The Introduction of Rational Expectations into Macroeconomics in the 1970's: reasonableness *versus* operationality of the hypothesis

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RESUMO

Este artigo descreve a introdução da hipótese das expectativas racionais na macroeconomia dos anos 1970 através dos trabalhos de Robert Lucas e Thomas Sargent, tendo como foco a discussão sobre a razoabilidade *versus* a operacionalidade da hipótese. Será mostrado que essa introdução foi criticada em termos metodológicos principalmente por não ser razoável na descrição dos fenômenos macroeconômicos. Por outro lado, será mostrado que a defesa metodológica da hipótese, feita por Lucas e Sargent, foi baseada em sua operacionalidade para lidar com esses mesmos fenômenos macroeconômicos.

ABSTRACT

This paper describes the introduction of the rational expectations hypothesis into macroecomics in the 1970's through the works of Robert Lucas and Thomas Sargent, focusing on the methodological discussion over the reasonableness *versus* the operationality of the hypothesis. I will show that this introduction was criticized in methodological grounds mostly for not being reasonable to describe macroeconomic phenomena. On the other hand, the methodological defense of the hypothesis, made by Lucas and Sargent, was based on its operationality to deal with the same macroeconomic phenomena.

1. Introduction

This paper describes the introduction of rational expectations into macroecomics in the 1970's, focusing on the methodological discussion over the reasonableness *versus* the operationality of the hypothesis. This introduction can be attributed specially to the works of Robert Lucas, Thomas Sargent, Neil Wallace and Robert Barro in that period, which impacted both theoretical and econometric macro modeling. I will show that this introduction was criticized in methodological grounds mostly for not being reasonable to describe macroeconomic phenomena. On the other hand, the methodological defense of the hypothesis was based on its operationality to deal with the same macroeconomic phenomena – and the concept of operationality will be made clear throughout the paper. This methodological divergence exposes the changes that were happening in macroeconomis in the 1970's, with the emergence of new classical macroeconomics and its challenge to the Keynesian paradigm. In this paper, I will focus specifically on the works of Robert Lucas and Thomas Sargent in the early 1970's. They both made original efforts to incorporate rational expectations into macroeconomic models and they both suffered the methodological criticism based on the argument that the rational expectations hypothesis was not reasonable to deal with macroeconomic phenomena. It will be shown that the arguments used by Lucas and Sargent to defend the hypothesis were not based on its reasonableness, but on its operationality.

De Vroey (2016: 212) argues that there were two kinds of criticisms to the introduction of rational expectations into macroeconomics. The first was about its strict relevance to specific markets and, thus, its irrelevance to deal with aggregate macroeconomic phenomena. The second was about the process of formation of rational expectations, meaning how agents learned and obtained information to form this kind of expectation. These two kinds of criticism have a common broader aspect, which is the idea that rational expectations is not a reasonable hypothesis, meaning that it has no resemblance to the real world. I will add a third kind of criticism to De Vroey's (2016) list, which is that models with rational expectations did not have anything to say about short-run economic policies, whereas in the real world policy makers had to deal with short run problems. Therefore, I will argue that Lucas and Sargent avoided the "reasonableness of the hypothesis" criticism since their methodological criteria was the operationality of the hypothesis, not its reasonableness. By "operationality" Lucas and Sargent meant, in a broad sense, that rational expectations hypothesis was the most suitable hypothesis to build equilibrium (stationary) models and to allow for econometric tests and predictions.

2.1. Rational expectations hypothesis in Lucas's macro models

Lucas's first macroeconomic model with rational expectations can be found in his paper "Expectations and the Neutrality of Money" (Lucas, 1972a), published in the April of 1972 issue of the Journal of Economic Theory. Lucas (1972a) builds an overlapping generations model from which emerges a positive correlation between nominal prices and real output, what he calls "a variant of the well-known Phillips curve" (p. 103). Monetary shocks have real effects in the short run just because young agents have information problems; they cannot distinguish whether the price change of their products is relative or absolute. A monetary expansion induces a rise in demand for all goods by the part of old agents, who receives the new money. Young agents raise the production of the goods they produce since they do not know if the rise in demand is real or nominal. Therefore,

real output increases as every agent perceives expansionary periods as good periods. If not for the incomplete information problem, agents would correctly predict future prices, since they have rational expectations, and the monetary expansion would not have real effects in the economy at all.

