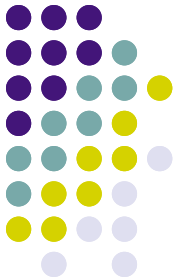
Estimating the Market Value of Illiquid Debt Using WRDS TRACE Data



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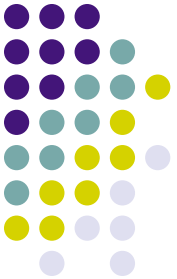

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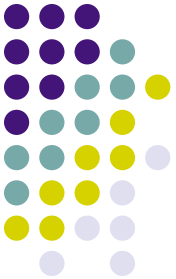


Why Bother Valuing Illiquid Debt?

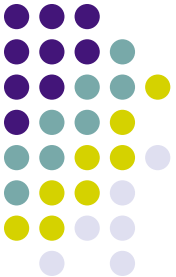
- Size of the Bond Market
  - As of 3Q11, the US bond market was $36.4 trillion
- Illiquidity of Bond Market
  - Of the 190,000-plus bonds that traded in the U.S. in 2011, less than 2% traded every day (WSJ)
  - Even large firms with very liquid publicly-traded equities may have bonds that are illiquid

Why Bother Valuing Illiquid Debt?

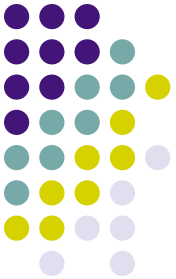
- The valuation method we use allows us to **value illiquid debt** on a day the firm's bond did not trade

- The valuation method also allows us to **estimate the aggregate market value of all the firm's debt**
  - In this presentation, we show an application of this in the context of a **solvency analysis**
  - Other uses: Enterprise Value and WACC calculations

Examples of Illiquid Debt Valuation Methods



- Last Traded Price
- Matrix Pricing
- Term Structure Models



Three-Step Procedure

- **Step 1:** Estimate the term structure of interest rates using US Treasury STRIPS
- **Step 2:** Estimate the yield spread using the estimated term structure and the firm's traded bonds to construct a corporate yield curve
- **Step 3:** Use the corporate yield curve to value the firm's illiquid debt

Step One: Term Structure

- We estimate the term structure using a **penalized spline** model

- We estimate the term structure with STRIPS data from January 20, 2011 through January 28, 2011
  - In Step Two, we "borrow" bond transaction data from prior trading days to get a sufficient number of observations for our optimization (assumes no credit event has occurred)

Step One: Term Structure

- We use the penalized LS criterion to estimate **δ**

$$\frac{1}{n}\sum_{i=1}^{n}\left[P_i^{STRIP} - C_i(t_{i,j})\exp(-\delta' B(t_{i,j}))\right]^2 + \lambda\delta' G\delta$$

