The Lucas Critique: A Lucas Critique

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Abstract

The Lucas critique has been – and continues to be – the cornerstone of modern macroeconomic modelling. In this note we apply the Lucas critique to macroeconomic modelling using deep rational expectations. In conclusion, we point out that Lucas's critique reveals a fundamental flaw in Lucas's own, popular 'solution', i.e., the so-called forward-looking rational expectations models. Heeding Lucas's call for model-consistent policy advice eventually requires an ontological shift in economics – which throws the door wide open to an exciting, hardly-explored field of economic research.

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1. Introduction

In 1976, Robert Lucas mounted an influential attack on the then common approach to macroeconometric modelling, by pointing out that the econometric models then *en vogue* lacked what is commonly called internal consistency. Put simply, model forecasts and rational choice were at odds with each other.

Lucas's critique henceforth gave rise to a new class of macro models which are built on rational decision making on the micro level, and deliver results on the macro level that are consistent with individual choices. Today, the so-called 'real business cycle', 'new classical' and 'new Keynesian' models claim to heed the call for model-consistent expectations in order to analyse alternative macroeconomics policies. Currently, the dynamic stochastic general equilibrium (DSGE) variant of these model types, represent the most popular approach.

In this note, we apply Lucas's critique to the choice of these models. It will be shown that contemporary macroeconomic modelling strategies are in obvious contradiction to rational choice and, therefore, by Lucas's standards – rather useless for actual policy analysis.

2. Lucas's Influential Criticism

Lucas (1976) famously took issue with the dominant econometric approach of the 1960s and 1970s, which was to use one and the same model for describing both the working of the economy, as well as for analysing the outcomes of alternative economic policies – without paying due attention to how people would react to those policies. Ignoring these reactions is a mistake, Lucas claimed, because they would, in fact, impact the model on which they are based. In Lucas's (1976) own words:

> '[. . .] given that the structure of an econometric model consists of optimal decision rules of economic agents, and that optimal decision rules vary systematically with changes in the structure of series relevant to the decision maker, it follows that any change in policy will systematically alter the structure of econometric models' (Lucas, 1976, p. 41).

Arguably, Lucas was not the first to recognise an inherent contradiction between giving policy advice for achieving a certain goal on the one hand, and assuming that nothing else of importance would change in due course on the other. In fact, as early as 1944, Haavelmo raised the problem of econometric stability and identifiability of model coefficients, and independently, as well as concurrently with Lucas, Goodhart (1975) came up with what was later dubbed 'Goodhart's law' – stating that the implementation of a certain policy which is based on some statistical regularity, will unavoidably change this regularity.

Lucas's unease with the assumption of stable coefficients was further matched by the views of others who also expressed their doubts – more or less along the lines of the above quote.[1] In contrast, however, Lucas not only criticised the implausible assumption, but also made a suggestion of how to overcome this problem. This second part of the Lucas critique eventually caught the imagination of many economists, and became the cornerstone of modern macroeconomic methodology.

In order to resolve the inconsistency problem, Lucas first introduced a new function that relates the state variables, parameters and shock to the policy variable, and then integrates this policy function into the model. The model parameters, thus, turn into functions of the policymaking process. Finally, Lucas argues, economic agents are able to understand the interrelatedness of policy conduct, and to predict the relevant model outcomes giving rise to so-called rational expectations solutions to macromodels.

In view of the fact that Lucas not only outlines a specific criticism, but also a remedy, reveals that the 'Lucas critique' is in fact a composite concept with two distinct parts. The first part is made up of the fairly well established issue of lack of parameter invariance in econometric modelling when considering deliberate policy action building on the very model. This part of the Lucas critique we may simply refer to as its positive part. The second component, which turned out to define macroeconomics for several decades to come, however, is normative by nature as it devises a remedy to the inconsistency problem.

The composite nature of the Lucas critique can be shown to be at the heart of the internal inconsistency of the critique itself when applying the positive analysis to its normative prescription.

3. Deep Rational Expectations

In the aftermath of Lucas' papers a whole new literature on models that achieve consistency between model-based expectations and the models themselves emerged. This 'Lucas-proof' modelling approach turned out to be so (seemingly) successful (Smets and Wouters, 2003; Smets and Wouters, 2007, for example) that in 2003, Lucas declared:

> 'that macroeconomics [. . .] has succeeded: Its central problem of depression prevention has been solved, for all practical purposes, and has in fact been solved for many decades to come' (Lucas, 2003, p. 1).

