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Errors in Variables: Comments on the State of Economic Science

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Errors in Variables: Comments on the State of Economic Science

Stephen E. Spear
Tepper School of Business, Carnegie Mellon University

July 22, 2015
Introduction


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Stephen E. Spear  Tepper School of Business  Errors in Variables  July 22, 2015
Introduction

- The drastic reduction in impact citations for economic theory since the turn of the century represents, in my opinion, a collective failure for economics as a science.

- It will be the contention of this talk that this reduction in impact stems from the failure of theory to take adequate account of empirical evidence at those boundaries where theory meets practice.

  - The major boundary here is macroeconomics, though industrial organization and finance must also be considered.
Theory and Empirics

- Scientific knowledge gets built up through forward induction
  - Forward induction uses empirical observation to motivate models that approximate observed reality
  - The empirical side of science tests the predictions of hypothesized models for accuracy, and insists on revision where prediction fails
  - The inductive part of science takes negative results and goes back to observation (as distinct from testing) in an attempt to refine or replace models that don’t work
Theory and Empirics

- Examples of this process abound
  - Ptolemaic planetary dynamics versus Copernican dynamics (and the role of telescopic observation of Jupiter’s moons)
  - Mendeleev’s empirical grouping of the elements in the periodic table led to the recognition of atomic structure
  - Engineering measurements of the speed of light led to the revision of Newtonian mechanics in Einstein’s theory of relativity
  - Planck’s empirical fitting of the black body spectrum to a discrete distribution led to the revision of classical electromagnetic theory known as quantum mechanics
Economic Theory and Empirics

- We see similar empirical and theoretical interactions in economics in the twentieth century
  - Frisch’s recognition that economic processes would transform naturally occurring economic shocks in ways that resembled observed business cycles
  - Samuelson’s work building on Marshall’s microeconomics and the early general equilibrium theory of Edgeworth and Walras
  - Keynes’ pioneering work on coordination failure in response to the failure of conventional general equilibrium theory to explain the Great Depression
  - The subsequent integration of Keynes’ ideas in the Hicks-Hansen synthesis and contemporary New Keynesian models
Economic Theory and Empirics

- In the period between 1985 and today, I believe the connection between empirics and theory in economics has broken down.
- This seems particularly true in the field of macroeconomics.
  - Circa 1980, macroeconomists worked in an increasingly pessimistic environment in which all attempts to take their models to data resulted in the data rejecting the model.
  - Kydland and Prescott (1982, *Time to Build and Aggregate Fluctuations*) showed a way out, by abandoning formal model testing in favor of calibration exercises, which became known as Real Business Cycle theory.
Economic Theory and Empirics

- The so-called New Keynesian synthesis adopted the framework of the RBC model by first incorporating labor market frictions, and later, after Romer’s introduction of the Dixit-Stiglitz model of monopolistic competition in his work on endogenous growth, by incorporating monopolistic competition in the NK framework.

- The core argument in favor of calibration is roughly that the information content of any unrejectable model of an efficient industrial economy will be on the order of that of the economy itself.

- But this is so in the physical sciences as well, where attainable energies to test for things like the unification of fundamental forces are too large, yet physicists don’t reject the standard model of quantum theory because they can’t explain the gravitational data.
Economic Theory and Empirics

- Following the early RBC and NK modeling developments, macro seems to stall
  - As the neoclassical growth model takes on the status of workhorse model, the empirics of calibration begin to play the role of shielding the underlying representative agent framework from criticism
  - At the same time, the ease of application of the recursive methodology of forward dynamic programming (particularly after the appearance of the Stokey and Lucas text) is adopted across the spectrum of applied theory, in macro, in industrial organization, and even in applied micro contexts
Economic Theory and Empirics

- A major result of this insulation of the model from broad empirical scrutiny is the development of a consensus that other models and results can be safely ignored, or viewed as side shows.
  - As evidence of this, I would hold up Victor Rios-Rull's 1996 *REStud* paper "Life-cycle economies and aggregate fluctuations".
    - This paper studies a 70 period-lived stochastic OLG economy and demonstrates that the OLG framework delivers simulation results which can match calibrated comovements to the same extent that RBC models do.
    - As the <500 citations for the paper demonstrate, the take-away in macro to this paper was that OLG models – and the difficulties associated with analyzing them – could be ignored since they gave rise the same results as the growth model.
Limitations of the Neoclassical Model

