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General equilibrium real and nominal interest rates ☆

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Abstract

We derive the general equilibrium short-term real and nominal interest rates in a monetary economy affected by technological and monetary shocks and where the price level dynamics is endogenous. Assuming fairly general processes for technology and money supply, we show that an inherent feature of our equilibrium is that any real variable dynamics, in particular that of the short-term real interest rate, is driven by both monetary and real factors. This money non-neutrality is generic, as it does not stem from any friction such as price stickiness, or from a particular utility function. Non-neutrality obtains because the ex ante cost of real money holdings is random due to inflation uncertainty. We then analyze in depth a specialized version of this economy in which the state variables follow square root processes, and the representative investor has a log separable utility function. The short-term nominal rate dynamics we obtain encompasses most of the dynamics present in the literature, from Vasicek and CIR to recent quadratic and, more generally, non-linear interest rate models. Moreover, our results pave the way to several new nominal term structures.

JEL classification: E31; G12; O42
Keywords: Real and nominal term structures; Inflation risk premium; Money neutrality; Production economy

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1. Introduction

We propose a general equilibrium of a frictionless monetary economy in which money is an argument of the representative individual's utility function. In a fairly general framework set in continuous time, we first derive and analyze the behavior of macroeconomic aggregates such as consumption, investment and real wealth and devote special attention to the inflation rate and the real and nominal interest rates. In a specialized version of the economy, where the representative agent has a log separable utility function and the state variables follow square root processes, we then provide explicit solutions to our model and derive in particular the implied dynamics for the real and short-term nominal rates. The main characteristic of our economy is that generically money is neither neutral nor superneutral, as monetary policy always affects the level and the dynamics of all real variables. [1] The transmission mechanism works as follows. An individual holding real balances faces an opportunity cost that ex ante is the nominal interest rate. However, the effective cost of money holding is not the nominal rate but the sum of the real rate and the inflation rate realized ex post. Under uncertain inflation, the two costs are distinct since, at the beginning of each period, the first one is known while the second is random. Investors' real wealth, and thereby all other endogenous real variables, are affected by this uncertainty. To further investigate the consequences of money non-neutrality, we provide a closed form solution for a specialized economy that can be viewed as the monetary extension of the real economy developed by Cox et al. (1985a,b), hereafter CIR. Our monetary economy turns out to possess original properties as compared to pure real economies or monetary economies in which the real and the nominal sectors are linked artificially or not at all.

The abundant and ever growing literature on term structure modeling and interest rate derivatives pricing witnesses the sizeable progress that has been accomplished in recent years both at the theoretical and the empirical levels. The adoption of new parametric and non-parametric techniques to estimate the term structure enhanced our understanding of the behavior of bond market prices and of the shortcomings of standard models. By comparison, relatively little effort has been devoted to providing these new models a sound economic background. The most widely used approach simply consists in assuming on a priori grounds a given dynamics for the short-term nominal rate and then deriving the dynamics of bond prices and/or the price of derivatives. Although the CIR model of the term structure was set in a gen-

[1] According to the standard definition, money is superneutral with respect to a given variable if a change in its growth rate does not affect the level of the variable (see Walsh, 1998, p. 56). This paper deals essentially with superneutrality, as it considers changes in the money growth rate, although it discusses neutrality occasionally. Since however we generally examine the impact of changes in the money growth rate on the dynamics of economic variables, not their levels, we will mostly make use of the following definition. Money is superneutral with respect to a given variable if a change in its growth rate does not affect the *dynamics* (expectation and/or volatility of the growth rate) of the variable. It will be obvious from the context whether this definition or the standard one is used. Finally, the phrase "non-neutrality" will be used throughout to mean "non-superneutrality".