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Customer-Base Concentration, Profitability, and the Relationship Life Cycle

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ABSTRACT: Using a recently expanded dataset on supplier-customer links, we introduce a dynamic relationship life-cycle hypothesis. We hypothesize that the relation between customer-base concentration and profitability is significantly negative in the early years of the relationship, but becomes positive as the relationship matures. The key driver of this dynamic is the customer-specific investments that the relationship entails. These investments result in larger fixed costs, greater operating leverage, and a higher probability of losses early in the relationship, but can significantly benefit the firm as the relationship matures. Although many of these money-losing firms in early-stage relationships were not studied in Patatoukas (2012), we find a market reaction to increases in customer concentration similar to that in his paper. This result provides powerful confirmatory evidence of the value of customer concentration. We document one of the intangible benefits of customer concentration, technology sharing, and show how this benefit increases as the relationship matures.

Keywords: relationship life cycle; customer concentration; customer-specific investments; selling; general and administrative expense; profitability; operating risk.

JEL Classifications: L25; M41; G31; G33.

I. INTRODUCTION

Winning the business of a major customer is a highly significant event in the life of the firm. Business from major customers can increase firm revenues markedly and permit efficiencies of scale in operations and delivery. Despite these advantages, economists have long warned of the danger of supplying a considerable fraction of firm output to a particular customer. Lustgarten (1975) credits Galbraith (1952) with the origin of the concept that large customers threaten a manufacturer's operating profits. The problem with major customers is that margin improvements achieved through selling efficiencies or other economies of scale do not necessarily accrue to the firm. Major customers recognize their strong bargaining position and can engage in *ex post* renegotiation over the contract terms (Klein, Crawford, and Alchian 1978; Williamson 1979). Once the firm has committed resources to production for a major customer, these customer-specific investments represent costs that the firm cannot fully recover unless they maintain the relationship. Major customers can impair firm profitability by demanding price concessions, extended trade credit, or other benefits. For example, Balakrishnan, Linsmeier, and Venkatachalam (1996) argue that major customers are aware of the firm's cost savings from Just-In-Time (JIT) adoption,

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and that subsequent customer demands for concessions prevent the adopters from improving profitability.[1] In his empirical study of customer concentration, Lustgarten (1975) concludes that at the industry level, high customer concentration reduces firm profitability.

Patatoukas (2012) challenges the conventional wisdom that customer concentration impairs firm profitability. Using Statement of Financial Accounting Standards (SFAS) 14 and Securities and Exchange Commission (SEC) Reg S-K mandated disaggregated revenue disclosures available from Compustat, he creates a firm-specific measure of customer concentration and finds a positive relation between customer concentration and accounting rates of return. Patatoukas (2012) points out that focusing exclusively on customer concentration and gross margins can obscure the effects of customer concentration on key valuation metrics, such as return on assets. Highlighting the ability of the DuPont profitability analysis to make this point, he follows earlier studies on firm profitability (Fairfield and Yohn 2001; Soliman 2008) by focusing on firms with positive operating performance. In this sample, he finds that firms with higher customer concentration have higher return on assets, lower selling, general, and administrative (SG&A) expenses, and enhanced asset turnover rates. Patatoukas (2012) further documents an intertemporal relation between changes in customer concentration and key operating variables that are consistent with his static analysis. A powerful confirmatory result is that stock prices react positively to changes in customer concentration, supporting the contention that customer concentration improves firm fundamentals.

Patatoukas' (2012) findings clearly illustrate that the conventional wisdom regarding the effects of customer concentration is flawed, thus challenging researchers to develop a more complete understanding of the effects of major customer relationships. To accomplish this, we apply the concept of the relationship life cycle, one of the fundamental postulates in the management and marketing literatures (Dwyer, Schurr, and Oh 1987; Wilson 1995). The dynamic interaction of customers and suppliers suggests that costs and benefits to the firm could change as the relationship develops and matures. Using this concept, we seek to understand whether the strength and economic direction of Patatoukas' (2012) findings vary over the relationship life cycle. Our results suggest that the solution to the divergent results in the literature can be explained by focusing on when customer concentration improves profitability, rather than whether customer concentration improves profitability.[2]

We take advantage of a recent expansion in the Compustat disaggregated revenue disclosures to vastly extend the empirical analysis of the relationship life cycle. Existing papers on the relationship life cycle, such as Jap and Anderson (2007), use point-in-time surveys to infer attributes of the different stages in supplier-customer relationships. We show how the relation between customer concentration and accounting measures changes as the relationship matures. We confirm the important economic insight in Patatoukas (2012) that customer concentration can lead to improved profitability. Yet our conclusions are, in some ways, broader because firms in the early stages of their relationship often exhibit markedly different characteristics than the more mature relationships examined in Patatoukas (2012). Firms early in a major customer relationship tend to be younger, with their sales more dependent on major customers, and they make considerable investments in customer-specific assets. Because these investments induce considerable operating risk early in the life cycle, such firms have a greater probability of negative earnings, and they exhibit greater demand uncertainty. These differences highlight the dynamic nature of the relationship between customer concentration and firm performance. We maintain that to fully understand the effects of customer concentration on firm profitability, it is necessary to understand the life cycle of the relationship.

Notably, we find that despite the initial adverse effect of higher customer concentration on return on assets and SG&A expenses, stock prices respond positively to changes in customer concentration. In fact, the contemporaneous return result in our expanded sample is remarkably close to that in Patatoukas (2012). This confirms the contention that increases in customer concentration are generally perceived by investors as good news for the firm. Our ability to document the positive returns associated with increases in customer concentration, despite the inclusion of negative operating earnings firms, provides strong confirmation of Patatoukas' (2012) conclusions on the value relevance of major customer relationships.

The importance of customer-specific SG&A investments (Williamson 1979; Anderson, Banker, and Janakiraman 2003) drives many of the effects of the relationship life cycle on firm profitability. We find that early in the relationship, firms with higher customer concentration make greater customer-specific SG&A investments, believing that such investments will eventually produce higher profits. However, customer-specific SG&A expenses are, by definition, less transferable than general SG&A investments and, thus, increase a firm's fixed SG&A costs, leading to higher operating leverage and a greater probability of negative earnings. Firms with high customer concentration are initially significantly more likely to incur losses than firms with lower levels of customer concentration (54.1 percent to 36.0 percent). These risks decline as the relationship matures and, eventually, firms with high levels of customer concentration are rewarded with higher operating profits and lower operating risk. Consistent with our contentions, as the relationship matures, the probability of negative earnings significantly

[1] Recently, Ng (2013) relates the example of Procter & Gamble, who plan to extend the time they take to pay suppliers from 45 days to 75 days.

[2] Patatoukas (2012) suggests that learning to coordinate operations is likely to provide benefits over time. Empirically, the fact that changes in the level of customer concentration lead to improved performance in the subsequent year demonstrates the necessity of investigating the dynamics of the customer-supplier relation. This paper develops the relationship life cycle as a framework for examining these dynamics.

declines. Notably, for suppliers in mature relationships, we find that the probability of negative earnings is lower (24.6 percent) for high customer concentration firms than it is for low customer concentration firms (25.9 percent). These results show that the relation between customer concentration and firms' operating risk and profitability largely reflects the differing costs and benefits that occur throughout the relationship life cycle.

Facing initial increases in operating leverage, a major customer relationship is a risky choice for firms. However, customer concentration can lead to operating efficiencies and the possibility of achieving higher profits in the future. By examining a subsample of firms where the age of the supplier-customer link can be identified, we find a number of results that are consistent with our relationship life-cycle hypothesis. We document an important benefit from having a major customer by showing that the initial year of the relationship leads to significant growth in firm sales. We also find that as the relationship matures, the initial adverse effects of customer concentration reverse, leading to lower cost of credit, increasing technology transfers, and improvements in firm operating margins and profitability. The initial relationship-specific costs from major customers eventually provide significant benefits to the firm.

The major contribution of this paper is to identify how the costs and benefits of customer concentration vary over the relationship life cycle. Knowledge of both the costs and benefits of customer concentration is important to managers making the crucial decision of whether to make the customer-specific investments required by a major customer. Our paper significantly expands the empirical analysis of the relationship life cycle, highlighting the usefulness of these customer revenue disclosures for economic analysis. Further, we extend the ability of Patatoukas' (2012) framework to illustrate how this information about customer concentration affects accounting measures of firm operations.

II. HYPOTHESIS DEVELOPMENT

There is an inherent tension in the relationship between the firm and a major customer. The traditional view contends that major customers can extract benefits from their suppliers and, thus, lower the supplier's profitability. However, there are several reasons why major customers could also be beneficial to the supplying firm. All orders are different, in some combination of their design, manufacturing process, or logistical delivery. Meeting the demands of many small customers is expensive and firms can achieve economies of scale from dealing with a few major customers. Although a number of small orders can produce the same total sales as a single large order, the supplying firm faces the problem of customer retention and acquisition. Because customer acquisition can be expensive, by dealing with a few major customers, firms can potentially reduce these costs. Cohen and Schmidt (2009) document some of the benefits of attracting large clients, and Carlton (1978) outlines how a lower customer-per-firm ratio helps the firm coordinate pricing and production decisions. Jap and Ganesan (2000), Fee, Hadlock and Thomas (2006), and Costello (2013) show how covenant restrictions and customer equity stakes can alleviate contracting problems arising in the relationship.

