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TRENDING TIME SERIES AND MACROECONOMIC ACTIVITY: SOME PRESENT AND FUTURE CHALLENGES

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Abstract

Some challenges for econometric research on trending time series are discussed in relation to some perceived needs of macroeconomics and macroeconomic policy making.

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Since the early 1980's, a good deal of time series econometrics has dealt with nonstationarity. The preoccupation has steadily become a central concern and it seems destined to continue, if only for the good empirical reason that most macroeconomic aggregates and financial time series are dominated by trend-like and random wandering behavior. Behavior, it should be said, that is very imperfectly understood (see below). As Hall's (1978) study so lucidly demonstrated, macroeconomists also have good theoretical reasons to look for martingale-like characteristics in the data. So, the study of trends brings together empirical-quantitative and theory-quantitative aspects of modeling and has, in turn, been empowered by that synergy. The literature is already vast and continues to grow swiftly, involving a full spread of participants and engaging a wide sweep of academic journals. With the immense volume of research that has already been done, what could possibly present major challenges for the future? It is salutary to recall that, in the beginning, some observers argued (mistakenly, it turned out) that the field was a dead end (why bother with unit roots?). Now, to others, the subject seems so heavily mined (who wants more unit root tests?) that they expect the vein of interest to surely run out soon.

This essay puts forward the alternate view that we have only begun to mine this enormous subject and that the veins of most interesting development are yet ahead of us. The

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brief from the Editor of a few pages means that there is no space to explore anything in detail, so the discussion here will simply point the way and stay at a high level of generality. Given that the ultimate goal of economics is to understand economic activity, substantive economic problems (including questions of policy) inevitably take priority over theory and technique. Yet, substantive problems regularly suggest promising lines of technical research. Useful methods (like functional laws and stochastic integration) are often more easily recognised as such when relevance is demonstrated - perhaps in terms of current events and policy concerns (see below for an example) and perhaps directly in terms of the needs of the subject (like understanding regressions with integrated regressors - Phillips, 1986 - or exchange rate target zones - Krugman, 1991). Accordingly, we shall take our cue from current economic events and single out an issue - productivity growth - that has major implications for macroeconomic trends. As Paul Krugman (1995) remarked: *"Productivity growth is the single most important factor affecting our economic well being..."*. The topic is full of worthy challenges for econometricians, including technical researchers. It has also been a subject of continuing pitfalls for macroeconomic commentators and forecasters.

Following a series of statements beginning in mid 1999 by the Chairman of the Federal Reserve, Alan Greenspan, it is now commonplace to attribute the recent low inflationary, strong growth of the US economy to a rise in productivity. Yet only a few years earlier, economists were concerned about a slump in US productivity. Again, no lesser observer than Paul Krugman (1995) commented that

> *"...the slowdown of American productivity growth since the 1970's is the most important single fact about our economy."*

Have economic fundamentals changed in a major way to bring about the dramatic recent uplift of productivity, and, if so, are our quantitative monitors so deficient that they provided no advance warning of the turnaround? The apparent trend change (or is it only a temporary blip? - see Solow, 2000) and need for better quantitative monitoring present serious econometric challenges. But, the issues go wider and deeper. Greenspan (2000) puts the implications in a way that bespeaks a startling ignorance:

> *"I know of nothing that even remotely looks like what we are experiencing today. The relationships are different.... The endeavour to apply the usual policies that we've employed over the years to what is going on today is misunderstanding the nature of the forces that are at play here."*

Earlier on, Krugman had highlighted general professional ignorance about productivity, saying

> "... *if we ask how economists answer two central questions about America's productivity slump: Why did it happen? And what can we do about it? The answer to both is the same: We don't know."*

Greenspan's unspoken allusions in 'forces at play' are to productivity and technology changes, the internet economy, financial bubbles in dot.com companies, wealth effects from stock market exuberance, and the shrinking NAIRU, to name a few. If these forces have so fundamentally changed the economy, and the policies that are needed to guide it, one might anticipate that major changes are needed in our models, or modelers can expect to be caught with their 'parameters down' again, as they were following the oil price shocks of the 1970's. The changes in the nature of economic activity now being forged by the rapidly emerging internet economy certainly seem unprecedented. Even the major economic transformations brought about in the nineteenth century by railroad transportation and in the twentieth century by automobiles and highway construction seem to be of a smaller magnitude than the changes in economic activity that will eventuate from 24/7 online consumer spending and financial trading.

How do we model trends when such fundamental changes are taking place? Reliance on a constant polynomial trend seems naive and misplaced (yet compare the empirical evidence many researchers find favoring a trend stationary representation of real GDP). Use of a stochastic trend with a constant drift seems better because an upward drift in productivity can be captured by a series of positive innovations, but also seems unsatisfactory because the sources of change remain mysterious and their implications for policy obscure, confirming Krugman's assertion about professional ignorance. The reality of 24/7 internet economic activity seems to present a more fundamental and pervasive change in the way our economy functions than what might be embodied in a few shocks, even allowing for them to have persistent effects. Finally (how easily the limits of present technology are exhausted!), we might seek to model the change by a trend break. But, if an observer as astute as Krugman failed to see the change coming, and if experts as experienced and well informed as he and Greenspan cannot understand it, then surely the chances of modeling it adequately using a break in a linear trend are naively optimistic. Unit roots and trend breaks do not explain the phenomenon, they simply account for it through the effect of a persistent shock, or by resetting initial conditions for the trend. Simply put, the inadequacy of our modeling apparatus in the face of an issue of such great importance is staggering.