Lucas (1972a) does not engage in a deep discussion about the reasonableness of the rational expectations hypothesis and the justification for its adoption. Nevertheless, Lucas (1972a: 104) explains why he is using the rational expectations hypothesis instead of some kind of adaptive expectations when talking about the concept of equilibrium used in the paper, which implies the rational expectations hypothesis:

> In this paper, equilibrium prices and quantities will be characterized mathematically as *functions* defined on the space of possible states of the economy, which are in turn characterized as finite dimensional vectors. This characterization permits a treatment of the relation of information to expectations which is in some ways much more **satisfactory** than is possible with conventional adaptive expectations hypothesis. (Emphasis added).

Lucas's (1972a) explanation for the use of the rational expectations hypothesis is that it is **satisfactory** in relating information to price expectations in such a way that agents know the "true probability distribution of next period's price" (p. 110), making the economy reach equilibrium in every point in time, differently from what would happen with adaptive expectations. In a footnote, Lucas (1972a: 110, n. 7) attributes the concept of rational expectations to Muth (1961). In Lucas (1972a), current and future prices are the same functions of random variables, what implies that current and future prices are random variables with the same distribution.

Despite being the first macroeconomic model with rational expectations elaborated by Lucas, the one introduced in "Expectations and the Neutrality of Money" (Lucas, 1972a) was not the first model of this type to be actually presented by Lucas to a large audience.[1] During the summer of 1970, few months after writing "Expectations and the Neutrality of Money" (Lucas, 1972a), Lucas prepared a paper in which he exposed the implications of rational expectations to the modeling and testing of the natural rate of unemployment hypothesis. The paper was written for a conference that Lucas was invited to participate as an advocate of the natural rate hypothesis. It was the first time Lucas wrote a paper especially for a conference and it was a deliberate effort in establishing his macroeconomics of equilibrium in the economics profession. The paper was called "Econometric Testing of the Natural Rate Hypothesis" (Lucas, 1972b) and was presented at the Federal Reserve Board conference "The Econometrics of Price Determination", in Washington, D.C., in October of 1970.

One decade later, Lucas (1983: 51) said in his interview to Klamer (1983) that he knew that James Tobin would be present at the conference and, so, he imposed himself

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[1] There is a draft version of "Expectations and the Neutrality of Money" dated from January of 1970, which was presented as a working paper at Carnegie-Mellon University and can be found at Lucas's Papers at Duke University (Robert E. Lucas Jr. Papers, 1960-2004 and undated. Rare Book, Manuscript, and Special Collections Library, Duke University, Durham, North Carolina, USA.). Unfortunately, there is no register of possible reactions to the paper, which is comprehensible, since it was an internal presentation.

the task of explaining to him the implications of rational expectations to the modeling and testing of the natural rate hypothesis in a way that he could comprehend. He also wanted to explain to Tobin, as a consequence, why standard tests of the natural rate of unemployment that did not adopt rational expectations were misleading. Lucas's choice of Tobin as his interlocutor was not random. Tobin was responsible for summarizing the papers of the conference and was considered a leading macroeconomist and an "honest" person by Lucas (1983: 51); someone that he could actually discuss his ideas with. In another occasion, when writing about his recollections of that period, Lucas (2004: 290) said that the paper was written with the intention of reaching a broad audience, which was not necessarily familiar with his theoretical and more complicated paper "Expectations and the Neutrality of Money" (Lucas, 1972a).

