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Review of Sargent's *The Conquest of American Inflation*[1]

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THERE WAS A time when there was no Phillips curve, when central banks—mostly inspired by the Real Bills Doctrine—were not tempted to exploit any unemployment–inflation trade-off. This was, of course, before Phillips published his results in 1958, before some governments—following the lessons of Samuelson, Solow, et al.—saw behind a statistical relationship a purpose for their policies. One could argue that the unemployment–inflation correlation was there and, if not Phillips, someone else would have "recognized the pattern," and, once the pattern had been recognized, policy makers concerned with unemployment, not just inflation, would be prompt to use it. But once policy makers started exploiting the unemployment–inflation trade-off the statistical relationship was likely to change.

There was a time when econometric policy evaluation was not questioned, when many governments took the statistical relationships provided by econometricians as a direct guide for their policies, disregarding the fact that the data used by econometricians was to be affected by their policies. This was, of course, before Robert E. Lucas Jr. published his critique in 1976. One could argue that, once the logical inconsistency was recognized and natural-rate theory vindicated, policy makers should have been discouraged from manipulating mere short-run statistical relationships. But, in spite of the logical inconsistencies, the Phillips pattern persisted and policy makers continued to pay attention to it.

There was a time when there was no reconciliation, when many policy makers continued to think about Phillips curves while the forefront of the academic profession simply disregarded them. This was, of course, before Thomas J. Sargent published *The Conquest of American Inflation.*

Sargent's book provides a reinterpretation of the US inflation record over the last half-century. Except for some cryptic passages, it is a pleasure to read. This is enough to recommend the book to economists. But there is more to it. The book is foremost a reflection on how macroeconomic theory has evolved since the beginnings of the rational expectations revolution. It is also a mature reflection by one of the leading "revolutionaries," who offers his—not always fully articulated—view on how we should now do dynamic economic theory. Full appreciation of it may take more than one reading.

American inflation (its high rates in

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the 1970s) and its conquest (to low rates in the 1980s and 1990s) simply sets the stage for an exploration in dynamic economic theory. Such exploration builds on some classical works. (To Phillips and Lucas, one must add other pioneers in modeling expectations, such as Muth, Cagan, and Friedman, and other Phillips curve modelers, such as Phelps, Solow, and Tobin.) However, as is acknowledged in the book, its more recent and direct roots can be found in three different lines of work. First and foremost are Sims (1988) and Chung (1990), who suggest how a government that adaptively learns from its Phillips curve experience may end up discovering a version of the natural rate theory. Second are King and Watson (1994), who show how different specifications of the unemployment–inflation tradeoff (i.e., alternative pattern recognition procedures) can lead to different policy recommendations. And third is Kreps, who, in addition to pioneering with Fudenberg and Levine (1993) the concept of self-confirming equilibria in game theory, asks: "How should we (as economists) model dynamic choice behavior, where the dynamics involve a process of adaptive learning?" (Kreps 1999, p. 264). The main contribution of Sargent's book is the integration and development of these three lines of work in a coherent novel theory.

The Conquest shows that, without abandoning the discipline of rational expectation equilibria, it is possible to account for apparent regime shifts (coefficient drifts in econometric models) without appealing to changes in policies, states of the system, underlying parameters, or exogenous changes in beliefs (sunspots). A fine exercise in Occam's razor! Indeed, in the face of the contrasting inflationary experience of the last decades, a more standard approach would have been to develop a theory incorporating some of these changes. One (and the only one discussed by Sargent) could be that once natural rate theories were understood—say, by Paul Volcker—there was a policy shift in the Federal Reserve Bank, and this change resulted in the subsequent price stabilization. Sargent argues that this interpretation does not fit the facts, since the Federal Reserve System continued to fit Phillips curves through the stabilization process. One could discuss (maybe by building them first!) how well alternative theories based on other changes can explain the US inflation facts. After all, as Sargent recognizes, his model does not provide a perfect fit! But this exercise of racing models against a data set, although necessary and interesting, would center our attention on the scenario more than on the play. As a matter of fact, such magnificent scenario is kept to a minimum by postulating an extremely simple and standard model of the natural-rate Phillips curve (presented in Chapter 3).

