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

Harjoat S. Bhamra

Imperial Business School

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1. Bigger Picture

2. What we know

3. Summary & Comments

Firms

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

Credit Spreads I

- Firm i has issued a bond, which matures at date $T > t$. Firm i defaults at some random time τ_i.
- Date-t price of zero coupon bond, which matures at date $T > t$, issued by Firm i

$$B_{i,t,T} = E_t^{\mathbb{Q}}[e^{-r(T-t)}1_{\tau_i > T}] = \underbrace{e^{-r(T-t)}}_{\text{equivalent risk-free bond}} [1 - \underbrace{\widehat{\Pr}(\tau_i \leq T)}_{\text{risk-neutral def. prob.}}]$$

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

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

Credit Spreads II

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

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

$$\begin{aligned}\boldsymbol{E}[s_{i,T}] &= -\frac{1}{T}\boldsymbol{E}\ln[1-\widehat{\Pr}(\tau_i \le T)] \\ &= \frac{1}{T}\underbrace{\left[\boldsymbol{E}\widehat{\Pr}(\tau_i \le T) + \frac{1}{2}\boldsymbol{E}(\widehat{\Pr}(\tau_i \le T))^2 + \ldots\right]}_{\text{all moments of cross-sectional dist of risk-neutral def probs}}\end{aligned}$$

Credit Spreads III

$$\boldsymbol{E}[s_{i,T}] = \frac{1}{T} \underbrace{\left[\boldsymbol{E}\widehat{\Pr}(\tau_i \leq T) + \frac{1}{2}\boldsymbol{E}(\widehat{\Pr}(\tau_i \leq T))^2 + \dots\right]}_{\text{all moments of cross-sectional dist of risk-neutral def probs}}$$

- 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:

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

- Model:

$$\boldsymbol{E}[s_{i,T}] = -\frac{1}{T}\boldsymbol{E}\left[\ln\left(1 - \frac{\widehat{\Pr}(\tau_i \leq T)}{\Pr(\tau_i \leq T)}\Pr(\tau_i \leq T)\right)\right]$$

- 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: $\frac{\widehat{\Pr}(\tau_i \leq T)}{\Pr(\tau_i \leq T)}$ 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 alot 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
  - Bhamra, Kuehn & Strebulaev (2010a, 2010b) did this (using data from Cantor, Emery, Ou, and Tennant (2008) from 1920-2007)

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 $\Rightarrow$ 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?

Comments

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

$$\boldsymbol{E}[s(\theta_i)] = s(\boldsymbol{E}[\theta_i]) + \frac{1}{2!}\mathbf{Var}[\theta_i]s''(\theta_i) + \frac{1}{3!}\mathbf{skew}[\theta_i]s'''(\theta_i) + \frac{1}{4!}\mathbf{kurt}[\theta_i]s''''(\theta_i) + \dots$$

- the size of the Jensen's inequality bias will depend on the variance, skewness and kurtosis of θ_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!

Comments

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!

Comments

- 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
    - Arnold, Wagner & Westermann (2013), Glover (2014), Kuehn & Schmid (2014),
  - 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.