Therefore, the presentation of "Econometric Testing of the Natural Rate Hypothesis" (Lucas, 1972b) at the Federal Reserve Board conference can be considered the first occasion in which a Lucas's macro model with rational expectations was exposed to a large and critical audience. Among the participants of the conference - besides James Tobin - there were two professors of economics from MIT, Paul. W. MacAvoy and Franklin M. Fisher, who also had their critical comments published in the volume of the conference (Eckstein, 1972). I will show, then, that the content of the criticisms were mostly about the reasonableness of the rational expectations hypothesis and of the macro equilibrium model in general, but that Lucas's defensive argument was based on the operationality of the rational expectations hypothesis, not on its reasonableness, revealing the fundamental methodological difference between him and his critics.

2.2. The origins of rational expectations in Lucas's work

It is important to note, though, that the Federal Reserve Board conference in October of 1970 was not the first time in which the reasonableness of the rational expectations hypothesis was subject to criticism. It had been done before, not to a Lucas's macro equilibrium model, but to Lucas and Prescott's (1971) investment model. "Investment under Uncertainty" (Lucas and Prescott, 1971), of Econometrica, from September of 1971, was the first published paper in which Lucas – with Prescott – used, indeed, the rational expectations hypothesis in a model. In the paper, the authors determine the behavior, through time, of investment, output and prices at the firm level and, simultaneously, at the competitive industry level when facing a stochastic demand, following Lucas's (1966, 1967) research agenda on investment by firms. However, differently from Lucas (1966, 1967), the rational expectations hypothesis used in Lucas and Prescott (1971) implied that actual prices at the industry level and prices forecasted by firms were random variables – not deterministic variables -, having not only the same mean value, as in Muth (1961), but the same probability distribution as a whole.

In a letter addressed to Lucas, dated from August 22nd, 1968, Prescott refers to "Investment under Uncertainty", saying that the paper was overall well received at the 1968 Meeting of the Econometric Society, in Boulder, Colorado, but the rational expectations hypothesis had been source of conflict among the participants.[2] Some of them thought that perfect forecast in price distribution was an extremely strong assumption. So, Prescott suggested to Lucas, in the letter, that either they could use Muth's definition of rational expectations to defend the hypothesis - although he was not sure if it was really possible - or they could argue that people had eventually learned about

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[2] Lucas Papers, Box 1, file folder "1968".

the true distribution of prices after participating in the market for a sufficient long period. This last alternative shows that, back in 1968, Lucas and Prescott were still considering defending the rational expectations hypothesis by arguing in favor of its reasonableness, its connection to the real world. Anyway, Prescott preferred the other option, as he considered Muth's approach more general and, thus, superior - since it postulated perfect forecast only in prices' mean not in prices' whole distribution -, what shows that the dominant criterion for the authors was the mathematical criterion, not the criterion of reasonableness. Prescott also says to Lucas in the letter that he would work on the paper and try to use Muth's definition – what he was never able to do.

Few months later, in a letter addressed to Prescott, dated from December 2nd, 1968, Lucas mentions the effect caused by the presentation of the same paper in a symposium on uncertainty and capital theory at Cowles Foundation, in Yale, in the end of November of 1968.[3] Once again, the adoption of the rational expectations hypothesis had been source of protest by the participants of the seminar. They wanted to know what exactly the hypothesis meant and if it was reasonable at all. According to Lucas, most of the people thought that the hypothesis was unreasonable and that he and Prescott were "cheating" (Lucas's quotes) by postulating equilibrium at each point in time. Basically, they wanted to know how firms obtained information to form expectations.

"Investment under Uncertainty" (Lucas and Prescott, 1971) was submitted to Econometrica seven months later, in June of 1969. In the published version of the paper, Lucas and Prescott (1971) eventually chose to present the rational expectations hypothesis as Muth's (1961) hypothesis, not as a result of people's learning in the market, although they could not actually use Muth's (1961) definition of actual and expected prices as random variables having only the same mean. The solution to this discrepancy was to make a safety clause and to inform the reader that they were extending Muth's (1961) definition to the case in which actual and expected prices were random variables with a common distribution (Lucas and Prescott, 1971, p. 660, n. 4).