Empirically, Lustgarten (1975) finds that customer concentration reduces profitability, but Newmark (1989) claims that Lustgarten's (1975) use of plant-based price-cost margin as a profitability measure fails to properly control for transfer prices. Patatoukas (2012) provides a framework for examining the effects of customer concentration on profitability at the firm level and uses Compustat data on major customers to greatly expand the breadth of analysis. He finds that customer concentration leads to higher firm profitability through efficiencies in SG&A expenses, inventory turnover, and cash conversion improvements.

However, Patatoukas (2012) follows prior literature on firm profitability by excluding negative operating margin firms from his analysis. Our preliminary examination of negative operating margin firms suggests that these firms are much more likely to be in the early stages of a long-term relationship with a major customer, and that they can exhibit markedly different customer-related costs than firms in later stages of a relationship. Indeed, even in Patatoukas' (2012) sample of positive operating margin firms, his intertemporal analysis of changes in customer concentration suggest that dynamics are important, as efficiency gains are likely to flow gradually through the firm's financial reporting system. To add structure to this observation, we hypothesize that the relation between customer concentration and firms' operating risk and performance largely reflect the different costs and benefits that occur throughout the relationship life cycle.

Wilson (1995) argues that insights from cross-sectional analysis do not always reveal the underlying dynamics of the relationship life cycle. We hypothesize that these dynamics affect the relation between customer concentration and firm profitability. Because accounting research has not previously addressed how the relationship life cycle affects firms' operating risk and performance, we draw on the literature in marketing and management to construct our hypotheses. This literature primarily focuses on the impact of major suppliers on smaller retailers, rather than major customers on smaller suppliers. However, from the theoretical and survey evidence, we can infer general principles to guide our exploration of how the relationship life cycle affects firm profitability. The limited accounting research that addresses life-cycle issues (Anthony and Ramesh 1992; Dickinson 2011) examines the life cycle of the firm rather than the life cycle of major customer relationships.

Dwyer et al. (1987) develop an influential theory of the relationship life cycle that characterizes the relationship as a marriage of buyer and seller that moves through several distinct stages. Like a marriage, a major customer relationship implies

certain restrictions on outside opportunities. These restrictions, in the form of relationship-specific investments, are the key to Wilson's (1995) contention that the success of the relationship can vary dynamically, presenting the firm with different costs and benefits at different stages of the relationship. Such relationship-specific investments provide potential value, but also increase operating risk. Wilson (1995) specifies that relationship-specific investments are maximized relatively early in the relationship, during the build-up phase, as they are necessary to maximize value creation in the later maturity stage. This contention is key as our hypothesis predicts that early relationship-specific investments lead to different stages, with different costs and benefits, in the life cycle of the relationship.[3]

Empirical work confirms that the costs and benefits of working with a major customer change over time. Kalwani and Narayandas (1995) use a small sample of firms to examine whether long-term relationships are superior to discrete transactions. Although they do not specifically examine major customer relationships, several of their findings are suggestive. They find that firms in long-term relationships often make relationship-specific investments—substantial investments that have little or no value outside the relationship. Over time, firms expect to benefit from process improvements and relationship-specific scale economies, eventually lowering costs. Kalwani and Narayandas (1995) find that such suppliers are able to achieve profitability by reducing SG&A expenses to a greater extent than their transaction-based counterparts. Jap and Anderson (2007) and Eggert, Ulaga, and Schultz (2006) use survey data to identify distinct stages in the supplier-customer relationship theorized by Dwyer et al. (1987). These papers provide evidence on how costs and profitability change as the relationship moves through different stages. Jap and Anderson (2007) find that the mature phase of the relationship can last for a considerable period and suggest that this reflects the fact that relationship-specific investments can provide long-term benefits. Eggert et al. (2006) conclude that the value created from major customer relationships can increase over time, but this positive outcome requires great commitment by both parties during the early build-up phase.

Not all of Dwyer et al.'s (1987) stages have been confirmed empirically, nor are they all relevant for our study. Dwyer et al.'s (1987) earliest stages include awareness and exploration that must precede our data for our firms to already be providing at least 10 percent of their output to a particular customer. Ignoring these early empirically irrelevant stages, we focus on the differences between two distinct stages documented in Jap and Anderson (2007): the expansion or build-up phase, and the subsequent maturity or relationship-maintenance stage.[4]

To understand how customer concentration is related to costs and profitability over the relationship life cycle, we make a set of simple assumptions that can be empirically verified. First, we assume that all supplier firms must invest in customer-specific assets. Next, we predict that the supplier makes the bulk of their investments in customer-specific assets early in the relationship. The second assumption follows from the logical premise that certain customer-specific assets must be in place to meet the customer's needs. Of course, customer-specific investments could increase over time if sales to the major customer increase. However, the evidence in Kalwani and Narayandas (1995), Eggert et al. (2006), and Patatoukas (2012) suggests that value creation increases over time, consistent with learning to more efficiently serve the major customer, allowing the firm to amortize their initial investment. Third, following Williamson (1979), Kalwani and Narayandas (1995), and Anderson et al. (2003), we maintain that SG&A expenses best reflect these relationship-specific investments. We test the validity of these assumptions by examining the extent to which SG&A expenses are fixed (Anderson et al. 2003). If a concentrated customer base leads firms to make customer-specific SG&A investments, then, by definition, such customer-specific investments are less transferable to other uses than more general investments. Firms with high customer concentration, thus, should have a larger fixed-cost component in their SG&A expenses. If this contention is true, then the elasticity of SG&A expenses with respect to sales should be lower the more concentrated the firm's customer base. Fourth, as documented by Kalwani and Narayandas (1995) and Patatoukas (2012), as firms move from the build-up to the maturity stage of the relationship, we expect to find suppliers reaching higher levels of profitability.

We also contend that a firm with high customer concentration faces higher demand uncertainty. This occurs because firms with major customers have relatively undiversified sources of revenue, and their customer-specific investments prevent them from easily finding alternative sales when faced with declining demand from their major customers. Thus, firms with high customer concentration face greater exposure to idiosyncratic demand shocks generated by their major customers. When major customers experience demand shocks, they transfer these demand shocks to their suppliers.[5]

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[3] In Wilson's (1995) theory, the value of the relationship to the parties involved depends on the improvement of such hard-to-measure concepts as trust, cooperation, and commitment. Schloetzer (2012) provides a recent example of an attempt to outline the effects of these difficult-to-quantify measures.

[4] Jap and Anderson (2007) refer to Dwyer et al. (1987) as predictively valid, but overly complex, concluding that it includes more distinct stages than are necessary to explain their results.

[5] Our contention that the elasticity of SG&A expenses with respect to sales is lower in firms with higher customer concentration is a potential explanation for the puzzling finding in Banker, Byzalov, and Plehn-Dujowich (2014) that cost elasticity is inversely related to demand uncertainty. If customer concentration is negatively related to cost elasticity and positively related to demand uncertainty, then firms with high customer concentration will have low elasticity and high demand uncertainty, particularly early in the relationship with their major customers.

We do not make any predictions about the dynamics of demand uncertainty. However, high demand uncertainty coupled with a higher fixed cost structure should lead to an increase in operating risk. This contention is a natural extension of our two assumptions, as higher fixed costs lead to increases in operating leverage, which, coupled with higher demand uncertainty, increases operating risk. We expect the increase in operating risk to result in a higher probability of losses. Since we predict that the fixed costs associated with major customers will gradually be amortized, we should observe a decrease in this probability as the relationship matures, even if demand uncertainty does not vary over the relationship life cycle. We examine whether the early-stage increase in operating risk is reflected in the credit channel and whether credit conditions improve as the relationship matures.