where $\boldsymbol{P^{STRIP}}$ is the traded price of STRIP *i (i=1, …, n)*

C denotes STRIPS *i*'s cash flow at time ***j***

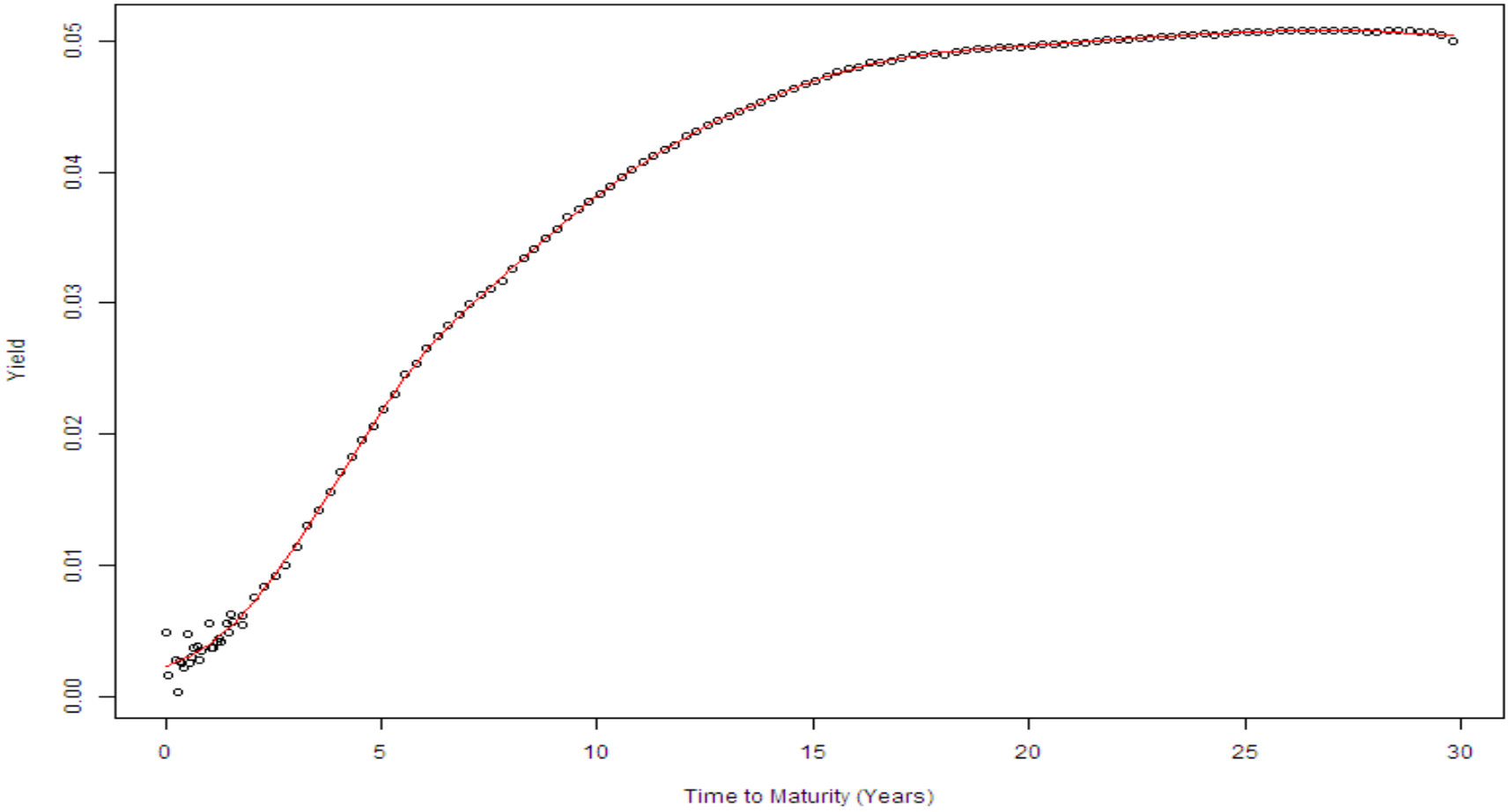
B is a vector of spline basis functions

δ is the coefficient vector

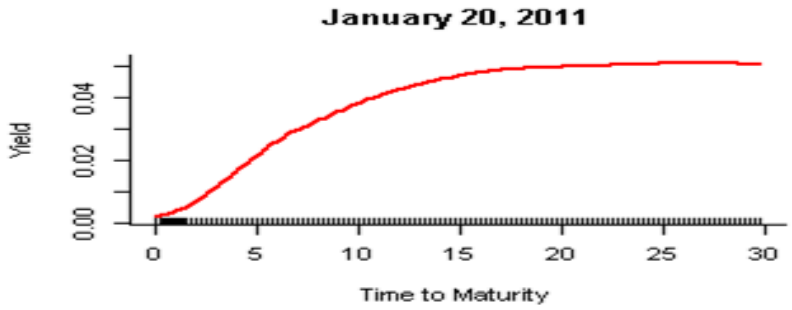
G a symmetric PSD penalty matrix

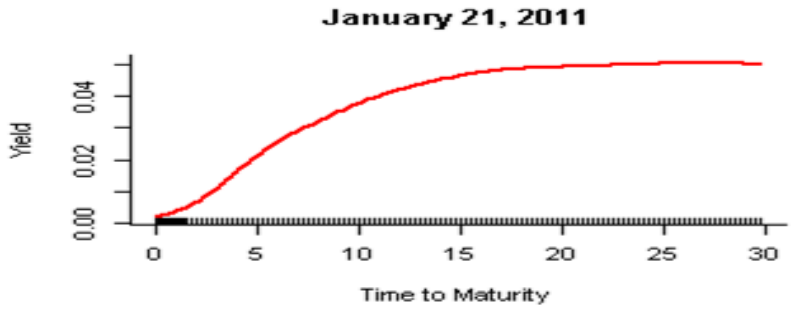
λ (smoothing parameter) is determined using restricted maximum likelihood

