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Understanding the relationship between Customer Concentration and Profitability in Public Firms in the Electronics Manufacturing Industry

A Thesis Presented

by

Alexander Benjamin Garcia Delgado

To the Keck Science Department

Of Claremont McKenna, Pitzer, and Scripps College

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Abstract

This study investigates the relationship between a supplier's profitability and their major customers. Previous literature concerning a firm's customer makeup and their profitability have produced two general conclusions. The first conclusion is that there is a negative correlation due to the power imbalance major customers gain over their suppliers, resulting in lower prices, overextended credit accounts, and inconsistent cash payments for the goods provided by the supplier. Other literature argues that there is a positive correlation due to mutual dependence between a customer and its supplier causing an increase in information sharing and joint actions, resulting in a higher profitability for the supplier. This study analyzed 136 firms in the electronics manufacturing industry in 2017 and found a positive and significant correlation between customer concentration and a supplier's profitability. The analysis also found a positive but insignificant correlation between mutual dependence and a supplier's profitability. The results suggest that gained efficiencies from greater customer concentration outweigh the effects of a disadvantageous power imbalance by major customers.

Introduction

Globalization has brought upon rapid change to the way we think of supply chains and supplier-consumer relations. With a world that is widely interconnected, emphasis has been placed on systemic risk within the fields of supply chain management and industrial organization. The term "supply chain" is now appearing more and more to be a "supply network". A firm's customers are a major component of the supply network of modern manufacturing firms. According to US manufacturing firms, about 30% of all sales are attributed to a small percentage of large customers (Campello and Gao, 2017). Extensive studies and analysis into this subject have shown that as firms develop relationships with these select few and very large customers, investments in specialized, customer specific assets occur and the customer obtains an economic leverage over their supplier, allowing them to negotiate a lower product price or delay regular payments for the products. (Kelly, Lusting, and Van Newburgh, 2013; Cohen and Frazzini, 2008)

This paper will build upon the existing literature concerning the correlation between a firm's major customers and that firm's profitability. This analysis will primarily focus on the publicly traded companies in the electronics manufacturing industry, a novelty in the current knowledge, which has primarily focused on the manufacturing business entirely. (Campello and Gao, 2013; Kim, 2017) The electronics industry, while it has been around for a significant amount of time, is an industry that is constantly evolving and supplying the innovation of the model world. This paper wishes to analyze the relationship between major customers and a supplier's profitability within the electronics manufacturing industry and to what magnitude the relationship compares to existing literature.

Literature Review

Extensive work has been done that looks into the impact of having major customers on a firm's profitability and overall performance. While results and correlations vary across the existing literature, there appears to be two schools off thought concerning the relationship between major customers and profitability that are based on economic reasoning.

Some literature suggests a negative correlation between major customers and a supplier's profitability. Galbraith and Stiles' 1983 article views the relationship between a firm and their major customers as a potential power imbalance. The article mentions the Rolls Royce investigation of 1969, which showed that Rolls Royce was a major customer of several suppliers and had significant power over these firms (Galbraith and Stiles, 1983). Due to the high sales volume attributed to Rolls Royce, Rolls Royce had significant leverage in demanding lower prices and conditions unequivocally advantageous to them. Smith Clayton Forge, a supplier for Rolls Royce's engine blades, had developed product specific forging technique unique for Rolls Royce (Galbraith and Stiles, 1983). This investment in customer specific assets by a supplier increased the leverage Rolls Royce had on their supplier, further placing Smith Clayton Forge in a disadvantageous and profit stifling situation. Rolls Royce, being a large part of multiple suppliers' total sales, had also received generous credit lines with these companies. (Galbraith and Stiles, 1983) These credit lines, while they did allow for the continued business between a supplier and their major customer, also allowed for an irregular cash payment schedule for the products and services being provided by the supplier. This problem grew into the worst situation for the suppliers when Rolls Royce defaulted in 1969, significantly affecting all of its suppliers in the process (Galbraith and Stiles, 1983). The Rolls Royce bankruptcy and investigation of 1969 strongly exemplifies the economic risks suppliers take when having major customers:

suppliers lose price negotiating leverage due to large sales volume, investing in customer specific assets, and overextending credit lines to their major customers. Further studies have shown that this power imbalance is not a case specific phenomenon and can be seen in other relationships, such as between manufacturing firms and large retail stores (Kelly and Gosman, 2000).

