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**University of
California, Davis**

**THE DOMAIN OF THEORIES AND
TESTS BY THE REALISM OF
ASSUMPTIONS**

by

Thomas Mayer



Working Paper #98-11

IN D.B.

**Department
of Economics**

The Domain of Theories and Tests by the Realism of Assumptions

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Comments Invited

The Domain of Theories and Tests
by the Realism of Assumptions

Thomas Mayer

Abstract

The principle that theories should be tested by the accuracy of their predictions but not by the realism of their assumptions needs to be qualified. As a practical matter we often need to evaluate the of applicability theories to cases for which they have not been tested by their predictions. Here we rely on the fact that theories are applicable only within a specific domain. In determining whether a specific case, which for which no direct tests are available is within the theory's domain, we look primarily at whether the assumptions of the theory are as applicable to it as they are to the cases for which the theory has been successfully tested.

Key words: realism of assumptions, rationality assumption, domain of theories.

JEL classification: B4.

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The Domain of Theories and Tests of the Realism of Assumptions

Thomas Mayer*

The leading justification that economists give for the unrealism of their assumptions is Friedman's precept that one should test theories only by the accuracy of their predictions and not by the realism of their assumptions. Elsewhere (Mayer, 1995, Ch. 7), I have advocated a moderate version of this precept. Here I argue that it needs to be qualified to take account of the fact that we do not test directly the implications of many of our statements, and to delineate the domain of those we do test. My focus is on the rationality assumption, but the same principle applies also to other assumptions. I deal only with positive economics, and not with the readily justifiable rationality assumption made in normative economics.

I. The Domain of Theories

Theories have limited domains. For example, quantum theory applies only to subatomic particles, and as yet cannot be fully reconciled with relativity theory. Unless the bounds of the domain are kept in mind theories may be used in circumstances where they do not apply, and also sometimes it may seem as though even correct theories are plagued by disconfirmed implications. But economists often do not specify the bounds of their theories and hypotheses by stating at least the most important *ceteris paribus* conditions. Instead, they leave it to the reader's intuition to interpret the limits.¹ For example, although neo-classical theory does not make the bound to its domain explicit, few economists consider it disconfirmed because someone who is asked for the time of day does not demand payment - the

theory is not intended to apply to this type of decision.

Economists do pay some attention to the domain of hypotheses by constructing alternative models that relax one or more assumptions of a previous model, But for two reasons that does not suffice. First, some assumptions, such as rational behavior, are relaxed only very infrequently, Second, there is the difficulty of telling whether these assumptions are met to a sufficient degree in the particular situation under discussion. What makes this problem worse is that for convenience and tractability assumptions are often stated in a stronger form than is strictly necessary for the theory to hold (see Mayer, 1995, Ch. 7) Thus, an economist may relax the closed economy assumption of a model and show that its results do not hold in an open economy, but often she cannot say by how much the results are changed if international trade accounts for, say 5 percent of GDP. By contrast, a physicist can tell by how much the existence of air pressure changes the speed of falling objects. This difference is probably due mainly to the limited role that experiments play in economics.² As a result, faced with a real world problem an economist, unlike a physicist, may have many models in his toolkit, but may not know which one to apply.

The domain of our theories and hypotheses therefore needs more attention, and it is required for the complete statement the maintained hypothesis.³ It can be delineated in two dimensions. An extensive dimension measures the "stretch" of the hypothesis. Does it cover open economies as well as closed ones, does it predict that the price level will rise if the growth rate of

money rises by more than 10 percent, or does it predict such an increase if the growth rate of money rises by just one percent? Sometimes, as in this case, such questions bring out the role of the *ceteris paribus* assumptions. One aspect of the extensive dimension is the amount of detail covered. Does the hypothesis claim to explain only the behavior of some average of stock prices such as the S&P 500, or does it claim to explain also the relative prices of individual stocks?

