptions and surreal models

Without striving for philosophical rigour, we accept the intuitive idea about true/false statements. A statement is factually true if it stands in a suitable relation to the facts of the world. For example, Popp (2002) proves that the statement "environmental taxes and regulations not only reduce pollution by shifting behaviour away from polluting activities but also encourage the development of new technologies that make pollution control less costly in the long run" is true because it corresponds to the facts of the economy. A statement is said to be false if it is rejected by the empirical evidence. For example, Rabin and Vayanos (2010) point out that the statement "an absolutely random event cannot have a market for expert predictions" is generally false because the empirical evidence shows that some people are willing to pay for predictions of truly random outcomes.

Generally speaking, economic models provide generalizations about the real world. The art of economic theorizing consists of both the formulation of assumptions and the articulation of those assumptions into a coherent model in order to gain an understanding of some aspects of the economy. There are no models without assumptions. Typically, the content of the economic assumptions involves attributes of markets (e.g. asymmetric information) and objectives of economic behaviour (e.g. profit maximization) presumably displayed by (real) humans.

Economic theoreticians separate questions concerning their conceptual scheme from questions concerning the extent to which that conceptual scheme applies to the real world. As a result, there are two worlds for an economic theorist: the model world M (the imaginary world inside the model) and the real world R (the world outside the model). In so far as one is working within M, one can dismiss any questions about the realism of the assumptions one makes. There is nothing wrong in ignoring R in a fundamental way. An abstract theorist might be intrigued with a mathematical question, such as the existence of rational expectations equilibrium or attempt to discredit certain assumptions by revealing the consequences of alternative assumptions. For example, one can attack the assumption of involuntary unemployment by assuming that the economy is always in equilibrium and showing that involuntary unemployment is out of the question.

However, a reasonable expectation is that someone somewhere somehow would be able to identify an acceptable connection between the crucial elements in M—including the content of the economic assumptions—and some of the elements belonging to R. Developing *credible knowledge* in economics is not just discovering logical connections within M. An absolutely essential part of the economics discipline is the construction of models applicable to particular ensembles of agents, markets and institutions located in R.

The assumptions used to analyse a set of observed and related facts can be either true or false or exhibit truth value difficult to establish. In the study of the used car market, economists would not assume that information is symmetric (i.e. buyers and sellers have the same information). The assumption is false, but the economic agents involved in the assumption can be reasonably connected with real humans. The assumption of profit-maximization in the used car market refers to the behaviour of sellers. The assumption may or may not be false, but it can be put in correspondence with sellers that exist in the world of experience. If necessary, the assumption of profit maximization can be paraphrased to determine the intended claim when making the assumption. For example, we can defend the reasonableness of this assumption by asserting that the mechanism of economic competition ensures that only (real) firms displaying profit seeking behaviour can possibly survive.⁴

The methodology of positive economics accepts all sorts of assumptions, including preposterous assumptions. In fact, it follows from the Friedman tenet that even grotesquely unrealistic assumptions are just fine in so far as the models involving them perform well in predicting phenomena of interest. Many economists and non-economists consider the tenet itself grotesque, while others praise Milton Friedman for having formulated such a deep insight. It is clear that the snag lies in the practical difficulty of drawing a line where realism ends and unrealism begins. The present paper does not pursue the will-o'-the-wisp of defining the elusive notion of “unrealistic assumption”. Instead, a polar case of unrealisticness is brought into sharp focus.

In general, assumptions are used for making assertions or conjectures about the real world. They involve entities. An entity X is either an object (e.g. an oligopolistic market structure) or one or more attributes of human beings (e.g. rationality and profit-seeking behaviour). Often—though not always—the entity X captures approximately the salient features of an empirical counterpart element that exists in R. For example, the attribute of financial literacy is attainable for many human beings, and an economic theoretician may formulate the assumption that “economic agents are financially literate” on the basis that the attribute is approximately exhibited by some residents in advanced economies such as Australia, Canada or the USA.

It is true that assumptions referring to attainable attributes can be extravagantly implausible, such as “all economic agents are financially literate in North Korea”. But it is true, also, that assumptions can refer to attributes that *cannot* be found in any human being, not even approximately. These assumptions are more than extravagantly implausible.