From the above literature, we infer two broad principles of major customer relationships that guide our empirical investigation. First, the relationship is dynamic, and optimal profitability for the firm may not occur until the relationship reaches its maturity phase. The second principle is that the often rapid growth of the relationship during the build-up phase requires large relationship-specific investments early in the life cycle. These principles suggest that we can expect customer concentration to have a negative impact on firm profitability early in the relationship. However, if the relationship succeeds, then suppliers can expect operating profitability to increase as the relationship matures. We can directly test these predictions for a subsample of supplier firms where major customers can be identified and, thus, the age of the link between the supplier and customer firms can be determined (*LINKAGE*). Where the necessary data to construct *LINKAGE* are not available, we use the age of the supplier firm as an instrument for the age of the relationship. Empirically, firm age is highly correlated with the age of major customer relationships, although we expect firm age to be an inferior instrument relative to *LINKAGE*.[6]

III. DATA

Financial Accounting Standards Board (FASB) accounting standards require all public companies to disclose the identities of their major customers representing more than 10 percent of their total sales. We extract the identities of each firm's major customers from the Compustat Customer Segment Files. We focus on the period between 1977 and 2007. For each firm, Compustat Customer Segment Files provide the names of its major customers, revenue derived from sales to each major customer, and the type of each major customer.[7]

For each firm, we determine whether its customers are listed in the CRSP-Compustat database. If they are, then we assign them to the corresponding firm's CRSP permanent company number (PERMNO). Because we focus on customer concentration and its impact on firms' operating and financial performance, even when the customer firm cannot be assigned a PERMNO, we still keep the supplier-customer link in the sample and identify the customer firm as a non-CRSP-Compustat company.[8]

Following Patatoukas (2012), we construct our primary measure of customer concentration (*CC*) using the following formula:

$$CC_{i,t} = \sum_{j=1}^{n} \left(\frac{Sales\ to\ Customer_{i,j,t}}{Total\ Sales_{i,t}} \right)^2 \tag{1}$$

If firm i has n major customers in year t, then the measure of customer concentration ($CC_{i,t}$) of the firm is defined as the sum of the squares of the sales shares to each major customer. The sales share to each customer j in year t is calculated as the ratio of firm i's sales to customer j in year t scaled by firm i's total sales in year t. Patatoukas (2012) constructs his customer concentration measure in the spirit of the Herfindahl-Hirschman index, and suggests that the measure captures two elements of customer concentration: the number of major customers and the relative importance of each major customer. By definition, customer concentration (*CC*) is bounded between 0 and 1 because *CC* is equal to 1 if the firm earns all of its revenue from a single customer, and as the customer base diversifies, *CC* tends to 0.

As in Patatoukas (2012), we exclude financial services firms from the sample. Our sample consists of all firms listed in the CRSP-Compustat database with non-negative book values of equity, non-missing values of customer concentration (*CC*), market value of equity (*MV*), annual percentage sales growth (*GROWTH*), and accounting rates of return at the fiscal year-end

[6] We agree with Eggert et al. (2006) that link age is an imperfect measure of life-cycle stage as some relationships may be designed to be shorter than others. However, the literature does not supply an alternative instrument.

[7] The dataset groups customers into three broad categories based on their type: "company" (COMPANY), "domestic government" (GOVDOM), and "foreign government" (GOVFRN). We exclude information on customers that are identified as domestic or foreign governments, even if they may be major customers for a certain supplier firm.

[8] Cohen and Frazzini (2008) report that the Compustat Customer Segment Files report the names of customer companies, but often fail to provide company identification codes such as customer firms' PERMNOs. For these firms, we use a phonetic string-matching algorithm to generate a list of potential matches to the customer name. We then hand-match the customer to the corresponding PERMNO based on the firm's name, segment, and SIC code.

when we can identify major customers.[9] After imposing these restrictions, we are left with 49,760 supplier firm-year observations between 1977 and 2007.

Sample Composition

Our sample is broader than that in Patatoukas (2012), who focuses on the subsample of firm-year observations with positive operating margins, whereas we include firm-year observations with operating losses. Of the 49,760 firm-year observations in our sample, 22,480 firm-year observations have the corresponding CRSP-Compustat customer data necessary to construct *LINKAGE* (45.2 percent), while 10,836 firm-year observations have operating losses (21.8 percent). Using the *LINKAGE* customer data subset, we can test our relationship life-cycle hypotheses. Over a comparable period, we have significantly more firm-year observations with positive operating margins (38,924) than Patatoukas' (2012) 25,389.[10] To alleviate concerns regarding our sample, we repeat all analyses using only the subset of firm-year observations with positive operating margins and find results qualitatively similar to Patatoukas (2012).

Descriptive Statistics

Figure 1 presents the time-series of average customer concentration from 1977 to 2007 as reported in the Compustat Customer Segment Files. During this period, each supplier averages 1.89 major customers who generate 33 percent of its annual sales. However, each supplier firm averages only 2 percent of their customers' cost of goods sold. Over the sample period, customer concentration exhibits a marked increase from the early years of the sample through 1997, a period coincident with a general increase in the number of listed firms. The number of firms reporting customer concentration then falls from a high of close to 3,500 in 1997 to what appears to be a steady state of just over 2,000 for the 2002–2007 period. Median customer concentration reveals a generally increasing trend over time, from a low of 0.03 in 1977 and 1978 to a high of over 0.06 in 2007.

Table 1 lists our variable definitions, grouped into two categories: (1) Supplier-firm characteristics, and (2) Cost of debt variables used in Table 8. *CC* is the basic measure of customer concentration described in Equation (1) and ΔCC measures the year-over-year change in *CC*.

Table 2 presents summary statistics for several key variables for both the full sample (Panel A) and the subset of firms with identifiable customers (Panel B). The variables *MV, AGE,* and *GROWTH* define the basic characteristics of supplier firms. *MV* measures the firm's market value of equity in millions of dollars. *AGE* is the firm's age in years, measured from the time of its initial public offering. *GROWTH* is the supplier firm's annual sales growth rate. *ROA, ROE,* and *SGA* define key operating characteristics of supplier firms. *ROA* is the ratio of income before extraordinary items to the beginning-of-year book value of total assets for the firm. *ROE* is the ratio of income before extraordinary items to the beginning-of-year book value of equity for the firm. *SGA* is the ratio of selling, general, and administrative expenses to sales. *INVHLD* is the ratio of inventory to the book value of total assets for the firm.

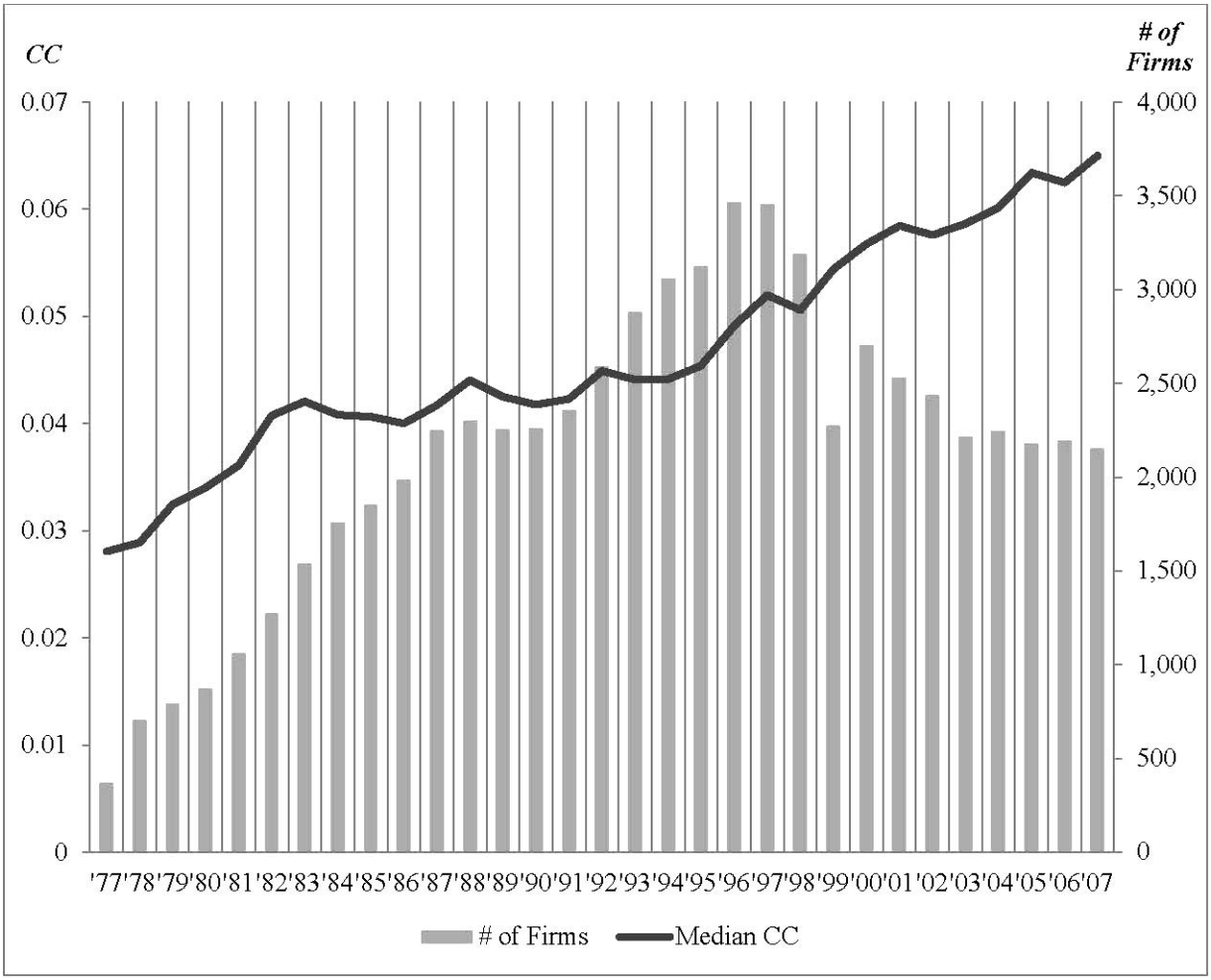
Panel A of Table 2 reports the mean, standard deviation, skewness, median, 25th, and 75th percentile values for the key variables in this study. *CC* averages 10.1 percent for the 49,760 observations in the sample, with a standard of deviation of 14.7 percent. The latter statistic suggests that there is large cross-sectional variation in firms' dependence on their major customers for revenues. Mean *CC* is close to the mean reported in Patatoukas (2012). This fact shows that any differing results due to our expansion of the sample are not attributable to radical differences in customer concentration. Our sample firms are younger and smaller than those in Patatoukas (2012). Firms in our sample average only 10.3 years of age compared to 14.8 in Patatoukas (2012), with a market cap of $806 million relative to Patatoukas' (2012) $1,206 million. Because we do not censor on profitability, the average *ROA* and *ROE* are lower at −0.01 (Patatoukas 2012, 0.06) and −0.03 (0.13), respectively. Three of our main dependent variables, *ROA, ROE,* and *SGA,* and the key explanatory variable, *CC,* are all significantly skewed. In order to mitigate the effect of skewness, we again follow Patatoukas (2012) and use the decile rank of *CC* (ΔCC) instead of *CC* (ΔCC) in our regression analyses.