On the opposite side of the same coin, there exists literature which suggests a positive correlation between a firm having major customers and the firm's profitability. The theoretical justification for this positive correlation is a mix of sociology and economic theory, stating that the mutual dependence of both suppliers and their major customers stifles opportunistic power imbalances in favor of maintaining the relationship (Granovetter, 1985). In addition to stifling opportunism from the major customer, further literature suggests that such relationships also promote information sharing within the supply chain of products, allowing for an improved and more synchronous asset management by the supplier firms. (Cowley, 1988) The benefits of a synchronous supplier and major customer relationship can be observed in case studies of collaborative marketing campaigns. (Bund, 1985). Patatoukas (2012) did an empirical analysis of supplier firms with major customers and found a positive contemptuous association between a firms Customer Concentration (CC) and the supplier firm's accounting rate of return (ARR). In this specific research, the positive association was linked to the theory that the efficiencies of having a major customer base outweighed the monetary losses due to disadvantageous prices forced by the major customers (Patatoukas, 2012). The efficiencies mentioned above include relatively lower selling, general and administrative costs, enhanced asset utilization, greater return on assets (ROA), and a greater inventory turnover.

Most of the literature regarding a firm's customer base and profitability studied public firms as a whole, focusing on the manufacturing sector (SIC 2000-4000), or looking at firms that have

retail companies (Target, Walmart, Amazon) as their major customers (Kelly and Gosman,2000). Existing literature on major customers in the electronics manufacturing industry is limited and primarily focuses on the effect of a firm's supply network on the firm's innovation output (Ghosh and Hora, 2014). While Ghosh and Hora primarily focus on the customer's perspective of the supply chain, they analyze the supply chain as a network rather than a direct link between a single supplier and single customer. This paper studies the electronics industry through the network lens, and I will be adopting this same lens, but will focus on the impact on the supplier firms' profitability characteristics.

Hypothesis Development

Previous literature has used a measure called *customer concentration* (CC) to measure how dependent a supplier's sales are on their major customers (Kim, 2014; Patatoukas, 2012; Kelly and Gosman, 2000; Balakrishnan,1996). The *customer concentration* metric takes into account the number of major customers and the respective sales generated from each customer. There is some division on the conclusions gathered using the customer concentration metric. Kelly and Goodman (2000) observed that within the manufacturer-retail relationships, manufacturing firms with major retail customers were less profitable. This lesser performance was attributed to the buying power of the retail companies, who held leverage over the suppliers due to the significant sales they generated for the supplier firm. Balakrishnan (1996) also had similar results, however the observations were focused on just-in-time (JIT) companies and their suppliers. The reasoning for this negative correlation was similar to that of Kelly and Goodman, finding that the customers had significant leverage which allowed for a disadvantageous price for the supplier and the possibility of irregular payment schedules by the customer (Balakrishnan (1996). More recently, Kim (2014) found that customer concentration negatively impacted a firm's profitability and overall performance, furthering the notion that having major customers hampers a firm's profitability. However, it is important to mention that Patatoukas (2012) observed a positive association between customer concentration and the supplier firms' profitability and overall performance. This observation was done on a sample of firms in several industries including manufacturing and construction, wholesale and retail trade, and public administration. Patatoukas observed that firms with a greater customer concentration reported lower gained efficiencies, such as lower cost of goods sold (COGS), selling, general and administrative costs (SGA), and inventory turnover rates. It is possible to expect that a firm with a smaller number of customers could specialize products and marketing strategy to each customer, allowing a better

utilization of the supplier's resources. A supplier that produces customer specific goods could become a just-in-time (JIT) firm, lowering the cost of holding inventory.

This paper will primarily focus on the electronics manufacturing industry (SIC 3600-3699), an industry where there is not a significant amount of literature. However, previous works that encompassed multiple industries, including manufacturing, in their samples have for the vast majority observed a negative association between customer concentration and a supplier firm's profitability. While there is some empirical evidence and a theoretical justification through gained efficiencies for a positive correlation between CC and a firm's profitability, most of the literature review has demonstrated a negative correlation. Therefore, I am compelled to introduce the following hypothesis:

Hypothesis One: Customer concentration has a negative correlation with a supplier firm's profitability in the electronics manufacturing industry.

