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Menzie D. Chinn
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Expectations Hypothesis of the Term Structure, the Liquidity Premium and Economic Activity

Expectations Hypothesis of the Term Structure: Math

If agents are risk neutral.

$$P_{1t} = \frac{\$100}{1+i_{1t}} \qquad (1) \qquad\qquad P_{2t} = \frac{\$100}{(1+i_{1t})(1+i^e_{1t+1})} \qquad (2)$$

If both one year and two year bonds offer the same one-year return (by arbitrage), then:

$$1+i_{1t} = \frac{P^e_{1t+1}}{P_{2t}} \qquad (3)$$

Rearranging:

$$P_{2t} = \frac{P^e_{1t+1}}{1+i_{1t}} \qquad (4)$$

What is the numerator of the right hand side of (4)? Iterating (1) forward, and taking expectations:

$$P^e_{1t+1} = \frac{\$100}{1+i^e_{1t+1}}$$

This can be substituted into (4) to obtain:

$$P_{2t} = \frac{\$100}{(1+i^e_{1t+1})(1+i_{1t})} \qquad (5)$$

We know in fact:

$$P_{2t} = \frac{\$100}{(1+i_{2t})^2} \qquad (6)$$

What will set (5) equal to (6)?

$$\frac{\$100}{(1+i_{2t})^2} = P_{2t} = \frac{\$100}{(1+i^e_{1t+1})(1+i_{1t})}$$

Which implies:

$$(1+i_{2t})^2 = (1+i^e_{1t+1})(1+i_{1t})$$

$$(1+2i_{2t}+i_{2t}{}^2) = (1+i^e_{1t+1}+i_{1t}+i^e_{1t+1}i_{1t})$$

$$2i_{2t} \approx i^e_{1t+1}+i_{1t}$$

$$\boxed{i_{2t} \approx \frac{1}{2}(i^e_{1t+1}+i_{1t})} \qquad (7)\ [7.4]$$

$$i^e_{1t+1} = 2i_{2t} - i_{1t} \qquad (8)$$

In general:

$$\boxed{i_{nt} = \frac{(i_{1t}+i^e_{1t+1}+\ldots+i^e_{1t+n-1})}{n}} \qquad (9)\ [7.6]$$

The Liquidity Premium Theory of the Term Structure

The linkage between the long-term and short-term interest rates can be decomposed thus:

$$i_{nt} = \frac{(i_{1t} + i^e_{1t=1} + ... + i^e_{1t+n-1})}{n} + rp_{nt} \qquad (10)\ [7.7]$$

Where i_{nt} is the interest rate on a bond of maturity n at time t, i^e_{1t+j} and is the expected interest rate on a one period bond for period $t+j$, based on information available at time t, and rp_{nt} is the liquidity (or term) premium for the *n*-period bond at time t. This specification nests the expectations hypothesis of the term structure (EHTS) (corresponding to the first term on the right hand side of equation 10), and the liquidity premium theory (corresponding to the second term).

The EHTS merely posits that the yield on a long-term bond is the average of the one period interest rates expected over the lifetime of the long bond. The liquidity premium theory allows that there will be supply and demand conditions that pertain specifically to bonds of that maturity (this is the segmented markets hypothesis). The presence of idiosyncratic effects associated with a certain maturity of bond is sometimes linked to the "preferred habitat theory", the idea that certain investors have a preference for purchasing assets of specific maturities. Since $l^n_t > 0$ and is expected to rise as n becomes large, the yield curve will slope upward when short rates are expected to be constant over time. The liquidity or term premium is assumed to rise with maturity n because holders of longer term bonds face greater interest rate risk.

Now, for the sake of simplicity, consider the case where $rp_{nt} = 0$ (i.e., the EHTS explains all variation in long rates). Suppose further expected short rates are lower than the short rate today. Then the long rate will be lower than the short rate (i.e., the yield curve inverts).

Since low interest rates are typically associated with decreased economic activity, an inverted yield curve should imply an expected downturn, especially given that $rp_{nt} > 0$, then an inversion should imply a downturn a fortiori.