An obvious and not unimportant example is the assumption that the representative economic agent is omniscient (*single mind assumption*, for short). This assumption is an extreme and supreme example of unrealistic assumption for two reasons. First, all the existing information is concentrated in a single mind. And second, the single mind is capable of understanding all the implications emerging from the totality of information available in the economy.

Is the single mind assumption a negligibility assumption? In general, negligibility assumptions are statements about the *fact* of negligibility.⁵ If the purpose is to predict economic life, the discrepancy between the IQ of X (omniscient human being) and the IQs of real humans is not small enough to be neglected relative to this purpose. Claims about negligibility do not appear to be true because the difference between automatic understanding of any available information inherent to X and the limited understanding of information by real humans is far from close.

One thing is to say that an assumption is outrageously unrealistic because it omits major factors observable in R, such as assuming that “there are no transportation costs obstructing the free flow of international trade”. Quite a different thing is to assume the existence of entities that cannot possibly exist in R. For example, the assumption “teleportation of tangible products is possible”, postulates the existence of an impossible phenomenon. *Fictional assumptions* refer to at least one entity X that is postulated in M but cannot possibly exist in R (at the time of formulating the assumption). As to the truth value of this special kind of assumption, one can make an intuitive point: they are false by definition. However, a different view is proffered by Uskali Mäki: a fictional assumption is factually neither true nor false because it is about nothing real (Mäki, 2002b, p. 9).⁶

A model containing at least one fictional assumption is termed *surreal model*. Models involving omniscient economic agents are surreal. Such model building does not presuppose that one believes that a particular fictional assumption is of any use in understanding R. It is impossible to make meaningful contact between the world postulated in a surreal model and the real world because the fictional assumptions located in M contain entities that cannot possibly exist in R. This sort of intellectual construct fits nicely with the notion of “conceptual explorations”, which investigate the internal properties of the models without considering the relationship between M and R (Hausman, 1992).

It should be clear, however, that conceptual explorations need not be based on surreal models. It should also be clear that knowledge based on surreal models may provoke the sort of academic mirage identified by Hayek (1974) as the “pretence-of-knowledge” syndrome. In his Nobel-prize acceptance lecture, Hayek (1974) writes: “To act on the belief that we possess the knowledge and power which enable us to shape the process of society entirely to our liking, knowledge which in fact we do not possess, is likely to make us do much harm”.

One reading of Hayek’s “pretence-of-knowledge” syndrome is as a reminder of the dangers of believing that knowledge emerging from surreal models provides trustworthy knowledge about R. For example, one could develop a surreal model-based teleportation of humans, animals and materials, and show that there exists a first best geographical distribution of resources on Earth. Few people would deny that to act on the belief that humans can shape the global economy to attain an ideal distribution of resources in R using the alluded surreal model is pretence-of-knowledge.

To sum up, there is an extreme and supreme (proper) subset of unrealistic assumption represented by all the suppositions involving the existence of at least one entity X which cannot possibly exist in the real world. The intuition behind the notion of fictional assumption can be highlighted as follows. What is the difference between the following two assumptions in terms of *existence* in the real world: the single mind assumption and “crocodiles have feathers?” None. The entities referred in these assumptions do not exist. It seems reasonable to identify the class of economic models involving fictional assumptions as the set of surreal models.

4. The inconvenient theorem: proof and illustration

The Friedman tenet was formulated more than half a century ago, but it remains as topical as ever: it is repeatedly invoked by some—but not all—economic theoreticians, probably because it leaves the set of acceptable assumptions unbounded. Notwithstanding, many practising economists take it as obvious that a discipline revolving around highly unrealistic assumptions is of dubious scientific value.

Friedman’s (1953) essay is a kaleidoscopic work. It is not the purpose of this paper to provide an alternative interpretation of the Friedman’s economic methodology. We only make two points about the Friedman tenet that come very naturally, indeed: (1) the tenet does not rule out an overly extreme position on the realism of the assumptions represented by the use of fictional assumptions in model building; and (2) the tenet has unintended consequences which are scientifically unattractive.