In this study, I will also be looking at the relationship between a supplier's *mutual dependence* with its major customers and how that effects its profitability. Like the customer concentration measure in the previous paragraph, there has been some consistent usage of the mutual dependence metric in literature. Mutual dependence is an interaction term that takes into account how embedded a supplier's sales are with a particular customer and also how important these sales are to the costumer's operation. A more detailed mathematical explanation is given in the next section. The concept of mutual dependence in the supplier-customer relationship stems from a social network view of this system, suggesting that dependence between both a customer and their supplier promotes trust and a willingness to subdue opportunistic power grabs in order to preserve the relationship (Uzzi, 1997). Kim (2017) found a positive correlation between a supplier's mutual dependence and their profitability when he looked at a sample size of 717

firms across multiple industries, including the electronic industry. Based on previous literature's analytic results and the theoretical justification of embeddedness increasing the profitability of a supplier, I am compelled to state the following hypothesis:

Hypothesis Two: Mutual Dependence is positively correlated with a supplier firm's profitability in the electronics manufacturing industry.

Data Sample Construction & Methodology

The data sample for this study was obtained from Standard & Poor's Compustat database, specifically the Historical Segment – Customer data. This study focused on North American public firms in the electronics manufacturing industry, which are associated by the firm having a Standard Industrial Classification code between 3600-3699. This study also focused specifically on the fiscal year 2017. The data sample consisted of public firms that had disclosed at least one major customer in fiscal year of 2017. The sample data from Compustat was further enhanced by only looking at major customers who were other companies and not government entities (local, state, and federal), individual people, or geographical areas. The data sample from compustat was additionally filtered by removing major customer entries that were not a single entity (ie. "2 customers", "10 customers"). The data entry for each supplier firm's major customers had to be a single identifiable and publicly traded company. As a result of the filtering, the data sample consisted of 136 publicly traded companies that had at least one major customer that was another company in the year 2017.

Having selected the study's sample size, several economic data on each company was collected. Data on each company in the sample included the number of major customers and the sales generated from each major customer. Additional supplier company specific information that was gathered included the firms' size (which is the natural log of their annual total sales), the dollar amount of cash on hand in 2017 (CASH), the supplier's cost of goods sold (COGS), their research and development expense in 2017 (RD), the total value of the shareholder's equity (TE), and the net value of the supplier's property, plant, and equipment. All of these figures were as of the date each company published their annual documents for the fiscal year 2017. All monetary figures are in USD and foreign monetary figures (JPY, KRW, TWD, CYN) were converted to

USD using the exchange rate at the date the financial fillings were published. (Historical Exchange Rates, 2021) Annual financial data was also collected on each of the major customers from the sample data. For this analysis, I used a hierarchical regression analysis on two dependent variables. The dependent variables for this analysis include the suppliers return on assets (ROA) and their return on sales (ROS). These variables are sufficient indicators of a firm's profitability and have been used in previous literature (Kim, 2017). A mathematical interpretation of ROA and ROS is listed below.

$$Return\ on\ Asset_i = \frac{Net\ Income_i}{Total\ Asset_i}$$

$$Return\ on\ Sales_i = \frac{Net\ Income_i}{Total\ Sales_i}$$

There will be a total of two hierarchical regression analysis, one on return on asset and one on return on sales. Each one of this hierarchical regression analysis will consist of two models. Model one will regress one of the dependent variables on only the control variables. The control variables include the supplier's cash, cost of goods sold, research and development expense, their total equity, the net value of their property plant and equipment, and the supplier firm's size. Cash was chosen as a control variable to account for a company's liquidity and ability to meet their financial obligations under the event that a customer does not pay or pays irregularly. The cost of goods sold was submitted to account for the size of the supplier's cost of operations. This study expects a negative correlation between COGS and supplier's profitability since a relative increase in COGS would directly result in lower net income. Research and Development expense is necessary because the sample data is in the electronic manufacturing industry, an asset and technology heavy sector. This study expects a negative correlation between research and development expense with the firm's profitability. Similarly, property, plant and equipment is

necessary to account for the wide ranges in firm sizes, specifically on the customer specific assets each supplier has relative to the rest of the sample. Lastly, total equity and firm size both account for a firm's overall size, which is necessary to include in order to not skew the result due to extremely small boutique suppliers or large, multinational ones. All of these control variables are in a United States Dollar amount with the exception of their firm size, which is the natural log of their total sales.

$$Firm\ Size_i = \ln (Total\ Sales_i)$$

Model two add two additional dependent variables, customer concentration and mutual dependence, to the construction of model one. These two independent variables are the main independent variables that incorporate a supplier's relationship with their major customers.

