Customers' Debt Financing and Suppliers' Innovations

ABSTRACT

In this study, we empirically investigate how customers' debt financing affects suppliers' innovation activities with respect to the number of patents, exploration and exploitation. We find that syndicated loan issuance to key customers has positive effects on the number of suppliers' patents, which are mainly driven by their increasing exploration. The results are stronger as the size of the loan to the key customer is larger. Our further tests highlight that such positive influences of customers' debt financing on the suppliers' exploration are weaker if the suppliers are highly dependent on the customers economically.

Keywords: Corporate debt financing, Innovation, Exploration, Exploitation, Customer-Supplier relationship

JEL Codes: G32, L14, O31

1. Introduction

Innovation is one of the most important investment decisions of a corporation. It is crucial for a firm's long-term survival in contemporary business environments. Especially exploration, a type of innovation exploring new field outside firm's current technology domain, becomes more important in the fast-changing technology environment of recent business. How to motivate innovation and which financial factors affect innovation has been main interest in corporate finance literature (Acharya and Xu, 2017, Chava, et al., 2013, Manso, 2011, Robb and Robinson, 2014). It is recognized in the literature that bank debt significantly affects corporate innovation. and (Chava, et al., 2013, Chava and Roberts, 2008, Choi, et al., 2016) implies that the ease of debt financing is related to increase in corporate innovation.

However, the incentive for innovation cannot be discussed separately from the customer-supplier relationship in a highly interdependent business environment. On average, approximately 25% of COMPUSTAT firms report conducting business with large customers, according to the Segment-Customer dataset. Research indicates that large customers significantly influence corporate decisions such as capital structure (Banerjee, et al., 2008, Brown, et al., 2009, Maksimovic and Titman, 1991), cash holdings (Itzkowitz, 2013), SEOs (Johnson, et al., 2018), earnings management (Raman and Shahrur, 2008), reputation (Johnson, et al., 2010, Kwon and Jung, 2022), among other factors. The role of debt financing also spills over to supply chain. Titman (1984), Williamson (1985), and Titman and Wessels (1988) document that the existence of large customer affects the capital structure of suppliers. Large customers can exert strong control over their suppliers particularly when supplier assets are highly specific for certain customers. Brown, et al. (2009) and Johnson, et al. (2018) provide evidence that the effects of corporate financing spill over to suppliers.

Currently, there is very limited information about the effects of debt financing on the product market. Our objective is to investigate how the debt financing a customer firm obtains affects the investment decision in innovation of its supplier firm. The fact that a customer firm obtains bank loans is good news for the customer firm (Best and Zhang, 1993), but the news could be perceived differently by its supplier in terms of the incentives for innovation. Using patent filing data from USPTO merged with segment-customer data of WRDS and DealScan dataset we analyze the effect of the customer bank loan on the innovation activity of the supplier firm. We find that suppliers who have a large customer tend to invest more in both exploration and exploitation, and that the portion of exploration is higher than exploration. We analyze the impact of the customer firm's bank loan on the supplier's innovation behavior. Consistently, the suppliers tend to invest more in both exploration and exploitation with a higher portion of exploration. These results imply that the presence of a large customer and the reinforcement of their existence serve as favorable business conditions for suppliers. We also find that, when customers exert greater influence over suppliers, the suppliers are inclined to reduce their exploration efforts upon the event of a customer loan.

This study contributes to literature in several ways. Firstly, this paper elucidates the ripple effects of a firm's debt financing decisions beyond its immediate financial implications. Specifically, it highlights how a customer firm's debt financing can indirectly influence the innovative activities of its suppliers. This adds a new dimension to our understanding of the broader impacts of debt financing in supply chains. Also, this research focuses on the effect of debt financing on corporate investment decisions while previous literature mainly focuses on the effects on debt financing. Secondly, our findings underscore the interconnectedness and interdependence of firms within a supply chain. The influence a customer firm wields over its

supplier can modulate the latter's strategic decisions, especially in the realm of innovation. This study reinforces the importance of considering stakeholder dynamics, particularly in the context of financial decisions and their cascading effects on other stakeholders. Thirdly, this research provides empirical evidence on the drivers of innovation at the firm level. It demonstrates that external financial factors, such as a customer's debt financing, can play a pivotal role in shaping a supplier firm's innovative endeavors, both in terms of quantity (number of patents filed) and strategy (exploration vs. exploitation). Furthermore, the nuanced finding that excessive influence from the customer can dampen certain innovative activities (like exploration) offers a more intricate understanding of the factors that can either foster or hinder innovation.