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[1] Lucas explicitly mentions Jacob Marschak and Jan Tinbergen (Lucas, 1976, p. 20, footnote 3).

From Lucas's 2003 perspective, a long and challenging mission had seemingly been accomplished. Back in 1976, Lucas had observed that contemporaneous models were doing a good job in short-term forecasting but 'are meaningless' (Lucas, 1976, p. 24) when it comes to long-term forecasting.

However, immediately after Lucas's initial publication several econometricians were able to show that this claim was very far-fetched, to put it mildly. For example, Klein (1985) found that inflation in the early 1970s was mainly due to exogenous shocks, yet not due to policy shocks as Lucas had claimed.[2] Eckstein (1983) likewise concluded that changes in policy regimes were only minor sources of structural change in the economy and of forecasting failures. Using the concept of super exogeneity, Favero and Hendry (1992) argued that some of Lucas's behavioural parameters did indeed not change in response to policy shocks - which is in obvious contradiction to Lucas.

These statistical arguments against the Lucas critique were accompanied by several other issues raised against it. For example, the stability of Lucas's 'deep parameters' (preferences and technology) have been questioned (Solow, 1978) as well as the way in which Lucas advocated the 'microfoundation' of macroeconomics (Summers, 1986; Syll, 2016; Murray, 2016) or the ability of agents to obtain and process the necessary amount of information for expectation formation (Klamer, 1984; Tobin, 1981). One may add the fact that the aggregation of individual utilities obtains anything but stable aggregate demand or supply schedules (Debreu, 1974; Sonnenschein, 1972; Mantel, 1974) and several other objections which are too numerous to cover in due detail.

Furthermore, Lucas's and his disciples's 'success' narrative of the Lucas critique now co-exists with an alternative interpretation tradition that focusses on alternative responses to the Lucas critique's positive part. Most prominently among them certainly is Lawson's (1997) transcendental realism that calls for the comparison of rival theories, all of which are necessarily fallible, but one may nevertheless discriminate between them based on empirical evidence.[3]

In the wake of the 2007/2008 financial crisis, Lucas's (1976, p. 42) claim that this newer class of models would systematically outperform traditional models that are not based on micro-founded rational expectation came under attack again (Stanley, 2000; Edge and Gurkaynak, 2010) and lost some of its appeal at large. The question thus re-emerges: what makes the 'Lucas-proof' model class vulnerable to challenges posed by the developments in the real economy and by competing models that lack model consistent expectations?[4]

All mentioned and not-mentioned alternative suggestions notwithstanding, one answer is Lucas's account of the benefits of introducing rational expectations. As has been shown before, Lucas rightfully emphasises that rational individuals will realise the consequences a policy choice has *according to a given model,* and hence this model must consistently account for the predictable effects of such policy moves. However, this notion leaves unexplained the actual *choice of the model*. In other words, before formulating model consistent expectations, an individual must choose a model to build expectations on in the first place. It is only reasonable to assume that rational individuals do also choose their model rationally.

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[2] See also Blinder (1988) on this issue.
[3] Goutsmedt, Pinzon-Fuchs, Renault and Sergi (2016) offer a discussion of several alternative reactions to the Lucas critique's positive part.
[4] Smets and Wouters (2003, 1151) argue that their model is 'very close to that of the best VAR models. This implies that the DSGE model does at least as good a job as the VAR models in predicting [. . .] over the period 1980:2 to 1999:4'.

Therefore, the question arises what would be a rational model choice. Again, Lucas (1976) provides a useful hint. Referring to the standard econometric practice of his day, he notes:

> 'No one, surely, expected the initial parametrizations of [the traditional] models to stand forever' (Lucas, 1976, p. 24).

By simple analogy, a rational individual would not have expected in 1976, or any time before or after, that the most popular (benchmark) micro-founded, 'Lucas-proof' model at any given point in time would 'stand forever'. The consequences are, again, far reaching. A rational individual would not only make up his mind about the consequences of a certain policy measure within a given model, he or she would also account for the fact that this very model would sooner or later be replaced by a better one that might yield different implications of the same policy. We may call this additional layer of rationality 'deep rational expectations'.

