GRUNBERG AND MODIGLIANI, PUBLIC PREDICTIONS AND THE NEW CLASSICAL MACROECONOMICS

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Surveys of rational expectations theory frequently cite the 1954 Grunberg/Modigliani paper on the predictability of social events (hereafter G-M) as a precursor to Muth's (1961) seminal rational expectations paper.[1] If this is true, given how frequently Muth is cited in the new classical macroeconomics literature, it would make the G-M paper a precursor to the new classical macro as well. Now this seems problematic for a number of reasons. First, Modigliani is a well-known critic of the policy-impotence results of the new classical macro theory (1977 for instance). Second, the G-M paper argues that "correct public predictions" are possible, a result which seems to be at odds with the so-called Lucas critique of economic policy evaluation (and

possibly the policy-impotence results as well). And finally, the G-M paper is closely related to a paper published the same year (1954) by Herbert Simon on the prediction of election results.[2] If the G-M paper is a precursor to the new classical macro theory then the Simon paper must be a precursor as well. It seems rather unlikely that two Nobel Laureates, one an outspoken critic of the policy results of the new classical macro theory, and the other the profession's best known critic of the rationality assumption, would both be early contributors to the new classical macro and its version of super-rationality.

It is the purpose of this paper to sort out these issues. Based on a reexamination of the papers by G-M, Muth, Simon and the arguments in the recent literature, I provide a reinterpretation of the relationship between the G-M and Simon (hereafter G-M-S) papers and new classical macroeconomics. It will be argued that strictly speaking the G-M-S papers *are* precursors to the general concept of rational expectations; any agent or agency making a correct public prediction in the manner suggested in the G-M-S papers is actually forming a rational expectation. But I will also argue that the G-M-S papers in no way anticipate the policy ineffectiveness results often associated with the new classical macroeconomics. The reexamination thus emphasizes the known but often forgotten fact that there needs to be a clear distinction between the assumption of rational expectations and the other assumptions of the models where rational expectations are commonly imposed.

The paper is arranged as follows. Section one provides a detailed reexamination of the G-M paper. In this section I introduce a simple diagram which not only allows for the main results of the G-M paper to be presented in a heuristically convenient way, but it also helps elucidate the differences between the G-M model and those appearing in the later literature. Section two contrasts the G-M-S papers with the Muth paper and the standard results from the new classical macroeconomics. This section contains the main argument of the paper. The third and final section contains the conclusion and a brief methodological discussion.

I. THE PREDICTABILITY OF SOCIAL EVENTS

The G-M paper is more of a contribution to the philosophy of social science than it is a contribution to economic theory. The purpose of the

paper is to defend methodological monism (the position that there should be no fundamental difference between the method of social science and the method of natural science) from the criticism that social science entails a type of prediction falsifying feedback which is either totally absent from, or at least far less pronounced in, physical science. In particular, G-M argue against the view that making a "public prediction" will alter the behavior of the relevant agents in such a way as to falsify a prediction which would have been "privately" correct. This general problem in the philosophy of social science is referred to as the problem of "self-falsifying" (or self-defeating) public predictions. The purpose of the G-M paper is simply to show that self-falsifying public predictions are not necessarily inevitable. Their main result uses a specific economic example to demonstrate that a correct public prediction is always possible even when the prediction causes the behavior of the relevant agents to change.

The example which G-M used to make their case is a supply and demand model similar to the cobweb-model. The quantity of the good available next period (q_{t+1}) is function of the price expected by suppliers next period (p^e). So the supply of the good is given by,

$$q_{t+1} = S(p^e). \tag{1}$$

The actual price which will prevail next period (p_{t+1}) is determined exclusively by demand so,

$$P_{t+1} = D(q_{t+1}). \tag{2}$$

This model would of course reduce to the standard cobweb model if the additional restriction $P_t = p^e$ were imposed; but G-M were not interested in this case. Rather, they were interested in the case where a "public prediction" by some agent or agency would influence the expected price. In their specification the expected price (p^e) is a function of the current price (P_t) as well as the public prediction of the future price (P). Thus, the expectation function of the suppliers is written as,

$$p^e = E(p_t, P). \tag{3}$$

One special case of the expectations function in (3) is where the predictions are "fully believed" by suppliers. In the case (3) reduced to $p^e = P$. This "fully believing" case is used frequently by G-M since it is relatively simple to manipulate and yet it still exhibits the desired supply sensitivity to the predicted price.