In the following passage, we can see the reasons why Lucas and Prescott (1971: 660) chose to use rational expectations instead of adaptive expectations in their model:

> Typically the forecasting rule postulated takes the form of anticipated prices being a fixed function of past prices - "adaptive expectations." But it is clear that if the underlying disturbance (in our case, the demand shift) has a regular stochastic character (such as a Markov process), forecasting in this manner is adaptive only in a restrictive and not very interesting sense. Except for an unlikely coincidence, price forecasts and actual prices will have different probability distributions, and this difference will be persistent, costly to forecasters, and readily correctible.
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> To avoid this difficulty, we shall, in this paper, go to the opposite extreme, assuming that the actual and anticipated prices have the same probability distribution, or that price expectations are rational. Thus we surrender, in advance, any hope of shedding light on the process by which firms translate current information into price forecasts. In return, we obtain an **operational** investment theory linking current investment to observable

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[3] The complete list of participants in the symposium includes: George Akerlof, David Cass, Duncan Foley, John Gould, Robert Hall, Al Klevorick, Robert Lucas, Edmund Phelps, Mike Rothschild, Harl Ryder, Joe Stiglitz and Hiro Uzawa.

current and past explanatory variables, rather than to "expected" future variables which must, in practice, be replaced by various "proxy variables."

In adopting the rational expectations hypothesis, Lucas and Prescott (1971: 660) intentionally avoid discussing the "process" by which firms translate information into price forecasts, what was a typical discussion related to adaptive expectation schemes. Proceeding this way, Lucas and Prescott (1971) also avoid the discussion over the most reasonable adaptive rule of price expectation formation. Nonetheless, Lucas and Prescott (1971: 664, n. 9) make a defensive comment, in a footnote, exactly on the reasonableness of the rational expectation hypothesis:

> […] now that the precise content of the "rationality" of expectations is made clear (in the following definition), we add a final comment on its **"reasonableness"**: we can think of no objection to this assumption which is not better phrased as an objection to our hypothesis that the stochastic component of demand has a regular, stationary structure. If the demand shift assumption is reasonable, then expectations rational in our sense are surely more plausible than any simple, adaptive scheme. If the demand assumption is unreasonable, then adopting an alternative expectations hypothesis will certainly not improve matters.

The adoption of the rational expectations hypothesis by Lucas and Prescott (1971) created an "operational investment theory", meaning that it allowed linking current investment to *observable* current and past explanatory variables instead of to some kind of *expected* future variables. This is so because the rational expectations hypothesis postulates a property of the outcome of some unspecified expectation formation process, which is that the future price sequence at time *t* is the same function of the stochastic and stationary component of the demand as is the actual price sequence. It means that future and actual prices have the same distribution of probability and, thus, firms know the true distribution of prices for all future periods. This assumption implies that the industry is always in equilibrium or, in other words, that prices and quantities are always market-clearing values. It also implies that all future values can be forecasted and, thus, the firm can maximize its present value for all future periods.

As we can see from the discussion related to "Investment under Uncertainty" (Lucas and Prescott, 1971), the rational expectations hypothesis had been criticized for not being reasonable even before making its way into macroeconomics in the early 1970's, but Lucas and Prescott avoided this kind of discussion by putting emphasis on the operationality of the hypothesis instead.

2.3. Reactions to rational expectations in Lucas's macro models

Back to October of 1970, at the Federal Reserve conference, Lucas (1972b) exposed the implications of rational expectations to the modeling and testing of the natural rate of unemployment hypothesis. Lucas (1972b) presents the natural rate of unemployment hypothesis in a model in which prices and quantities are market clearing outcomes and prices expectations are rational. The model is composed by an aggregate

supply equation, an aggregate demand equation, a policy rule equation and a rational expectations' equation for future prices. The rational expectations' equation for future prices applied to the aggregate supply equation constitutes the natural rate of unemployment hypothesis itself.

When introducing the rational expectations hypothesis into the model, Lucas (1972b: 96) defines it as meaning that the expectation of the difference between actual and expected prices equals zero, or what he calls "*rational* in the sense of Muth (1961)". Then Lucas (1972b: 96, n.7) discusses briefly the adequacy of the hypothesis in a footnote:

> My concern in this paper will be to show that rational expectations can lead to **workable, testable** cycle models. For the argument that this hypothesis is also **plausible** and consistent with a variety of evidence, the reader is referred to Muth (1961). (Emphasis added).

