Essays on nonstationary nonlinear time series models

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In empirical time series analysis and forecasting, practitioners routinely adopt linear models as simple approximations to complicated, typically nonlinear economic relations. Linear models are useful in substantive economic problems. Ignoring nonlinear features, however, can be misleading for policymakers. The proposed methods in this thesis are additions to the toolkit for understanding nonlinear relations. In this chapter, I will discuss some practical relevance of the two main components of the dissertation – structural break inference and cointegrating polynomial regressions with a focus on the application of the Environmental Kuznets Curve (EKC) hypothesis.

As Hansen (2001)'s study lucidly remarked, "structural change is pervasive in economic time series relationships, and it can be quite perilous to ignore. Inferences about economic relationships can go astray, forecasts can be inaccurate, and policy recommendations can be misleading or worse." However, as will be seen in the following debate, the break locations are not always evident to modelers. It suggests the necessity of (trend) break estimation and inference as considered in Chapter 2.

The debate mentioned above is about the changes in economic growth. In recent years, it has been widely acknowledged that the nature of world economy has been altered by some fundamental changes. The first of these changes is associated with the sustained growth in human capital throughout the world, which is summarized as one of the new Kaldor facts (Fact 5) by Jones and Romer (2010). For example, the years of schooling in advanced countries have a steady increase by 5 to 6 years in the past decades. The growth accounting exercise conducted by Jones (2002) shows that educational attainment has contributed around 30% of the growth in total output per hour in the United States during 1950 to 1993. As such, educational level is potentially an essential driving force of economic growth in the second half of the twentieth century. Another change is the advancement of information technology (IT) including computers, semiconductors and software etc. Advocates of "New Economy" believe that the developments in IT, and the spillovers from IT into non-IT sectors can also drive the growth of economy persistently and stably; discussions can be found in, for instance, Jorgenson and Stiroh (2000), Baily and Lawrence (2001), Baily (2002), Black and Lynch (2004). The recent wave of technological innovation in machine learning, artificial intelligence, genetic engineering, 3D printing and so on, further leads many economists to see a bright future for economic growth.

On the other hand, skeptics argue that the growth rate cannot remain high permanently. At the end of the day, it must slow down because of a set of headwinds such as economic inequality (Gordon (2012, 2014)). At the center of debate for the U.S. economy, Robert J. Gordon takes the view that the demise of growth has already occurred four decades ago (Gordon (2014)). He enumerated some contradictions between the actual macro data of productivity growth and the predictions of techno-optimists. For example, the growth rate of output per hour is 1.59% on average from 1972 to 2013, substantially lower than the average 2.36% from 1891 to 1972. Earlier on, he found that the effects of New Economy on productivity growth are absent in 88% of the economy (Gordon (2000)). Not coincidentally, "You can see the computer age everywhere but in the productivity statistics", Robert M. Solow has commented (cited in Jorgenson et al. (2008)). Krugman (1999) supported from a similar standpoint that "...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".[1] This economic growth debate shows opposite views of growth patterns, possibly leading to different policy proposals. For this reason, a formal statistical evaluation is thus of crucial importance. The results developed in Chapter 2 are potentially useful.

Similarly, the false conclusion of the EKC evidence may also bring an undesirable shift in the development policies of both developed and developing

[1] See the essay "Technology's Wonders: Not So Wondrous".

countries. The growth trajectories of the EKC support a “growing now, cleaning later” development tactic. It is because the EKC essentially implies an automatic reversing behavior of deterioration when the income is beyond a certain threshold. Without critical evaluation of the EKC, the implied strategy may lead to some irreversible changes in Earth’s climate system. According to Global Environment Outlook (GEO-6) published by the United Nations Environment Programme, “the environmental change sweeping the world is occurring at a faster pace than previously thought, making it imperative that governments act now to reverse the damage being done to the planet.” Moreover, it is a popular opinion that environmental change or deterioration can cause tremendous pressure on overall human well-being including economic prosperity and social justice. Therefore, believing the EKC evidence mistakenly may have further negative impact on ecosystems and thus human well-being. Chapters 3 and 4 consider the cointegrating polynomial models and offer some statistical methods that allow researchers to assess the EKC carefully.

All in all, the conclusions from this thesis are relevant for both academic and non-academic researchers. I sincerely hope that this thesis offers rigorous methods and valuable insights for policymakers to make the right decisions. With this thesis, I have contributed to the research community, but definitely, more general methods and models should be done in the future.