Figure 1 allows us to examine and manipulate the G-M model in a convenient way. Starting in the southeast quadrant we have the demand curve from equation (2) and immediately above it the supply curve from equation (1). For any expected price the northeast diagram determines the quantity which will be supplied next period and the demand curve in the southeast diagram determines the resulting price. The expectations function (3) is drawn in the northwest quadrant. This function relates the expected price (p^e) to the publicly predicted price (P) and has the current price (P_t) as a shift parameter. In the case where the suppliers "fully believe" the prediction, the expectations function simply becomes a 45 degree line. This fully believing case is depicted in Figure 2. Finally, the "reaction function" (R(P)) for the model is given in the southwest quadrant. This function is derived by arbitrarily selecting predicted prices from along the horizontal axis of the southwest quadrant and then tracing through the other three diagrams to find the price which would result from that prediction. Thus R(P) shows the "reaction" of the system to any particular price, that is, it specifies the relationship between each public prediction and the price which would result next period given that prediction. The reaction functions in Figures 1 and 2 show that for "most" public predictions the predicted price and the actual price next period will not be the same. Figure 1 can be used to show that even predicting the equilibrium price (a price which would be a privately correct prediction) may prove to be incorrect for the general case where the prediction is not fully believed by suppliers.

G-M's main result is based on a fixed point argument. Any agent or agency with sufficient information to make a correct private prediction (i.e., to know the supply and demand functions) can be assumed to know the way that predictions influence expectations (i.e., know the expectations function).[3] Given knowledge of the expectation function and the other parts of the model, the reaction function can easily be obtained. Once the reaction function is known it is relatively straight
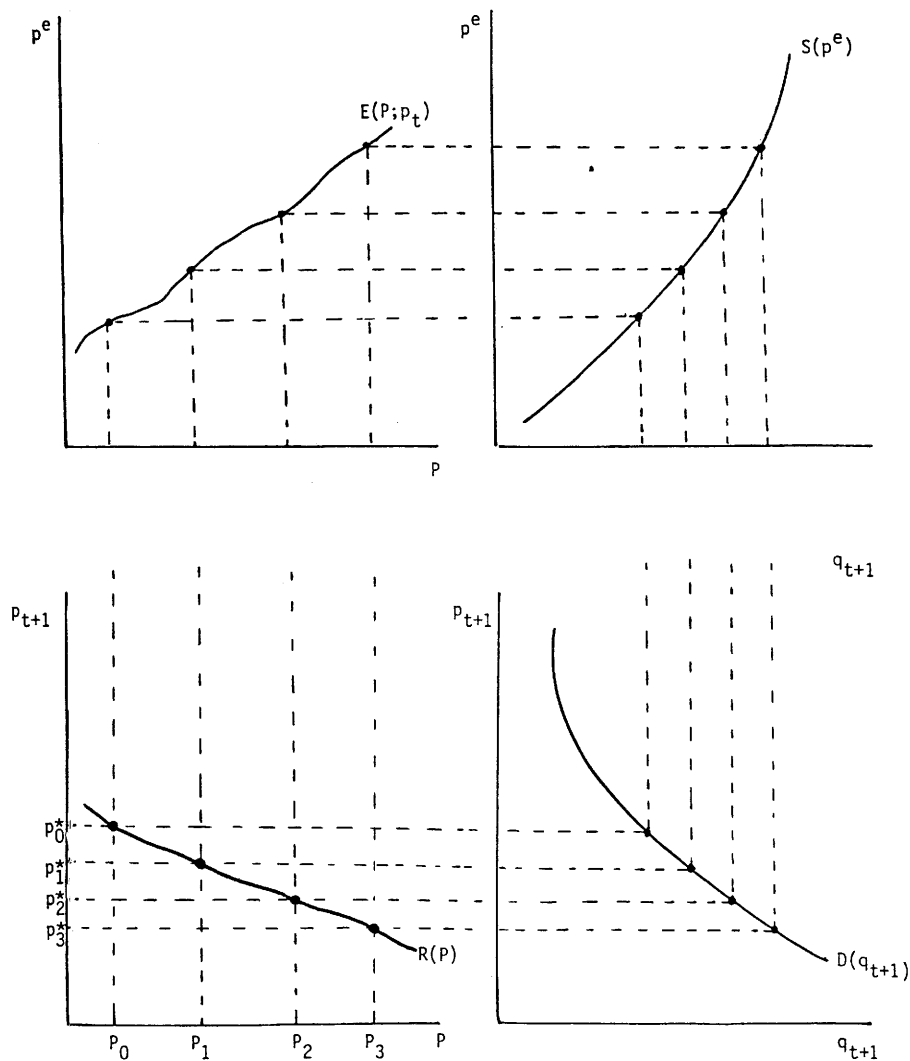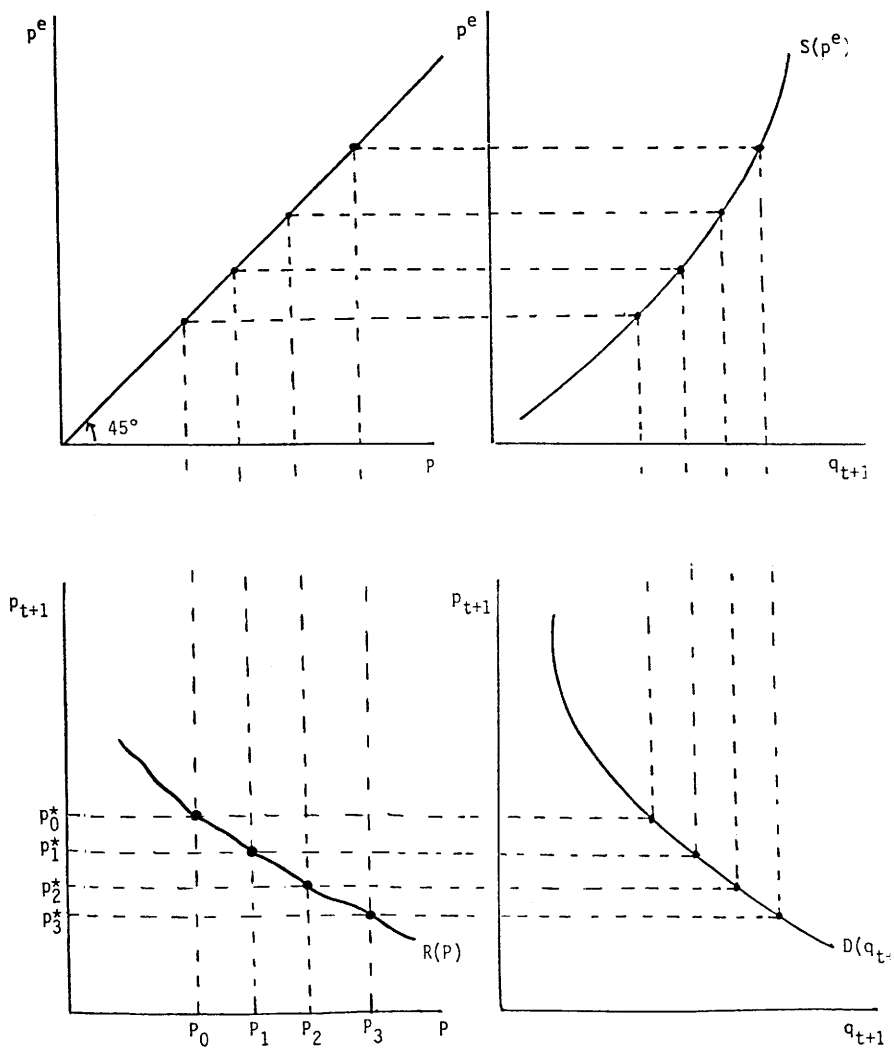
Figure 1.