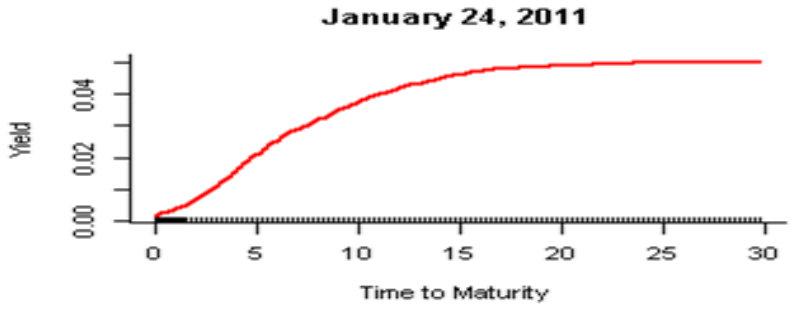
Yields on US Treasury STRIPS & Estimated Term Structure for January 28, 2011

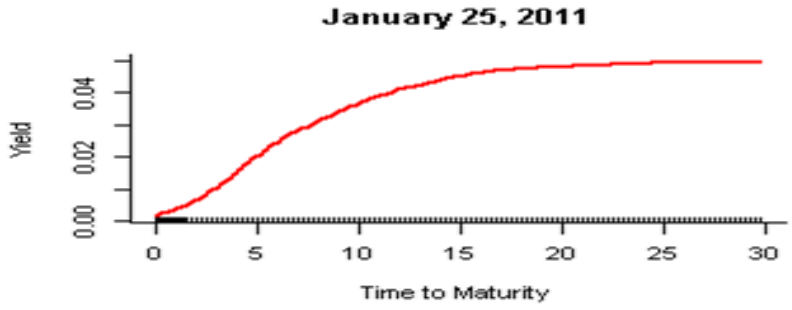


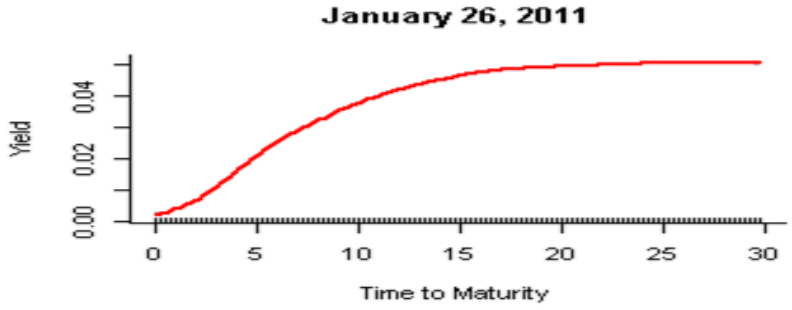
Estimated Term Structure

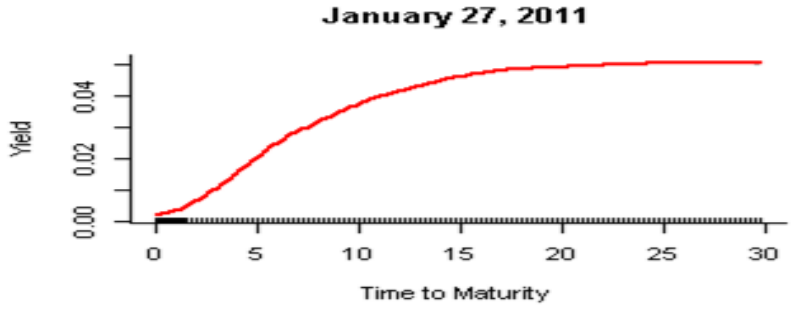












Step Two: Yield Spread

- The company we use in our example is Dell
  - We value Dell's illiquid bonds on **January 28, 2011**
- We find the spread **S** that minimizes

