Discussion of "Term Structure Modeling with Supply Factors and the Federal Reserve's Large-Scale Asset Purchase Programs"*

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1. Introduction

I would first like to thank the organizers for inviting me to discuss this interesting and thought-provoking paper. This paper estimates a model of the term structure of government bond yields where, in addition to the usual level and slope factors, the supply of Treasury and mortgage-backed securities plays a role in the pricing of government bonds. This approach offers an alternative methodology to assess the impact of the large-scale asset purchase (LSAP) programs and the maturity extension program (MEP) on the term structure of interest rates. This is important because many previous studies did not have structural restrictions beyond an event study or an empirical model which postulated that a given future bond yield responds linearly to supply changes. This approach imposes no structure on how bonds with different maturities might respond to supply changes, however. The approach in this paper adds a requirement that all bond yields evolve in a manner consistent with no arbitrage. This then provides a method to assess the impact of supply on the entire yield curve.

2. The Model

The model starts out as a fairly standard workhorse model of the term structure called an affine term structure model. Under no

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arbitrage and some assumptions on the dynamics of state variables in the risk-neutral measure (which will exist if there is no arbitrage), we can write the time t price of a zero-coupon bond which pays 1 at time T as

$$B(t,T) = \exp(a(t,T) + b(t,T)X(t)), \tag{1}$$

where $X(t)$ is a vector of state variables, $a(t,T)$ is a deterministic function, and $b(t,T)$ is a vector of determinstic functions. In this paper, $X(t)$ includes the usual slope and level of the term structure: the novel part of the paper is to also include three supply variables in $X(t)$. One difficulty is immediate. What is the underlying model for the evolution of these variables? In order to fit the affine framework, they are assumed to be AR(1) processes and the vector $X(t)$ is a vector autoregressive (VAR) process. Further assumptions are required to translate the dynamics in the risk-neutral measure to the data-generating measure.

The shortcoming of this model is that bond yields can become negative. This suggests that while the model might work reasonably well in the period 1994–2007, in the recent low-yield environment it might encounter difficulties. It also implies that yields are linear in supply, and this might be a little bit of a stretch.

We should also ask what is the interpretation of the LSAP and MEP supply shocks. Are these unexpected shocks, or do investors form expectations of the future programs which conform to an AR(1) framework? For example, is LSAP2 unexpected or could this be anticipated given LSAP1? If it is unexpected, it would seem to fit into this framework, but otherwise perhaps not. The paper, in a later section, does address the future unwinding of a large purchase; this issue might fit into that framework as well.

Nevertheless, when the model is estimated using the 1994–2007 data, it provides a good fit to the data. The model also provides reasonable estimates of the impact of the LSAP and MEP programs on the ten-year yield—in line with previous studies. Here I believe the paper should better showcase the technique. The strength of this approach is to estimate the impact on the entire yield curve, so it seems like it might be beneficial to present yield curves with and without a given supply change.

3. Conceptual Background

The paper motivates this approach by appealing to limits of arbitrage. Limits to arbitrage certainly could affect the term structure if potential arbitraguers face constraints which limit their ability to take advantage of price discrepancies. However, this would seem to conflict with a term structure model which stems from a no-arbitrage framework. Perhaps this conflict can be reconciled, but this does require some further attention.

Some of the difficulty we encounter when discussing the pricing of government bonds seems to arise from modeling assumptions. We usually assume that economic agents are price takers—that is, they assume that they can buy or sell any quantity they want without affecting prices. Indeed, the economic content of the Fundamental Theorem of Asset Pricing by Dybvig and Ross (1987) is that no arbitrage is equivalent to a price-taking agent who prefers more to less with an optimal solution to a consumption investment problem. The idea that the supply of securities enters into the stochastic discount factor is not inconsistent with this basic paradigm. An inconsistency arises if individuals believe their actions will affect these risk factors. Assuming agents are "small," there is probably no reason to expect there is any inconsistency. My feeling is that there is no need to appeal to limits of arbitrage in the framework the paper is operating.

However, if we want to write a full structural model which relates the yield curve to underlying economic activity, we encounter many more problems. In these models we typically derive the price of nominal risk-free payoffs by computing a price at which agents are content to not trade the security. In many of these types of models, this is a good thing because the aggregate consumption is not sufficient to support even a nominal riskless payout across all states.

This type of approach also suffers from some other drawbacks. For example, a representative agent model will not attach any value to assets which serve as a store of value. My feeling is that U.S. government bonds do derive some value because they are widely considered a store of value. In this sense, I think that truly understanding how asset purchase programs work would require a model in which agents desire these store-of-value assets. Then one would want to model how agents perceive these programs and whether these

perceptions alter the desirability of these assets. Of course, this is a tall order. This model would probably resemble monetary models in which agents held money as a store of value because it helped hedge against low-income states—for example, as in Bewley (1980). This type of model requires that there is no predictable end of trade and assets which extend over the life of the economy. This would seem to present a difficulty in attaching a store of value to government bonds. However, my work with Greg Willard such as Loewenstein and Willard (2003) and Loewenstein and Willard (2012) shows how finitely lived assets could also serve as a store of value when agents are continuously marked to market.

4. Conclusion

Overall, this is an interesting and thought-provoking paper. On the one hand, it gives us a good sense of the effects of the LSAP and MEP programs. On the other hand, it also suggests the need for further developments on the theoretical side.

References

Bewley, T. 1980. "The Optimum Quantity of Money." In *Models of Monetary Economies*, ed. J. Kareken and N. Wallace. Minneapolis: Federal Reserve Bank of Minneapolis.

Dybvig, P. H., and S. A. Ross. 1987. "Arbitrage." In *The New Palgrave: Finance*, ed. J. Eatwell, M. Milgate, and P. Newman, 57–71. New York: MacMillan Press.

Loewenstein, M., and G. A. Willard. 2003. "Liquidity and Arbitrage." Mimeo, University of Maryland.

———. 2012. "Consumption and Bubbles." Forthcoming in *Journal of Economic Theory*.