Counterparty Risk: Implications for Network Linkages and Asset Prices

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Background & Motivation

- The amount of credit a lender extends to a borrower in the network depends on the risk of each agent and the macroeconomy. Consequently, credit should convey important information about firm- and aggregate-level fundamentals.

- Trade credit is among non-financial firms' largest sources of short-term financing, and consequently, plays a key macroeconomic role.

- Motivated by this intuition, we study the implications of credit provision for micro- and macro-level risks and for network linkages, using trade credit in production networks as a laboratory.

Research question

1. Does offering trade credit increase a supplier's exposure to operating and counterparty risks?

2. How does trade credit relate to macroeconomic risk?

3. Can trade credit provide information on suppliers' trade counterparties (i.e., customers), such as their quality?

4. Do changes in trade credit affect the strength of supplier-customer links, and the production network's density?

Research Contents-Empirical Analysis

- First, we find that trade credit is an important determinant of firms‘ risk profiles. Firms that extend more trade credit, and have higher ratios of receivables-to-sales (henceforth R/S), earn a significantly lower risk premium(7% p.a.) .

- Second, trade credit impacts the dynamics of supplier-customer links. At the micro-level, high R/S firms have longer duration links to their customers. At the macro-level, aggregate trade credit positively predicts the density of the production network.

- Third, to reconcile the first two findings we establish a novel link-duration spread: firms that have longer-lived relationships with their customers command lower expected returns.

Research Contents-Theoretical Analysis

- We construct a production-based asset pricing model to quantitatively explain the cross-sectional empirical facts.

- We then construct a quantitative model to jointly explain why low R/S firms have both higher stock returns and lower duration links with their customers.

- Finally, we empirically examine the characteristics of supplier-customer pairs and verify several model assumptions and implications.

Related Literature

- Traditional studies rely on capital adjustment costs to explain aggregate and cross-sectional risk premia via differential exposures to aggregate productivity. (e.g., Berk (1999), Boldrin (2001), Zhang (2005) et al.).
  - Our study proposes an alternative mechanism: time-varying exposures to systematic frictions involved in the search for potential customers.
- Dou, Ji, Reibstein, and Wu (2019) show that the departure of key talent affects the fragility of supplier-customer links.
  - We highlight that trade credit affects the durability of these links.
- Cohen and Frazzini (2008) and Menzly and Ozbas (2010) examine the predictability of stock returns using supplier-customer links.
  - We show that supplier-customer links are themselves predictable via trade credit.

Research Data

- Our sample includes all public firms in the CRSP/Compustat universe, excluding financial firms and public utilities.
  - We focus on the years ranging from 1978 to 2016 because data on trade receivable is sparse prior to 1978.

- Firm-level data on supplier-customer relationships is obtained from the FactSet Revere database which provides comprehensive coverage of inter-firm links.
  - Importantly, by reporting both the start and end date of each supplier-customer link, the FactSet data allows us to measure link duration.
  - This allows us to document how trade credit usage is related to the dynamics of inter-firm links.

Empirical Fact 1: Trade credit and risk premium

- We measure the extent of trade credit provision for firm i in year t by scaling the firm's trade receivables by its sales:

$$R/S_{i,t} = \frac{\text{Trade receivables}_{i,t}}{Sales_{i,t}}$$

- At the end of each June from 1978 to 2016, we sort firms into portfolios based on the value of R/S in the fiscal year ending in calendar year t−1.

- We form three portfolios on each sort date. The low (high) R/S portfolio includes all firms whose R/S ratio is at or below (above) the 10th (90th) percentile of the R/S ratios. The low and high R/S portfolios are well-diversified, with each containing about 340 firms.

Portfolio in year t	Portfolio in year $t+1$		
	Low	Medium	High
Low	0.849	0.129	0.022
Medium	0.015	0.948	0.037
High	0.018	0.372	0.610

Empirical Fact 1: Trade credit and risk premium

- By and large, there is an inversely monotonic relation between average returns and R/S.
- Moreover, we find an economically and statistically significant spread between the returns of low and high R/S firms.