What, if anything, can we say about the acceptance of fictional assumptions in economics? It is possible to show that one inevitable conclusion follows: the methodology of positive economics does not exclude science fiction. To our knowledge, this had not been previously enunciated in the economic literature, and for lack of a better name, we will refer to it as the *Inconvenient Theorem*.

One can confirm the logical compulsion of the Inconvenient Theorem straightaway. On the one hand, the methodology of positive economics does not prohibit the use of fictional assumptions in model building. On the other hand, the essential distinguishing feature of science fiction is a narrative based on fictional assumptions. Therefore, the intersection between economics and science fiction is not empty. To rule out the point of contact between economics and science fiction, economic theorists have no choice: they have to avoid fictional assumptions. The solution is obvious from common sense.

An illustration of the Inconvenient Theorem immediately suggests itself. It is based on the *rational expectations assumption* (REA), that is the assumption that people should correctly understand the economic model and be able to form correct predictions from it about future outcomes.⁷ Many economists believe that, while intricate and sophisticated, the REA is irrelevant to the real world.

The REA was an innovation in model building introduced by Muth (1961). It took 10 years before economists began to use this innovation. The first important paper in which Robert Lucas Jr. used rational expectations was written jointly with Edward Prescott (Lucas & Prescott, 1971). A few years later, there was an explosion of articles on rational expectations.

The implications of the REA include: expectations are uniform, all economic agents are identical, markets play no role as information-processing entities and economic agents do not innovate (and never will). In particular, the REA disregards the interactions of real humans, each of whom possesses only partial information and limited capacity of understanding.

Criticisms on the rational expectations approach are not new. It is no exaggeration to say that Hayek (1945) criticized the REA before it was formulated. Notably, Arrow (1978) and Tobin (1980) launched severe attacks on the rational expectations approach. Despite the authority of both Arrow and Tobin and the common sense nature of their criticisms, the rational expectations approach was the dominant paradigm until the financial crisis 2007–2008.

The intuition behind the basic postulate of the rational expectations theorists seems to be logically impeccable: rational people with the same information are bound to come to the same conclusion. There is, however, a disquieting snag in this intuition: the postulate reduces the problem of understanding to one of information. But having information is one thing, understanding what it means is quite another.

Information is not given to anyone in its totality and automatic understanding of the massive amount of information in the real world is out of the question. It would hardly be necessary to point out that the REA assumption implies the single mind assumption. This fictional limiting case should be carefully distinguished from non-fictional limiting cases, such as perishable goods thought of as limiting form of durable goods with high depreciation rates. Both perishable goods and durable goods exist in the real economy, but human beings with the capacity of automatic *understanding* of the content and implications of all the available information cannot be found on our planet.

The magic incantation of rational expectations (a fictional assumption *par excellence*) appeared to have engendered a misleading mirage embraced by the economics profession before the financial crisis 2007–2008. “Freshwater” economists such as Robert Lucas Jr. and Edward Prescott, mistook mathematical beauty for truth, and proffered a tunnel vision economy in which super-rational

individuals interact in perfect markets. This point was forcibly made by Krugman (2009): “As I see it, the economics profession went astray because economists, as a group, mistook beauty, clad in impressive-looking mathematics, for truth.”

The current core of macroeconomics—in essence, the *Dynamic Stochastic General Equilibrium* (DSGE) approach—has been the target of harsh criticism because of its fictional content. The artificial reality described by the DSGE model revolves around the REA. Caballero (2010) has expressed that the use of the DSGE approach “is dangerous for both methodological and policy reasons”. In particular, Caballero (2010) indicates that the intersection between the artificial world of the core of macroeconomics and the real world is empty: the DSGE model “speaks of no particular real-world issue with any reliability”. Furthermore, he points out that refining the REA is like taking a shortcut through quick sand:

(...) We are digging ourselves, one step at a time, deeper and deeper into Fantasyland, with economic agents who can solve richer and richer stochastic general equilibrium problems containing all sorts of frictions. Because the “progress” is gradual, we do not seem to notice as we accept what are increasingly absurd behavioural conventions and stretch the intelligence and information of underlying economic agents to levels that render them unrecognizable. (Caballero, 2010, p. 90)