So Lucas (1972b) avoids any further discussion about the reasonableness of the rational expectations hypothesis simply by redirecting the reader to Muth's (1961) paper. He makes clear that his criterion for using the rational expectations hypothesis is based on its operationality, or, in his own words, on the possibility to build "workable, testable cycle models".

Lucas (1972b: 99) argues that the wrong test on the existence of the natural rate of unemployment would be on the restriction that the sum of the coefficients of current and past aggregate demand - that include the Phillips curve parameter and the policy parameters - is equal to zero, meaning that aggregate demand shifts would not affect real output in the long run. This kind of (wrong) "standard" test - which implies a test on the magnitude of the parameter of the Phillips curve in a model with adaptive expectations - had been performed by Lucas and Rapping (1969b), and also by Cagan (1968) and Gordon (1970). The last two had been endorsed by Tobin (1968) and Solow (1970), respectively, the economists that Lucas elected as references for this kind of macroeconomic framework.

The solution of Lucas's (1972b) system of four equations – with rational expectations – implies that real output depends on the Phillips curve parameter (the response of real output to the difference between current and expected prices) and on policy parameters. Lucas (1972b: 99-100) says that the assumption of rational expectations actually implies restrictions "across equations", between policy parameters and behavioral parameters in the model. The right test on the natural rate of unemployment under rational expectations would be, then, a test on these restrictions.[4] Therefore, the existence (or not) of the natural rate of unemployment could be characterized as "a 'system priority', like stability or identifiability".

In his summary paper of the conference, Tobin (1972a: 13) comments on Lucas's paper saying that it was a rigorous and sophisticated defense of the natural rate of unemployment hypothesis, but criticizes the reasonableness of the rational expectations hypothesis by saying that it was a too much strong assumption regarding the capability of agents of receiving and processing information:

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[4] See Hoover (1988: 177) for a more detailed description of this test.

The participants [of the economy] not only must receive the correct information about the structure [of the economy] but also must use all of the data correctly in estimating prices and in making quantitative decisions. These participants must be better econometricians than any of us at the Conference.

Besides being a too much strong assumption, the rational expectations hypothesis and the consequent Lucas's (1972b) modeling of natural rate hypothesis would not even be useful for the policy makers, as Tobin (1972a: 13) says:

[…] a pragmatist might conclude that he agrees with the natural rate hypothesis in principle but also believes that, in as long a run as can be of concern to policy-makers in an uncertain and unchanging world, a trade-off does exist for policy makers as well as for statisticians.

Lucas immediately responded to this criticism of the rational expectations hypothesis as being a too much strong assumption in a letter to Tobin dated from November 2nd, 1970. He argues that, although he assumes in the paper that each agent knows the entire structure of the economic system, this assumption is not crucial to the existence of the natural rate of unemployment. One could still obtain the natural rate even if the agents formed their expectations about the correct distribution of future prices conditioned on only a part of the available information or even on no information on current realizations at all. They just need to know the correct conditional distributions of prices, but that does not mean that they know the structure of the entire system. They could infer the correct conditional distributions from a histogram of past prices, which, for its turn, depended of the entire structure of the economy. In the end of the letter, Lucas says he is attaching a paper that deals with this issue in a more precise and artificial setting. The paper is "Expectations and the Neutrality of Money" (Lucas, 1972a).

Back to the Federal Reserve Board conference in October of 1970, it was not only James Tobin who criticized Lucas's (1972b) macro equilibrium model with rational expectations. Another strong criticism came from MacAvoy (1972). MacAvoy's (1972: 116) first criticism to Lucas (197b) is about the high level of aggregation of the model, which would make impossible for the applied researcher to analyze the different pricing practices of the sectors of the economy. He continues to criticize Lucas (1972b) by saying that government would not have parameters of a competitive economy in his model, since the government himself was able to control prices. He also says that the Federal Reserve monetary policy would eventually change the rational expectations function $P_t = E(P_t^*) + \eta_t$, (where P_t is the current price level, P_t^* is the future price level and ηt is a random variable). MacAvoy (1972: 117) criticizes, then, the reasonableness of the rational expectations hypothesis:

The author [Lucas (1972b)] could have rendered a great service by venturing into testing and measuring, as well, to show that his expectations function has **more than plausibility**. At present, this function **lacks documentation from observed behavior** in competitive industries and may be descriptive of noncompetitive industries only because those controlling

output set present and future prices by making η_t "step" price adjustments (so that markets do not clear with demand changes, violating another assumption). (Emphasis added).

