The Credit Spread Puzzle - Myth or Reality?
by Peter Feldhuetter and Stephen Schaeffer

Harjoat S. Bhamra

Imperial Business School

2015
1 Bigger Picture

2 What we know

3 Summary & Comments
Why do we care about firms?

- Provide employment
- When they grow, the economy grows – presumably good for economic welfare of human beings

Natural to care about

- risks impacting revenues, costs, profits etc
- various characteristics of firms and how they change over time – both for individual firms and the distribution of firms across sectors and the economy
• Firm $i$ has issued a bond, which matures at date $T > t$. Firm $i$ defaults at some random time $\tau_i$.  

• Date-$t$ price of zero coupon bond, which matures at date $T > t$, issued by Firm $i$

$$B_{i,t,T} = E_t^Q [e^{-r(T-t)}1_{\tau_i > T}] = e^{-r(T-t)} [1 - \hat{\Pr}(\tau_i \leq T)]$$  

  equivalent risk-free bond  risk-neutral def. prob.  

• Credit spread for bond with maturity date-$T$ issued by an individual firm:

$$s_{i,T} = -\frac{1}{T} \ln[1 - \hat{\Pr}(\tau_i \leq T)]$$
Credit Spreads II

Empirical data focuses on the mean credit spread for a portfolio of bonds from firms – credit rating and maturity fixed, e.g. BBB and 5 years

\[
\frac{1}{I} \sum_{i=1}^{I} s_{i,T} = E[s_{i,T}], \text{ cross-sectional mean}
\]

\[
E[s_{i,T}] = -\frac{1}{T} E \ln[1 - \hat{Pr}(\tau_i \leq T)]
\]

\[
= \frac{1}{T} \left[ E \hat{Pr}(\tau_i \leq T) + \frac{1}{2} E(\hat{Pr}(\tau_i \leq T))^2 + \ldots \right]
\]

all moments of cross-sectional dist of risk-neutral def probs
Credit Spreads III

\[ E[s_{i,T}] = \frac{1}{T} \left[ E\hat{Pr}(\tau_i \leq T) + \frac{1}{2} E(\hat{Pr}(\tau_i \leq T))^2 + \ldots \right] \]

all moments of cross-sectional dist of risk-neutral def probs

- Credit spreads for a particular rating encode information about:
  1. cross-sectional distribution of risk-neutral default probabilities for a portfolio of firms at various maturities
  2. the term structure of credit risk for a portfolio of firms
  3. distribution of firm characteristics which affect default: firm value, leverage, volatility
  4. time evolution of distribution firm characteristics – creates differences in credit spreads across maturities
Credit Spread Puzzle: What is it?

- **Data:**
  \[
  \frac{1}{I} \sum_{i=1}^{I} s_{i,T} = E[s_{i,T}], \text{ cross-sectional mean}
  \]

- **Model:**
  \[
  E[s_{i,T}] = -\frac{1}{T} E \left[ \ln \left( 1 - \frac{\hat{Pr}(\tau_i \leq T)}{Pr(\tau_i \leq T)} \frac{Pr(\tau_i \leq T)}{Pr(\tau_i \leq T)} \right) \right]
  \]

- **Conditions on model:**
  - realistic physical default probabilities

  **Credit spread puzzle** arises if
  - cannot match the average credit spread for a particular rating and maturity with realistic physical default probabilities: \( \frac{\hat{Pr}(\tau_i \leq T)}{Pr(\tau_i \leq T)} \) is not ok

  **Puzzle can exist for various ratings and at various maturities**
How to resolve/avoid the credit spread puzzle: some things we already know

Realized defaults don’t say much about expected defaults unless you have a lot of data

- Matching the expected physical default probabilities from a model to realized default probabilities is dangerous
- Realized default probabilities can differ substantially from expected physical default probabilities – same intuition as Merton (1980) for using stock price data to estimate expected returns
- Can remedy this with a longer time series and compare simulated default probs from model with data
How to resolve/avoid the credit spread puzzle: some things we already know

Failure of Representative Firm Approach

- Don’t try and match an empirical cross-sectional mean with a credit spread from an individual (representative) firm!
  - Credit spreads are convex in leverage

\[
\frac{1}{2} s_{1,T}(L_1) + \frac{1}{2} s_{2,T}(L_2) > s_{rep,T} \left( \frac{1}{2} L_1 + \frac{1}{2} L_2 \right)
\]