2. Data and Methodology

2.1. Data

We start our sample construction utilizing the COMPUSTAT annual fundamental data spanning from 1993 to 2021, and subsequently merge this with the Segment-Customer dataset to determine the supplier-customer relationships. We adopt a methodology analogous to Banerjee, et al. (2008) for the identification of the customer gvkey, linking the customer ID to the COMPUSTAT gvkey using customer names and abbreviations. In instances where a customer abbreviation corresponds to multiple company names within the CRSP/Compustat merged dataset, we employ the business descriptions of both supplier and customer to refine our matching process. To ascertain whether a customer has received a bank loan, we use the Dealscan-Compustat link provided by Chava and Roberts (2008). Furthermore, we quantify innovation activities based on the number of patent filings, categorizing a filing as exploration if it falls within classes that the assignee has not applied to in the preceding decade. Our initial dataset is derived from the USPTO patent filing metadata available on PatentsView, supplemented by the patent data from Kogan, et

al. (2017) for gvkey matching to patent assignees up until 2010. This is further extended through the WRDS US patent linking table for the period between 2011 and 2019. For the intervening years between the datasets of Kogan, et al. (2017) and the WRDS US patent link, gvkey assignment is meticulously conducted manually using the assignee name, ensuring a comprehensive matching for the entire span from 1926 to 2021. Definitions of variables are provided in Appendix A.

2.2. Empirical design

We first test our baseline regression by employing the following linear regression with sample firms with customers for firm *i* in year *t* using *Exploration* as the dependent variable.

$$Innovation_{i,t+1} = \beta_0 + \beta_1 Customer\ loan_{i,t} + \gamma X_{i,t} + I_{SIC4} + \delta_t + \epsilon_{i,t} \quad (1)$$

The *Customer loan* indicator captures the difference in *Innovation (t+1)* between firms with customer loans and firms without customer loans [1]. Control variables $X_{i,t}$ includes *Exploration (t), Market Cap., Leverage, Herfindahl index, R&D ratio, ROA, Tobin's q, and Age.* We include the 4-digit Standard Industrial Classification (SIC) indicator I_{SIC4}, and year indicator δ_t. Standard errors are clustered at the firm-level. We anticipate that $\beta_1 > 0$

Next, based on the baseline regression in Equation (1), we add *High customer loan* indicator to test the effect of loan amount.

$$Innovation_{i,t+1} = \beta_0 + \beta_1 High\ customer\ loan_{i,t} + \beta_2 Customer\ loan_{i,t} + \gamma X_{i,t} + I_{SIC4} + \delta_t + \epsilon_{i,t} \quad (2)$$

[1] From Equation (1), $Innovation_{i,t+1}[Customer\ loan_{i,t} = 1] - Innovation_{i,t+1}[CCustomer\ loan_{i,t} = 0] = \beta_1$

The *High customer loan* indicator captures the difference in *Innovation (t+1)* between firms with high customer loans and firms with low customer loans[2]. The *Customer* indicator captures the difference in *Innovation (t+1)* between firms with low customer loans and firms without customer loans[3]. All the other specifications are the same as those in Equation (1). We anticipate that $\beta_1 > 0$ and $\beta_2 > 0$.

3. Results and Discussion

3.1. Customer Loan and Innovation: Univariate Analysis

Panel A of Table 1 presents a univariate estimate of the mean values of innovation and firm characteristic variables for sample firms with customer. We divide sample firms with customer into two groups: firms without customer loan and firms with customer loan. Panel A shows that all innovation measures are higher for firms with customer loan. The average *Exploration rate (t+1)* for firms with customer loan is 0.093, which is significantly higher at the 1% level than 0.082 for firms without customer loan. These results are consistent with other innovation measures, including *Total patent number (t+1)*, *Exploration number (t+1)*, and *Exploitation number (t+1)*.