Customer concentration (CC) is the sum of sales generated by each major customer, *j,* divided by the total sales of the supplier, *i,* squared. This variable has a range from 0 to 1 and reflects how much of a supplier's sales are attributed to major customers. A mathematical equation for customer concentration is shown below.

$$Customer\ Concentration_i = \sum_{j=1}^{J} \left(\frac{Sales_{ij}}{Sales_i}\right)^2$$

The second dependent variable of interest that was added in model two is mutual dependence (MD). This dependent variable is an interaction between how important a customer is to the supplier (S_{ij}) and how important the supplier is to the customer (P_{ij}). S_{ij} is similar to customer concentration, where we divide the sales generated by a customer by the total sales of the supplier, however we are not squaring the fraction here. P_{ij} represents how important the supplier is to the customer's annual purchases. It is calculated by the dividing the sales generated

by customer *j* by the customer *j*'s cost of goods sold for the same year. Each interaction between S_{ij} and P_{ij} is weighted by a factor of ω_{ij}. This weighing factor is S_{ij} divided by the total sales of supplier *i*. Mutual dependence can be interpreted as an interaction term between customer concentration and how important a supplier is to their customer. This measure has a range from 0 to 1, where a value of 1 would mean that all the sales generated by a customer equate all the cost of goods sold of the customer. Mathematical equations for MD_{ij} and its components are below.

$$MD_i = \sum_{j=1}^{J} \omega_{ij}(S_{ij} * P_{ij})$$

$$\omega_{ij} = \frac{\left(\frac{Sales_{ij}}{Sales_i}\right)}{\sum_{j=1}^{J}\left(\frac{Sales_{ij}}{Sales_i}\right)}$$

$$S_{ij} = \left(\frac{Sales_{ij}}{Sales_i}\right) and\ P_{ij} = \left(\frac{Sales_{ij}}{Cost\ of\ goods\ sold_j}\right)$$

Results

The hierarchical regression analysis produced four individual regressions, two different models for each of the two dependent variables ROA and ROS. Table 1 shows the results of each of the regressions run on STATA.

The first thing to note is that the R^2values for model one on both the ROA and ROS regressions were .4437 and .3137, respectively. These values are sufficient and appropriate compared to R^2 values from existing literature with similar regression analysis (Kim, 2017). The adjusted R^2 for both model ones were slightly less at 0.4144 and 0.3137, however they were still adequate when compared to previous regressions ran in existing literature.

Focusing on the hierarchical regression on ROA, there was a significant increase in the R^2 from model two to model one. There was a 0.093 increase between an R^2 of 0.5362 in model two and 0.4437 in model one. This indicated that customer concentration and mutual dependence had some descriptive power in a supplier's return on assets.

The hierarchical regression analysis on ROS also demonstrated an increase in the R^2 between model two and model one, however, it was significantly smaller compared to the regression on ROA. There was a 0.025 increase between a R^2 of 0.3385 in model two and 0.3137 model one. This increase indicates that customer concentration and mutual dependence have some descriptive power on ROS, however, not as great as in the regression on ROA.

Looking at the values for customer concentration (CC) in model two for the regression on ROA, we see a coefficient of 0.2532 and a $P > |t| = 0.035$. This means that customer concentration has a positive and statistically significant effect on a supplier's ROA at a 95% confidence level. Customer concentration in model two of the regression on ROS demonstrated a coefficient value

of 0.987203 and $P > |t| = 0.039$. This is important as the analysis shows that customer concentration has a positive and significant effect on a supplier's profitability. This does not support hypothesis one, which stated that customer concentration is negatively associated with a supplier's profitability.