Then there is the intensive dimension of the domain. How much accuracy does the hypothesis claim: does it make quantitative or only qualitative predictions, and in the former case to how many significant digits is the result stated or intended to be taken seriously? For example, how similar must the prices of certain identical commodities be in different countries for the law of one price to be considered confirmed? (See McCloskey, 1985, Ch. 9) Unless we are told this how can we evaluate an hypothesis by the empirical evidence?

Failure to delimit the domain of theories both in terms of its range of its applicability and in terms of its accuracy may be a major reason why so often various empirical studies offer seemingly contradictory evidence. Moreover, even the same piece of evidence may be read as confirming or disconfirming a theory depending upon its (undescribed) domain. And as Zeckhauser (1986) pointed out, failure to specify the limits plays a central role in the debate between behavioral and what he calls rationalist economists.

Once one pays attention to the domain of theories it becomes apparent that testing by the accuracy of assumptions does serve

an important function. Consider, for example, a test of the hypothesis that monopsonistic and oligopsonistic elements play no significant role in wage setting. Suppose tests that have been undertaken for the automobile, paper and textile industries support this hypothesis. Does this mean that it is also correct for, say the airline and restaurant industries? Such questions are important because we are interested in the role of oligopsonistic wage setting in the economy as a whole, and not just in the three industries for which it was tested. So, we ask how representative they are, and we answer this question by seeing whether the structure of their labor markets resembles that of other industries, that is if they are located in more isolated areas, if their labor force has more firm-specific human capital, etc. But in asking such questions we are testing by the applicability, that is the "realism" of the assumptions of monopsonistic wage theory.

To illustrate the problems created by the need to specify the domain of a theory and its relation to testing by the realism of assumptions consider the following five other problems. The first is a test of Friedman's (1957) hypothesis that the proportion of permanent income saved is independent of the level of permanent income. The domain of this hypothesis is relatively clear, all or nearly all households.

But in the second problem, testing purchasing-power-parity theory, one needs to pay more attention to the theory's domain. Should the test verify whether it holds on a month-to-month basis, or is its domain confined to periods of several decades? A test showing that it does not hold on a weekly basis, or in

highly controlled, highly autarchic economy even in the long run, would not shake anyone's confidence in this theory. By contrast, a demonstration that it does not hold for relatively open economies in data covering a century would be fatal for it, because we believe that the necessary assumptions for purchasing-power theory are much more applicable in the latter case than in the former cases.

A similar issue arises in a third problem, testing efficient market theory. Is its domain merely a tendency of yields on similar assets to be similar, or is it intended to be the law-like generalization that all the relevant information available at any one moment is already embodied in all asset prices? In the former case one would treat the relatively smooth yield curve as an indication that the theory is correct. In the latter case one would conclude from the appearance of some anomalies, such as systematic excess stock yields in January, that the theory is disconfirmed. The relative smoothness of the yield curve does little to support the belief that efficient market theory is correct over so large a domain that all assets are priced efficiently, because the latter requires stronger and hence less plausible rationality assumptions than the former.

A fourth problem is the frequent claim about globalization, that the world must now be treated as essentially a single economy. A recent paper (Ceglowski, 1998) reviewing the literature disconfirms this claim by showing that the existence of the U.S./Canadian border does make a difference to commodity prices and trade flows. This provides a strong refutation of the "one-world" hypothesis since proximity and shared language,

customs and life-styles, as well as the absence of tariffs, makes the assumptions of the one-world hypothesis particularly applicable for the U.S. and Canada. If the law of one price does not operate in the U.S-Canada domain, we would not expect it to operate in other international domains either. By contrast, a study that found equally large effects of borders on trade flow and price dispersions between the United States and Nepal would not be considered nearly as compelling.

The final problem is a test of the hypothesis that large firms with market power will sometimes use predatory pricing to drive rivals out of business. Someone who wants to test this hypothesis must select a sample of industries to investigate. He could pick random sample. However to obtain a strong refutation it would be more efficient to select those industries in which the hypothesis is particularly plausible. But the only way to pick such cases is to select situations in which the necessary assumptions of the hypothesis are met most closely.