Panel B of Table 2 examines statistics for the subsample of firms whose customers can be identified, which enables us to calculate *LINKAGE,* the weighted average of the (log) years that a firm has maintained sales to its major customers. The average and standard deviation of *CC* are comparable to the full sample at 11.6 percent and 14.8 percent. Indeed, the summary statistics of all the key variables are comparable to the full sample. The *LINKAGE* subset firms are moderately larger, with a

[9] Including firms with both negative earnings and negative book values confounds a direct interpretation of higher *ROE* as a good outcome. We drop negative book value firms to avoid this confusion. In unreported analysis, we include negative book value firms and find consistent results.

[10] Hoechle, Schmid, Walter, and Yermack (2012) report a temporary deletion of valid Compustat Segment Files observations during 2007–2008. This problem may have restricted the data available to Patatoukas (2012). In addition, there have been periodic updates to the Compustat Segment Files since the publication of his article. These factors could account for the difference in sample sizes between our paper and Patatoukas (2012).

FIGURE 1
Time-Series Trend of Customer-Base Concentration



This figure plots the time-series of the cross-sectional median of customer-base concentration over the 1977–2007 period. The line chart shows the time-series trend of the yearly median customer-base concentration measure (*CC*) and the bar chart shows the number of firms that report their major customers in Compustat Customer Segment Files.

mean market value of $997.0 million compared to $806 in the full sample, and have a slightly lower sales growth rate of 20 percent (22 percent).[11]

In the rest of the paper, we explain how the relationship life cycle impacts the relation between customer concentration, firm profitability, and operating efficiency.

IV. RESULTS

Firm Performance and the Relationship Life Cycle

Preliminary Sorts

Table 3 presents an analysis of four key variables that we sort first by customer concentration and then by the length of the business relationship. Panel A measures the stage of the relationship using the *LINKAGE* variable where we can explicitly match customers to suppliers to determine the age of the relationship. We provide data on the average level of *CC, ROA,* the

[11] Patatoukas (2012, 373) also provides evidence that this subset is consistent with the full sample.

TABLE 1

Variable Definitions

Variable	Definition
Supplier Firm Characteristics	
CC	Customer-base concentration measure ($0 \leq CC \leq 1$).
ΔCC	Annual change in *CC*.
LINKAGE	Weighted average duration of the link between the firm and its major customers.
MV	Market value of equity.
AGE	Firm age, measured from the time of the firm's Initial Public Offering (IPO).
GROWTH	Annual sales growth.
ROA	Income before extraordinary items/Beginning-of-year book value of assets.
ROE	Income before extraordinary items/Beginning-of-year book value of equity.
SGA	Selling, general, and administrative expenses/Sales.
GM	Gross margin: (Sales − Cost of goods sold)/Sales.
PM	Profit margin: Income before extraordinary items/Sales.
INVHLD	Inventory/Beginning-of-year book value of assets.
ATO	Asset turnover: Sales/Beginning-of-year book value of assets.
FLEV	Beginning-of-year book value of assets/Beginning-of-year book value of equity.
CONGLO	An indicator variable equal to 1 if the firm reports at least two business segments.
COGS Elasticity	Elasticity of cost of goods sold with respect to sales.
SG&A Elasticity	Elasticity of SG&A cost with respect to sales.
Demand Uncertainty	Standard deviation of annual changes in log-sales over the recent five years.
Cost of Debt-Related Variables Used in Table 8	
TLMTA	Total liabilities/Market value of total assets.
CASHMTA	Cash and short-term assets/Market value of total assets.
SIGMA	Standard deviation of the firm's daily stock returns over the past three months.
MB	Market-to-book ratio.
RSIZE	Log ratio of market capitalization to Standard & Poor's (S&P) 500 index.
PRICE	Log price per share.
EXRET	Monthly log excess return on equity relative to S&P 500 index.
SPREAD	Percentage spread of the loan interest rate over London Interbank Offered Rate (LIBOR).
RETVAR	One-year variance of daily stock returns in the previous year of the loan start year.
MATURITY	Maturity of the loan in years.
LOANAMT	Amount of the loan.

This table describes the main variables used in this study. Most of the firm and customer firm characteristics are defined as in Patatoukas (2012). Firm-customer relationships are obtained from the Compustat Customer Segment Files. Market equity prices, accounting profitability measures, and other financial statement items are from the CRSP-Compustat merged database. In Table 8, we analyze the cost of debt, and include firm-level predictive variables suggested by Campbell et al. (2008). Market value of total assets is adjusted as in Campbell et al. (2008) by marking up the book value by 10 percent of the difference between the market and book values of equity.

percentage of suppliers with negative earnings (a key measure of operating risk), and SG&A expenses (*SGA*). By examining the data in this way, we provide initial support for our contentions concerning how the relationship life cycle affects firm performance.

We first note in Table 3 that there are no significant differences in customer concentration as relationship age changes. This is important, as it demonstrates that any results we attribute to the *LINKAGE* variable are not confounded by simultaneous changes in customer concentration. When we examine *ROA,* we find that average profitability is negative early in the relationship and that profitability consistently improves as the firms move through the different stages of the relationship. Consistent with Patatoukas' (2012) results, we also document a customer concentration effect. The improvement in *ROA* is consistently greater the higher the level of customer concentration. This simple sort demonstrates that both the age (*LINKAGE*) and the significance of the customer relationship (*CC*) have marked significant effects on supplier firm profitability. Consistent with the *ROA* results, the percentage of firms with negative earnings shows a corresponding pattern. Early in the relationship, a comparatively high number of firms have negative earnings, and the likelihood of negative earnings is much higher (54.1 percent) for high customer concentration firms than low customer concentration firms (36.0 percent). As the relationship matures, firms are significantly more likely to be profitable. The greatest increase in the likelihood of profitability occurs in

TABLE 2

Descriptive Statistics for the Main Variables

Panel A: Full Sample

Variable	Obs.	Mean	Std. Dev.	Skewness	25th Percent	Median	75th Percent
CC	49,760	0.101	0.147	2.930	0.014	0.046	0.125
ΔCC	43,048	−0.003	0.094	−0.534	−0.018	0.000	0.015
MV	49,335	805.6	3,886.7	12.0	16.5	65.7	318.6
AGE	49,760	10.3	9.0	1.3	3.0	7.0	15.0
GROWTH	49,667	0.22	0.62	4.60	−0.03	0.10	0.29
ROA	49,760	−0.01	0.22	−2.77	−0.05	0.03	0.09
ROE	49,760	−0.03	0.51	−2.90	−0.10	0.07	0.18
SGA	49,760	0.39	0.63	6.12	0.14	0.24	0.40
INVHLD	49,410	0.16	0.15	0.83	0.03	0.14	0.26

Panel B: Firms with Link Age Information

Variable	Obs.	Mean	Std. Dev.	Skewness	25th Percent	Median	75th Percent
CC	22,489	0.116	0.148	2.785	0.024	0.063	0.148
ΔCC	20,616	−0.005	0.092	−0.682	−0.022	−0.001	0.017
LINKAGE	22,489	4.0	3.5	2.1	1.9	3.0	5.0
MV	22,375	997.0	4,596.6	10.4	19.3	76.1	359.7
AGE	22,489	10.7	9.3	1.3	4.0	8.0	15.0
GROWTH	22,464	0.20	0.56	4.46	−0.04	0.10	0.29
ROA	22,489	−0.01	0.21	−2.70	−0.05	0.03	0.09
ROE	22,489	−0.02	0.49	−2.92	−0.09	0.07	0.18
SGA	22,489	0.37	0.55	6.34	0.13	0.23	0.40
INVHLD	22,338	0.16	0.14	0.83	0.03	0.14	0.25

This table reports the mean, standard deviation, skewness, 25th percentile, median, and 75th percentile values of key variables used in this study. The sample contains Compustat firms with major customer information from 1977 to 2007. Panel A describes the full sample of 49,760 firm-year observations where a customer concentration (*CC*) value can be assigned to a firm. Panel B reports the same values for the same set of variables for the subset of firms that have identifiable major customers.
Variable definitions are described in Table 1.

firms with the highest levels of customer concentration. Such firms are 29.5 percent more likely to be profitable when their relationships mature, while firms in the lowest customer concentration quintile increase their likelihood of profitability by only 10.0 percent over the relationship life cycle. These results show that the benefits of customer concentration are important, but they come with significant operating risks early in the life cycle.