Figure 2.

forward to find a self-fulfilling public prediction; it is simply a fixed point of the reaction function. Diagrammatically this fixed point is shown in Figure 3 by the predicted price P* (where the reaction functions cuts the 45 degree line). Since Brower's Fixed Point Theorem guarantees that such a fixed point will always exist for any continuous function on a bounded domain (though it may not be unique), G-M can argue that a correct public prediction is always possible. While the authors elaborate a bit more on the empirical reasonableness of the boundedness and continuity assumptions, and emphasize the mathematical restrictions are only sufficient not necessary, this one example constitutes the main result of their paper. G-M conclude that the paper "establishes the falsity of the proposition that the agent's reaction to public prediction necessarily falsifies all such prediction and that therefore social scientists may never hope to predict both publicly and correctly" (p. 478).

Simon's paper "Bandwagon and Underdog Effects and the Possibility of Election Predictions" (1954) is very similar to the G-M paper. Simon is also making a methodological point about the possibility of successful prediction in the social sciences. He concludes, much as G-M concluded, that his result, "refutes allegations commonly made about the impossibility, in principle, of correct prediction of social behavior" (p. 252). Simon's example is from political science rather than economics but the basic approach is very much the same. He considers a single example, the impact of a published election prediction on the eventual outcome of the election; he shows through a fixed point theorem that a correct prediction can be made even if the prediction influences voting behavior; and finally he argues that the mathematical assumptions of the model hold in empirically interesting cases. Given the similarities in the two papers, it seems appropriate to refer to the papers collectively as "the G-M-S result on the possibility of a successful public predictions." We now turn to the relationship between these papers and the later literature.

II.   G-M-S AND RATIONAL EXPECTATIONS

The first model which Muth offered in his now famous paper on rational expectations (1961) was a linear stochastic version of the G-M

Figure 3.
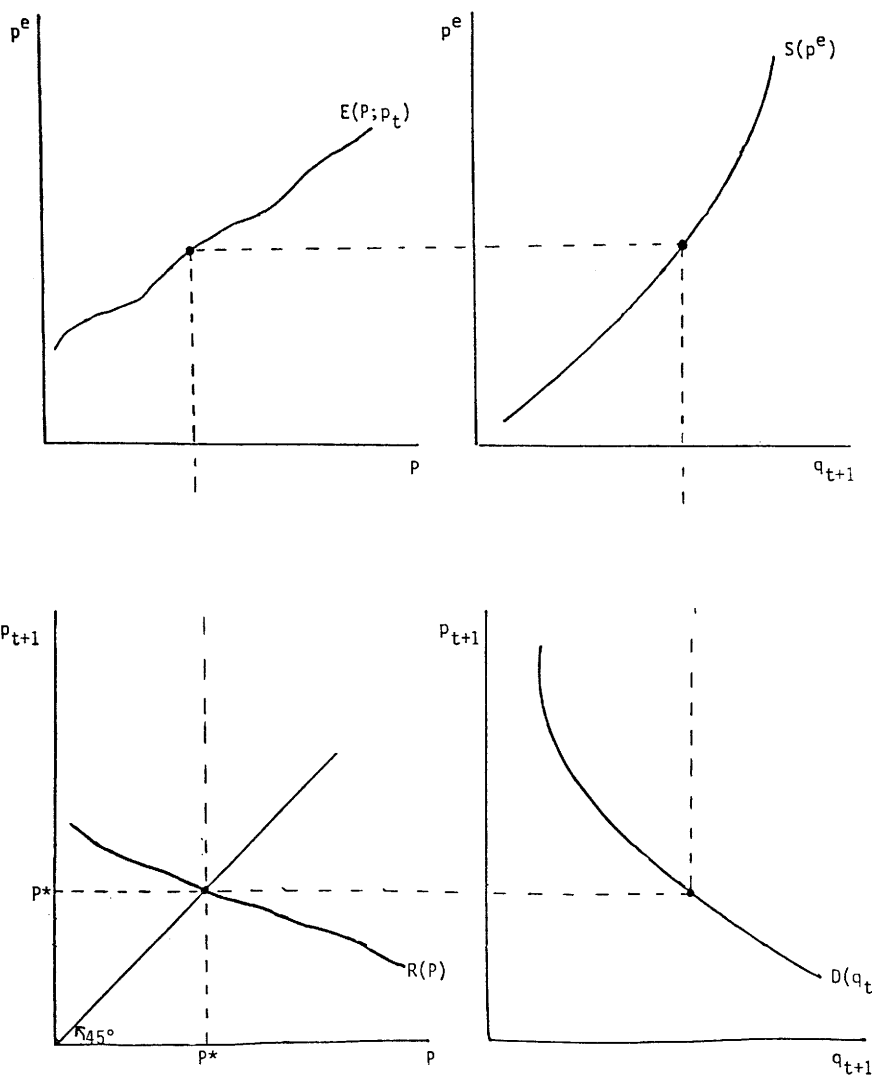
model. The model (converted into the previous symbolism) is given by,