Thus, although the primary test of a hypothesis is its predictive performance, the accuracy of its assumptions still plays a role in four of the five situations just discussed, because it affects the domain over which the hypothesis is treated as subject to testing, and subsequently as confirmed or 'rejected. This amount to more than a claim that tests by the realism of assumptions are relevant only to the applicability of a theory but not to its truth, because a full account of the theory should include a statement about its domain.

Attention to the domain of neo-classical theory has for two reasons become more important in recent years. First, the

rationality assumption has been more rigorously applied as rational expectations theory became the way to do macroeconomics (see Russell, 1998) New classical economists have argued persuasively that the domain of rational-choice theory should be extended to the way expectations are formed. But they are less persuasive when they go beyond that and extend the rationality assumption to claim that agents know the correct model. The adaptive expectations model may, despite its dubious assumption that agents do not use all the readily available information, be a better approximation than the assumption that during the sample period agents knew a model which had not yet been published. Shouldn't one assume instead that the model held by agents is the model that was pervasive at the time, rather than the new model, so that, for example, someone presenting a monetarist model in 1965 should have assumed that agents had a Keynesian rather than a monetarist set of expectations? Rational expectations theory gained persuasive power from a belief that if one assumes fully rational behavior for some purposes, one must assume it for all. But that is not so because theories have specific domains.

Insistence that agents know the correct macroeconomic model may also have gained currency in macroeconomics from an illegitimate analogy with microeconomics. In the theory of the firm there is a reasonable case ~~that~~ entrepreneurs know at least as much as economists do because they are the ones with hands-on experience, and can learn through trial and error. But they have no hands-on experience superior to the economist's in macroeconomic prediction

The second factor that has made looking at the rationality

assumption particularly important is that it has expanded its reach into other social sciences (see Baron and Hannan, 1994, Miller; 1997). That rational income maximization can explain so much economic behavior does not necessarily mean that it can also explain political choices. This is currently a much debated issue in political science.⁴ When explaining exchange rates we can ignore religious sentiment, when explaining voting behavior that is more questionable. Yet rational choice theory has had some successes in other fields, and that strengthens its plausibility in economics, the domain in which one would expect it to perform best.

II. Some Implications for Neo-classical Theory

The results of predictive tests of neo-classical theory should thus be interpreted in the light of the domain of the theory that they relate to. That the empirical evidence convincingly shows that demand curves slope downward is hardly persuasive evidence for the more ambitious predictions of neo-classical theory, such as that security markets do not over-react to news, or that workers are concerned only with their real and not their nominal wages (cf. Russell, 1997). In terms of a cliché that is often invoked to defend neo-classical theory, that there are no \$5 bills lying on the pavement allows us to say that there are no \$50 bills lying there either. But it does not allow us to say there are no \$1 bills lying on the pavement.

This principle also works for and not just against neo-classical theory. Suppose the critics of neo-classical theory succeed in refuting its claim that workers care only about real wages and not about money wages. That does not refute all of

neo-classical theory. It can be saved by shrinking its claimed domain. If such an immunizing strategy would have to be used on a large scale neo-classical theory would become a degenerative research program, but even in a well developed science an occasionally significant restriction of a theory's domain would hardly be surprising. Even if a research program has had to retract some of its claims, it may still provide a greater stock of verified, significant claims than do its rivals; one should not confuse the level and the rate of change of a theory's contribution. That its originators were overly enthusiastic should not be held against the current, more modest version of a research program.

III. Determining the Domain of the Rationality Assumption

There is little doubt that in some situations the rationality assumption is entirely appropriate; a starving person offered a choice between two loaves of bread will choose the larger one. But does the domain of rationality extend far enough to meet the requirements of Ricardian equivalence? We cannot test individually the applicability of the rationality assumption for all the numerous statements we want to make. But what we can do is to rank these statements by the strength of the rationality assumption that they require, and then to test for the upper limit to the domain of the rationality assumption.⁵

The term "strength of the rationality assumption" is sometimes hard to interpret. It is easy to think of cases where the relative strength of different versions of the assumption is unequivocal; for example, suppose that making the correct decision in situation A requires a knowledge of only high-school.

algebra, while in situation B it requires a knowledge of matrix algebra. But in many actual cases the decision about which is the stronger assumption is more equivocal, and some judgment based merely on casual empiricism and intuition may be required. Some bases for such a judgment are discussed below.