Application to the United States

One of the implications of the EHTS is that expectations of a sequence of low short term rates in the near future will result in the long rate being lower than usual. Short term interest rates are typically low when the economy has encountered a slowdown, or has entered in a recession. At the same time, many recessions have been triggered by increases in the short term policy rate (the Fed funds rate). Hence, it is often thought that an inversion of the yield curve presages a recession. In Figure 1, I plot two spreads: (i) the 10 year-3 month spread, and (ii) the 10 year-2 year spread.

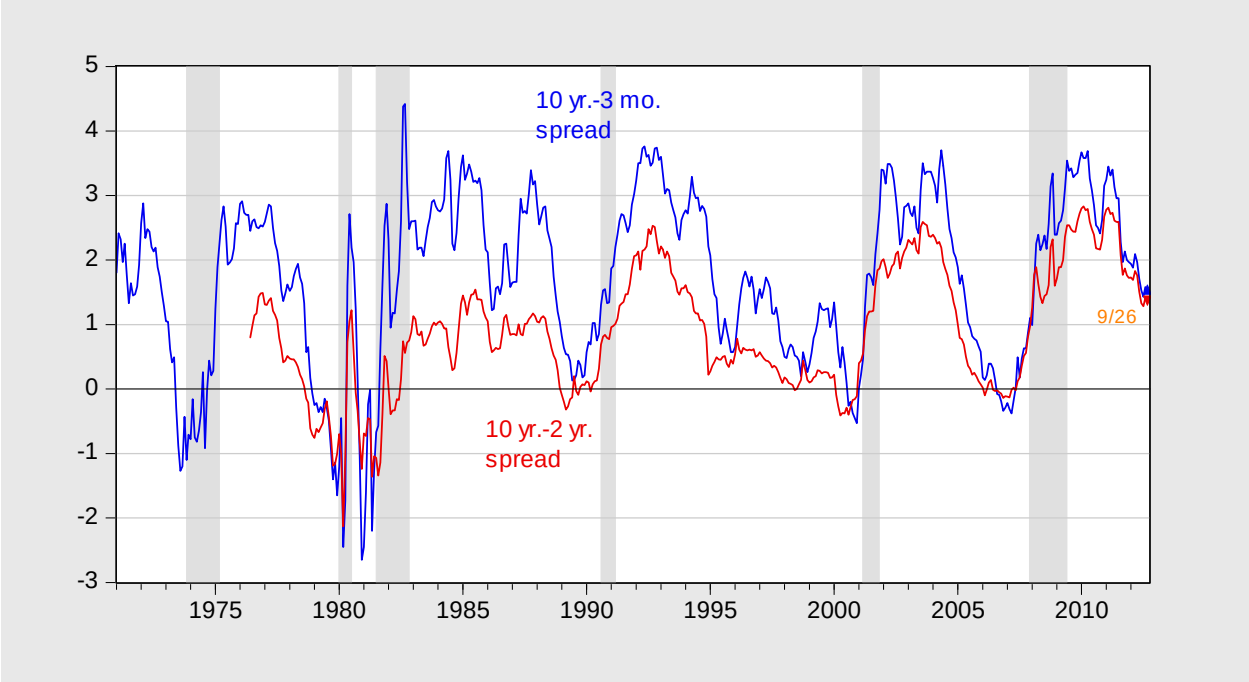

Figure 1: Ten year-three month spread (blue), and ten year-two year spread (red). NBER defined recession dates shaded gray. Source: St. Louis Fed FRED, and NBER.

Notice that inversions of the yield curves (when the lines dip below zero, or come close is) often precede recession. There is a large literature which tries to assess whether the relationship between the yield curve and subsequent economic activity (either growth or recession) is robust. A separate, but related, question whether the term premium provides additional information above and beyond that provided by lagged income and other indicators.

The studies assessing the US evidence include Harvey (1988, 1989), Stock and Watson (1989), Nai-Fu Chen (1991), and Estrella and Hardouvelis (1991). A general reading of the literature is the yield curve did have some predictive power, but was declining over time. Wright (2006) argued that the level (namely, the level of the short term interest rate) as well as the slope of the yield curve needed to be included.