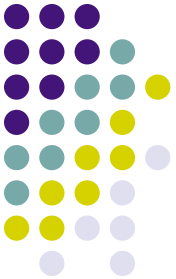
$$\sum_{i=1}^{n}\left\{P_i^{DELL}-\sum_{j=1}^{z_i}C_i^{DELL}(t_{i,j})\exp(-(r_j+S)t_{i,j})\right\}^2$$

where P^{DELL} denotes the price of Dell bonds that traded

r is the corresponding yield based on the estimated term structure in Step One

- In determining **S**, we "borrow" observations from prior trading days (assumes no credit event has occurred during the period)

Where Did We Get Our Pricing Data for Dell Bonds?



- We can use any source of bond data

- In this presentation, we use TRACE Data obtained from WRDS
  - Only available to academics before, WRDS was recently (November 2011) made available to commercial users
  - WRDS TRACE data reports intraday transaction data for bond trades, which allows us to calculate and use VWAP

What Does Dell's WRDS TRACE Data Look Like?

	A	B	C	D	E	F	G	H	I	J
1	CUSIP_ID	BOND_SYM_ID	COMPANY_SYMBOL	TRD_EXCTN_DT	TRD_EXCTN_TM	MSG_SEQ_NB	TRC_ST	WIS_FL	CMSN_TRD	ASCII_RPTD_VOL_TX
2	247025AE9	DELL.GB	DELL	1/20/2011	13:05:51	26240	T	N	N	142000
3	247025AE9	DELL.GB	DELL	1/20/2011	13:05:59	26252	T	N	N	142000
4	247025AE9	DELL.GB	DELL	1/20/2011	13:05:59	26253	T	N	N	142000
5	247025AE9	DELL.GB	DELL	1/24/2011	16:43:00	50698	T	N	N	5000000

	K	L	M	N	O	P	Q	R	S	T	U	V
1	FRMT_CD	RPTD_PR	YLD_SIGN_CD	YLD_PT	ASOF_CD	DAYS_TO_STTL_CT	SALE_CNDTN_CD	SALE_CNDTN2_CD	SPCL_TRD_FL	DISS_RPTG_SIDE_CD	CHNG_CD	RPTD_HIGH_PR
2	A	112.042	+	5.970054		0	@			D	7	112.042
3	A	112.403	+	5.938843		0	@			S	5	112.403
4	A	112.123	+	5.963039		0	@			D	1	112.403
5	A	118.156	+	5.458976		0	@			B	7	118.156

	W	X	Y	Z	AA	AB	AC	AD	AE
1	HIGH_YLD_SIGN_CD	HIGH_YLD_PT	RPTD_LOW_PR	LOW_YLD_SIGN_CD	LOW_YLD_PT	RPTD_LAST_PR	LSAL_YLD_SIGN_CD	LSAL_YLD_PT	ORIG_MSG_SEQ_NB
2	+	5.970054	112.042	+	5.970054	112.042	+	5.970054	
3	+	5.938843	112.042	+	5.970054	112.403	+	5.938843	
4	+	5.938843	112.042	+	5.970054	112.123	+	5.963039	
5	+	5.458976	118.156	+	5.458976	118.156	+	5.458976	

Why Do We Need to Clean WRDS TRACE Data?

- WRDS TRACE Data needs to be cleaned for corrected, withdrawn, truncated & reversed trades

	A	D	E	F	G	J	K	L	N	O	AE
1	CUSIP_ID	TRD_EXCTN_DT	TRD_EXCTN_TM	MSG_SEQ_NB	TRC_ST	ASCII_RPTD_VOL_TX	FRMT_CD	RPTD_PR	YLD_PT	ASOF_CD	ORIG_MSG_SEQ_NB
31	24702RAD3	1/26/2011	15:33:01	48149	T	2923000	A	101.605	3.930524		
32	24702RAD3	1/26/2011	15:33:01	50252	C	2923000	A	101.605	3.930524		48149
190	24702RAH4	1/24/2011	11:35:04	13737	T	12000	A	103.2	1.03852		
191	24702RAH4	1/24/2011	11:35:04	23704	W	10000	A	103.2	1.03852		13737
329	24702RAK7	1/21/2011	10:09:00	7405	T	5MM+	E	99.838	1.463014		
440	24702RAL5	1/21/2011	16:45:58	19430	T	5000	A	97.9673	2.770683	R	
441	24702RAL5	1/21/2011	16:45:58	19432	T	5000	A	97.9673	2.77123	A	
442	24702RAL5	1/21/2011	16:45:58	51213	T	5000	A	97.9673	2.770683		