In Section II, we hypothesize that firms incur operating risks because major customer relationships require significant customer-specific investments early in the relationship. Table 3, Panel A also demonstrates that at the beginning of the relationship, SG&A expenses are markedly higher for firms in the highest customer concentration quintile (76.2 percent) than they are for firms in the lowest customer concentration quintile (36.2 percent). This result is consistent with our contention that customer-specific investments are primarily reflected in SG&A expenses. Over time, firms across all customer concentration quintiles have significantly lower levels of SG&A expenses as the relationship matures. These results suggest that customer-specific investments are an important driver of firm profitability in the business relationship. Early in the relationship, they can reduce firm profitability, but as the relationship matures, these costs decline and major customer relationships lead to higher profitability.

Panel A of Table 3 considers only the subsample of firms with identifiable customers. In Panel B, we use firm age, *AGE,* as a proxy for *LINKAGE,* where the correlation of *AGE* with *LINKAGE* is 0.42. This statistic indicates that while Panel A identifies a relationship life-cycle effect, *AGE* may contain enough information about the relationship age to allow us to determine whether relationship life-cycle effects exist in the full sample. Although Panel A establishes the distinct impact of *LINKAGE* on firm performance, using *AGE* as a proxy for *LINKAGE* allows us to analyze the full sample. Results in Panel B

TABLE 3

Customer-Base Concentration and Stock Characteristics

Panel A: Double-Sort Customer Concentration and Linkage

	Lowest CC	2	3	4	Highest CC
CC					
Shortest	0.006	0.020	0.047	0.104	0.321
2	0.006	0.021	0.048	0.106	0.333
3	0.006	0.021	0.048	0.106	0.325
4	0.006	0.021	0.048	0.105	0.314
Longest	0.006	0.021	0.048	0.107	0.319
L-S	0.000	0.001	0.000	0.003	−0.002
ROA					
Shortest	−0.024	−0.022	−0.027	−0.070	−0.120
2	−0.005	−0.002	−0.016	−0.036	−0.056
3	0.005	0.011	−0.005	−0.019	−0.039
4	0.011	0.019	0.014	0.011	−0.010
Longest	0.020	0.038	0.040	0.026	0.036
L-S	0.045***	0.060***	0.067***	0.096***	0.156***
% neg. ROA					
Shortest	0.360	0.379	0.391	0.459	0.541
2	0.292	0.315	0.371	0.405	0.444
3	0.294	0.328	0.357	0.405	0.442
4	0.290	0.271	0.312	0.318	0.382
Longest	0.259	0.222	0.231	0.248	0.246
L-S	−0.101**	−0.157***	−0.161***	−0.211***	−0.295***
SGA					
Shortest	0.362	0.385	0.406	0.492	0.762
2	0.371	0.332	0.394	0.407	0.588
3	0.347	0.319	0.326	0.366	0.484
4	0.311	0.290	0.283	0.278	0.372
Longest	0.273	0.238	0.226	0.219	0.222
L-S	−0.089***	−0.147***	−0.180***	−0.273***	−0.540***

Panel B: Double-Sort Customer Concentration and Age

	Lowest CC	2	3	4	Highest CC
CC					
Youngest	0.005	0.019	0.046	0.100	0.344
2	0.005	0.020	0.045	0.100	0.318
3	0.005	0.020	0.046	0.100	0.319
4	0.005	0.020	0.045	0.100	0.309
Oldest	0.005	0.019	0.045	0.100	0.316
O-Y	0.000	0.000	−0.001	0.000	−0.029**
ROA					
Youngest	−0.008	−0.033	−0.034	−0.057	−0.090
2	0.010	−0.012	−0.016	−0.032	−0.048
3	0.017	0.009	0.000	−0.005	−0.032
4	0.034	0.024	0.013	0.010	0.001
Oldest	0.048	0.047	0.045	0.039	0.045
O-Y	0.055***	0.080***	0.080***	0.097***	0.135***

(continued on next page)

TABLE 3 (continued)

	Lowest CC	2	3	4	Highest CC
% neg. ROA					
Youngest	0.325	0.391	0.385	0.422	0.475
2	0.297	0.352	0.374	0.394	0.420
3	0.268	0.309	0.325	0.337	0.374
4	0.215	0.257	0.293	0.324	0.343
Oldest	0.164	0.178	0.191	0.220	0.217
O-Y	−0.161***	−0.214***	−0.194***	−0.202***	−0.257***
SGA					
Youngest	0.378	0.452	0.467	0.511	0.761
2	0.336	0.373	0.378	0.423	0.509
3	0.312	0.309	0.319	0.326	0.453
4	0.261	0.278	0.277	0.271	0.321
Oldest	0.199	0.198	0.184	0.177	0.225
O-Y	−0.179***	−0.254***	−0.283***	−0.334***	−0.536***

***, ** L-S (O-Y) differences are statistically significant at the 1 percent level and 5 percent levels, respectively.
Table 3 reports the mean values of key variables in double-sorted portfolios. In Panel A, we double-sort stocks annually by the weighted average duration of their customer links (*LINKAGE*) and their level of customer-base concentration (*CC*). In Panel B, we double-sort stocks every year based on firm age (*AGE*) and *CC* for the full sample. We specifically analyze four stock characteristics: *CC* itself; profitability (*ROA*); the percentage of unprofitable firm-years in each portfolio (*% neg. ROA*); selling, general, and administrative expenses scaled by sales (*SGA*), and report the means for these variables in the double-sorted portfolios. The L-S (O-Y) row reports the differences between means of the firms with the longest and shortest major customer relationships (L-S) and the oldest and youngest (O-Y) firms. We include firms that have non-missing customer-base concentration measures, non-missing accounting profitability measures, and non-negative book values of equity for both panels.

are similar to the results in Panel A. The youngest firms exhibit the same profitability and SG&A characteristics as firms early in the relationship life cycle. As these firms mature, profitability improves. Thus, although firm age is an imperfect instrument for *LINKAGE,* the results in Panel B suggest that young firms tend to have young relationships with their major customers and that firm age contains enough information on relationship duration to substitute for *LINKAGE* in future studies on the life-cycle effects of major customer relationships when *LINKAGE* is unavailable.

Cost Rigidity and Demand Uncertainty

The dynamics underlying the life cycle reflect how the customer base affects firm costs, which initially involves the patterns of cost rigidity in SG&A expenses. In this section, we briefly examine cost rigidity and demand uncertainty across the relationship life cycle. To demonstrate the relative importance of SG&A costs in our sample, we first note that the mean (median) cost of goods sold (COGS) is 64.4 percent (65.1 percent) of sales in our sample and SG&A expenses average 39.1 percent (23.1 percent). As a component of SG&A expenses, advertising expense averages only 1.0 percent of sales.[12]

Panel A of Table 4 examines the elasticity with respect to sales of COGS and SG&A expenses, as well as mean demand uncertainty, across five different quintiles of customer concentration. Our examination of cost elasticity is derived from the cost-rigidity arguments of Anderson et al. (2003) and Baumgarten, Bonenkamp, and Homburg (2010). Cost elasticity with respect to sales measures the percentage variation in costs relative to percentage variation in firm sales. We find that for all firms, costs are inelastic, varying less than one-to-one with sales variation. We also find that the higher a firm's customer concentration, the lower its cost elasticity. The differences are significant across the concentration quintiles, and particularly dramatic for *SG&A Elasticity*. SG&A cost elasticity is 0.79 for firms in the lowest customer concentration quintile, falling to 0.56 in the highest customer concentration quintile. We infer from these statistics that firms with higher customer concentration make greater fixed investments in customer-specific SG&A expenses. Such investments allow firms to more easily expand their operations when major customers increase their demand (Banker et al. 2014). However, when demand falls, these customer-specific fixed investments are more difficult to eliminate or transfer to other customers than more general investments.

To show how major customers affect demand, we examine how sales volatility varies with customer concentration. Banker et al. (2014) postulate that demand uncertainty, measured by the volatility of sales, can lead to lower cost elasticity. They argue that firms facing high demand uncertainty make large fixed investments to capitalize in high-demand states. Firms that do not make such investments would, due to high short-term adjustment costs, be unable to capitalize on the high profits available in

[12] This 1.0 percent figure indicates that advertising expense improvements are likely to be too small to materially impact profitability.