If one ranks the required rationality assumptions by their strengths one can see the frequent failure to consider the domain of the rationality assumption in another light; as a failure to distinguish between interpolation and extrapolation. To illustrate, rank the hypothesis by the strength of their required rationality assumptions, with 1 denoting the least amount of rationality that is required and 10 the most. Suppose that the predictions of hypothesis 5 (say, the life-cycle hypothesis of consumption) were confirmed. One can then consider the rationality assumptions made by hypotheses 1-4 as justified, but cannot argue from the success of hypothesis 5 that the rationality assumption used in hypothesis 10 (say Ricardian equivalence) is also confirmed.

The distinction just drawn between interpolation and extrapolation does not mean that extrapolation should always be avoided. But it does mean that any conclusion based on extrapolation needs to be independently confirmed by direct empirical tests.

Another benefit from ranking hypotheses by the strengths of their required assumptions (but not just by the strength of their rationality assumptions) is that one can then see which anomalies are worrisome. If the empirical evidence speaks against hypothesis 10, one can abandon it without fear that if one does

so, one must also abandon hypotheses 1 to 9. There is no longer the Hobson's choice that some rational expectationists seem to insist on: either accept extreme rationality despite the mounting evidence against it, or reject the analysis of economics in terms of rational behavior altogether and turn in your union card as an economist.

IV. Ranking Rationality Assumptions

Although ranking rationality assumptions by their strengths will often involve more or less arbitrary judgment, some plausible criteria can be set out. Thus it seems plausible that the rationality assumption is more likely to be satisfied when the stakes are large. Similarly, managers of firms in highly competitive industries are under more pressure to behave rationally than are managers of legally protected monopolies. Agents are more likely to act in a rational and self-interested fashion in impersonal transactions, such as buying bonds, than when making personal loans to friends. Some decisions, such as whether to accept a wage-cut, or take a less prestigious job, involve a person's feelings of self-worth, and are therefore encumbered by strong emotions that may interfere with rational decision-making. In some cases rational decision-making may be difficult because of the great foresight it would require. In cases where the pay-off is transparent, e.g. buying a 6 ounce bottle at \$1 or a 12 ounce bottle at \$1.50, decisions are more likely to be rational than in more complex cases, e.g. buying a 3 ounce bottle at \$0.89 or an 8 ounce bottle at \$2.39. Markets with highly educated and sophisticated agents (e.g. bond markets) are more likely to show rational behavior than are markets with less

educated agents (e.g. the market for small CD's). Market outcome:; are also more likely to satisfy the rationality criteria when the market structure allows rational agents to take advantage of mistakes made by less rational agents (cf. Russell, 1998, Zeckhauser, 1986).

Whether repetitive or occasional transactions are more likely to be rational is not clear. On the one hand, in repetitive transactions customers have more experience with and more incentive to inform themselves, but on the other hand, habits may play a larger role, and they may also have developed emotional ties to their trading partners.

This list of criteria determining the extent of rational behavior is probably incomplete, and at least in some cases it may be impossible to measure even ordinally the extent to which they apply to a particular hypothesis. Moreover, some may point in one direction and some in the other. Nevertheless, it is instructive to apply these criteria to two cases, efficient market theory, and the economics of the family.