	Value-weighted		Equal-weighted	
Portfolio	Mean	SD	Mean	SD
Low R/S	1.185	5.029	1.191	6.348
Medium	1.062	4.545	1.286	6.122
High R/S	0.589	5.981	0.744	7.476
Spread	0.597	4.128	0.448	3.439
(L-H)	(2.95)		(2.28)	

- And our results are robust to alternative choices of portfolio breakpoints (30%，70%).

	Mean	SD
Low R/S	1.129	4.292
Medium	1.050	4.571
High R/S	0.871	5.451
Spread	0.259	2.498
(L-H)	(2.09)	

Empirical Fact 1 : The resource of counterparty premium

- We examine whether the counterparty premium is explained by 5 common unconditional factor models: CAPM, FM 3-5 factor, Hou(2015) q-factor.
- The results show that the monthly α's obtained from these projections are always greater than 0.49% per month and statistically significant.
- Common empirical asset-pricing models fail to explain the counterparty premium.

	(1)	(2)	(3)	(4)	(5)
MKTRF	-0.312	-0.308	-0.288	-0.256	-0.276
	(-6.13)	(-6.03)	(-5.45)	(-5.02)	(-5.08)
SMB		0.035	0.025	0.132	0.154
		(0.47)	(0.34)	(1.64)	(2.35)
HML		0.053	0.096	-0.050	
		(0.56)	(1.09)	(-0.51)	
MOM			0.107		
			(1.84)		
Profit.				0.367	0.322
				(3.40)	(2.88)
Invest.				0.138	0.181
				(1.06)	(1.55)
α	0.798	0.775	0.684	0.585	0.487
	(4.07)	(3.97)	(3.57)	(3.06)	(2.56)

Empirical Fact 1 : Trade credit and macroeconomic factors

Counterparty premium: a puzzle?

- From the perspective of financial statement analysis, high R/S firms are typically perceived as having low operating efficiency, and as potentially having high exposures to shocks that deteriorate their customers' financial conditions.

- However, the fact that they command lower risk premia suggests that high R/S firms are, in fact, safer than low R/S firms. The sign of the counterparty premium supports the hypothesis that endogenously safer firms choose higher levels of R/S.

- Nonetheless, the risk of low R/S firms is anomalous from the perspective of extant factors and known spreads.

Empirical Fact 1 : Trade credit and macroeconomic factors

- Consequently, counterparty risk may be a distinct determinant for investors' stochastic discount factor (SDF) and stock prices.

- We examine this possibility by evaluating whether a counterparty risk factor is priced in the cross-section of stock returns.

$$M_{\mathrm{t}} = 1 - b' f_t - b_{CPR} CPR_{\mathrm{t}} \quad (2)$$

- f is a k*1 column vector that contains either the excess market return only, or the Fama and French (1993) three factors. All factors underlying the equation are demeaned.

- We estimate the risk factor loadings in equation (2) by generalized method of moments(GMM) using the following set of moment conditions:

$$E\left[M_t r_{i,t}^{e}\right] = 0$$

- $r_{i,t}^{e}$ denotes the excess return of test asset i at time t.

Empirical Fact 1 : Trade credit and macroeconomic factors

- First, we estimate the risk factor loadings using 25 value-weighted portfolios double sorted on size and book-to-market.
- We then add the test assets with the Fama-French 17 value-weighted industry portfolios (42).
- Third, We add the test assets with 10 portfolios sorted on each of investment and momentum (62).

- The GMM evidence suggests that a counterparty risk factor is priced in the cross-section of returns, and carries a negative market price of risk.

Panel B: Four-factor model

	25 portfolios		42 portfolios		62 portfolios	
	FF3F	+CPR	FF3F	+CPR	FF3F	+CPR
b_M	3.988	9.313	4.042	5.022	3.952	5.481
$t(b_M)$	(3.14)	(4.74)	(3.29)	(3.79)	(3.36)	(4.34)
b_S	1.489	1.190	0.372	0.673	0.181	0.534
$t(b_S)$	(0.87)	(0.61)	(0.22)	(0.40)	(0.11)	(0.32)
b_H	6.375	4.777	4.991	4.992	4.385	4.138
$t(b_H)$	(3.62)	(2.18)	(2.85)	(2.75)	(2.52)	(2.36)
b_{CPR}		-17.803		-3.589		-5.331
$t(b_{CPR})$		(-4.08)		(-2.27)		(-3.52)
MAE	0.608	0.478	0.728	0.708	0.775	0.737

Empirical Fact 2: Trade credit and the production network

- Trade credit provision involves both a supplier that offers the credit and a customer that promises to repay it.

