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Endogenous monetary policy shifts and the term structure: Evidence from Japanese government bond yields

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ABSTRACT

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I construct a no-arbitrage term structure model with endogenous regime shifts and apply it to Japanese government bond (JGB) yields. This model subjects the short-term interest rate to monetary regime shifts, specifically a zero interest rate policy (ZIRP) and normal regimes, which depend on macroeconomic variables. The estimates show that under the ZIRP regime, the effect of deflation (inflation) on lowering (raising) bond yields amplifies on the long end of yield curves, compared with a case with positive interest rates under the normal regime. On the other hand, output gaps' ability to raise bond yields weakens for all maturities. *J. Japanese Int. Economies* **29** (2013) 170–188. Faculty of Economics, University of Tokyo, 7-3-1, Hongo, Bunkyo-ku, Tokyo, Japan.

1. Introduction

How are bond yields affected by endogenous shifts in and out of a zero interest rate policy (ZIRP)? Policy shifts are typically endogenous because they depend on the state of economy. For example, a ZIRP may be introduced when the Taylor-rule policy rate, which is a function of real activity and inflation variables, hits the zero lower bound of the policy rate. Policymakers may lift a ZIRP when the exit conditions on macroeconomic variables are satisfied. The answer to this question is relevant for countries currently under a ZIRP and struggling to meet macroeconomic conditions to exit the

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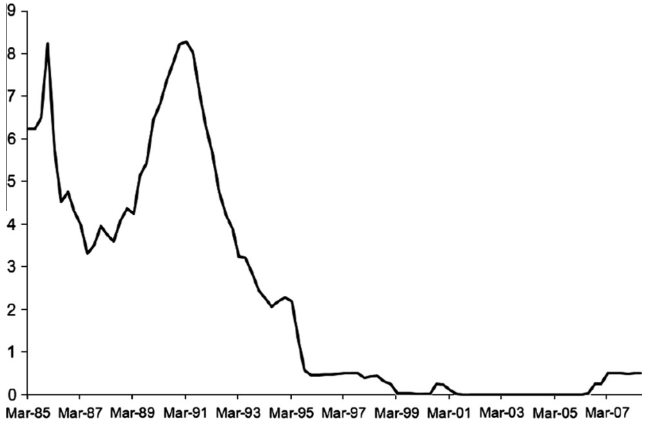

Fig. 1. Uncollarterized overnight call rate in Japan (annualized rate in percent).

ZIRP. The answer is of particular importance for Japan, which has already experienced such policy shifts several times. For Japan, small increases in bond yields can strain public finances with the ratio of public debt to GDP already exceeding 200%.

I examine this question by constructing a no-arbitrage term structure model with discrete regime shifts. The model has three key features. First, the probability of transitioning from a ZIRP depends on the state variables that appear in the monetary policy rule (e.g., output gap and inflation), allowing the entry and exit conditions of a ZIRP to depend on the state. Second, the model uses discrete regime shifts in the affine term structure framework, addressing possible nonlinearity in the conditional means of short-term yields (Ang and Bekaert, 2002).[1] Third, the state vector, which includes the policy rate, depends on the current, rather than the previous, monetary policy regime. This third feature is not trivial: today's policy rate should depend on today's monetary policy regime.[2] For example, a ZIRP status from the previous period does not guarantee that today's policy rate is set at the ZLB. Putting differently, if the model did not include the third feature, it would inappropriately allow a policy rate well above zero even during ZIRP periods. The model includes the policy rate in the state vector so that the lagged policy rate can affect the dynamics of macroeconomic variables, as modeled in the standard monetary VAR models (e.g., Stock and Watson, 2001) and several macro-finance term structure models (e.g., Ang et al., 2006; Hördahl et al., 2006).

This paper's model is related to the existing discrete regime-switching affine term structure models (ATSMs)[3] in the following ways. First, most existing models that incorporate the third feature assume a constant transition matrix (e.g., Bansal and Zhou, 2002; Ang et al., 2008; Hamilton and Wu (2012)). This paper extends these models by introducing state dependent transition probabilities. Second, Dai et al. (2007, henceforth DSY) implement state-dependent transition probabilities and discrete regime shifts (the second and third features) under the data generating or physical ($\mathbb{P}$) measure, while their state vector depends on the previous regime. This paper extends DSY's work by adding dependence on the current policy rate (the third feature) and by providing formal propositions and proofs and discussion on the link between the $\mathbb{P}$ and the risk neutral ($\mathbb{Q}$) measures.

[1] Alternatively, term structure models that lie outside of the affine family have been applied to the Japanese zero rate environments. See Ichiue and Ueno (2012) for an application of Black (1995) model to JGB yields and Kim and Singleton (2012) for a comparison between Cox et al. (1985) type affine model and non-affine models.

[2] To illustrate this argument, consider a simple censored Taylor rule: $r_t = \max\left[r_t^*, 0\right]$ where r is the policy rate and r^* is the shadow rate. Equivalently, this rule can be rewritten as: $r_t = 0$ if period t's regime is a ZIRP, $r_t = r_t^*$ otherwise. Thus by definition, the current policy rate depends on the current regime.

[3] Alternatively, Ang et al. (2011) model monetary policy shifts with continuous time-varying Taylor rule coefficients, treating these coefficients as latent factors. This paper differs from their model as it focuses on discrete and observable monetary regime shifts.