- Jensen’s Inequality ⇒ using an individual firm dooms you to low credit spreads relative to data [David (2006)]
- For both simple structural models and models featuring macroeconomic risks of credit risk, we know quantitatively how large this problem is for various maturities and credit ratings [BKS (2010a, 2010b)]
- We even know how the same statistical aggregation problem impacts models of equity returns and the equity risk premium [BKS (2010a, 2010b)]

- Model a cross-section of firms instead! [BKS (2010a, 2010b)] – applied in other contexts by several others!
This paper I

Uses same main ideas as BKS (2010)

- Matches simulated physical default probabilities from data with realized default frequencies from long time series
- Uses the idea of modeling credit spreads from a cross-section of firms to match the cross-sectional mean credit spread in the data.
  - This is why the credit spread puzzle is a myth
- Lots of time spent documenting how strong the Jensen’s Inequality effect is for different horizons and ratings
  - Already know size of credit spreads based on a cross-sectional model for AAA, A, BBB, BB, B for 5 year and 10 year horizons [BKS (2010)]
  - This paper does it for very short maturities (< 1 year) – how much does this add?
This paper II

Nice things not in BKS (2010)

- Derives the variance of the estimate of expected physical default probabilities (when using observed defaults).
- Results on time series variation in model implied average spread v. data
- Matches model to transaction level data over time. BKS (2010) used firm-level leverage over time.
Exploit and defend your results

- Using realized default probabilities to estimate expected physical default probabilities causes **additional** problems relative to Jensen bias.
- This paper quantifies some of this. Make this the first part of the paper.
- People don’t have to rely purely on default observations to estimate default probabilities: Campbell, Hilscher, & Szilagyi (2008), Chava & Jarrow (2004), Shumway (2001).
- Surely there are ways to significantly decrease the variance of estimated expected physical default probabilities. Defend against this!
Comments

We only care about the bias because it explains something

- e.g. BKS (2010) show that the bias is weaker at longer maturities (so does this paper)
- BKS show this helps generate a flatter slope for term structure of spreads relative to the representative firm approach
- This paper has results about 3 sets of maturities (BKS only has 2). Can you explain the curvature of the term structure?
- This paper has results about the bias for expected default probabilities. Can you use this to explain anything new?
Go beyond mere documentation

- The bias maybe this large or that large, but why is it the way it is?
- BKS show that the **time evolution** of the distribution of leverage explains why the bias is different for longer maturities – there is more skewness in the conditional distribution of leverage at longer horizons

$$E[s(\theta_i)] = s(E[\theta_i]) + \frac{1}{2!} \text{Var}[\theta_i] s''(\theta_i) + \frac{1}{3!} \text{skew}[\theta_i] s'''(\theta_i)$$

$$+ \frac{1}{4!} \text{kurt}[\theta_i] s''''(\theta_i) + \ldots$$

- the size of the Jensen’s inequality bias will depend on the variance, skewness and kurtosis of $\theta_i$ (model input such as leverage)
- can you relate any of this to the **curvature** of the term structure?
- how does the variance, skewness and kurtosis of leverage vary across credit ratings?
- With such excellent data, would be criminal not to use it!
Turn the Merton model into a strength

- Merton model assumes exogenous debt structure, exogenous leverage, exogenous default,
- Chen (2010), BKS (2010) use structural model with macro risks with dynamic debt structure, endogenous leverage, endogenous default – macro risks help with leverage and risk premium
- Transaction level data much easier to use with exogenous debt structure, exogenous leverage!
Don’t
- say the credit spread puzzle is a myth because ‘many papers’ don’t use a cross-section or don’t have a long enough times series for defaults
- say we have almost no empirical estimates of the size of the Jensen’s inequality bias

Do
- acknowledge the intellectual debt owed to Caballero and coauthors
  - Their insight: using implications from an individual firm model is not a good way to understand aggregated variables
  - Cite one of the papers: Caballero & Bertola (1994), Caballero & Engel (1993), Caballero & Pindyck (1993), Caballero & Engel (1991)
- acknowledge that cross-sectional heterogeneity is fundamental to understanding puzzles in other areas of finance
  - Berk, Green, & Naik (1999)
Conclusion

Paper’s main weaknesses:

- Existing work already resolves the credit spread puzzle (and the risk premium puzzle) by using a cross-section of firms and a long time series for defaults using a structural model with dynamic capital structure and macroeconomic risks.

Paper’s main strengths:

- impressive empirical implementation via use of transaction level data.
- explicit derivation of variance of expected default probability based on observing defaults.

Exploit data fully by building on existing literature.