Cross-country Analysis

The evidence for predictive power across other countries is less developed; see Chinn and Kucko (2010) for discussion. The graphs analogous to Figure 1, for European countries and Japan are presented in Figure 2.

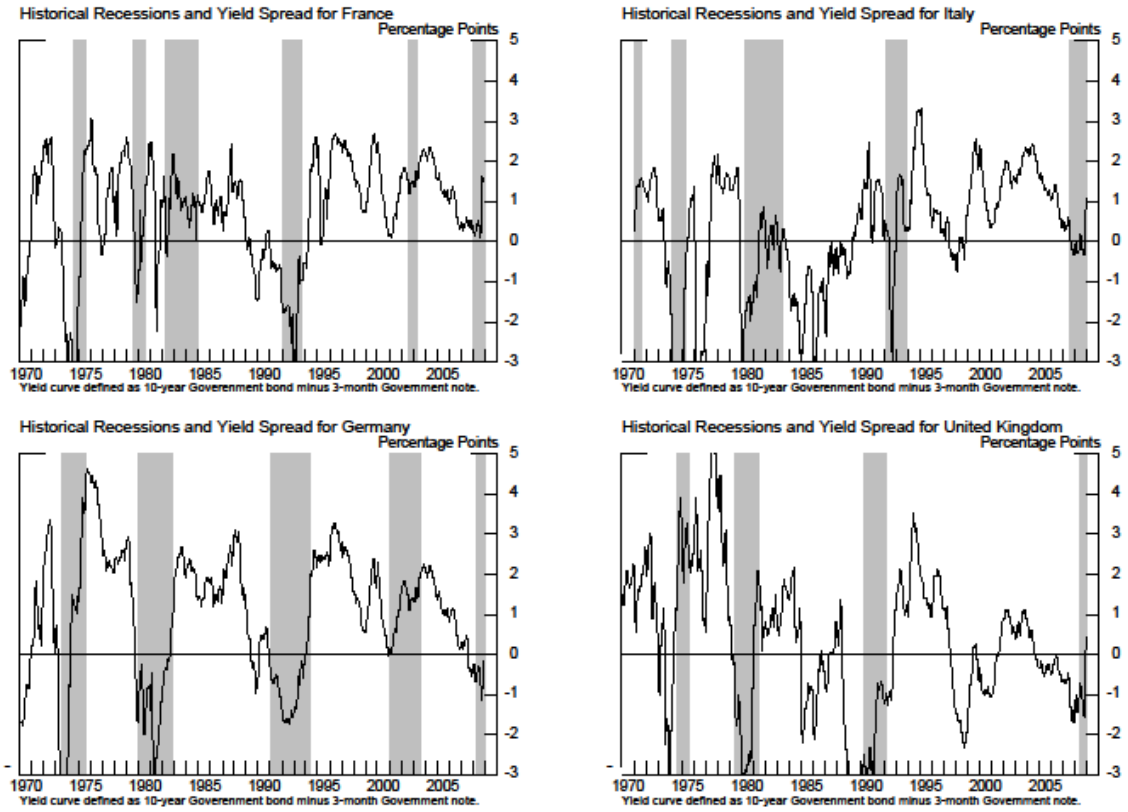

Figure 2. Ten year-three month spread. ECRI-defined recession dates shaded gray. Source: St. Louis Fed FRED, and ECRI.

The graphs are suggestive, but do not confirm the posited relationships.

Table 1: Yield Curve/Growth Recessions, Full Sample (1970-2009)

	Constant	Slope	Constant	Slope
Canada	0.208	**1.854**	**0.954**	**1.212**
	0.532	0.209	0.420	0.180
France	0.271	**1.383**	0.998	**0.527**
	0.554	0.338	0.372	0.200
Germany	0.075	**1.416**	0.623	**1.006**
	0.634	0.259	0.372	0.137
Italy	**1.273**	**0.871**	**1.567**	-0.025
	0.629	0.300	0.402	0.178
Japan	1.333	**1.299**	**1.983**	0.297
	0.762	0.391	0.553	0.286
Netherlands	0.173	**0.946**	**0.655**	**0.482**
	0.526	0.246	0.244	0.117
Sweden	1.021	**0.746**	**2.178**	-0.061
	0.710	0.263	0.545	0.212
U.K.	0.620	**0.882**	**0.781**	**0.604**
	0.403	0.207	0.285	0.113
US	-0.037	**1.630**	0.362	**1.456**
	0.628	0.289	0.442	0.190