$$S_{t+1} = \delta p_t^e + u_{t+1},$$
$$D_{t+1} = \beta p_{t+1},$$
$$S_{t+1} = D_{t+1}. \tag{4}$$

where all variables are presented as deviations from equilibrium values and the expected value of the error term u_{t+1} is zero. The expected price (P_t^e), as in the G-M paper, is the expectation of the price which will prevail at time $t+1$, formed at time t.

On the second page of his paper Muth provides the (much quoted) definition of rational expectations, ''I should like to suggest that expectations, since they are informed predictions of future events, are essentially the same as the predications of the relevant economic theory.'' (p. 316). Though other definitions of rational expectations have been offered, this original definition by Muth has endured and it remains the standard characterization in the literature.

Applying this definition to the supply and demand model in (4) Muth equates the rationally expected price with the equilibrium price. Suppliers with rational expectations will base their price expectations on the ''relevant economic theory'' and since the relevant theory predicts the equilibrium price, the equilibrium price is the price which suppliers will expect. Neglecting the stochastic aspect of Muth's model and characterizing it is terms of the previous Figures; rational expectations by suppliers simply makes the expectation function a horizontal line at the equilibrium price. Given such a horizontal expectation function, Muth's statement that, ''A 'public prediction,' in the sense of Grunberg and Modigliani, will have no substantial effect'' (p. 316), is entirely correct. In fact, with rational expectations on the part of the suppliers, not only will a public prediction have no ''substantial effect,'' it will simply have no effect at all.

Clearly the authors of the G-M-S papers did not assume that the economic or political agents in their models formed their expectations rationally. Neither the suppliers in the G-M model nor the voters in Simon's model are necessarily formulating their expectations on the basis of the ''relevant'' theory. But suppliers and voters are not the

only "agents" in the models of G-M and Simon. These models also include other agents (or agencies) which *actually do* the predicting, and *these predicting agents* do form their expectations rationally by Muth's definition. In both papers, a "correct" public prediction is possible precisely by considering the relevant theory (a theory which necessarily includes the expectational response of agents) in making the prediction. As asserted in the above introduction, the G-M-S papers do, strictly speaking, anticipate the theory of rational expectations.

While it is true that "some" agents in the G-M-S models form expectations rationally, these models differ in most other respects from the rational expectations models of the new classical macro theorists. In particular, the G-M-S models do not necessarily imply policy "impotence." One might suspect that since many models where agents have rational expectations exhibit policy (or predictive) "impotence,"[4] successful public prediction would disappear from the G-M-S models if the economic and political *agents* in these models formed their expectations rationally. This is not the case. The basic results of the G-M-S papers hold even if all agents formed their expectations rationally. In the G-M model, for instance, rational expectations on the part of the suppliers simply implies a perfectly elastic expectation function at the equilibrium price. Figure 4 clearly demonstrates that a correct public prediction can be made even under these circumstances. All a correct public prediction requires is that the predicting agent or agency, like the suppliers, predict the equilibrium price. Therefore a more complete characterization of the G-M-S result is that "a correct public prediction can be made *even if* agents form their expectations rationally." This is of course not very interesting from the view point of the original G-M-S problem-situation. These authors were concerned with showing that correct public predictions could be made even when those predictions influenced agent's behavior. If agents have rational expectations the correct public predictions can still be made, but it is not relevant to the problem which concerned G-M-S, since the agents behavior is not affected by the predictions.