TABLE 4

Impact of Customer-Base Concentration on Operating Leverage and Demand Uncertainty

Panel A: Customer-Base Concentration and Elasticity of Operating Expenses with Respect to Sales

Customer-Base Concentration	*COGS Elasticity*			*SG&A Elasticity*			*Demand Uncertainty*		
	n	Mean	Median	n	Mean	Median	n	Mean	Median
Lowest	9,867	0.97	0.98	9,867	0.79	0.83	7,030	0.19	0.13
2	9,889	0.95	0.97	9,889	0.72	0.74	7,024	0.22	0.15
3	9,889	0.91	0.96	9,889	0.69	0.70	6,722	0.24	0.17
4	9,843	0.92	0.96	9,845	0.66	0.65	6,282	0.26	0.19
Highest	9,727	0.87	0.96	9,727	0.56	0.52	5,838	0.32	0.22
H-L		−0.10***	−0.02***		−0.23***	−0.31***		0.12***	0.09***

Panel B: Relationship of Customer Concentration to Cost Elasticity and Demand Uncertainty

	(1)	(2)	(3)	(4)	(5)	(6)
	COGS Elasticity		*SG&A Elasticity*		*Demand Uncertainty*	
Intercept	1.199	1.483	0.666	−0.864	0.462	0.348
	(2.44)	(2.42)	(1.49)	(−0.98)	(7.73)	(7.18)
Rank(*CC*)	−0.059	−0.160	−0.149	−0.287	0.076	0.180
	(−1.90)	(−1.92)	(−2.61)	(−4.55)	(6.26)	(22.14)
Rank(*CC*) * *LINKAGE*		0.039		0.083		−0.090
		(0.84)		(3.49)		(−6.30)
MV	0.000	−0.010	0.067	0.044	−0.022	−0.018
	(0.20)	(−2.07)	(5.74)	(2.78)	(−34.19)	(−24.24)
AGE	−0.006	−0.015	−0.025	−0.019	−0.056	−0.047
	(−0.61)	(−1.05)	(−1.27)	(−0.92)	(−6.84)	(−7.54)
GROWTH	−0.003	−0.008	0.009	0.049	0.110	0.091
	(−0.11)	(−0.20)	(0.56)	(1.60)	(14.08)	(17.72)
CONGLO	0.074	0.063	0.019	−0.006	0.010	0.012
	(3.23)	(2.97)	(0.81)	(−0.13)	(2.04)	(2.48)
FLEV	0.002	0.000	0.012	−0.008	0.005	0.004
	(0.86)	(−0.14)	(1.31)	(−0.61)	(2.42)	(1.62)
Industry F. E.	Yes	Yes	Yes	Yes	Yes	Yes
Avg. R^2	0.051	0.077	0.055	0.077	0.225	0.281
n	49,112	22,307	48,652	22,112	32,843	15,181

*** H-L cross-sectional differences are statistically significant at the 1 percent level ($p < 0.01$).

Panel A of Table 4 reports the mean and median elasticity values of cost of goods sold (COGS) and selling, general, and administrative expenses (SG&A) with respect to sales, as well as the mean and median values of demand uncertainty for each customer-base concentration quintile. The H-L row reports the cross-sectional differences between the mean and median *COGS Elasticity, SG&A Elasticity,* and *Demand Uncertainty* estimations of the highest and lowest customer-base concentration quintiles. Panel B reports Fama and MacBeth (1973) regressions of *COGS Elasticity, SG&A Elasticity,* and *Demand Uncertainty* on *Rank*(*CC*). The elasticity of COGS (SG&A expense) with respect to sales of firm *i* in year *t* is calculated as the change in log-COGS (SG&A expense) for firm *i* from year *t*–1 to year *t*, $\Delta\ln COGS_{i,t}$ ($\Delta\ln SG\&A_{i,t}$), divided by the change in log-sales for firm *i* from year *t*–1 to year *t* ($\Delta\ln Sales_{i,t}$). *Demand Uncertainty* for firm *i* is defined as the standard deviation of annual changes in log-sales calculated on a rolling five-year basis, as in Banker et al. (2014). *Rank*(*CC*) is the decile rank of customer concentration (*CC*). Other control variables include the log of market value of equity (*MV*); the log of firm age (*AGE*); annual sales growth rate (*GROWTH*); the indicator variable that equals 1 if the firm reports at least two business segments (*CONGLO*); the leverage ratio, defined as book value of assets divided by book value of equity (*FLEV*); and link age (*LINKAGE*), the weighted average of the duration of the relationships between a firm and its major customers where the weights are sales shares to each respective customer. n is the number of firm-year observations.

high-demand states. Their arguments are consistent with our findings on cost elasticity and customer concentration if demand uncertainty increases with customer concentration. In Table 4, Panel A we find that demand uncertainty significantly increases (t-statistic = 9.81) from the lowest customer concentration quintile (0.19) to the highest customer concentration quintile (0.32). In a portfolio context, firms with a few major customers are relatively undiversified in sales and, thus, customer-specific demand shocks are more likely to impact their sales compared to firms with diversified customer bases.

The monotonically increasing relation we find between customer concentration and demand uncertainty complements the arguments of Patatoukas (2012) and Banker et al. (2014). If the relationship encourages firms to make customer-specific

investments, then firms will have more inelastic cost structures and potentially higher profits if the relationship succeeds. However, the higher fixed costs incurred, coupled with higher demand uncertainty, could lead to higher operating risk for these firms, as documented above in Table 3, where customer concentration is associated with a higher probability of negative earnings early in the relationship.

However, Table 3 also reveals that customer concentration has positive effects on profitability and lowers operating risk as the relationship matures. We examine the effects of the relationship life cycle on the elasticities of COGS and SG&A expenses and demand uncertainty in a regression framework in Table 4, Panel B, which also controls for the covariates suggested in Patatoukas (2012). To analyze the effects of *LINKAGE,* we create the interaction variable *Rank*(*CC*) $*$ *LINKAGE,* which combines the rank of customer concentration, *Rank*(*CC*), with the sales-weighted average duration of a firm's major customer relationships. In this specification, the coefficients on *Rank*(*CC*) represent the baseline effects of the youngest relationships and the interaction variable determine whether these effects change as the relationship matures.[13]

Our regression results confirm that both customer concentration and relationship age have significant effects on *SG&A Elasticity*. Customer concentration significantly lowers *SG&A Elasticity,* but as the relationship matures, costs become less rigid. The results in Panel B also confirm that *SG&A Elasticity* is the primary channel for recording customer-specific investment. Customer concentration does not have a significant effect at the $p < 0.05$ significance level on *COGS Elasticity,* and the interaction effect with *LINKAGE* is insignificant. These results support our contention that customer-specific investments are primarily reflected through SG&A expenses, and that the effects of these expenses on firm profitability tend to be most pronounced early in the relationship life cycle.

In Panel B of Table 4, Columns (5) and (6) examine the effects of customer concentration and relationship age on *Demand Uncertainty*. In these regressions, we find that *Demand Uncertainty* increases significantly as customer concentration increases, a result that confirms the limited sales diversification in major customer relationships. However, the coefficient on the interaction variable *Rank*(*CC*) $*$ *LINKAGE* is negative and significant, indicating that as relationships mature, the adverse impact of customer concentration on sales volatility is mitigated.

Impact of Duration of Customer Links on Firm Performance

The results in Table 4 support our underlying assumptions about the effects of the relationship life cycle on suppliers with major customers. Our primary goal is to expand the existing literature by demonstrating how the relationship life cycle explains the complex relation between customer concentration, firm profitability, and operating efficiency. To establish that our life-cycle hypothesis can contribute to explaining this complexity, we need to determine first, that there are different stages with differential effects on firm operations over the life cycle, and second, that these stages are consistent with our hypothesis. Specifically, we have argued that SG&A investments should increase early in the relationship and that these investments lower initial profitability, but reverse as the relationship matures. To investigate these arguments, we separate 22,311 firm-year observations with identifiable customer data into five quintiles based on the duration of the relationship with major customers. In each year, the dummy variables *LA_Q1, LA_Q2, LA_Q3, LA_Q4,* and *LA_Q5* equal 1 if the firm-year observation falls into the first, second, third, fourth, or fifth quintile of *LINKAGE* in a particular year.

We examine the effects of relationship age in Panel A of Table 5 by estimating the coefficients on *Rank*(*CC*) as the relationship matures. We first note that the coefficients on the interaction variables are, with the exception of the gross margin regression in Column (5), statistically significant. This indicates that the stage of the relationship life cycle is important in measuring the effects of customer concentration on firm operations and profitability. Further, we observe that the initially adverse effects of customer concentration are mitigated as the duration of the relationship increases. In Column (1), we regress *ROA* on *Rank*(*CC*) and the standard set of controls utilized throughout the paper. Results in Column (1) show that the coefficient on *Rank*(*CC*) is statistically significant and economically relevant at −0.06, suggesting that return on assets is 6 percent lower for firms with the youngest relationships. The interaction of *Rank*(*CC*) with the dummy variable *LA_Q2* is statistically significant and equal to 0.04, suggesting that a significant portion of the adverse impact of customer concentration on profitability is alleviated as the major customer relationship matures into the second quintile of relationship age. *Rank*(*CC*) $*$ *LA_Q3,* which denotes the interaction between *Rank*(*CC*) and the dummy variable that takes on the value of 1 if the firm is in the third quintile of *LINKAGE,* has a coefficient of 0.059, suggesting that firms can eliminate all the adverse effects of customer concentration on profitability once the duration of the link reaches approximately four years. Subsequent rows reveal that the adverse effects of customer concentration on *ROA* are fully reversed for the two top quintiles of relationship age.

