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# Markov-switching stochastic trends and economic fluctuations

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## Abstract

I investigate cointegrating relationships such that, even though the long-run attractors are assumed to be linear, the dynamics of the equilibrium errors depends on the business cycle. I postulate a Markov-switching common stochastic trends model to study both the short-run responses to permanent shocks and the effects of recessions in the long-run growth. I apply these findings to explore the short- and long-run asymmetric relationships among output, consumption and investment.

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## 1. Introduction

Many non-stationary variables, even though may behave separately in the short-run, present a closely related long-run pattern. Engle and Granger (1987) describe these variables as being in a long-run equilibrium, in the sense that a linear combination of their levels behaves as an attractor. Thus, while most of the time the system is out of equilibrium, economic forces such as market mechanisms or government interventions, tend to correct these equilibrium errors. One drawback of the Engle–Granger approach is that it implicitly imposes symmetry in the dynamics of the equilibrium errors. This leads recent studies to consider that market mechanisms and government interventions may also lead to asymmetric dynamics of the equilibrium errors. On the one hand, Caballero and Hammour (1994) argue, within a creative–destruction framework, that

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there are market mechanisms moving the economy from a deep recession into the attractor more aggressively than it falls from expansions. On the other hand, the asymmetric adjustment may also be due to policy interventions. During recessions, policy authorities usually react more drastically against the adverse economic situation, accelerating the convergence toward the attractor. Even though we assume similar initiative for mitigating the effects of expansions and recessions, many authors have postulated the existence of a convex aggregate supply curve implying that monetary policy would have stronger effects within recessions. Garcia and Schaller (2002) have found empirical evidence supporting this view.

The examination of this non-linear adjustment mechanism has been one important development in recent time-series literature. The natural way of dealing with this problem has been by incorporating non-linear econometric techniques to both the vector error correction model of Engle and Granger (1987) and the common stochastic trends representation of Stock and Watson (1988a). Within the former, examples are the Markov-switching approach of Krolzig (1997, 1999), Krolzig and Toro (1999), Psaradakis et al. (2001), Krolzig et al. (2002) and Francis and Owyang (2003), the threshold approach of Balke and Fomby (1997) and Enders and Siklos (2001), the bilinear model approach of Peel and Davidson (1998), and the smooth transition regression approach of van van Dijk and Franses (2000), and Rothman et al. (2001). Within the latter, examples are the dynamic factor regime switching model of Kim and Piger (2002), and the Markov-switching bayesian approach of Paap and van Dijk (2003).

In this paper, I contribute to the growing literature on non-linear long-run adjustment by developing an alternative representation to the Markov-switching vector error correction model stated in Krolzig (1997, 1999): the Markov-switching common trends representation. For this attempt, I incorporate the asymmetric adjustment to the long-run equilibrium by assuming that the dynamics of the equilibrium errors is subject to regime switching business-cycle pattern. I show that this is closely related to a Markov-switching extension of the common stochastic trends representation developed by Stock and Watson (1988a). This leads to a decomposition of the series into permanent and transitory components that behave asymmetrically within the business cycles. In line with the dynamic factor model of Kim and Piger (2002), my specification captures two types of business-cycle asymmetries. According to the asymmetry advocated by Hamilton (1989), the long-run component is viewed as combinations of random walks whose rates of growth are state-dependent. According to the asymmetry suggested by Friedman (1993) and analyzed by Kim and Nelson (1999), the short-run component presents Markov-switching coefficients and exhibits asymmetric deviations of the variables from the trend component.

I apply these findings to examine the short- and long-run relationships among output, consumption and investment and compare my results with those of the linear approach of King et al. (1991), henceforth KPSW. This empirical analysis leads to the following interesting results. First, I find empirical evidence in favor of the claim that the equilibrium errors dynamics exhibits business-cycle asymmetries. Second, the estimated Markov-switching common trends representation presents lower in-sample one-step ahead forecast mean squared error than the linear approach. Several tests

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