It goes without saying that the Inconvenient Theorem is a positive statement, in the sense that it is not a conclusion as to whether the Friedman tenet is bad or good. Having said this, it is undeniable that the Inconvenient Theorem throws a wrench into the design of economic policy based on surreal economic models. Economics consists not only of model building to understand R, but also offering models that enable prediction and control of real phenomena. Surreal economic models may allow economic theoreticians to escape from the “mess” of reality. But these models display an unintended consequence: they are an integral part of science fiction. This prompts the riddle of the fictional assumptions: Are surreal models acceptable as a guide for policy design? The answer is particularly important for both practising economists and policy makers.

Why do economists give conflicting advice to policy-makers? One possible reason—but obviously not the only one—is that economists disagree on the validity of alternative models about how the world works. In particular, rational expectations economists condone the use of models postulating economic agents that do not exist even approximately in R for policy guidance, while others such as Tobin (1980) and Caballero (2010) perceive surreal models as being dangerous for policy design.

An affirmative answer to the riddle is not free of difficulties. To see this, consider two completely different but important questions that both Robert Lucas Jr. and Stephen Hawking would answer in the affirmative. First, is prediction of economic life possible within the rational expectations paradigm? According to Lucas (1995) the answer to this question is “Yes”, if the idealized economy is populated by super-rational economic agents. Lucas would remain silent about the existence of super-humans, or perhaps he would say “It’s all as if.” Second, is time travel to the future possible within the laws of nature? According to Hawking (2010) the answer is “Yes,” if we use the super-fast train.

What do the Lucas super-rational economic agent and the Hawking super-fast train have in common? Neither the rational expectations actor nor the super-fast train exists in the real world. However, Stephen Hawking differs from rational expectations theorists, in that Hawking does not use the implications of his artificial reality to provide policy guidance to space agencies, but the rational expectations economists often used their surreal models to inform central banks and promote the idea of a *Panglossian* economy.

5. The strong version of the www constraint

What makes knowledge in economics credible? To achieve credible knowledge, one can seek consistency between the model and the functioning of the world by designing specific rules of coherence between M and R. We believe that the criterion introduced by Mäki (2001), namely *the way the world works constraint* (or *www constraint*, for short) provides an important test for credible knowledge in economics. The www constraint is based on four premises that can be paraphrased as follows:

- C₁. Economists pursue comprehension of the economy;
- C₂. Comprehending the economy means to understand how the economy works;
- C₃. The economy's workings are a matter of causal processes being in place; and
- C₄. Comprehension of the economy is sought by means of models.

For reasons that will become apparent in a moment, we call this (original) version of the www constraint “weak www constraint”.

An obvious question arising is: Does the www constraint exclude science fiction? There is an element of indecisiveness inherent to the weak version of the www constraint. The constraint typically plays the role of a weaker exclusion device, in that it helps to exclude model candidates which depicts R “in such a way that we have reason to believe that the world *does not* function that way, or, more strongly, that it *cannot* function that way, or, still more strongly, that it cannot function at all, given what we know about it” (Mäki, 2001, p. 385, [italics in original]).

But the weak www constraint remains silent about surreal models. In order to guarantee an empty intersection between economics and science fiction, a *stronger* version of the www constraint is needed. A stronger version of the www constraint would impose an additional condition to the preceding four premises. The additional constraint can be stated as follows:

- C₅. To avoid a point of contact between the economics discipline and science fiction, surreal economic models have to be excluded from economics.

The fact that we have proven the Inconvenient Theorem does not imply that we are decrying the importance of, or indeed the eventual necessity for, fictional assumptions in economics. It simply supports the view that economics models require scrutiny based on the strong version of the www constraint if they are going to be used to inform economic policy.

6. Summary and concluding remarks

Many economic theoreticians have found the message of Friedman's (1953) essay liberating because his methodology does not impose constraints on the realism of economic assumptions. Perceptions have been sharply divided on the impact of the famous Friedman's (1953) methodological essay on the progress of economics as a scientific discipline. Some economists view economics as a scientific success thanks to its adherence to the Friedman tenet while others see this tenet as a retardatory factor. Beyond any doubt, one peculiar source of controversy and confusion has been the lack of an unambiguous working definition of the term “unrealistic assumption” combined with Friedman's attitude of not publicly addressing the criticisms of his essay.