Cleaning WRDS TRACE Data

- Dick-Nielsen (J. Fixed Income, 2009) developed a method for adjusting same-day corrections/withdrawals and reversed trades
- We improve on this method by
  - Using average traded volume based on data in the TRACE Fact Book in lieu of the 1MM+ High-Yield and 5MM+ Investment Grade truncated trade volume to reduce information loss
  - Re-arranging the order of how trades are filtered to prevent unintended deletions

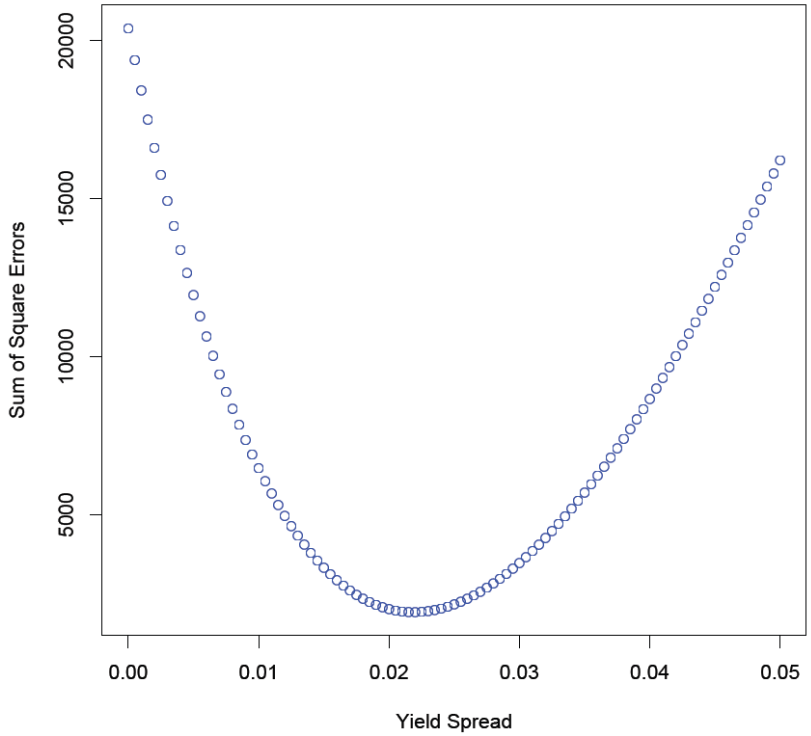
Data on Dell Bonds

Characteristics of Dell Bonds Outstanding as of January 28, 2011										
CUSIP	24702RAH4	24702RAD3	24702RAK7	24702RAG6	24702RAL5	24702RAE1	24702RAJ0	247025AE9	24702RAF8	24702RAM3
Coupon Rate	3.375%	4.700%	1.400%	5.625%	2.300%	5.650%	5.875%	7.100%	6.500%	5.400%
Coupon Type	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Maturity Date	06/15/12	04/15/13	09/10/13	04/15/14	09/10/15	04/15/18	06/15/19	04/15/28	04/15/38	09/10/40
Principal (M)	$400.00	$599.50	$500.00	$500.00	$700.00	$497.54	$600.00	$300.00	$400.00	$300.00