[Insert Table 1 about here]

One could argue that more robust measures of customer loan, such as the deal amount, be further explored. In Panel B, we rerun the same univariate analysis by separating firms with customer loan into two groups, firms with low customer loan and firms with high customer loan. Panel B shows that all innovation measures are higher for firms with high customer loan. The average *Exploration rate (t+1)* for firms with high customer loan is 0.099, which is significantly

[2] From Equation (2), $Innovation_{i,t+1}[High\ customer\ loan_{i,t} = 1, Customer\ loan_{i,t} = 1] - Innovation_{i,t+1}[High\ customer\ loan_{i,t} = 0,\ Customer\ loan_{i,t} = 1] = \beta_1$

[3] From Equation (2), $Innovation_{i,t+1}[High\ customer\ loan_{i,t} = 0, Customer\ loan_{i,t} = 1] - Innovation_{i,t+1}[High\ customer\ loan_{i,t} = 0,\ Customer\ loan_{i,t} = 0] = \beta_2$

higher at the 1% level than 0.087 for firms with low customer loan. Additional tests using other innovation measures, *Total patent number (t+1)*, *Exploration number (t+1)*, and *Exploitation number (t+1)*, exhibit similar patterns. Overall, the results in Table 2 suggest that customer debt financing positively affect supplier innovation but is more likely to incur exploration opportunities. This positive effect is more likely as customers have higher loan amount.

3.2. Customer Loan and Innovation: Multivariate Analysis

Panel A of Table 2 presents the results of Equation (1). In Column 1 of Panel A, we use the *Customer loan* as our main explanatory variable, which captures the difference in *Exploration rate (t+1)* between firms with customer loans and firms without customer loans in the sample period. Column 1 shows a positive point estimate of 0.006 for *Customer loan*, which is significant at the 5% level. In terms of economic significance, this result indicates that firms with customer loan take, on average, 7.32% (27.68=0.006/0.082×100) higher exploration rate than firms without customer loan, whose average *Exploration rate (t+1)* is 0.082. In Columns 2 to 4 of Panel A, we repeat the same analysis as Column 1 of Table 2 by replacing *Exploration rate (t+1)* with *Total patent number (t+1)*, *Exploration number (t+1)*, and *Exploitation number (t+1)* respectively, based on the same empirical specifications, and obtain similar results.

[Insert Table 2 about here]

Next, to pair with univariate analysis in Panel A of Table 1, we compare the innovation measures between firms with low customer loan and firms with high customer loan. In Panel B, based on Equation (2), we add *High customer loan* indicator to the existing *Customer loan* indicator as an explanatory variable. In Column 1 of Table 2, the *High customer loan* indicator captures the difference in *Exploration rate (t+1)* between firms with high customer loans and firms with low customer loans. We find a positive point estimate of 0.010 for *High customer loan*, which

is significant at the 5% level. Considering that the average *Exploration rate (t+1)* for firms with low customer loans sample is 0.087, the results show that firms with high customer loans on an average take 11.50% (11.50=0.010/0.087×100) higher exploration rate than other firms with customer loans, and thus are economically significant. Columns 2 to 4 of Panel B show similar patterns for different measures of innovations: *Exploration rate (t+1)* with *Total patent number (t+1)*, *Exploration number (t+1)*, and *Exploitation number (t+1)*. Overall, these results in Table 2 confirm the positive view of customers' debt financing.

3.3. Customer-Supplier Relation

To further verify factors that limits our baseline analysis in Table 2, we conduct several conditional tests on cases that customers can exert strong control over their suppliers. In Column 1 of Table 3, based on a linear model, we regress each firm's *Exploration rate (t+1)* on an interaction term, *Customer loan* × *Customer sales (dummy)*, while we control for the standalone terms in the same regression. Other empirical specifications are the same as in the previous regression analyses.

[Insert Table 3 about here]

The *Customer loan* indicator captures the difference in the *Exploration rate (t+1)* between firms with customer loans and firms without customer loans when the suppliers are less depends on the largest customer. The coefficient on *Customer loan* (0.009) is positive and statistically significant at the 1% level. The negative coefficient of the interaction term (-0.008), which is statistically significant at the 10% level, however, implies that exploration rate decreases as the portion of sales the suppliers made to the largest customer increases. The sum of the *Customer loan* indicator and the interaction term, *Customer loan* × *Customer sales (dummy)*, captures the difference in *Exploration rate (t+1)* between firms with customer loans and firms without

customer loans when the suppliers are highly dependent on the largest customers. The sum of the point estimates, 0.001 (0.001= 0.009–0.008), indicates that the positive difference between firms with customer loans and firms without customer loans sharply reduces. In Columns 2 and 3 of Table 3, we repeat the same analysis as Column 1 of Table 3 by replacing *Customer sales (dummy)* with *Customer sales (%)*, and *Durable industry*, respectively, and find similar results. Overall, the findings in Table 3 suggest that highly dependent suppliers are less likely to have an exploration opportunity upon the event of a customer loan.