So MacAvoy (1972) criticizes the rational expectations hypothesis in Lucas (1972b) because he thinks that it has no correspondence in reality. He looks at the real world in which firms control prices in some industries, while the government is able to control some other prices too, and does not see a good description of that in Lucas's (1972b) model. MacAvoy (1972: 117, n.1) is, then, even more emphatic about the absence of reasonableness in the rational expectations hypothesis:

> Lucas cites Muth [1961] for consistency of his function with a "variety of evidence", but I found only indications in this source of the relative **implausibility** of the simple cobweb (p. 344). The cobweb is not the null hypothesis, the rejection of which implies the acceptance of Lucas rational expectations. (Emphasis added).

Few days after the conference, Lucas wrote a letter to MacAvoy in which he sent a revised version of his paper (Lucas, 1972b), and where he says that MacAvoy's interpretation of Muth's (1961) rational expectations hypothesis as specific to the solution of the cobweb model was completely wrong. He did not discuss MacAvoy's (1972) criticism to the reasonableness of the hypothesis any further, though.

Another criticism to Lucas's (1972b) model in the same conference was made by Franklin M. Fisher. Fisher (1972: 113) also criticizes the reasonableness of rational expectations hypothesis by saying that although he agrees that a policy that goes long enough can make people have correct expectations on average, he disagrees that after a policy change average expectations will be correct in the short run. He, then, exposes his idea of what would be the proper definition of rational expectations, according to his reasonableness criteria:

> A proper view of rational expectations seems to me to be that the limit of the expected value of the expected prices is the same as the limit of the expected value of actual prices given that there are no policy shifts. I see no reason, however, why the two expected values should be equal at every moment in time.

Fisher (1972: 113) goes on emphasizing this criticism and the idea that in Lucas's (1972b) model individuals participating in the economy would have to be able to understand the new policy as fast – or even faster – as the policy maker himself. In the end, he concludes saying that he does not think that the natural rate model is better than a standard Keynesian short-run macro model in guiding economic policy.

3.1. Rational expectations hypothesis in Sargent's macro models

The first paper in which Sargent uses the rational expectations hypothesis in a macroeconomic model is "Rational Expectations, the Real Rate of Interest, and the Natural Nate of Unemployment", published in 1973 on the Brookings Papers on Economic Activity. Sargent (1973: 433) says that his work is "heavily dependent" on the analysis of the natural rate of unemployment hypothesis made by Lucas (1972a, b, 1973, 1976) and Lucas and Rapping (1969)

Sargent (1973) builds a macroeconomic model in which the relationship between interest rate and expected inflation is presented and Fisher's theory (of the "natural rate of interest") is analyzed. Expected inflation is first modeled under adaptive expectations and, afterwards, under rational expectations. Sargent (1973: 433) argues that under rational expectations the natural rate of unemployment hypothesis and Fisher's theory on the relation between interest rate and expected inflation ("natural rate of interest" hypothesis) form the same package. Sargent (1973) proposes, then, some tests for the rational expectations model, concluding that the most straightforward one would be simply the test on the natural rate of unemployment itself. The model presented in the paper is described basically by two propositions. The first deals with the natural rate of output (unemployment) and states that deviations of output from its normal level are statistically independent of systematic fiscal and monetary policies. The second deals with the real rate of interest and states that the real rate is independent of the systematic part of the money supply. Sargent (1973) says that the validity of the first proposition is shown in Lucas (1972a, b, 1976), while the second proposition should stand and fall with Lucas's natural rate of unemployment proposition. Therefore, the econometric test of these propositions together would be simply the econometric test on the natural rate of unemployment hypothesis itself. Sargent cites Lucas (1972b, 1973) as examples of proper tests on the natural rate of unemployment and proposes another one, which turns out to be inconclusive to him, since it rejects the natural rate of unemployment but is claimed to be superior to any available structural models that denies the natural rate in predicting the rate of unemployment.