V. Efficient Market Theory

If the rationality assumption is applicable anywhere it should be in organized security markets with their typically large transactions, competitive structure and impersonal transactions, opportunities for arbitrage, and with the important role played by highly sophisticated and educated participants. Concerns relating to self-worth are probably no more serious in these markets than in many others. To be sure, successful operations require much foresight and pay-offs are not transparent. But these are problems that sophisticated agents as envisioned by

neo-classical theory should be able to deal with. One would therefore expect the data to unequivocally confirm efficient market theory. But they do not. In his comprehensive survey of efficient market theory Stephen LeRoy (1989, pp. 1595, 1609, 1611-12, 1613-14) concludes that:

Most of the evidence accumulated in the nearly 20 years since ... [1970 when Fama's survey seemed to confirm the theory] has been contradictory. ... The consensus now is that the anomalies pose a serious problem that cannot be shrugged off. ... The majority of trades appear to reflect belief on part of each investor that he can outwit other investors, which is inconsistent with common knowledge of rationality. ... It would seem almost self-evident that the recent [1980s] wave of leveraged buy-outs provides strong evidence against market efficiency. The astronomical fees to investment bankers that these mergers generate are difficult to reconcile with any nontautological version of market efficiency, as are the stock price gyrations that accompany leveraged buy-outs. ... Finally, we have the October 19, 1987, stock market sell-off ... [S]tock values dropped half a trillion dollars on that single day in the complete absence of news that can plausibly be related to market fundamentals. ... However attractive (to economists) capital market efficiency is on methodological grounds, it is extraordinarily difficult to formulate nontrivial and falsifiable implications of capital market efficiency that have not in fact been falsified.

Similarly, Thomas Russell (1997, p. 97) reports that: "the evidence for inefficient markets, both from time series-data and from cross-section data, is so pervasive that many empirical investigators now take seriously the possibility that market prices do not reflect rational behavior." Russell concedes that: "These results are not uncontroversial", and cites Fama and French as believing that the apparent failures of the theory can be explained by risk variables omitted in the tests. But he goes on to say that:

many investigators now take seriously the possibility

that it is necessary to use models of behavior in which investors are not fully rational. ... one would have to be extremely committed to rationality not to agree that in the area of financial economics ... a number of important market phenomena are well explained by assuming that not all behavior is fully rational." (1997, pp. 88-90).

All in all, the rationality assumption does not seem to perform well in the market for which it is most plausible. That would appear to suggest that at least the extensive domain of neo-classical economics is so small that it would be hard to locate.

VI. The Family and Other Traditionally Non-Economic Issues

One would expect the rationality assumption, and hence the economic theory based on it, to be much less applicable when dealing with issues such as marriage and divorce, racial discrimination, voting behavior and crime, than in dealing with the pricing of securities.⁶ In these situations competitive pressures are usually less than in security markets, personal factors and considerations of self-worth bulk larger, only a smaller proportion of the participants is highly educated, great foresight is often required, and pay-offs are often opaque, in part because of the scarcity of legally enforceable contracts. Moreover, (except in the case of racial discrimination) rational agents usually cannot profit from the mistakes of less rational agents and drive them, out of the market.⁷

But as the work of Becker and his students demonstrates, economic theory has much to contribute to important questions in many of these areas ⁸ For example, Becker, Landes and Michael (1977) were able to explain many observed characteristics of divorce by using economic theory to show that the probability of

divorce is decreased by an increase in the anticipated earnings of men, a lesser likelihood of unanticipated events, an increase in the number of children, marriage within one's own religious, educational and I.Q. groups, and not marrying at a relatively early age. To be sure, many of these findings can be explained by "common sense", but the relevant point here is that they show that even in a very personal matter people behave as economic theory predicts.

VII. A Puzzle?

That efficient market theory appears to fail while the economics of the family is a successful research program seems surprising at first glance. One possible explanation is that the conditions listed above as determining the suitability of the rationality assumption are mistaken, or that they have been incorrectly applied. That seems unlikely. Another possibility is that subsequent research will resolve most of the anomalies of efficient market theory. That, too, seems, unlikely. A third explanation of the poor performance of efficient market theory is that it is due to the failure not of the rationality assumption, but of some other assumption. But it is hard to imagine what that assumption could be.