- Therefore, we examine the differences between firms that offer more trade credit and firms that offer less trade credit through the lens of the production network.

- We show that trade credit is an important determinant for the duration of suppliercustomer relationships (i.e., network links). Firms offering less trade credit maintain shorter relationships with their customers.

- This result holds at the macro-level: aggregate trade credit increases the production network's density.

Empirical Fact 2 : Network characteristics

We check whether high and low R/S firms differ in terms of key network-based characteristics：

- Prior papers have established that network (eigenvalue) centrality, upstreamness customer concentration and volatility are associated with risk premia.
- In addition, we also consider another overlooked characteristic: the average duration (in months) of a suppliers' links with its existing customers.

High R/S firms are typically more upstream producers than low R/S firms. However, this cannot explain the counterparty premium as Gofman et al. (2020) show that more upstream firms earn higher returns.

	Low (L)	Medium	High (H)	Diff(L-H)	t(Diff)
Centrality	0.31	0.44	0.42	-0.11	(-0.91)
Upstreamness	1.65	2.74	3.03	-1.38	(-15.34)
HHI (Customer)	0.17	0.35	0.24	-0.07	(-1.03)
IVOL (Customer)	1.47	1.49	1.24	0.24	(1.15)
Duration	39.60	46.69	47.98	-8.38	(-2.68)

Empirical Fact 2 : Link duration and trade credit

- We estimate Fama-MacBeth regressions utilize supplier-level characteristics to predict (1) the expected duration of a supplier's links with its customers, and (2) the probability that supplier-customer links break.

$$D_{s,t} = const + \beta X'_{s,t} + \epsilon_{s,t} \quad \forall\, t \in \{2003, \ldots, 2016\} \quad (4)$$

- We use two measures for $D_{s,t}$: (1) the average life of a supplier's existing links going forward (in months). (2) an indicator variable that identifies the event in which the links between the supplier and its current customers break in the future.

- Specifically, the indicator takes on a value of one if 50% of the supplier's links that exist in year t do not survive until year t+3.

- $X'_{s,t}$ include the R/S ratio, the natural logarithm of the supplier's market value, investment rate, and profitability. Each predictor is scaled by its unconditional standard deviation for ease of interpretation.

Empirical Fact 2 : Link duration and trade credit

- The left side of the table shows that increases in the amount of trade credit offered are associated with longer lived supplier-customer relationships.
- A one standard deviation increase in R/S extends the expected link duration by about five months.
- The right side of the table yields similar results, showing that increases in R/S reduce the probability of supplier-customer links breaking.
- A one standard deviation increase in a supplier's R/S reduces the likelihood of links breaking by 9%.

	Future duration		Pr (Break = 1)	
Constant	55.62	56.70	0.58	0.57
	(11.49)	(11.38)	(23.32)	(25.76)
R/S	4.69	5.86	-0.09	-0.09
	(3.59)	(3.66)	(-3.11)	(-3.98)
SIZE		-2.20		-0.01
		(-5.15)		(-0.34)
I/K		-2.84		0.01
		(-1.94)		(0.88)
ROA		2.82		-0.04
		(3.61)		(-3.36)

Empirical Fact 2 : Production network analysis

- The aggregation of equation (4) across all firms implies that the average level of trade credit should positively predict the density of the production network.
- To test this conjecture we project the future density of the production network on the average level of R/S across all firms:

$$Density_{t+k} = const + \beta_{rs}\,\overline{R/S_t} + \beta_{IP}\Delta IP_t + \beta_d Density_t + \eta_t$$

- $Density_t$ is the density of the production network at quarter t, defined as the ratio of observed-to-potential links in the network.
- ΔIP_t is the quarterly log-growth rate of industrial production.

- Each independent variable is normalized by its standard deviation and, for ease of interpretation, we divide each slope coefficient by the unconditional mean of network density.