One much discussed extension of the basic rational expectations argument is the so-called Lucas critique of econometric policy evaluation.[5] Since the Lucas critique seems to be highly regarded, even by critics of the new classical macro,[6] and since it explicitly concerns the

Figure 4.
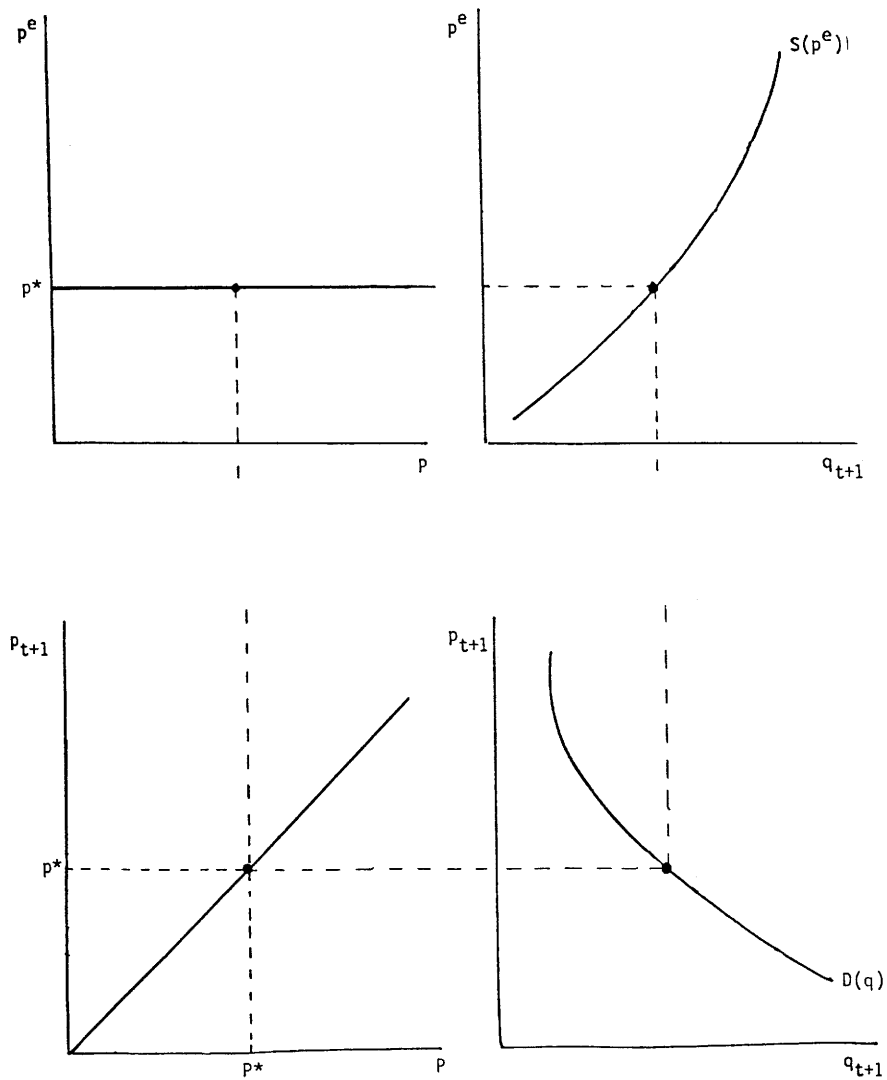
issue of "prediction" when agents form expectations rationally its relationship to the G-M-S papers seems to be an obvious question. The central argument of the Lucas critique is that rational agents consider policy rules in forming expectations, and therefore an econometric model which predicts the impact of a change in policy will err because of the way the policy change affects the behavior of economic agents. Put alternatively, the argument is that if agents are rational, those things which most Keynesian econometric models consider to be structural (consumption functions, investment functions, etc.) are not really structural, but rather change as a result of changes in policy. Lucas and Sargent argue that such "difficulties are *fatal*: that modern macroeconomic models are of *no* value in guiding policy" (1979, p. 2).[7]

