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Augmenting the Taylor rule: Monetary policy and the bond market

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HIGHLIGHTS

- I augment the Taylor rule using principal components constructed from bond yields.
- The principal components improve the Taylor rule's in-sample and out-of-sample fit.
- The fit improves for both linear and threshold Taylor rules.

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ABSTRACT

I show that augmenting the Taylor rule with bond yields observed at the start of the quarter significantly improves the in-sample and out-of-sample fit. Moreover, the augmented rule produces lower forecast errors than those of linear and non-linear policy models.

1. Introduction

The Taylor rule is widely used as a descriptive tool for monetary policy. Clarida et al. (2000), for instance, use the rule to both estimate the Fed's policy behavior as well as to evaluate the adequacy of the Fed's response to inflation. In addition, Taylor (2005) notes that the rule's policy prescriptions are discussed at Federal Open Market Committee (FOMC) meetings. The Taylor rule, however, assumes that central bankers focus only on inflation and output when setting monetary policy. Taylor (1993) argues that central banks do not (and should not) blindly follow such a simple policy rule. Excluding variables that policy makers consider in setting monetary policy may result in large, observed deviations from the estimated policy rule.

How to amend the rule is the focus of much research. For example, Clarida et al. (2000) include lags of the Fed funds rate to account for monetary policy inertia, and Branch (2014) shows that macroeconomic forecast uncertainty is associated with more passive monetary policy. In addition, Bernanke (2004) notes that asset prices provide forward looking macroeconomic information useful to policy makers. Though Rigbon and Sack (2003) and Fuhrer and Tootell (2008) have looked at the Fed's response to equity prices,[1] Bernanke (2004) notes a long literature documenting the predictive relation between bond yields and macroeconomic variables. This paper incorporates the information in bond yields by augmenting the Taylor rule with the yields' first three principal components. To mitigate any feedback from Fed monetary policy to bond yields, I lag the principal components rather than use contemporaneous values, and I do not include Treasury bills since there is evidence that short rates in recent years are closely linked to market expectations of monetary policy. I evaluate the

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[1] Bernanke and Woodford (1997) caution that asset prices reflect expectations about monetary policy. Nimark (2008), however, shows conditions under which the central bank can learn about economic variables by filtering out market expectations from bond yields.

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Table 1
Principal components of US Treasuries and corporate bonds: 1983Q1–2014Q4.

	1st PC	2nd PC	3rd PC
1 year treasury	0.343	0.648	0.291
3 year treasury	0.354	0.389	0.043
5 year treasury	0.357	0.199	−0.121
10 year treasury	0.358	−0.049	−0.251
20 year treasury	0.357	−0.196	−0.343
30 year treasury	0.355	−0.245	−0.440
Aaa yield	0.356	−0.266	0.139
Baa yield	0.347	−0.467	0.711
Variation explained	96.93%	99.34%	99.88%

in and out-of-sample fit of these augmented Taylor rules while also accounting for policy inertia, unconventional monetary policy, possible non-linearities, and forecast uncertainty.

2. Data

The augmented Taylor rule may be written as:

$$i_t = \alpha + \beta\pi_t + \gamma y_t + \Phi X_t + \epsilon_t \tag{1}$$

where i_t is the Fed funds rate, π_t is inflation, y_t is the output gap, and X_t is a $kx1$ vector of other variables thought to affect monetary policy. To estimate the Taylor rule, I obtain quarterly observations on the average Fed funds rate and chain-weighted GDP deflator from the St. Louis Fed, and real GDP from the Philadelphia Fed's real-time macroeconomic database. Following Bunzel and Enders (2010) and Rudebusch (2002), inflation is measured as 100 times the log difference in the GDP deflator at time t and $t-4$, and the output gap as the difference between log real GDP and its filtered value from the Hodrick–Prescott filter.

I augment the Taylor rule by including in X_t lagged values of the first three principal components of constant maturity Treasury and seasoned corporate bond yields. Observations are obtained from the St. Louis Fed. The bonds used and their corresponding loadings are reported in Table 1. The first three principal components account for 99.88% of the total variation in the yields. The first principal component loads fairly evenly on all the yields, suggesting the component primarily affects yield levels. Shocks to the second factor, however, tend to rotate the yield curve, having an opposite impact on short term rates than on long-term rates and corporate bonds. Finally, positive shocks to the third factor flatten the yield curve while increasing the credit spread. Note that since I include corporate yields, these principal components do not correspond directly to level, slope, and curvature factors in term structure models. Using the principal components of Treasury and corporate bond yields, however, avoids choosing which term spreads and credit spreads to include. In addition, the extracted factors do not have to load on the yields if the underlying factors are truly independent of corporate yields.

To ensure these principal components do not simply proxy for macroeconomic uncertainty (see Branch, 2014), I also include the forecast dispersion in the Philadelphia Fed's Survey of Professional Forecasters (SPF), defined as the difference between the 75th and 25th percentile forecasts. In addition, I include the one-quarter ahead macroeconomic uncertainty factor recently developed by Jurado et al. (2015) and available on Sydney Ludvigson's website. Finally, I include two lags of the Fed Funds rate since Bunzel and Enders (2010) find that two lags are sufficient to capture the

Table 2
Taylor rules.

	Observed Fed funds rate				Shadow Fed funds rate	
	1983Q1–2014Q4		1983Q1–2008Q4		1983Q1–2014Q4	
	(1)	(2)	(3)	(4)	(5)	(6)
Inflation	0.121** (0.054)	0.146*** (0.052)	0.183*** (0.058)	0.243*** (0.056)	0.118** (0.054)	0.099 (0.062)
Output gap	0.097*** (0.036)	0.058 (0.050)	0.167*** (0.042)	0.114** (0.047)	0.107*** (0.036)	0.039 (0.050)
Policy inertia	0.957*** 0.019	0.556*** 0.069	0.933*** 0.027	0.612*** 0.079	0.970*** 0.017	0.837*** 0.067
1st PC		0.416*** (0.064)		0.323*** (0.077)		0.180** (0.078)
2nd PC		0.862*** (0.203)		0.726*** (0.243)		0.276 (0.187)
3rd PC		1.118*** (0.241)		1.288*** (0.298)		0.512 (0.333)
Inflation forecast dispersion		0.017 (0.115)		−0.064 (0.119)		−0.010 (0.160)
Real GDP forecast dispersion		−0.166 (0.104)		−0.152 (0.109)		−0.311** (0.121)
Macro uncertainty		−1.575** (0.661)		−2.557*** (0.695)		−0.532 (0.779)
Constant	−0.149 (0.111)	2.972*** (0.580)	−0.181 (0.165)	3.313*** (0.591)	−0.225** (0.112)	1.151 (0.667)*
Observations	128	128	104	104	128	128
Adjusted R^2	0.982	0.986	0.971	0.976	0.984	0.985
Akaike information criterion	134.802	112.689	121.658	106.528	154.883	154.452

Note: Standard errors in parentheses.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.