Sargent (1973: 431) firstly presents the rational expectations hypothesis as "'rational' in Muth's sense", meaning that public's expectations are not systematically worse than the predictions of the economic models - and referring to Muth (1961). Later in the paper, Sargent (1973: 439) is more specific and says that rational expectations hypothesis applied to his model would require that "the public (a) knows the true reduced form for the price level, (b) knows the probability distributions or rules governing the evolution of the exogenous variables, and (c) combines this information to form optimal (least squares) forecasts of the price level". And then Sargent (1973: 439) presents the two reasons why this kind of expectations should be adopted:

> First, it makes **concrete and operational** the appealing notion that people use information besides past prices in forming their forecast of the price level. Second, in certain instances it has been possible to test the hypothesis empirically […] and the hypothesis has fared pretty well when tested on data on stock prices, commodities prices, and interest rates. (Emphasis added).

As seen in Lucas's case (Lucas 1972a,b; Lucas and Prescott, 1971), the argument is that rational expectations relate available information to expected variables in such a

way permit building equilibrium (stationary) models that can be tested and that can provide forecasts. That is the meaning of the term "operational" for Sargent and Lucas.

3.2 The origins of rational expectations in Sargent's work

According to Sent (2006: 15), Sargent's work was always guided by attempts to establish a connection between neoclassical economics and econometrics, in a way to develop a universal economic science. Sargent's early interpretation and use of rational expectations were econometrically motivated by the idea that the econometrician and the agents of a model should behave symmetrically (Sent, 2006: 38). This idea can be found in Sargent's (1971) paper "A Note on the Accelerationist Controversy", where he discusses two types of process of expectations' formation. One is a kind of adaptive expectations, where people form their expectations considering the errors of predictions of past inflations. The other is the rational expectations, where people know the actual process of inflation and, thus, can make the same prediction as the econometrician that builds the models. In this specific paper, Sargent (1971) defends that this last kind of expectation should be used in models testing the Friedman-Phelps accelerationist version of the Phillips curve.[5]

In a following paper - Sargent's (1972a) "Rational Expectations and the Term Structure of Interest Rates" - the same idea about the symmetry between the agents and the econometrician can be found. Sargent (1972a) tests a combination of two hypothesis on the behavior of the term structure of interest rates. One is that forward rates are forced to equality with the short rate that investors expect to prevail in the subsequent periods. The other is that the expectations of investors are rational in the sense of Muth (1961). The two hypothesis combined form the hypothesis of efficient markets. The first one had been subject to various empirical tests alone, without assuming rational expectations. Sargent (1973) argues that the right test should be the one that combined the two of them, since rational expectations would guarantee that agents would not waste information available to form expectations, just like the econometrician building he model.

These early works show that Sargent's motivation to use rational expectations in his models were, indeed, econometrical. In other words, Sargent's motivation was based on the operationality of the rational expectations hypothesis. I would add that rational expectations were especially suitable to analyze financial markets. These two aspects of Sargent's motivation and use of rational expectations would be criticized in his macroeconomic model presented at Brookings Institute (Sargent, 1973).[6]

3.3 Reactions to rational expectations in Sargent's macro models

Sargent's (1973) paper had two commentators at the presentation at Brookings Institute. One of them was David Fand and the other was Stephen Goldfeld. After their

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[5] It is interesting that Sargent (1971: 34-5) also discusses which hypothesis would be more reasonable for agents to assume in the model. His conclusion is that agents should have rational expectations because it was a better description of the inflation time series in the U. S., in the previous years.
[6] Before the 1973 macro paper presented at Brookings, Sargent (1972b) published a paper in which he was already analyzing the relation between anticipated inflation and the nominal rate of interest, but it was not a complete macro model.

comments, there was a general discussion about the paper. The rational expectations hypothesis was subject to criticism by most of the participants of the seminar, and the basic argument was that it was not a good description of how macroeconomic expectations were actually formed in the real world.