On first gloss the Lucas critique seems to be in direct conflict with the results of the G-M-S papers. The G-M-S papers seem to say that prediction is possible when agents form their expectations rationally, while the Lucas critique seems to say that such prediction is impossible. This first impression proves to be incorrect though on closer examination. There really is no conflict between the two sets of results; the G-M-S papers are concerned with a fundamentally different problem than the Lucas critique. To see how the two arguments are different, return to the G-M model under rational expectations in Figure 4. If a shift parameter were included in the supply function, say an excise tax, then the model would have a different rational expectations equilibrium for each value of this parameter. The rationally expected prices would then be a series of horizontal lines in the northwest quadrant, one corresponding to each level of the tax parameter. Based on the G-M model, correct public prediction would still be possible even after such a change in tax policy. The agent or agency doing the predicting would simply predict the new equilibrium price for each tax rate. Such a correct public prediction could always be made given the informational assumptions of the G-M model.

Now suppose that the model is subjected to a "fundamental" policy change, such as an entirely *different type* of tax which fundamentally alters the shape of the supply function (rather than merely shifting it as before). Clearly in the G-M framework, this fundamentally new policy would not be a problem for the agent or agency doing the predicting.

The old supply function would simply be replaced by the new supply function and correct public predictions could be made just as before. The Lucas problem simply does not develop in the context of the G-M model because the G-M model always assumes that the predicting agent or agency ''has'' the full relevant structural information. G-M only considered models where a correct private prediction could be made (where the necessary structural information was ''known'') since they were explicitly concerned with the question of a self-falsifying public prediction and not the question of correct private predictions.

In contrast, the Lucas critique is concerned with the question of a correct private prediction. To see the problem, suppose that the only way of knowing the supply function was based on econometric estimation from past data. It is reasonable to argue that a change in the supply caused by an excise tax (or the resulting price) could be predicted using standard econometric techniques. For instance if a tax of x per unit changed the quantity supplied by y percent in the past, this relationship could be used to predict the future relationship between the tax and quantity supplied. Now though, consider an entirely new *type* of tax which fundamentally alters the relationship between taxes and supply. For such a ''fundamental'' policy change predictions based on the old estimates might be grossly inaccurate, and there is no information available to estimate the new relationship. Now this *is* the Lucas problem. Notice that this problem only exists for econometric policy evaluators, it is not a problem for the economic agents themselves; they know how to react to the new tax regime. Thus, the Lucas problem is, as Lucas clearly indicates, strictly a problem of econometric prediction under different policy rules. It stems from the problem of learning about the structure of the economy from its past behavior when the future is unlikely to be like the past. The Lucas critique is simply not a problem which occurs in, or affects the results of, the G-M-S papers given the information assumptions which they employ.

In summary then, I have shown that while the G-M-S papers were technically precursors to the literature on rational expectations, no paradox is implied by this fact. It is quite apparent that G-M-S were concerned with a totally different problem than that which concerned either Muth or the later rational expectations macro theorists. In the G-M-S papers both the agents forming the rational expectations and

the information available to those agents are very different than in later work. In particular, the G-M-S papers do not in any way anticipate either the policy impotence results common in rational expectations macro models or the Lucas critique. These much publicized implications of the rational expectations assumption are a result of the other assumptions of these macro models. The models of the new classical school as well as the problem-situations of their authors are different from the concerns of G-M-S. Given all this, there really is no paradox associated with Modigliani's criticism of the rationality assumption, and these authors' early unintended anticipation of the rational expectations notion.