- It doesn’t take a sophisticated econometric analysis to see the consequences of this adoption of calibration as the measure of success of a model.
- The RBC workhorse model – the neoclassical growth model – is, in fact, highly restrictive.
  - At its most general, it is a model of finitely-many dynastic families, all of whom discount the future at the same rate.
  - The model as generally applied in RBC macro requires that markets are complete, perfectly competitive, and that agents are all symmetrically informed.
  - With these assumptions, the structure of the model is such that the first welfare theorem holds, and, as a consequence, all outcomes are Pareto optimal – there is no room for useful policy interventions.
Limitations of the Neoclassical Model

- The extension of the RBC model in the NK literature and the more recent new dynamic public finance (NDPF henceforth) literature relax the assumptions of perfect competition and symmetric information, but largely maintain the reliance on the growth model as the workhorse.

- While these extensions have been useful in moving macro away from the simplistic RBC framework, the dynastic family/representative agent framework remains a problem.
Limitations of the Neoclassical Model

- What RBC/NK/NDPF misses
  - Life-cycle heterogeneity and consequences
  - Self-fulfilling prophecies – sunspot equilibrium
  - Market incompleteness
  - Increasing returns and market power

- For the remainder of the talk, I will focus on these issues
Life Cycle Heterogeneity

- In a stochastic environment, the heterogeneity of the life-cycle induces an incompleteness of markets for risk-sharing that is completely absent in the neoclassical model, though it is captured in overlapping generations models.

- The incompleteness occurs because in models where agents live more than two periods, portfolio rebalancing decisions induce income effects (the size of which depend on the distribution of wealth) that then require the inclusion of endogenous state variables to determine competitive equilibrium (see the Henriksen and Spear [2012] paper "Endogenous market incompleteness without market frictions..." for details).

- Rios-Rull’s model incorporates this feature (though without recognizing the endogenous incompleteness it induces) in what Victor called a "recursive competitive equilibrium" based on his recursive handling of agent optimization in his model.

- The induced asset market incompleteness of the model manifests itself primarily by inducing a deviation away from perfect consumption smoothing (in which, absent discounting, agents consume the same share of total resources in different states of nature).
Life Cycle Heterogeneity

- This deviation away from consumption smoothing is apparent in the Rios-Rull simulations, and is a prominent feature of follow-on work on wealth and consumption inequality such as the (2004) Storessletten, Telmer and Yaron paper "Consumption and risk-sharing over the life-cycle"
  - The endogenous deviation from consumption smoothing induced by the market incompleteness means that the competitive equilibrium does not deliver Pareto optimal allocations, and creates a role for social insurance policy that is simply not present in the neoclassical growth model
Life Cycle Heterogeneity

- As a kind of corollary to this set of results, recent work by Cres, Markeprand and Tved (2012) "Incomplete financial markets and jumps in asset prices" has shown in the context of the growth model that asset price jumps cannot occur if markets are complete.
  - Hence, to make the RBC/NK/NDPF models coherent with observations of real asset markets, some form of market incompleteness has to be assumed.
  - This feature of contemporary macro models makes the 2008 financial crisis all the more embarassing for economics, above and beyond the contention made by a number of prominant macroeconomists that this was simply a productivity shock that induced all of the observed long-term unemployed to elect not to work.
Life Cycle Heterogeneity

- There is also a long line of research (based on the pioneering work of Cass and Shell) on the possibility of self-fulfilling rational expectations equilibria in dynamic economic models.
  - This work has been summarized by Shell in what he calls the Philadelphia Pholk Theorem, which states that if an economic model admits competitive equilibria that are not Pareto optimal, the model can exhibit sunspot equilibria.
  - This conjecture has been widely verified now, in the context of OLG models, models of incomplete markets, and models of imperfect competition.
  - Sunspot equilibrium analysis also provides a natural framework for addressing questions about phenomenon like bubbles.
Life Cycle Heterogeneity

- A third example of how OLG dynamics deviate from the dynamics of the neoclassical growth model can be found in the work of Jones and Manuelli’s (1997) *JEDC* paper "The sources of growth" in which they show that while constant returns to scale technologies can generate endogenous growth in the neoclassical framework, no such result can hold in an OLG environment.