David Fand (p: 474) questioned how a model with rational expectations would apply in different situations and different types of worlds, asking if a change from fixed to floating rates, for example, would be interpreted as a structural change.

Stephen Goldfeld (p: 475) asked if one should actually believe in the assumptions underlying Sargent's model. Goldfeld considered the model based on rational expectations as "the heart of Sargent's paper", saying that agents knew essentially everything about the model. He went on saying that "it is very strongly restrictive to assume that the public really knows the model and its parameters", and that "softening the assumption of complete knowledge really requires adding the assumption of linearity", and someone could not find these assumptions congenial. Goldfeld (p: 477) also asked about the short-run policy implications of the validity of the natural rate of unemployment and of the Fisher hypothesis. He questioned how rational expectations should be formed in a world in which the government is able to impose different kinds of policies.

In the general discussion, Robert J. Gordon (p: 478) said that he was skeptical that output fluctuations in the real world were due to errors in price predictions. He also argued that the overall price level was typically downward inflexible, making a rational expectations model inappropriate in explaining anticipated movements. He said that upward and downward movements could be symmetrical for commodity and security markets, but not for the aggregate price behavior. Robert J. Gordon (p:479) also argued that even the forecasts of experts did not seem to be unbiased and serially uncorrelated, as proposed by Sargent in his model, giving examples such as the consistent underprediction of prices for years after the Second World War and the cyclical pattern of businessmen's errors in anticipations of their own investments.

Thomas Juster (p: 479) argued about the cost of forming rational expectations. He said that there are different types of economic agents with different incentives to make the effort to do the rational expectations kind of forecast. Only a small class of economic actors would behave in accordance with rational expectations, while most of households and small business would not.

Artur Okun (p: 479) said that the question related to the rational expectations should be "whether enough participants had the incentive to arbitrage to make rationality dominate in markets".

William Poole (p. 479) defended Sargent's model with rational expectations against Keynesian models with adaptive expectations, but argued that it should consider the accumulation of knowledge in the formation of expectations. He said that information and knowledge available to form rational expectations change over time and different people have different access to it; policy makers typically have more rapid access to information and have fuller information than private agents, what enables policymakers to improve economic performance.

Finally, Franco Modigliani (p. 480) argued that some tradeoff between inflation and unemployment could exist in a world with rational expectations because of vacancies and other features that departed from market clearing, making the natural rate of unemployment "just an intellectual curiosity". Sargent (p. 480) replied to Modigliani saying that whether it was right or wrong, the natural rate of unemployment had immediate relevance on the impact caused by systematic and predictable changes on the economy.

4. Conclusion

The rational expectations hypothesis was originally formulated by Muth (1961) with the intention to describe the behavior of firms in a specific industry regarding the formation of price expectations. This hypothesis was used by Lucas in his early research in the analysis of investments by firms located in an industry (Lucas 1966, 1967; Lucas and Prescott, 1971). It was also used by Sargent in his early research in the analysis of financial markets, mainly with an econometric motivation (Sargent, 1972). Afterwards, the same hypothesis made its way into macroeconomic models through the hands of both Lucas and Sargent as an operational tool to analyze and to test macroeconomic (aggregated) models and to deduce economic policies from it, as in Lucas (1972a, b, 1973) and Sargent (1973). The first reactions to the use of rational expectations in macroeconomics were that it was not suitable to describe macroeconomic phenomena, that it was not a good description of how people learned and obtained information to form expectations and that it was useless for short run economic policy. These arguments can be summarized in the idea that rational expectations were not reasonable to analyze macroeconomic phenomena. Lucas and Sargent defended the hypothesis by saying that it was operational in the sense that it related current and past information to expected variables in such a way that equilibrium (stationary) models could be built and econometric tests and predictions could be made.

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