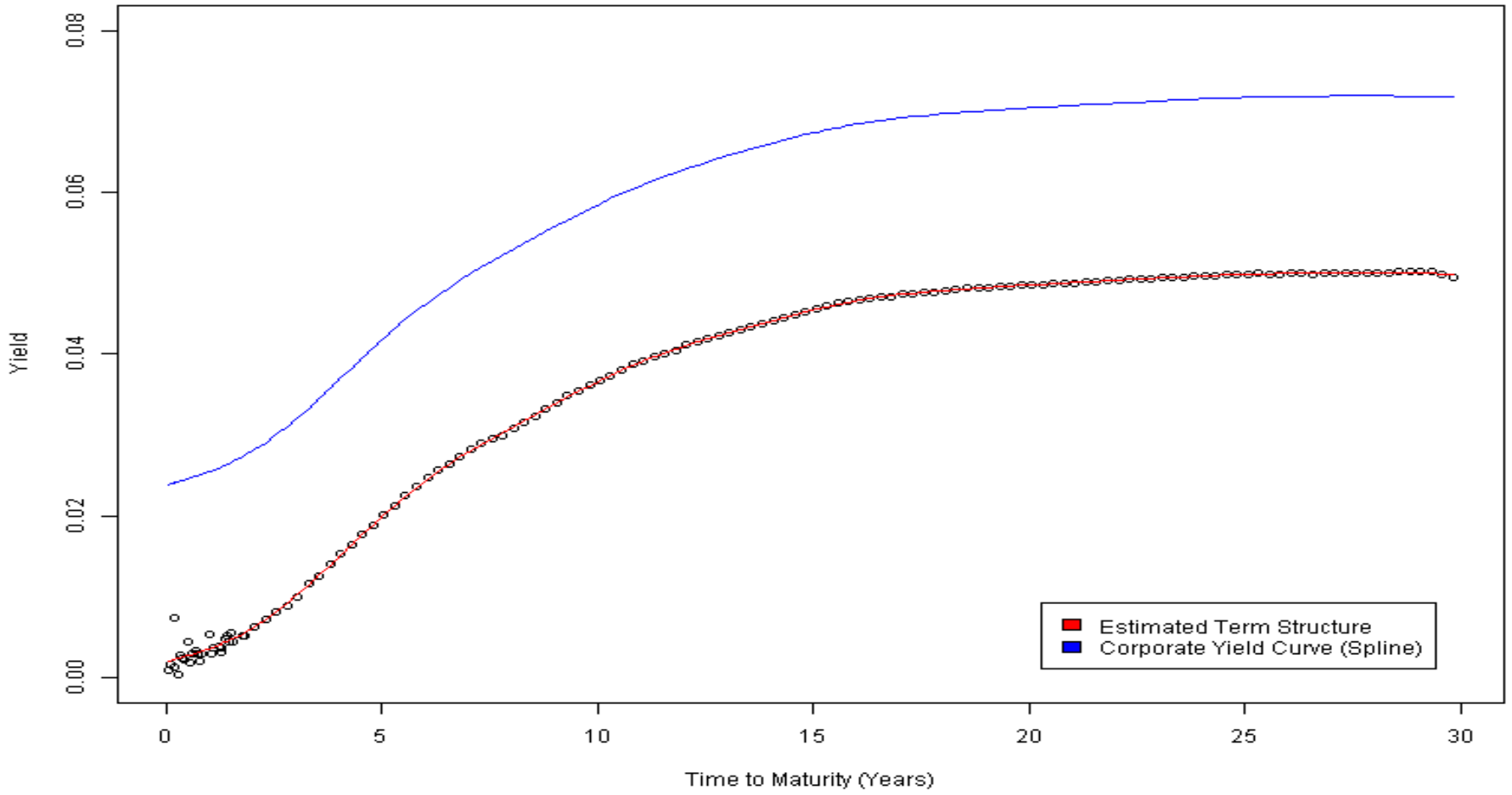
Volume-Weighted Average TRACE (Cleaned) Prices (VWAP) of Outstanding Dell Bonds										
Date	24702RAH4	24702RAD3	24702RAK7	24702RAG6	24702RAL5	24702RAE1	24702RAJ0	247025AE9	24702RAF8	24702RAM3
01/20/11	$103.388	$107.425	$99.996	$110.889	$98.005	$109.266	$109.885	$112.189		$90.516
01/21/11	$103.373	$107.338	$99.841	$111.062	$97.979	$109.277	$110.309			$92.021
01/24/11	$103.370	$107.409	$99.911	$110.837	$98.241	$109.710	$111.145	$118.768		$91.844
01/25/11	$103.372	$107.564	$99.969	$110.872	$98.269	$109.838	$110.558			$93.856
01/26/11	$103.469	$103.119	$99.967	$110.617	$98.021	$108.611	$109.818	$114.215	$103.575	$91.761
01/27/11	$103.449	$107.641	$100.071	$110.753	$98.304	$109.828	$110.306	$111.309	$103.966	
01/28/11	$103.469	$107.674	$100.288	$111.054	$98.298	$109.504	$110.615	?	?	?