Mutual dependence (MD) in model two of the regression on ROA had a coefficient of 0.0701 and a $P > |t| = 0.451$. This indicates that MD had a positive but insignificant effect on a supplier's ROA. Similarly for the regression on ROS, the coefficient for MD was 0.0907 and had an $P > |t| = 0.805$. Both of these results indicated that MD has a positive, but statistically insignificant effect on a supplier's profitability at a 95% confidence level. This result only partially supports hypothesis two.

Table [1]: Regression Results of the Hierarchical Analysis on ROA (left side) and ROS (right side)

Model 1:
Variables in Model:
Adding : **FS Cash COGS RD TE PPE**

Source	SS	df	MS		
Model	3.07774865	6	.512958109	Number of obs	121
				F(6, 114)	15.15
Residual	3.8594392	114	.03385473	Prob > F	0.0000
				R-squared	0.4437
				Adj R-squared	0.4144
Total	6.93718785	120	.057809899	Root MSE	.184

ROA	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
FS	.0999301	.0120487	8.29	0.000	.0760617	.1237984
Cash	-1.95e-07	.0000331	-0.01	0.995	-.0000657	.0000653
COGS	-.0000446	.0000159	-2.80	0.006	-.0000761	-.0000131
RD	-.0000216	.0000433	-0.50	0.619	-.0001074	.0000642
TE	4.90e-06	9.49e-06	0.52	0.607	-.0000139	.0000237
PPE	3.55e-06	3.86e-06	0.92	0.359	-4.09e-06	.0000112
_cons	-.6213886	.0665681	-9.33	0.000	-.7532595	-.4895176

Model 1:
Variables in Model:
Adding : **FS Cash COGS RD TE PPE**

Source	SS	df	MS		
Model	17.2201905	6	2.87003175	Number of obs	121
				F(6, 114)	8.69
Residual	37.6699757	114	.330438383	Prob > F	0.0000
				R-squared	0.3137
				Adj R-squared	0.2776
Total	54.8901662	120	.457418051	Root MSE	.57484

ROS	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
FS	.2494146	.0376422	6.63	0.000	.1748456	.3239835
Cash	-.000071	.0001033	-0.69	0.493	-.0002756	.0001336
COGS	-.0001089	.0000497	-2.19	0.031	-.0002074	-.0000104
RD	-.0000863	.0001353	-0.64	0.525	-.0003543	.0001817
TE	.0000206	.0000297	0.70	0.488	-.0000381	.0000794
PPE	7.62e-06	.0000121	0.63	0.528	-.0000163	.0000315
_cons	-1.521356	.2079706	-7.32	0.000	-1.933344	-1.109368

Model 2:
Variables in Model: **FS Cash COGS RD TE PPE**
Adding : **CC MD**

Source	SS	df	MS		
Model	2.26430792	8	.283038491	Number of obs	101
				F(8, 92)	13.29
Residual	1.95873772	92	.021290627	Prob > F	0.0000
				R-squared	0.5362
				Adj R-squared	0.4958
Total	4.22304565	100	.042230456	Root MSE	.14591

ROA	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
FS	.1033803	.0111569	9.27	0.000	.0812217	.1255389
Cash	3.14e-06	.0000312	0.10	0.920	-.0000588	.0000651
COGS	-.0000466	.0000169	-2.76	0.007	-.0000802	-.000013
RD	-.0000119	.0000449	-0.27	0.791	-.0001011	.0000772
TE	3.31e-06	8.26e-06	0.40	0.689	-.0000131	.0000197
PPE	3.54e-06	3.83e-06	0.92	0.358	-4.06e-06	.0000111
CC	.2532421	.1185639	2.14	0.035	.017764	.4887201
MD	.0701199	.0926382	0.76	0.451	-.1138676	.2541074
_cons	-.6592852	.067818	-9.72	0.000	-.7939777	-.5245928

R-Square Diff. Model 2 - Model 1 = **0.093** F(2,92) = **-19.103** p = **1.000**

Model 2:
Variables in Model: **FS Cash COGS RD TE PPE**
Adding : **CC MD**

Source	SS	df	MS		
Model	15.7770598	8	1.97213248	Number of obs	101
				F(8, 92)	5.89
Residual	30.8256372	92	.335061274	Prob > F	0.0000
				R-squared	0.3385
				Adj R-squared	0.2810
Total	46.602697	100	.46602697	Root MSE	.57884