So, what might be done about it? Here are a few simple thoughts to get us off the ground:

1. Start by acknowledging the impoverished class of trend mechanisms we have for our time series models and invent alternatives. Possibilities include using additional data (which might carry their own separate sources of trending effects and help to provide explanations of change) that mix time series macro data with relevant cross section information, like panel/pseudo-panel observations on technology items (e.g., computer hardware and software sales and measurements of internet traffic) and changing demographics. Surely, the ways in which fixed capital computing technology raise productivity involve some complex interactions and synergies with human capital, which are absent from most (not all - e.g. Galor and Zeira, 1993) economic theory mod-

els. Interactions between individual agents, economic institutions and various emerging technologies, which economists are now seeking to incorporate in models (see Brock and Durlauf, 2000), also play a major role in the productivity gains. Greenspan (2000) recognises these processes, saying in the same Question and Answer session to Congress cited above that

> *"...the fundamental root of this extraordinary successful economy that we have is, one, the synergies of a number of new technologies that have come together, coupled with a financial system and an economic system which has enabled those particular new technologies to be developed in a manner to very markedly enhance the standards of living of the American people."*

These synergies are totally submerged in econometric models that rely on deterministic time polynomials and unit roots for trending mechanisms. New econometric formulations and new methodology for handling such problems are desperately needed.

2. Recognise that the trend formulations we currently use in our models are misspecified, and, in circumstances like the present, heroically naive. An alternate concept I favor (see Phillips, 1998a) is that trend formulations do no more than provide coordinate systems for capturing trend effects. These coordinate systems offer valid alternative ways of modeling trends, and each provides its own frame of reference for the trend behavior. Even lagged variables and deterministic functions can successfully coexist and explain the same trending behavior - rates of convergence then adjust to accommodate the joint explanation of the trend (Phillips, 1998b). What this means in practice, is that we must learn to do inference about trends in settings where the real trend in the data is far more complex than the coordinates we are using to describe it.

3. Understand that there are implications for prediction. Even if we knew the true form of a trend, it may be so complicated relative to the available data that it would be necessary, or preferable, to work with a simpler model. Useable models need to have their parameters fitted and it is the information in the data that determines how close we can get empirically to the generating mechanism and the optimal predictor, this distance being larger when deterministic trends are employed and smaller for stochastic trends (Ploberger and Phillips, 1999). Polynomial trends turn out to be riskier in prediction than stochastic trends and so they need to be more heavily penalized when we choose between models. Unfortunately, the more reliant we are on constant time trends, the more likely we are to miss early signals of changes like those in productivity growth. So, a methodology for choosing models that evolve in form over time is helpful in identifying changes (e.g. West and Harrison, 1989, and Phillips, 1996).

4. Deterministic trends need not be polynomial. They can be slowly varying and even evaporating (i.e., their effects die out), an alternative which seems relevant in modeling

financial bubbles. Extensions along these lines await a definitive study and involve some new asymptotic theory.

5. Economic policy interventions (like central bank cash rate changes) result from the diagnosis of a myriad of macroeconomic, microeconomic and financial statistics. The resulting zero-one decision is a macroeconomic binary choice with a complex of indicators, many of them being nonstationary. Probability laws for characterizing such interventions depend on the nonstationarity, the simplest being a new 'arc sine law' of intervention that has been established recently by the author and Joon Park (2000), showing that interventions are most likely to come in a stream of interventions (like recent interest rate hikes by the Federal Reserve) or periods of no intervention (like that which preceded the latest phase of increases). These probability laws can be generalised to a wider class of processes and tested empirically. Ironically, these laws have the capacity to characterize policy decision-making even when very little is known about 'the nature of the forces at play'.

6. Use descriptive techniques to clarify features of the data, without being wedded to particular models. For nonstationary data, this means working with sojourn densities that characterize the time spent by the series in local neighbourhoods and which can be estimated by nonparametric methods (see Phillips, 1998c). This approach enables us to estimate hazard rates for data like exchange rates, interest rates and inflation, and do such things as measure historical risks of deflation (Phillips, 1999). Descriptive analysis of this type has the advantage of showing features of the data that models, even models that allow for regime changes, sometimes miss (some examples are given in Phillips, 1998c).

Not all recent views of technological progress accept that rapid changes are taking place. In another essay, "Technology's Wonders: Not so Wondrous", Paul Krugman (1996) wrote

> *"...the idea that we are living in an age of dramatic technological progress is mainly hype; the reality is that we live in a time when the fundamental things are actually not changing very rapidly at all",*

and gave the example that

> *"...building a computer that plays high-level chess turns out to be an easy problem - nowhere near as hard as, say, designing a robot that can vacuum your living room, an achievement that is still probably many decades away".*

Economists, like meteorologists, must be forgiven for making appalling predictions. The Dyson company (see http://www.dyson.com for details) has now developed and is marketing in the UK a battery-powered robotic vacuum cleaner (Model DC06 - a device that is 95%

navigation and 5% vacuum cleaner) that will automatically vacuum a room without assistance or programming, navigating its way around tables and chairs, negotiating uneven surfaces and avoiding stairs, all with the help of its 50 sensors and three onboard computers. DC06 and its future cousins in home appliances can be expected to change 'fundamental things' around the house, freeing up time, enhancing the supply of labor and raising output and consumption per capita.

Technological progress is hard to forecast and hard to model well, making Alan Greenspan's and Paul Krugman's admissions of ignorance about productivity all the more relevant. Econometricians get passed the difficult task of empirically modeling trends in economic activity. Reliance on the impoverished class of models currently in use certainly is cause for humility. The challenge to us is to innovate in our own technologies for capturing trends, for econometic forecasting with trending data, and for formulating useful rules of economic policy that recognise the data do trend. Some would say there is still much to do. I would say we are only beginning.

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