We observe qualitatively similar results in Columns (2) through (4) of Table 5, Panel A, for the return on equity (*ROE*), asset turnover (*ATO*), and profit margin (*PM*) regressions. These results suggest that for all measures of profitability, adverse

[13] We lose some observations in Panel B due to missing covariate observations or when a sufficiently long time-series of data is not available to construct the dependent variables.

TABLE 5

Customer-Base Concentration and Firm Performance over the Relationship

Panel A: Impact of Customer Concentration on Firm Performance as Customer Links Mature

	(1) *ROA*	(2) *ROE*	(3) *ATO*	(4) *PM*	(5) *GM*	(6) *SGA*
Intercept	−0.186	−0.244	1.100	−0.855	0.327	0.874
	(−3.53)	(−2.25)	(6.68)	(−7.32)	(14.48)	(10.30)
Rank(*CC*)	−0.060	−0.121	−0.246	−0.391	−0.066	0.229
	(−6.74)	(−5.10)	(−6.72)	(−6.09)	(−4.67)	(5.39)
Rank(*CC*) ∗ *LA_Q2*	0.040	0.101	0.144	0.108	−0.015	−0.101
	(4.34)	(4.47)	(6.23)	(2.16)	(−1.37)	(−3.20)
Rank(*CC*) ∗ *LA_Q3*	0.059	0.113	0.169	0.227	−0.003	−0.165
	(8.41)	(6.52)	(10.07)	(4.64)	(−0.31)	(−3.48)
Rank(*CC*) ∗ *LA_Q4*	0.079	0.141	0.235	0.322	0.009	−0.227
	(6.47)	(6.26)	(8.54)	(3.96)	(0.53)	(−4.85)
Rank(*CC*) ∗ *LA_Q5*	0.088	0.154	0.322	0.318	−0.014	−0.251
	(6.38)	(5.65)	(8.21)	(4.04)	(−0.86)	(−4.90)
MV	0.029	0.055	−0.025	0.050	0.022	−0.029
	(16.07)	(16.58)	(−3.85)	(8.44)	(11.00)	(−8.76)
AGE	0.011	0.021	0.044	0.069	−0.012	−0.051
	(2.51)	(2.66)	(3.98)	(3.00)	(−1.86)	(−8.35)
GROWTH	0.015	0.058	0.381	0.035	0.027	0.005
	(2.75)	(5.52)	(22.43)	(1.65)	(4.10)	(0.46)
CONGLO	−0.001	−0.002	0.038	0.060	−0.055	−0.083
	(−0.23)	(−0.29)	(3.02)	(7.25)	(−25.58)	(−13.21)
FLEV	−0.002	−0.012	0.016	0.009	−0.005	−0.012
	(−2.08)	(−1.11)	(3.86)	(4.42)	(−4.29)	(−15.73)
Industry F. E.	Yes	Yes	Yes	Yes	Yes	Yes
Avg. R^2	0.220	0.198	0.374	0.168	0.249	0.231
n	22,311	22,311	22,311	22,311	22,311	22,311

Panel B: Impact of Customer Concentration on Firm Performance as the Firm Matures

	(1) *ROA*	(2) *ROE*	(3) *ATO*	(4) *PM*	(5) *GM*	(6) *SGA*
Intercept	−0.176	−0.266	1.356	−0.879	0.222	0.766
	(−5.42)	(−3.22)	(3.91)	(−4.99)	(5.27)	(10.77)
Rank(*CC*)	−0.073	−0.117	−0.322	−0.602	−0.064	0.325
	(−5.04)	(−4.89)	(−17.91)	(−3.72)	(−2.58)	(6.13)
Rank(*CC*) ∗ *AGE_Q2*	0.033	0.044	0.124	0.320	0.047	−0.158
	(3.14)	(2.29)	(5.82)	(2.47)	(2.25)	(−4.11)
Rank(*CC*) ∗ *AGE_Q3*	0.057	0.080	0.210	0.416	0.024	−0.235
	(9.11)	(7.03)	(4.61)	(3.59)	(1.49)	(−9.35)
Rank(*CC*) ∗ *AGE_Q4*	0.084	0.139	0.246	0.538	0.008	−0.334
	(4.95)	(6.53)	(18.27)	(3.36)	(0.21)	(−9.67)
Rank(*CC*) ∗ *AGE_Q5*	0.088	0.140	0.363	0.555	−0.027	−0.377
	(3.48)	(3.25)	(22.56)	(3.46)	(−0.72)	(−8.98)
MV	0.031	0.059	−0.019	0.060	0.020	−0.036
	(11.34)	(13.40)	(−2.47)	(−4.56)	(9.73)	(−4.68)
GROWTH	0.007	0.033	0.370	0.012	0.028	0.028
	(0.55)	(1.25)	(7.46)	(0.63)	(4.28)	(2.71)
CONGLO	−0.004	−0.004	0.005	0.058	−0.055	−0.084
	(−1.35)	(−1.74)	(0.60)	(4.53)	(−22.12)	(−8.78)
FLEV	−0.002	−0.010	0.012	0.009	−0.005	−0.013
	(−1.99)	(−1.32)	(2.04)	(2.98)	(−7.98)	(−6.42)

(continued on next page)

TABLE 5 (continued)

	(1) *ROA*	(2) *ROE*	(3) *ATO*	(4) *PM*	(5) *GM*	(6) *SGA*
Industry F. E.	Yes	Yes	Yes	Yes	Yes	Yes
Avg. R^2	0.206	0.171	0.326	0.140	0.206	0.204
n	49,118	49,118	49,118	49,118	49,118	49,118

Table 5 reports the results of yearly Fama and MacBeth (1973) regressions of accounting performance measures on *Rank*(*CC*) and a set of control variables. *Rank*(*CC*) is the decile rank of customer-base concentration (*CC*). The sample includes 1977 to 2007 firms that have non-missing customer-base concentration measures, non-missing accounting profitability measures, and non-negative book value of equity. In Panel A, for each firm, we calculate the weighted average of the duration of its links with its major customers (*LINKAGE*) and sort firms into five portfolios based on *LINKAGE*. *LA_Q2, LA_Q3, LA_Q4,* and *LA_Q5* are dummy variables that equal 1 if *LINKAGE* falls into the second, third, fourth, and fifth quintiles, respectively. Panel B reports analogous results for the full sample for *AGE* quintiles. The dependent variables include (1) return on assets (*ROA*); (2) return on equity (*ROE*); (3) asset turnover (*ATO*); (4) profit margin (*PM*); (5) gross margin (*GM*); and (6) the ratio of SG&A expenses to sales (*SGA*). Other control variables include the log of market value of equity (*MV*); the log of firm age (*AGE*); annual sales growth rate (*GROWTH*); the indicator variable that equals 1 if the firm reports at least two business segments (*CONGLO*); and the leverage ratio, defined as book value of assets divided by book value of equity (*FLEV*). In both panels, we average the coefficients over time and report the means in the first rows and the corresponding Newey-West adjusted t-statistics below in parentheses. For both panels, n is the number of firm-year observations used in the regression.

effects of customer concentration are reduced, eliminated, or reversed as the links with major customers mature. In Column (5), we regress gross margin *GM* on *Rank*(*CC*). These results reveal that the adverse effect of customer concentration on gross margin is not negated with the duration of the major customer links, suggesting that major customers continue to exercise some bargaining power throughout the duration of the relationship. In Column (6), we show that long-duration links with major customers lead to large efficiency gains in the form of reduced SG&A expenses. In fact, our results suggest that firms in the two oldest *LINKAGE* quintiles experience reductions in SG&A investments that are greater than those incurred at the beginning of the relationship. In all the analyses conducted in Panel A, we follow Patatoukas (2012) and control for firm age (*AGE*), as well as firm size (*MV*), sales growth rate (*GROWTH*), the indicator variable for firms having more than one line of business (*CONGLO*), and financial leverage (*FLEV*). Perhaps the most significant of these control variables is firm age (*AGE*). Controlling for *AGE* establishes that the impact of the duration of the customer links (*LINKAGE*) on firm performance is independent from the impact of *AGE* on firm performance. This result establishes that relationship life-cycle effects are distinct from the life cycle of the firm.

In Panel B of Table 5 we estimate the same regression specification as in Panel A, but use *AGE* as a proxy for relationship age to facilitate the use of all the sample data. We find results using *AGE* that are strikingly similar to those reported for *LINKAGE* in Panel A. In the full sample, customer concentration significantly negatively impacts *ROA* (Column (1)) and leads to higher *SGA* (Column (6)), but as in Panel A, these negative consequences of early-stage relationships on firm performance are reversed as the relationship matures.

To summarize, Table 5 expands upon one of the main tables in Patatoukas (2012, Table 2, Panel A). We find key support for our relationship life-cycle hypothesis. Major customers have a significant effect on firm profitability and operations, but these results differ depending on whether the relationship is in the early build-up stage versus in a more mature state. Initially, major customer relationships tend to negatively affect firm profitability and increase costs, but as the relationship matures, these results reverse and customer concentration is significantly positively related to firm profitability.