Empirical Fact 2 : Production network analysis

- Consistent with the above conjecture, a one standard deviation increase in aggregate R/S predicts the one-quarter ahead network density will rise by about 4% relative to density's mean.

- The predictive power of the aggregate R/S ratio is economically sizable and statistically significant up to five-quarters ahead.

- Furthermore, the economic significance of trade credit is of the same magnitude as that of lagged density.

	1Q ahead		3Q ahead		5Q ahead		7Q ahead	
R/S	0.06	0.04	0.05	0.03	0.06	0.05	0.04	0.04
	(3.25)	(4.25)	(2.53)	(2.50)	(2.67)	(2.75)	(1.42)	(1.48)
Density		0.07		0.06		0.03		0.01
		(13.82)		(5.29)		(1.98)		(0.34)
IP		0.00		-0.02		-0.01		0.01
		(0.28)		(-1.85)		(-0.53)		(0.37)
R^2	0.17	0.83	0.09	0.51	0.13	0.20	0.03	-0.01

Reconciling facts 1 and 2: the link duration premium

- Our empirical results have shown that low R/S firms have higher expected return (Fact 1) and lower duration links with their customers (Fact 2).
- We reconcile these two facts jointly to see whether the differences in link duration can explain the counterparty premium by establishing a novel “link duration” premium.

- We conduct a univariate portfolio sort using the link duration characteristic:
  - First, the sorts begin in April 2003 instead of June 1978, given the availability of FactSet data.
  - Second, we rebalance the portfolios monthly.

Reconciling facts 1 and 2: the link duration premium

- Suppliers that maintain shorter-lived links with their customers earn average value-weighted returns that are 0.98% per month higher than those earned by suppliers that maintain longer-lived links.

- This link duration premium is aligned with the R/S spread, as low R/S firms maintain low duration links.

- This suggests that the economic origin of the counterparty premium is potentially related to the duration of supplier-customer links.

	Panel A: Univariate sort on link duration	
Portfolio	Mean	SD
Low (L)	2.005	2.005
Medium	0.860	3.795
High (H)	1.021	1.021
Spread	0.984	2.533
(L-H)	(4.26)	

Reconciling facts 1 and 2: the link duration premium

- We examine this possibility in Panel B of Table 7 by conducting a conditional portfolio double sort analysis.

- The R/S spread is close to 1% per month among low link duration suppliers, but is insignificant at the 10% level. The R/S spread is qualitatively negative within the medium link duration portfolio, and is statistically indistinguishable from zero among high link duration suppliers.

- These results show the link duration effect crowds out the counterparty premium.

Panel B: Controlling for duration

	Low Dur.	Medium	High Dur.	
Low R/S	2.28	0.82	1.49	
Medium	1.97	0.84	0.98	
High R/S	1.30	0.83	1.02	
Spread	0.98	-0.02	0.47	Joint test
(L-H)	$(p = 0.11)$	$(p = 0.52)$	$(p = 0.20)$	$(p = 0.61)$

Conclusion

- We document three novel facts: First, low R/S firms earn a higher risk premium. Second, R/S is an economically important and statistically significant predictor of the average duration of supplier-customers links. Third, low link duration firms earn a higher risk premium.

- We construct a production model with trade credit to quantitatively explain the counter party premium jointly with the link duration effect. The model delivers the prediction that low R/S firms have lower link duration with their counterparty.

- We empirically explore possible interpretation for the systematic costs associated with searching for a counterparty. We show that firms that search for new customers have lower profitability.

- In all, the empirical and theoretical evidence suggests that trade credit contains valuable information for both risk and for the dynamics of the production network.

Summary

- This paper studies the relation between trade credit, risk, and the dynamics of production network linkages. We find that firms that extend more trade credit earn 7% p.a. lower risk premia, and maintain longer relationships with their customers. Moreover, suppliers with longer-duration links to their customers command lower expected returns.

- Using a production-based model, we quantitatively explain these facts. Trade credit helps to hedge customers against liquidity risks, thereby reducing suppliers' exposures to costs incurred in finding new customers.

- Overall, trade credit is informative about the lifespan of supplier-customer links, the production network's density, and macroeconomic risk.