A fourth, more plausible explanation is that the seeming better performance of economic theory in explaining family behavior than financial market behavior is an illusion because different standards are being applied to these topics. Efficient market theory had become the standard paradigm in finance, and thus a potentially fruitful target. Numerous anomalies have been found and have received much attention. Much less attention is

being paid to the fact that the theory also has its important successes. We do not (except for the closed-end funds puzzle) find almost identical securities that can be expected to provide widely divergent yields. There is a January effect (yields of small stocks are higher in January than in other months), but January is just one of the twelve months. If one applies falsificationist rules, then efficient market theory has been disconfirmed. But as a rough heuristic it still works, though with some important exceptions. By contrast, the advocates of the Beckerian economics of the family cite many examples of the theory's successful predictions. In doing so they apply the much less strict rules of verificationism. Perhaps, as the economics of the family matures and becomes the target of more critics, many exceptions will be discovered (see Goldfarb, 1995). In other words, efficient market theory is too ambitious because the theory claims such a large domain. Its extensive domain is large because it tries to explain asset prices in so much detail, while its intensive domain is large because it makes precise predictions. By contrast the economics of the family makes primarily qualitative predictions, and has not tried to explain just about everything that occurs in the family.

VI. Summary

Theories are applicable only within a restricted domain, and their success within that domain does not justify conclusions drawn from them in areas outside the domain for which they have been confirmed. And in establishing the domain of theories the realism of assumptions plays an important role. While it is possible to list a set of factors that help to determine the

domain of the rationality assumption, a comparison of efficient market theory with the economics of the family shows that one must also consider carefully the way the theory has been confirmed.

Endnotes

* I am indebted for helpful comments to Tom Russell and to participants in the Conference on Philosophy, Methodology and Economics at the University of New Hampshire.

1. Some notable exceptions are Gary Becker, Thomas Russell and Richard Zeckhauser. A philosopher of science, the late Richard Rudner, once remarked that a major difference between the physical and the social sciences is the extent to which the former demarcate the domain of their hypothesis.

2. The argument that the greater ability to experiment accounts for the greater success of the natural sciences is usually countered by saying that astronomy, cosmology and evolutionary biology also cannot experiment. But that is not compelling. While astronomy and cosmology cannot experiment themselves, they can rely on the experimental results generated in physics and chemistry. And evolutionary biology, is hardly among the more solidly established natural sciences. If all natural sciences were like evolutionary biology their prestige would not exceed the prestige of economics by as much as it does, if at all.

3. It may not be realistic to ask the original proponents of a theory or hypothesis to establish its limits, but subsequent researchers should do so.

4. Thus a psychologist and political scientist Robert Abelson (1995, p. 34 writes: "in correcting for the near-sighted view that human behavior is unremitting, selfish instrumentalism, the first step is to acknowledge that this position has boundaries. The second step is to identify those boundaries empirically and theoretically. . . ."

5. Some degree of rationality is obviously the norm, and hence a hypothesis that requires that agents have only a limited degree of rationality also makes what may be a strong assumption. But such a hypothesis is unusual. Usually if the hypothesis is correct given a certain degree of rationality it is correct also if agents are more rational.

6. To some extent the common reluctance to believe that economic theory can explain factors such as divorce, crime, etc., may be due to an illusion. We know from personal observation that individual characteristics, such as a capacity for love and a conscience inculcated in childhood, are major determinants of the propensity to seek a divorce, or to commit a crime, so that not

much room is left for economic determinants. That is true on the individual level, but when we aggregate and look at large populations these individual idiosyncrasies cancel out.

7. However in terms of the agent's welfare decisions are often larger in some of these markets than in security markets. For most people an unwise marriage has more important consequences than any single action they take in the security markets.

8. For a summary of work on discrimination, crime and the family see Becker (1993). Miller (1997) **summarizes** the influence of economics on political science. For a survey of the debate about the applicability of the rational actor model to political science see the Winter-Spring 1995 issue of the Critical Review, and its summary by **Friedman** (1995).

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