III.   CONCLUSION

In concluding I would like to return to the original methodological/ philosophical problem which motivated the G-M-S papers. Has this problem been solved or is this philosophical issue still alive? Surprisingly, Modigliani seems to argue that it never was really alive. In his interview with Klamer (1983, p. 25) he states, ''I must confess that that article with Grunberg and my two articles with Miller on corporate finance are written with tongue in cheek, to really make fun of my colleagues.'' While this may have been Modigliani's attitude, the other two contributors certainly do not seem as cavalier about their earlier work. Grunberg (1986) has continued to discuss the topic, and Simon (1982) provided a quite spirited defense of his 1954 paper when ti was criticized by philosophers a few years ago.[8]

The problem of public prediction has a long history in the philosophy of social science. Grunberg (1986, p. 475) dates it from John Venn in 1866, and the list of influential philosophers and social scientists who have tried their hand at the problem's solution is quite lengthy.[9] For instance, the philosopher Karl Popper (1957, p. 13; 1974, pp. 121–22) was concerned with the related problem of self-fulfilling public predictions, referring to it as the ''Oedipus effect,'' while the sociologist Robert K. Merton (1936, 1948) discussed both the ''self-fulfilling'' and the ''self-falsifying'' variants of the problem. Ernest Nagel even dedicated several pages to both sides of the problem

in his influential survey of the philosophy of science (1961, pp. 468–9).

Despite the prestigious attention the question has received historically, it currently does not seem to be a topic of much interest within the philosophy and methodology of economics. This lack of attention is certainly not because the problem is considered "solved" by G-M-S or others, but rather because of the recent turn away from positivism within the philosophy of economics. When logical positivism reigned supreme, questions such as the self-falsifying nature of public predictions which emphasized the possible differences between the empirical testability of theories in social science and their natural science counterparts seemed to be more important than they do today in the post-positivist era.

While philosophers and methodologists do not seem particularly interested in the issues raised in the G-M-S papers the same cannot be said of economic theorists. In economics the issues raised by the G-M-S papers may be resurfacing. One of the theoretical reactions to rational expectations macro models which exhibit strong policy impotence has been the literature on so-called "sunspot" equilibria (Azariadis 1981; Cass and Shell 1983). These models investigate the impact the "extrinsic" uncertainty on rational expectations equilibria. Any factor is considered to be extrinsic if it affects the behavior of economic agents but does not affect the "fundamentals" of the economy such as endowments or preferences: "sunspots" are the paradigm case of such extrinsic factors. Unlike the new classical models, these sunspot models may have a role for government action even though economic agents form their expectations rationally. As extrinsic factors are defined in these models it seems that the agents or agencies actually making the public predictions in the G-M-S papers would qualify as extrinsic. The degree to which this connection with the G-M-S paper may be examined in future theoretical literature remains to be seen.

ACKNOWLEDGMENTS

NOTES

1. For instance it is cited in Begg (1982, p. 26), Merton (1987, p. 150), Minford and Peel (1983, p. 7), and Shiller (1978, p. 3). Shaw (1984) includes the paper in his bibliography even though it is not actually discussed in the text.

2. Not only does the first footnote in both papers glowingly acknowledge the help of the other author(s), each seems to credit the other with the idea of using a fixed point theorem.

3. "Once private prediction is assumed to be possible, the agent's reaction to a public prediction must also be regarded as knowable" (G-M, p. 466).

4. The reader is referred to any one of the excellent surveys of rational expectations (for instance, Begg, 1982; Minford and Peel, 1983; and Sheffrin, 1983) for a discussion of these standard results.

5. The argument was first presented in Lucas (1976) but the (negative) implications are more heavily emphasized in Lucas and Sargent (1979). The surveys by Begg (1982) and Sheffrin (1983) contain excellent presentations of the topic.

6. Christopher Sims recently referred to the Lucas critique as an "established orthodoxy" (1986, p. 2), and even Modigliani considers it to be a "thoughtful criticism" (1977, p. 5).

7. See for instance Sargent 1986 and Sims 1986.

8. Simon was responding to Aubert (1982) and Ofsti and Osterberg (1982).

9. Richard Henshel (1982) cites an earlier paper which gave fifty-four separate references to the problem and he considers this "only a fraction of the available material" (p. 513).

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