- This result points strongly to the need to consider models of increasing returns in order to understand endogenous growth in an environment that does not look like a small collection of dynastic families.

- Despite all of these examples, none of this work gets even close to the 500 citation threshold that the Kim, Morse and Zingales study posits as indicating professional attention to them.
Economic Theory and Science

- So, I arrive next at the question of what would good scientific conduct require of economic theory to move macroeconomics and the study of dynamic stochastic general equilibrium theory (and its applications) beyond the current self-absorption with the neoclassical model?

- If we look to the frameworks of modern physics, chemistry and biology, the answer is readily apparent: we need to examine models that nest different frameworks and then use the different predictions that come out of the different nesting assumptions to decide which model is better.

- But we **already have such a framework in the overlapping generations model**.
- Barro’s early demonstration of the use of operative bequests to link the neoclassical and OLG models in his work on Ricardian equivalence.
- Muller and Woodford’s (1988) JET paper "Determinacy of equilibrium in stationary economies with both finite and infinite lived consumers" showing that in the presence of both dynastic families and OLG agents, the OLG dynamics dominate.
Economic Theory and Science

- Given this nesting of the models, there are a number of ways that empirical economists could test the validity of the macro modeling assumptions
  - ...which brings me to the title of talk: Errors in Variables
  - In addition to obvious things like studying bequests and active estate planning, the general versions of the fully dynamic, stochastic OLG versus RBC/NK/NDPF models include major differences in the specification of state variables for the model.
  - There is also the issue of differences in predictions about economic efficiency between the two frameworks that could be tested
Errors in Variables

- As I noted earlier, the most general versions of stochastic OLG models need to include endogenous state variables.
  - Recent work by Citanna and Siconolfi has shown that the wealth distribution of the economy can play this role generically.
  - Hence, one test of OLG versus standard macro models would be to study whether wealth or income distribution variables explain a significant part of the variance of GDP.
Errors in Variables

- Models in which endogenous state variables appear also make distinctly different predictions about the efficiency of *liaisez-faire* market equilibrium
  - Work by Gabrielle Demange has shown that some form of the so-called Cass Criterion can be used to evaluate the efficiency of the production side of the economy
  - Based on this work, there have been a number of studies that have attempted to evaluate production efficiency of the U.S. economy
    - Abel, Mankiw, Summers, and Zeckhauser (*RE* Stud 1989) is typical of such work
  - Because this analysis is based on the assumption that the underlying neoclassical growth model is appropriate, it offers the satisfying conclusion that the U.S. and other industrial economies operate efficiently
Errors in Variables

- But this kind of analysis ignores the possibility that the distribution side of the economy might not be efficient
  - As shown in HS, if lagged endogenous variables are required for the determination of competitive equilibrium, the competitive allocation is generally not Pareto optimal
  - This result is intuitive: no central planner would introduced additional variance in a stochastic consumption allocation via endogenous state variables as long as consumers are risk-averse
  - So, an additional test of the neoclassical versus OLG frameworks would involve looking at the efficiency aspects of distribution
    - One additional thing to note is that neoclassical frameworks with things like habit formation or other intertemporal non-separabilities can lead to the need for endogenous state variables (see Duffie, Geanakoplos, Mas-Colell and McLenna *E’trica* 1994)
    - I would conjecture that the nature of the deviation from optimality across the two frameworks would differ, based on the horizon effects between the two models with respect to consumer behavior
Errors in Variables

- A third dimension on which the neoclassical and OLG models differ is in their predictions of what aspects of technology matter for growth
  - I noted earlier the Jones-Manuelli finding that growth driven by CRS technologies cannot occur in OLG contexts
  - This suggests that empirical study of the importance (or lack thereof) of increasing returns to scale in technology as a driver of growth could also provide a test of the two models
  - In the context of the neoclassical model, IRTS currently occurs in two distinct forms:
    1. External returns to scale, typically viewed as human capital accumulation
    2. Monopolistic competition with IRTS due to specialization (via Romer’s adoption of the Dixit-Stiglitz model in endogenous growth)
Errors in Variables