After half a century of the publication of his essay, Friedman wrote: “I have myself added to the confusion by early on adopting a policy of not replying to critiques of the article” (Friedman, 2009, p. 355). Or, to put it differently, Milton Friedman did not feel under obligation of publicly addressing the comments and criticisms on his 1953 essay and decided to stick to his “no reply” rule. As a result, the most important essay of economic methodology of the twentieth century will live its own life forever. In particular, this means that we will never know whether Friedman would have accepted fictional economic assumptions as valid premises for economic theorizing and policy design.

This paper has been devoted to an exposition and elaboration of a single syllogism: given that fictional assumptions are allowed by the Friedman tenet, and that the defining characteristic of science fiction is the existence of at least one fictional assumption, it follows that science fiction cannot be ruled out from positive economics. More precisely, positive economics and science fiction overlap but are not identical.

The most obvious illustration of the Inconvenient Theorem is given by any model which involves the REA in a fundamental way. Underlying the REA is the postulate of automatic comprehension: the availability of information automatically implies the understanding of the information. This compelling point—obvious, but often forgotten—is a *non-sequitur*. In a nutshell, when abstraction is used to postulate economic agents that are super-humans, as in the single mind assumption, we enter in the domain of sciencefiction.

The message conveyed by this paper is clear: there is no constraint inherent to the Friedman tenet that prevents economics from entering into the realm of science fiction or leading some parts of economics into Hayek's pretence-of-knowledge syndrome. What may not be as obvious is that the Friedman tenet throws a wrench on policy design. In fact, the riddle of the fictional assumptions—i.e. is the use of surreal models acceptable for policy design?—cannot be easily overlooked. One way to exclude science fiction from the economics discourse is to use the strong version of the www constraint.

We believe that economics is a scientific discipline—meaning by the term “scientific”, a body of propositions based on assumptions that are derived from empirical observation, and both the assumptions and the predictions are capable of verification. Criticism is an integral part of scientific activity and the efforts for challenging assumptions are necessary for scientific progress in economics. Assumptions are not impenetrable black boxes. We gain further understanding of the possibilities and limitations of the assumptions by critically evaluating their contents and implications.

We also believe that surreal models should not be taken seriously as guides to policy. Otherwise, economists would be accepting science fiction as a valid tool for applied economic analysis. As for those who argue that surreal models are useful to inform policy, we may leave them the task of proving their case.

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Notes

1. The terms “realism” and “unrealistic assumption” are not defined in F53. Friedman uses a variety of terms to refer to the idea of unrealistic assumptions, such as “descriptively inaccurate” and “descriptively false” (Friedman, 1953, p. 14). These expressions are not characterized other than through examples. The examples, in turn, are not free of ambiguities.

2. A terminological digression is pertinent here. Professor Uskali Mäki has stressed the importance of distinguishing between “Friedman's methodology” and the “methodology of F53” to avoid confusion: “Indeed, *Friedman's methodology* and the *methodology of F53* are not one and the same thing, even though the two are likely to be connected” (Mäki, 2009b, p. 52 [Italics in original]). From now on, we confine attention to the methodology of F53.
3. A road map (in chronological order) for readers that wish to enter the labyrinth engendered by the multiple evaluations of the methodology of positive economics is as follows: Rotwein (1959), Nagel (1963), Melitz (1965), Boland (1979), Mäki (1986, 1992, 2002b, 2009b).
4. “Paraphrasing” is not the “open sesame” to justify the reasonableness of any assumption. There are limits to the art of paraphrase. A general principle has been suggested by Uskali Mäki: “a paraphrase can be used to justify a sentence if it transforms the sentence into a statement that involves factual claims about the domain of study”. (Mäki, 2000, p. 332 [Italics in original])
5. For a precise definition of “negligibility assumption”, (see Mäki, 2000, p. 322).
6. For the purposes of the present paper, these differing views are immaterial.
7. A stronger version consists of assuming that people have probability beliefs that coincide with the probabilities predicted by the model.

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