4. Conclusion

In this research, we document that a supplier's innovation patterns can be heavily affected by the customers' financing activities. Among others, we highlight the positive influence of the customer's debt financing on the supplier's innovations in terms of the number of patents, which is mainly driven by its increased exploration. This implies that if the customer faces any favorable news that potentially enhance its firm value (i.e., syndicate loan issuance), this will encourage its supplier to exercise future growth options by pursuing innovations in new fields instead of sticking to its ongoing business areas. However, such incentives of suppliers to develop new fields through additional exploration become weaker if the suppliers are economically dependent on the existing customers to a large extent, i.e., the suppliers are held up by their customers.

Our findings have several practical implications for firm innovations as follows. Not just the maintenance of the relationship with key customers but also changing circumstances around the customers such as their external funding are crucial factors behind the suppliers' incentives to innovate. In this regard, it is important to broaden the scope of analyses by covering the overall business environments of the customers as well as those of the suppliers including their financing options to have complete pictures about firms' innovation motives. Customers' hold-up is another

key mechanism that potentially shapes firm innovations conditional on the customers' changing business environments. How to resolve customers' hold-up problems should be a vital matter for the suppliers' managers to optimize their innovation activities for future growth.

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Table 1: Customer Loan and Innovation – Univariate Analysis

Panel A: Full	Firms with customer (N=62,519): A		Firms without customer loan (N=52,408): B		Firms with customer loan (N=10,111): C		Test of difference (T and Mann-Whitney) (B-C)						
Variables	Mean	Median	Mean	Median	Mean	Median	Mean Diff.	t	p		z	p	
Exploration rate (t+1)	0.084	0.000	0.082	0.000	0.093	0.000	-0.011	-4.652	0.000	***	-14.115	0.000	***
Total patent number (t+1)	101.091	0.000	96.090	0.000	127.016	0.000	-30.927	-4.232	0.000	***	-18.289	0.000	***
Exploration number (t+1)	3.404	0.000	3.201	0.000	4.452	0.000	-1.251	-9.804	0.000	***	-15.883	0.000	***
Exploitation number (t+1)	97.688	0.000	92.888	0.000	122.564	0.000	-29.675	-4.075	0.000	***	-18.547	0.000	***
Market cap	1,878.277	133.001	1,730.034	123.056	2,646.658	187.466	-916.623	-8.435	0.000	***	-16.666	0.000	***
Leverage	0.183	0.077	0.185	0.074	0.178	0.092	0.007	1.059	0.290		-6.043	0.000	***
Herfindahl index	0.060	0.046	0.060	0.046	0.062	0.048	-0.003	-3.646	0.000	***	-7.813	0.000	***
RND ratio	0.919	0.008	0.944	0.007	0.790	0.014	0.155	0.775	0.438		-7.583	0.000	***
ROA	-0.150	0.010	-0.174	0.007	-0.026	0.021	-0.148	-5.347	0.000	***	-11.097	0.000	***
Tobin q	4.011	1.504	4.340	1.507	2.306	1.486	2.035	1.623	0.105		1.734	0.083	**
Age	15.924	12.000	15.689	12.000	17.143	12.000	-1.454	-10.315	0.000	***	-8.292	0.000	***

Panel B: Subsample	Firms with customer loan (N=10,111): A		Firms with Low customer loan (N=5,210): B		Firms with high customer loan (N=4,901): C		Test of difference (T and Mann-Whitney) (B-C)						
Variables	Mean	Median	Mean	Median	Mean	Median	Mean Diff.	t	p		z	p	
Exploration rate (t+1)	0.093	0.000	0.087	0.000	0.099	0.000	-0.012	-2.756	0.006	***	-6.723	0.000	***
Total patent number (t+1)	127.016	0.000	93.989	0.000	162.126	0.000	-68.137	-4.247	0.000	***	-8.726	0.000	***
Exploration number (t+1)	4.452	0.000	4.016	0.000	4.917	0.000	-0.901	-3.808	0.000	***	-7.789	0.000	***
Exploitation number (t+1)	122.564	0.000	89.973	0.000	157.209	0.000	-67.236	-4.204	0.000	***	-8.489	0.000	***
Market cap	2,646.658	187.466	1,856.515	136.131	3,486.617	274.382	-1,630.102	-6.653	0.000	***	-14.775	0.000	***
Leverage	0.178	0.092	0.167	0.064	0.190	0.126	-0.023	-4.100	0.000	***	-8.393	0.000	***
Herfindahl index	0.062	0.048	0.057	0.047	0.067	0.049	-0.010	-7.798	0.000	***	-6.435	0.000	***
RND ratio	0.790	0.014	1.025	0.020	0.540	0.012	0.485	1.802	0.072	*	6.721	0.000	***
ROA	-0.026	0.021	-0.039	0.016	-0.012	0.024	-0.026	-2.506	0.012	**	-3.250	0.001	***
Tobin q	2.306	1.486	2.557	1.571	2.039	1.412	0.518	7.667	0.000	***	8.941	0.000	***
Age	17.143	12.000	14.738	11.000	19.700	14.000	-4.963	-18.178	0.000	***	-15.374	0.000	***