The starting point of the book is a deconstructionist account of the Lucas critique and, more generally, of the way that we have been studying macroeconomic time series polluted by policy interventions (chs. 1 and 2). Such reflection also provides an introduction to the book and, in particular, to the central concept of the book: "Self-Confirming Equilibrium" (SCE), which is fully developed in the core chapters 7 and 8. In an SCE: 1) the government postulates a Phillips curve that can be fitted to past data; 2) the government follows an optimal policy consistent with its "perceived" Phillips curve; 3) private agents have rational expectations, in the sense that their inflation forecasts coincide with the government's inflation policy; 4) new data is generated by the "true" Phillips curve; and 5) the government has rational expectations, in the

sense that data is consistent with its perceptions (i.e., its regressions satisfy standard orthogonality conditions).

In the context of strategic games, SCE is a weaker concept than Nash equilibrium (agents' beliefs must be consistent with equilibrium outcomes, but may not be mutually consistent across agents as Nash equilibrium requires; see Fudenberg and Levine 1993). However, as the above specific definition shows, a self-confirming equilibrium is a rational expectations equilibrium (REE), once agents' pattern recognition devices have been postulated. In other words, it is not a requirement of "rational expectations" that, in the above definition, the government postulates the "true" Phillips curve (although such a strong version of REE is often identified with REE). This also means that multiplicity of SCE may be the norm, since there may be many agents' pattern recognition devices consistent with the actual laws of motion and rational expectations restrictions. It does not mean, however, "everything goes," since the consistency restrictions are fairly stringent (e.g., the pattern "there is no Phillips curve" would not satisfy condition 5). It does not mean everything can be explained, since, as the book shows, the resulting theory provides testable implications.

Sargent only discusses two possible classes of self-confirming equilibria. Both have the government postulating a reduced form Phillips curve where there is no explicit account of private agents' beliefs (trivially self-confirmed by 3). Following King and Watson, Sargent allows the government to have two different pattern recognition devices according to whether it fits unemployment on output (the "classical fit") or output on unemployment (the so-called "Keynesian fit," since Keynesians were its proponents). Alas, different regression patterns result in different self-confirming equilibria. However, with private agents' future reactions to current inflation not explicitly accounted for, lagged inflation (or unemployment) disappears from the underlying—"true"—Phillips curve. In other words, under these perceptions, SCEs are static in nature; the inflation and unemployment processes are serially uncorrelated. With a "classical fit" the SCE corresponds to the one-period Nash equilibrium, while with a "Keynesian fit" the SCE has a higher inflation level. In particular, while in both SCEs unemployment is at its natural rate, the efficient Ramsey outcome of zero inflation is not achieved in these SCEs. Can the Ramsey outcome be achieved in some alternative SCE? (More on this below.)

Only when dynamics are explicitly introduced does Sargent reply to Kreps' question (ch. 8). The answer takes the form of what he calls "1990's adaptive expectations." In contrast with "1950's adaptive expectations" (i.e., Cagan and Friedman), agents no longer have to learn about a basic parameter—say, the inflation level—but about the parameters governing their perceived law of motion. That is, given a direction of fit, the government updates its estimated reduced form Phillips curve (allowing for lags) following some recursive method. Since this is learning in real time, the government's estimates determine its policies. That is, not only the government recursively changes its perceptions (as in Kreps' 1999, "anticipated utility"), but also such updates determine the actual law of motion of the economy. We no longer have a so-called dynamic equilibrium model where everything could have been decided in period zero (as in Arrow–Debreu), nor a recursive equilibrium model where policy is a stationary function of some state variables (as in Real Business Cycle models). In Sargent's models the same

policy functions are recursively modified. We are now in new territory. (Shouldn't we call it "Adaptive Recursive Equilibrium?")