- External RTS face a problem if the external factor is costly to produce and accumulate (via Euler’s theorem on homogeneous functions)
  - Shell’s early work in the context of the neoclassical model internalizes costly innovation via taxation
  - Galor’s work on unified growth theory internalizes the human capital accumulation via family decisions, which requires an OLG framework
- These results suggest another test of the two models
Errors in Variables

- Models of monopolistic competition and specialization raise the additional question of whether specialization or phenomena such as network effects, economies of scope and actual economies of scale (resulting in oligopolistic market structures) are more important as drivers of growth
  - A clear need here is for more work oligopolistic general equilibrium theory
  - Some work on this exists
  
1. Goenka, Kelly and Spear on OLG dynamics with imperfect competition (in a pure exchange environment) uses the Shapley-Shubik market game structure and shows that thin markets can lead to complex dynamics

2. Korpeoglu and Spear show how to extend the market game to incorporate production with IRTS
Errors in Variables

- The financial implications of the neoclassical approach compared to OLG environments also suggests some tests of the two models
  - Stochastic, multi-period OLG models predict different efficiency outcomes associated with different financial market structures (see HS and follow-on work by Frabrizio and Spear incorporating production)
  - Geanakoplos, Magill and Quinzii ("Demography and the long-run predictability of the stock market," Brookings Papers, 2004) show that in the incomplete markets environment of the stochastic OLG framework, asset prices are predictable
  - As noted earlier, Cres, Markeprand and Tved ("Incomplete financial markets and jumps in asset prices," SSRN WP 2012) show that in a neoclassical growth framework with complete markets, jumps in asset prices of the kind typically observed in real stock markets cannot occur, suggesting that markets are incomplete
Finally, let me also address the role of experimental economics in testing between the two models I’ve been considering.

- Implementing experimental versions of the two models is conceptually easy to do and has been done on numerous occasions in the experimental economics literature.
- This suggests that testing some of the predictions outlined above in experimental contexts should be possible.
- This has already been done for some of the predictions.
- Marimon, Spear and Sunder ("Expectionally-driven market volatility: An experimental study," JET, 1995) showed that sunspot equilibria of the type predicted to occur in OLG environments could occur in the lab.
- Duffy and Fisher ("Sunspots in the laboratory," AER, 2005) provide an even better demonstration of this.
- Crockett and Duffy ("A dynamic general equilibrium approach to asset pricing experiments" SSRN WP, 2010) have shown in the context of the neoclassical model that when agents have an active reason to trade, the kinds of the asset price bubbles that have been observed experimentally in this model do not occur.
Conclusions

- Let me conclude this discussion by noting Paul Romer’s presentation at the 2012 Institute for International Economic Studies Symposium (briefly, the Nobel Symposium) on his work on endogenous growth.

- In the presentation, Paul explicitly discounts the work from his thesis as involving "magical thinking" via the assumption that human capital inputs to production are purely external, and except for this external effect, technology is convex, thus preserving the standard perfectly competitive paradigm of the neoclassical framework.

  - The problem with this, as we have noted previously (and as Romer also notes in his presentation) is the Euler theorem implication that if the accumulation of the external factor of production is costly, there will be no resources available to pay for it.

- Shell’s thesis showed how to get around this problem via a system of tax-supported investment in human capital, though this work has been widely ignored. Yet Romer’s self-confessed "magical thinking" paper has garnered over 15,000 citations!
Conclusions

- Romer goes on to (correctly, in my estimation) highlight his most important contribution to the endogenous growth project as his introduction of increasing returns to scale as an internal driver of endogenous growth via specialization.
  - Romer accomplishes this by incorporating the Dixit-Stiglitz model of monopolistic competition on the production side of an otherwise standard neoclassical growth model.
- But despite the success of this approach, a decade and a half after this work and adoption of aspects of the monopolistic competition model in the NK branch of macro, this thread of theory research appears to have "fizzled" (in the words of Paul Krugman).
Conclusions

- Romer, in his Nobel Symposium lecture attributes this "fizzling" to a notion of groupthink, predicting that
  - Groupish claims about methodology will prevent economists who disagree from fully engaging in the conversation needed to resolve disagreement.
  - "That’s not the way we do things"
  - "We don’t use monopolistic competition, we don’t theorize about preferences"

- Paul tempers this pessimistic view with the observation that it can and will be countered by the logic of mathematics in the theoretical modeling, and the confrontation of theory with facts, a view I very much agree with