Note: ***, ** and * denote significance at the 1 %, 5 %, and 10 % level, respectively.

Table 2: Customer Loan and Innovation – Multivariate Analysis

Panel A	Dependent Variable (t+1)			
	(1)	(2)	(3)	(4)
Variables	Exploration rate	Total patent number	Exploration number	Exploitation number
Customer loan	0.006**	0.049***	0.065***	0.035***
	(0.003)	(0.011)	(0.011)	(0.010)
Controls	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes
Observations	62,519	62,519	62,519	62,519
R-squared	0.063	0.767	0.352	0.825

Panel B	Dependent Variable (t+1)			
	(1)	(2)	(3)	(4)
Variables	Exploration rate	Total patent number	Exploration number	Exploitation number
High customer loan	0.010**	0.052**	0.064***	0.033*
	(0.004)	(0.020)	(0.019)	(0.018)
Customer loan	0.001	0.024*	0.034**	0.020
	(0.003)	(0.014)	(0.013)	(0.012)
Controls	Yes	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes	Yes
Observations	62,519	62,519	62,519	62,519
R-squared	0.063	0.767	0.352	0.825

Note: Standard errors are in parentheses. ***, ** and * denote significance at the 1 %, 5 %, and 10 % level, respectively.

Table 3: Customer-Supplier Relation

	Dependent Variable: Exploration rate (t+1)		
	(1)	(2)	(3)
Variables	X = *Customer sales (dummy)*	X = *Customer sales (%)*	X = *Durable Industry*
Customer loan x [X variable]	-0.008*	-0.022**	-0.033**
	(0.005)	(0.010)	-0.014
Customer loan	0.009***	0.013***	0.007**
	(0.003)	(0.004)	(0.003)
[X variable]	-0.010***	-0.024***	0.005
	(0.002)	(0.005)	(0.011)
Control	Yes	Yes	Yes
Year dummy	Yes	Yes	Yes
Industry dummy	Yes	Yes	Yes
Observations	62,519	62,519	62,519
R-squared	0.063	0.063	0.063

Note: Standard errors are in parentheses. ***, ** and * denote significance at the 1 %, 5 %, and 10 % level, respectively.

Appendix A: Variable Definitions

Variable	Explanation
Age	Years since the company start to exist in COMPUSTAT
Customer loan	1 if the largest customer receives a bank loan in the fiscal year; 0 otherwise
Customer	1 if the company has a customer reported; 0 otherwise
Durable industry	1 if the company belongs to durable industry (SIC 3400-4000); 0 otherwise
Total patent number (t)	The total number of patents filed in the fiscal year t and eventually granted.
Exploration number (t)	The number of patents categorized as exploration
Exploitation number (t)	The number of patents categorized as exploitation
Exploration rate	Exploration rate in the fiscal year *t* (Exploration number (t)/ Total patent number (t))
Herfindahl index	Normalized Herfindahl-Hirschman index in Fama-French industry
Market cap.	Market capitalization (Common Shares Outstanding [CSHO] * Price Close [PRCC_F])
Leverage	Total long-term debt / Total assets
R&D ratio	R&D intensity (R&D Expense [XRD] / Sales [SALE])
ROA	Fama-French industry adjusted ROA
Tobin's q	Tobin's q ({Total current liabilities [LCT] + Total long-term debt [DLTT] + Number of common shares outstanding [CSHO] * Closing price on fiscal year end data [PRCC_F]}/ Total assets [AT])
Customer sales (%)	The percentage of sales the company made to the largest customer out of total sales