Owing to the transitory nature of any economic model, an individual would therefore *rationally* choose not to place too much weight on the implications of any given model.[5] Exactly how much weight he or she does place remains *prima facie* unknown. What can be safely said, nonetheless, is that it is pretty unlikely that an individual would expect that the implied consequences of a particular given model will fully surface. By backward induction, he or she will hence not consider the rationally optimal solution of this particular model to offer a sound basis for decision making.[6]

Consider Leeper, Traum and Walker (2017) as a case in point. The authors describe their approach in the following way: 'We augment a monetary DSGE model from the class that Christiano, Eichenbaum, and Evans (2005) and Smets and Wouters (2007) develop with a rich set of fiscal details ...' (Leeper et al., 2017, p. 2409). With three models mentioned in one sentence the key question now obviously becomes what model is the 'right' one for building expectations and policy simulations.

In Christiano, Eichenbaum and Evans's (2005) paper the 'right' model apparently was Christiano et al.'s (2005) model, while in Smets and Wouters's (2007) it was theirs. In both these models the rational agents maximise their respective objective functions over an infinite time horizon (Smets and Wouters, 2007[7]), while being at the same time unaware of the fact that their employed models would be outdated in no less than two or ten years respectively. This ignorance is, of course, in obvious contradiction to Lucas's admonition that no one should expect a model's initial parametrisation 'to stand forever'.

Therefore, Leeper et al. (2017) do not only invalidate Christiano et al.'s (2005) and Smets and Wouters's (2007) approaches, but they repeat their fundamental mistakes. All their agents possess the amazing skill to optimise over infinite time horizons without actually being able to look further than two years into the future. What tastes somewhat like the proverbial plank in one's eye has significant implications.

To see this, one might consider a positive fiscal policy shock. Most rational expectations models – especially of the real business cycle type – have it that the long-run effect of this shock will be no change in output, but a rise in the price level. By virtue of these models, the rationally optimal individual policy response is to raise prices immediately, thus driving the output effect to zero – even in the short-run. In light of the Lucas critique and deep rational expectations, raising prices may not be the truly rational, optimal response, however. This is simply because a rational agent would expect that newer and better models of the

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[5] Alternatively, one might say that the Lucas critique requires to make the model choice to become part of the model of a rational agent.
[6] A similar idea has been developed by Frydman and Goldberg (2011, p.63).
[7] See pp. 1–3 in the online model appendix: https://assets.aeaweb.org/assets/production/articles-attachments/aer/data/june07/20041254_app.pdf)

economy will sooner or later emerge that might propose, for instance, that the best response could be not to raise prices or even to lower them.

Consequently, there is only one situation in which relying on any given model truly is the rational choice. This situation arises when the ultimate, unanimous 'true' model is at hand. Such a situation is, however, for pretty obvious reasons – neither plausible nor desirable to ever occur.[8] If the 'true' model was known, ingenious researchers like Smets, Wouters, Eichenbaum, Blanchard, Lucas, Leeper and all future generations of economists, would stop amending existing models or coming up with new ones to account, for example, for new developments such as the financial crisis. The alternative to this rather unrealistic prospect would be to, once and for all, restrict the universe of potential models to a set of models with agreed-upon properties. This alternative would, however, mean putting research in a straitjacket which would signify the end of economics as a science. Therefore, the ultimate model is not available, neither now, nor in the future.

4. Lucas-proof Squared

Deep rational expectations require that models must not only feature model-consistent expectations, but also take into account the transitory nature of the model itself. Rationality, therefore, does not only require rational expectations to be applied to the model, but also to the model choice. A model has thus to cover rational expectations within the model, as well as rational expectations with respect to model selection. This requirement adds yet another layer to the well-known Lucas critique. The problem remains, however, how to achieve that goal?

To the best of my knowledge, research has not yet produced an answer – though it is possible to tell what approaches do not work. One of those infeasible approaches is (Bayesian) model averaging, for example. Model averaging does not work because it does not solve the problem of not knowing what future, superior models will imply. So far, model averaging has only be applied and analysed with respect to known models, or known classes of models. Averaging should, however, be applied to as yet not-knowable models which is, of course, impossible.

Likewise mainly empirical models, like vector-autoregression models, may produce 'useful' forecasts, even in the presence of structural or policy shifts, but they, too, can merely serve as an approximation and tentative guide to policy analysis and optimal decision making. Their advantage might be, however, that they trade in some of the first layer Lucas critique for the second, because they tend to encompass many possible models (Sims, 1982; Lütkepohl, 2005) while not building on model consistent expectations.

It is also possible to identify two potential ways to make models truly 'Lucas-proof'. One either has to give in on rationality, or one should consider uncertainty.