If the government behaves as a standard econometrician, weighting all past observations equally, the process converges to the corresponding SCE and, therefore, the model does not capture the stabilization process of the 1980s and 1990s. In particular, even if it starts with a regression model with lags, the coefficients on lagged inflation (and unemployment) converge to zero since, as we have seen, the underlying Phillips curve model is static. To learn, however, does not mean to behave as a standard econometrician. There is a degree of freedom in how past data is used (e.g., discounted) to update beliefs. In particular, in a nonstationary environment (say, in the 1970s) it is better to use a tracking procedure, that is, to discount past data at a geometric rate.[3] With such a procedure, convergence is in distribution and one should not expect the system to be always around the SCE. But then, can one say anything about how such a dynamic equilibrium system would behave?

Fortunately, the theory of large deviations provides tools to characterize what should happen when the process *escapes* from its SCE. Using simulations of the Adaptive Recursive Equilibrium process, Sargent shows that, in fact, deviations from the corresponding SCE most likely result in low inflation episodes, close to the Ramsey outcome. The fast escapes resemble the Volcker stabilization process, although there is no underlying change of policy. What is happening should not surprise econometricians (even if they do not know large deviation theory). In fitting short-run (downward sloping) Phillips curves there is a tendency to estimate data from different curves (i.e., curves corresponding to different expectations of the private sector with the same slope but a different intersect). As a result, the econometrician perceives a steeper curve and, when past data is geometrically discounted, this process reinforces itself. In such an escape route the econometrician reports to the government a strong version of the natural-rate theory. In *The Conquest* these results are obtained by simulation, but the missing technical chapter can be found in the follow-up "Escaping Nash Inflation" (In-Koo Cho and Sargent 1999). There, large deviation theory is applied to a simplified version of the model to show that, in fact, escape routes are rapid moves toward the Ramsey outcome.[4]

As we see, Sargent shows how one can still be rigorous and provide testable prescriptions that answer Kreps, while having theorists, econometricians, and policy makers talking to each other. In fact, he provides a virtual account of such dialogue when he estimates his models. In Chapter 9 a fairly sophisticated econometrician uses GMM estimates of the reduced Phillips curve using historical data to provide the adaptive government with updated perceived Phillips curves to implement its inflation policy. Under both "fits" the estimated adaptive process results in low inflation for the 1980s and 1990s, although both

[3] In their adaptive learning model of Latin American Hyperinflationary episodes, Marcet and Nicolini (1998) also model agents as using "tracking procedures" along such non-stationary episodes. Their paper, and Sargent's book, are fairly unique in that learning models are used to explain macroeconomic phenomena that can not be properly accounted for by more standard rational expectations models.

[4] More specifically, as in Sims (1998), their "postulated" reduced Phillips curve does not include gaps and they only study the "classical" direction of fit. Such simplifications, respect to Chapter 8, allow Cho and Sargent to characterize the *escape routes*.

models miss the very high inflationary episodes of the 1970s and the prescribed stabilization starts before it actually took place. Overall, a somewhat better data match is achieved when the government is a "Keynesian fitter" although—according to the model—welfare would have been higher with a "classical fitter."

As presented, these results are encouraging and, at the same time, disturbing. If the low inflation is the result of an escape route then, eventually, the short-run Phillips trade-off will be exploited. As a result, inflation will—slowly—return to a high level close to the corresponding SCE, where it should be most of the time (i.e., "mean dynamics" would tend to govern the evolution of inflation). That is, if Sargent's models are a good representation of how monetary policy is conducted, then high inflation should reemerge. In other words, under this interpretation, there has been no conquest of American inflation.

Nevertheless, there may have been a conquest. Of course, one could argue this to be the case because Sargent's Phillips curve-fitters no longer reflect how monetary authorities—say, Alan Greenspan—behave nowadays. They are better represented as Taylor rule-fitters with a low inflation target (the credibility problem solved?). Or one could argue that central banks in developed countries are now subject to enough competitive pressure—say, from inside money—that the 1970s are definitively in the past. However, the arguments for policy or economy changes, even if they may have a grain of truth, are not part of the game.[5] After all, most economists and econometricians faced with Sargent's simulated or estimated data would argue that there has been a policy or parameter change, while we know there has been none. But, even within Sargent's rules of the game there may have been a conquest, although, to know this, some of the arguments in Sargent's book would need to be clarified and further developed. In particular, what needs clarification is the existence of multiple SCEs associated with alternative ways in which the private sector's beliefs are perceived.