Step Two: Yield Spread

- We performed the optimization using Dell's traded bonds from January 20 to January 28
  - We use a total of **60** bond price/date observations
- We find the implied yield spread for Dell over this period is **219bp**



Estimated Corporate Yield Curve On January 28, 2011



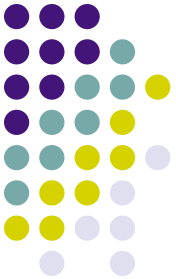
Step Three: MV of Illiquid Debt

- The price of Dell's illiquid debt is given by

$$\widehat{P}_i^{DELL} = \sum_{j=1}^{z_i} C_i^{DELL}(t_{i,j}) \exp(-(r_j + S)t_{i,j})$$

- The estimated price for the Dell's three bonds that did not trade on January 28 are

			Price on 1/28/11		
				Alternative Methods	
CUSIP	Coupon Rate	Maturity Date	Penalized Spline	Last Traded Price	Matrix Price
247025AE9	7.100%	04/15/28	$117.42	$111.31	$113.23
24702RAF8	6.500%	04/15/38	$106.74	$103.97	$105.96
24702RAM3	5.400%	09/10/40	$91.06	$92.11	$91.28



Solvency Analysis

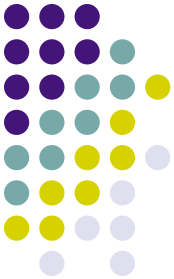
- After estimating the market value of the firm's illiquid debt, we can use that information together with the market value of the firm's traded bonds to perform a solvency analysis

- A firm is solvent if **MV(Assets) > Obligations**, where the MV(Assets) is equal to

  MV(Long Debt) + MV(Other Liabilities) + MV(Equity)

- **MV(Long Debt)** = $\sum_{i=1}^{n} \text{Debt}_i * \text{Principal Outstanding}_i$

Estimate of the Market Value of Dell's Debt on January 28, 2011



CUSIP	Coupon Rate	Maturity Date	Principal Amount (M)	January 28, 2011 Price	Estimated Price?	MV of Debt (M)
24702RAH4	3.375%	06/15/12	$400.0	$103.47		$413.9
24702RAD3	4.700%	04/15/13	$599.5	$107.67		$645.5
24702RAK7	1.400%	09/10/13	$500.0	$100.29		$501.4
24702RAG6	5.625%	04/15/14	$500.0	$111.05		$555.3
24702RAL5	2.300%	09/10/15	$700.0	$98.30		$688.1
24702RAE1	5.650%	04/15/18	$497.5	$109.50		$544.8
24702RAJ0	5.875%	06/15/19	$600.0	$110.61		$663.7
247025AE9	7.100%	04/15/28	$300.0	$117.42	YES	$352.3
24702RAF8	6.500%	04/15/38	$400.0	$106.74	YES	$427.0
24702RAM3	5.400%	09/10/40	$300.0	$91.06	YES	$273.2
		TOTAL	**$4,797.0**			**$5,065.1**

- Book value of debt is $4,896 million

Solvency Analysis

Market Value of Assets	Value
MV of Long-Term Debt	$ 5.07 bn
MV of Other Liabilities	25.94 bn
MV of Equity	25.22 bn
	Total Market Value of Assets $ 56.23 bn

Obligations	Value
Long-Term Debt	$ 4.80 bn
Other Liabilities	25.94 bn
	Total Obligations $ 30.74 bn

Assets Less Obligations	$ 25.49 bn

References

- Dick-Nielsen, Jens, 2009, “Liquidity Biases in TRACE,” *The Journal of Fixed Income*, Vol. 19, 43-55.
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