The first option does not appear very attractive because it is not plausible to assume that individuals would systematically act against their own interests. Other roads, such as bounded rationality or rational inattention, also have their problems. Bounded rationality, for example, is haunted by the discomfort of assuming that a superior researcher can distinguish between complete and incomplete rationality, but an economic agent cannot. Likewise, in as far as that lack of rationality is owed to rational inattention, the item under consideration may not be interesting (enough) for the agent to bother much, so no one else should bother either.

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[8] Among the less significant implications we would conclude that many economic journals would instantly cease publishing because everything that could be said about macromodels would have already been said.

The concept of (fundamental) uncertainty, however, is potentially able to reconcile rationality, model consistent expectations and the Lucas critique. Fundamental uncertainty, following the definition of Keynes (1937), emphasises the possibility of not-knowable events and hence not-knowable models. And because these events and models are not knowable, they cannot follow a probability distribution function, and it is neither possible to apply expected utility maximisation, nor Bayesian learning or averaging.[9]

Fundamental uncertainty would imply that no matter how hard we try, no economic model would ever come close enough to the true underlying fabric of the economy, simply because no such true fabric exists. Therefore, fundamental uncertainty finally elevates the Lucas critique to an as yet, not widely discussed dimension – although Goodhart (1975; 1983) already offered some clues.

'Godhart's law' may be seen as a more general formulation of the Lucas critique's positive part, because Goodhart does not only consider changes to the model triggered by private agents actions, but also changes due to shifts in the institutional environment (Chrystal and Mizen, 2001, p. 12). The key questions then become: what is the source and motivation for private or public sector action and what can be expected from them? Interestingly, both questions are tightly related as both, at a very basic level, inquire about human imagination and creativity. To the extent that it is impossible to know all possible motives and ideas humans may come up with, is it impossible to imagine all potential ways in which the resulting actions feed back into the economy. This impossibility is at the heart of Christiano et al.'s (2005) and Smets and Wouters's (2007) inability to incorporate all future amendments to their own models from the very beginning, and the consequential inconsistency between optimisation horizon and durability of their respective models.

The message of the Lucas critique is, therefore, an ontological one. It signifies the shift from the quest for some given truth, to the quest for understanding human behaviour in an environment in which humans constantly create, amend, destroy and re-create social relationships without ever arriving at invariant social laws that govern human life. This latter world view is quite obvious in contrast to the traditional ontology that assumes some underlying truth waiting to be discovered, dating back to Mill (1844), and which is also referred to by Chrystal and Mizen (2001, p. 13) in their tribute to 'Goodhart's law'.

When rejecting objective truth, the way is cleared for fundamental uncertainty – because fundamental uncertainty builds on the not-knowable, whereas rational expectations rest on assuming an underlying, objective foundation that can be discovered, or sufficiently closely approximated, provided that enough resources are invested. If, however, the relationships to be modelled do not even exist, or emerge from creative, non-predictable processes, fundamental uncertainty is the concept of choice. Therefore, the Lucas critique must eventually be regarded a trigger and motivation for a research agenda that aims at integrating fundamental uncertainty into economic analysis.

For the time being, standard rational expectation modelling should be understood as a means of facilitating decisions in the face of otherwise paralysing fundamental uncertainty. In the medium and long run, however, individual decision making under fundamental uncertainty still awaits a systematic investigation. The Lucas critique should be taken as a strong reminder to shed light on this, as yet, unexplored problem.

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[9] In order to avoid confusion one should note that fundamental uncertainty must not be mistaken for Knightian uncertainty (Knight, 1921). Knight deals with known events for which probability functions exist but whose parameters are unknown and not-knowable. In contrast to that, Keynesian uncertainty deals with unknown events for which (consequently) no probability function can be given. Knightian uncertainty is, in principle, accessible to econometric analysis (Schorfheide, 2000, for example) whereas Keynesian uncertainty has not yet be shown to be accessible.

5. Conclusions

The Lucas critique has pointed out the necessity of incorporating optimal, individual decision making in economic model building. A thorough analysis of this demand shows that only deep rational expectations – which also take into account the transitory nature of all human knowledge and hence of economic models – can truly inoculate against Lucas's criticism.

Although it is still too early to fully understand the impact of deep rational expectations, a preliminary inspection of the available options seems to suggest that Lucas's critique must be understood as an urgent call for seriously acknowledging fundamental uncertainty in economic analysis and policy advice.

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