ROS	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
FS	.284932	.04426	6.44	0.000	.1970278	.3728362
Cash	-.0000489	.0001237	-0.40	0.694	-.0002947	.0001969
COGS	-.0001307	.0000671	-1.95	0.054	-.0002639	2.52e-06
RD	-.0001213	.0001781	-0.68	0.498	-.0004749	.0002324
TE	.0000244	.0000328	0.74	0.459	-.0000407	.0000894
PPE	.000011	.0000152	0.73	0.469	-.0000191	.0000412
CC	.987023	.470349	2.10	0.039	.0528693	1.921177
MD	.0907601	.3675007	0.25	0.805	-.639128	.8206481
_cons	-1.83052	.2690376	-6.80	0.000	-2.364852	-1.296188

R-Square Diff. Model 2 - Model 1 = **0.025** F(2,92) = **-2.154** p = **1.000**

Discussion

It is important to explore why the empirical analysis did not support the hypothesis that customer concentration is negatively associated with a supplier's profitability. Two possible explanations for this contradiction could be the effect of gained efficiencies and the increasing demand for electronic components.

Previous literature, such as Patatoukas (2012) found a positive correlation between customer concentration and a supplier's profitability. The author reported that although suppliers with a greater customer concentration reported lower margins, they also reported lower expenses such as cost of goods sold and selling, general, and administrative expenses. That article also reported that customer with greater CC also reported higher inventory turnover rates and greater asset utilization (Patatoukas, 2012). There exists the possibility that within the electronics manufacturing industry, the gained efficiencies from a greater customer concentration are more effective than in other industries. Suppliers could possibly invest in product specific assets for producing their customer's products, such as the buying of new equipment to produce a model specific camera for their customer's phone.

Aside from the benefits of a streamlined operation for the supplier, there could be the additive effect of joint actions between electronics manufacturing suppliers and their clients. Information sharing and joint actions, such as a collaborative marketing campaign, can lessen the disadvantageous position of suppliers with their customers and improve the profitability of the suppliers (Bund, 1985). This effect, although not explored in this study, could possibly have a significant impact on suppliers within the electronics manufacturing industry. It is possible that the combination of gained efficiencies and increased information sharing between suppliers and

major customers as a result of customer concentration outweigh the potential negative power imbalance.

Currently, in March of 2021, there is a massive shortage for electronic components, more specifically microchips, due to the massive increase in demand for the production of everything from children's toys to multi-million-dollar aircrafts (King, Wu, and Pogkas, 2021). While this explosive demand is a few years after our sample data, I believe it is reflective of the high demand for electronic components, especially as more and more products produced have at least one electric component in them. According to the World Bank, in 2017 there were 102.8 active cellular subscriptions per 100 people, and this number has since increased to 109.4 in 2019 (World Bank, 2019). Similarly, the percentage of the people connected to the internet increased from 28.754% in 2010 to almost 49% in 2017 (World Bank, 2017). The world is quickly becoming more and more connected, thus increasing the demand of the smart devices and the electronic components that make these devices possible. It could be possible that this high demand for electronic components lessens the power imbalance between suppliers and major customers in favor of the suppliers. Studying this further would be an interesting avenue for greater exploration.

The analysis in this study, specifically the positive but statistically insignificant effect mutual dependence had on a supplier's profitability, only partially supported the second hypothesis. It is important to ask why the mutual dependence was statistically insignificant.

The statistical insignificance of MD could be due to the size of the sample data. While the study ensured that all of the suppliers were North America publicly traded companies, the major customers could be either public or private companies. Since some of the major customers were private companies, it was difficult to gather financial data necessary to calculate their mutual

dependence. This resulted in overall less data points to run the regression on. A possible avenue for further exploration of the mutual dependence of suppliers would be to run a regression across several years to gain more data.

Lastly, it is important to reflect on the importance of this study and how it contributes to the existing literature. The technology sector is rapidly growing and in order to make smart investment and business decisions within this field, we must fully understand the systemic risk that exists. The networks between electronic manufacturing firms and their major customers are a part of this systemic risk and thus is worth investigating to better understand it.

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