Sargent's starting point for his SCE formulations is the "Phelps problem," in which a reduced form long-run Phillips curve is derived from having private agents adaptively forecasting inflation and the government knowing the "true" Phillips curve and how agents forecast (ch. 5). In this case, the government takes into account that a constant inflation policy will eventually be learned by private agents (the so-called Induction Hypothesis) and the resulting outcome is close to the Ramsey outcome; provided the government is patient enough. Furthermore, the same result reemerges when private agents optimally choose their learning rules within a pre-specified class of learning algorithms (last section of ch. 7). Unfortunately, while the class of learning rules considered is fairly general (encompassing Cagan and Friedman's adaptive expectations model), it does not include the corresponding government's optimal policy. Therefore, the resulting outcome cannot be an SCE, but only an equilibrium with misspecified beliefs (a new and interesting construct presented in ch. 6). However, one does not have to constrain beliefs

[5] These arguments may well complement each other, but one needs to develop them separately. It should also be noticed that a Taylor-rule-fitter is likely to adaptively revise its estimate of the "potential output" and an Adaptive Recursive Equilibrium model may be the better way to analyze such an economy. As a matter of fact, without making full use of Sargent's approach, Orphanides (1999) shows how historical revisions of the "potential output" may help to explain the US inflation experience within a constant Taylor rule policy.

to a misspecified set. Unfortunately, when moving from a misspecified to self-confirming equilibria part of the starting point, the fact that the government takes into account how agents forecast seems to be forgotten.

The results on misspecified models suggest the existence of an SCE corresponding to the natural-rate long-run vertical Phillips curve. Suppose the government postulates a Phillips curve that explicitly takes into account that agents' beliefs are based on some rule. Although it is not strictly necessary, we can also suppose that, according to (3) in Sargent's definition of SCE, such a rule is the same optimal policy rule. Then, the resulting Adaptive Recursive Equilibrium process is more complicated than the one described in Chapter 8 since the optimal policy appears in the perceived Phillips curve, not just in the *true* Phillips curve. Such a process should result in correlated processes for inflation and unemployment and it should converge to an SCE where the *Induction Hypothesis* characterizes the equilibrium path and the government implements the Ramsey outcome. If this conjectured natural rate SCE exists, the low inflation of the 1980's and 1990's may as well correspond to such an SCE path (or the corresponding Adaptive Recursive Equilibrium process). In contrast, in Sargent's SCE models the *Induction Hypothesis* can only be part of an "escape route" and the last twenty years can only be estimated as such deviations from SCE.

That the government may—and should—take into account that agents' beliefs (learning rules) are not arbitrary is relevant for another discussion of the book. In what apparently is a sidetrack from the main argument, but follows the current dynamic macro literature, Sargent discusses credible policies in the context of the dynamic version of the Phillips curve model (ch. 4).[6] As expected, given the well-known Folk Theorems, he concludes (p. 48): "the multitude of [sequential equilibrium] outcomes mutes the model empirically." But, as he acknowledges—building on the work of Cho and Matsui (1995)—when agents' beliefs have more structure (consistent with a broad class of learning rules), reputation and learning are linked and they may not be a "multitude of outcomes." In fact, all equilibrium paths may be close to Ramsey outcomes.[7] In other words, long-run Phillips curve SCE (or equilibrium with misspecified beliefs) are likely to integrate elements of adaptive learning and reputation. If this has been the US experience, then there has been a conquest of American inflation. Unfortunately, the identification problem remains open.

In summary, Sargent's book may not provide the last word on the US inflation experience, not even on how this experience can be explained as the dynamic outcome of an adaptive process that may converge to—or escape from—a self-confirming equilibrium. It certainly is a path-breaking contribution. It shows new ways to analyze dynamic economies. It is a basic reference to understand—and develop—dynamic macroeconomic theory in the 21st Century.

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[6] I would recommend the reader interested in this part to consult Ljungqvist and Sargent (2000).

[7] The recent work of Ireland (1999) and Marimon, Nicolini and Teles (1999) further develops this new approach integrating reputation and learning.

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