Table 3: Yield Curve/Growth Recessions, Late Sample (1998-2009)

	1 Year		2 Year	
	Constant	Slope	Constant	Slope
Canada	-1.138	1.066	-0.812	0.933
	1.696	0.705	1.556	0.708
France	-4.091	**2.923**	**-2.693**	**2.016**
	2.148	1.237	1.334	0.739
Germany	-4.147	**5.055**	-1.855	**3.123**
	1.742	1.743	1.708	1.055
Italy	**-4.955**	**3.451**	-1.930	1.259
	2.429	1.462	1.750	0.926
Japan	-8.507	7.063	0.925	-0.447
	6.627	4.730	2.367	1.575
Netherlands	-0.846	1.386	0.177	0.625
	2.022	1.335	0.849	0.545
Sweden	**-7.126**	**5.915**	-2.472	2.678
	3.262	2.045	2.557	1.395
U.K.	-0.753	0.808	**-0.730**	0.013
	0.409	0.832	0.319	0.454
United States	0.058	0.316	-0.611	**1.090**
	0.988	0.485	0.843	0.311

Notes: OLS regression coefficients. HAC robust standard errors below OLS estimates. **Bold entries** indicate significance at 5% msl.

Table 8: Probit Model Performance

	Next 6 Months		Next 12 Months	
Canada				
10 yr-3 mo	**-0.526**	-0.064	**-0.606**	-0.140
	(0.104)	(0.133)	(0.127)	(0.182)
3 mo		**0.317**		**0.345**
		(0.083)		(0.097)
Pseudo R2	0.307	0.480	0.354	0.533
France				
10 yr-3 mo	**-0.351**	-0.219	**-0.402**	**-0.269**
	(0.088)	(0.110)	(0.115)	(0.136)
3 mo		0.100		0.102
		(0.058)		(0.063)
Pseudo R2	0.100	0.146	0.117	0.163
Germany				
10 yr-3 mo	**-0.647**	**-0.541**	**-0.602**	**-0.480**
	(0.148)	(0.199)	(0.159)	(0.201)
3 mo		0.083		0.102
		(0.098)		(0.110)
Pseudo R2	0.324	0.332	0.286	0.299
Italy				
10 yr-3 mo	**-0.256**	-0.152	**-0.202**	-0.111
	(0.081)	(0.105)	(0.091)	(0.124)
3 mo		0.059		0.052
		(0.040)		(0.048)
Pseudo R2	0.087	0.119	0.054	0.087
Japan				
10 yr-3 mo	-0.047	**-0.715**	-0.013	**-0.633**
	(0.088)	(0.156)	(0.113)	(0.170)
3 mo		**-0.371**		**-0.352**
		(0.074)		(0.091)
Pseudo R2	0.003	0.241	0.000	0.225
Sweden				
10 yr-3 mo	**-0.286**	-0.123	**-0.290**	-0.147
	(0.109)	(0.131)	(0.126)	(0.154)
3 mo		**0.125**		0.111
		(0.053)		(0.067)
Pseudo R2	0.105	0.163	0.106	0.154
United Kingdom				
10 yr-3 mo	**-0.254**	-0.117	**-0.300**	-0.178
	(0.118)	(0.128)	(0.137)	(0.152)
3 mo		**0.176**		**0.184**
		(0.069)		(0.079)
Pseudo R2	0.099	0.238	0.130	0.273
United Sates				
10 yr-3 mo	**-0.433**	**-0.341**	**-0.652**	**-0.573**
	(0.110)	(0.125)	(0.143)	(0.154)
3 mo		0.092		0.121
		(0.078)		(0.110)
Pseudo R2	0.139	0.163	0.252	0.284

Notes: OLS regression coefficients. HAC robust standard errors below OLS estimates. **Bold entries** indicate significance at 5% msl. Data ranges from January, 1970 to September, 2009.