Impact of Customer Concentration on Operating Efficiency throughout the Relationship Life Cycle

To determine the impact of customer concentration on operating performance over the relationship life cycle, we examine the effect of customer concentration on inventory, asset turnover components, advertising expenses, and working capital efficiency, while controlling for firm size, age, sales growth, lines of business, and financial leverage. The key independent variables in this analysis are *Rank*(*CC*), to measure the effect of customer concentration in the youngest relationships, and the interaction variables *Rank*(*CC*) $*$ *LINKAGE,* whose coefficients reveal how the details of firm operations change as the relationship matures.

The coefficients of *Rank*(*CC*) in Table 6 show that many of Patatoukas' (2012) conclusions about customer concentration and operating efficiency hold in our expanded sample. Columns (1) and (2) show that major customers allow suppliers to significantly reduce inventory holding costs (*INVHLD*), but the coefficient on *Rank*(*CC*) $*$ *LINKAGE* reveals that inventory turnover only materially increases as the relationship matures. With the exception of cash turnover and advertising expenses,

TABLE 6

Impact of the Duration of Customer Links on Operating Performance

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Asset Turnover Components							Working Capital Efficiencies		
	INVHLD	*INVT*	*RCVBLE*	*NPP&E*	*INTANG*	*CASH*	*ADVERT*	*DAYS_RCVBLE*	*DAYS_INVT*	*DOUBTFUL*
Intercept	0.117	29.476	3.837	18.096	67.911	108.254	0.009	93.644	61.902	0.052
	(25.50)	(4.48)	(9.89)	(4.49)	(1.52)	(2.96)	(2.07)	(12.99)	(7.91)	(5.38)
Rank(*CC*)	−0.032	−2.021	1.356	1.598	9.019	−32.882	−0.008	20.271	6.071	0.005
	(−7.34)	(−0.76)	(2.88)	(1.65)	(1.06)	(−13.23)	(−10.07)	(5.17)	(1.31)	(1.04)
Rank(*CC*) ∗ *LINKAGE*	0.008	3.011	0.215	−0.255	45.919	15.530	0.000	−11.135	−11.447	−0.009
	(3.40)	(3.09)	(0.59)	(−0.50)	(2.17)	(9.87)	(0.21)	(−4.48)	(−8.08)	(−4.80)
MV	−0.015	0.724	0.016	−1.327	−0.020	−6.823	0.001	−2.388	−3.978	−0.004
	(−24.27)	(3.27)	(0.35)	(−6.25)	(−0.01)	(−3.72)	(1.370)	(−7.94)	(−4.73)	(−12.61)
AGE	0.013	−3.385	−0.155	0.267	−8.587	−0.841	−0.001	−2.034	1.328	0.000
	(10.62)	(−4.08)	(−1.01)	(0.44)	(−1.32)	(−0.37)	(−1.96)	(−1.67)	(1.22)	(0.28)
GROWTH	0.003	7.581	6.018	10.104	23.179	8.659	0.000	−30.578	−24.520	0.000
	(1.58)	(7.43)	(9.14)	(8.55)	(3.16)	(3.78)	(0.90)	(−20.55)	(−9.41)	(−0.14)
CONGLO	0.001	−0.158	0.042	−2.531	−46.819	−4.005	−0.004	−5.338	−10.795	−0.002
	(0.21)	(−0.37)	(0.77)	(−2.05)	(−1.88)	(−1.43)	(−24.51)	(−1.68)	(−5.11)	(−2.25)
FLEV	0.001	0.067	0.072	0.055	2.408	8.219	0.000	−0.163	−0.872	0.001
	(8.01)	(1.51)	(1.57)	(0.66)	(1.32)	(5.78)	(0.42)	(−1.28)	(−1.27)	(2.95)
Industry F. E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Avg. R^2	0.469	0.310	0.376	0.178	0.171	0.146	0.150	0.200	0.259	0.171
n	22,160	19,201	22,178	22,303	11,011	22,166	22,311	22,247	22,160	16,972

This table presents Fama and MacBeth (1973) regressions using firms with identifiable customers. We analyze the impact of customer concentration and relationship age on the components of firms' operating performance. The dependent variables include: (1) *INVHLD:* the ratio of inventory to the book value of total assets; (2) *INVT:* inventory turnover; (3) *RCVBLE:* accounts receivable turnover; (4) *NPP&E:* net PP&E turnover; (5) *INTANG:* intangible asset turnover; (6) *CASH*: cash turnover; (7) *ADVERT:* advertising expense to sales; (8) *DAYS_RCVBLE:* days' receivables, measured as the ratio of accounts receivable to sales multiplied by 365; (9) *DAYS_INVT:* days' inventory, measured as the ratio of inventory to cost of goods sold multiplied by 365; and (10) *DOUBTFUL:* provisions for doubtful accounts, measured as the ratio of estimated doubtful accounts receivable to total accounts receivable. *Rank*(*CC*) is the decile rank of a firm's customer concentration score. Other control variables include the log of market value of equity (*MV*); the log of firm age (*AGE*); annual sales growth rate (*GROWTH*); the indicator variable that equals 1 if the firm reports at least two business segments (*CONGLO*); the leverage ratio, defined as book value of assets divided by book value of equity (*FLEV*); and link age (*LINKAGE*), the weighted average of the duration of the relationships between a firm and its major customers. We average the coefficients over time and report the means in the first rows and the corresponding Newey-West adjusted t-statistics below in parentheses. n is the number of firm-year observations used in the regression.

the other components of asset turnover are consistent with the contention that customer concentration improves operating efficiency. However, customer concentration has a significantly negative effect on cash turnover.[14]

We see a similar pattern for intangibles turnover in Table 6, Column (5), whereas significantly higher intangibles turnover (*INTANG*) is a result associated with increases in *LINKAGE*. Columns (3) and (4) reveal that receivables turnover and property, plant, and equipment (PP&E) turnover do not improve along the relationship life cycle. Column (6) shows that cash turnover improves for firms that have long-duration links with their major customers. This suggests that longer-duration links with major customers help build trust between the parties, which leads to more efficient deployment of cash. We observe in Column (7) that while earlier results document relationship life-cycle improvements in SG&A expenses, the same is not true for advertising expenses. The benefits from a reduction in advertising expenditures are present in this sample, but importance of the relationship itself, rather than the relationship duration, appears to be the driving factor. In Columns (8) through (10), we examine the effect of customer concentration on working capital efficiency. The results reveal that all working capital efficiency improvements come with time. As the relationship matures, the ratio of accounts receivable to sales (*DAYS_RCVBLE*), the ratio of inventory to cost of goods sold (*DAYS_INVT*), and the provision for doubtful accounts relative to accounts receivable (*DOUBTFUL*) all decrease.

V. IMPACT OF CHANGES IN CUSTOMER CONCENTRATION ON FIRM VALUE AND PERFORMANCE

Our expanded sample of major customers contains many suppliers in the early stages of their relationship life cycle. Such firms tend to invest heavily in customer-specific SG&A expenses and, consequently, have lower return on assets and a greater probability of negative earnings. A powerful test of the valuation conclusions in Patatoukas (2012) is to determine whether the market can anticipate the offsetting benefits of major customer relationships that are not yet evident in accounting earnings. In this section, we investigate the valuation implications of changes in customer concentration, *Rank*(ΔCC). As in Patatoukas (2012), we calculate the effects of changes in the rank of customer concentration to better define the direction of causality between customer concentration and firm operating characteristics. To investigate how our relationship life-cycle hypothesis can provide structure to Patatoukas' (2012) intertemporal analysis, we combine two Patatoukas (2012) analyses in Table 7, where we estimate the effect of changes in customer concentration rank on contemporaneous and future abnormal returns, as well as future operating performance.

In Column (1) of Panel A of Table 7 we show that contemporaneous buy-and-hold equity returns are positively related to changes in customer concentration, *Rank*(ΔCC), suggesting that investors believe that increasing reliance on major customers is a positive development for the firm. Abnormal stock returns increase an average of 7.2 percent in the year of the customer concentration increase, a figure very similar to the results in Patatoukas (2012) for positive operating margin firms. Given that our sample includes many early-stage business relationships where the firm is more likely to have negative earnings, this result provides strong support of Patatoukas' (2012) general contention that the stock market views increases in major customer relationships as positive events for the firm. In Columns (3) and (4), we find that the market appears to incorporate the valuation impact of customer concentration in the current year; although abnormal returns are positive in year t+1 (relative to the year of customer concentration change), they are not statistically significant.[15] Incorporating life-cycle effects through the interaction coefficient *Rank*(*CC*) $*$ *LINKAGE* does not materially change this result, although customer concentration increases later in the business relationship tend to have a less positive effect on firm returns in the current year.

To test a causal relation between changes in *Rank*(*CC*) and operating performance, we regress next period's changes in *ROA* (ΔROA) and *SGA* (ΔSGA) on changes in customer concentration and changes in a set of control variables. Our results in Table 7, Panel A, Columns (5) through (8) present these results for the subsequent year (t+1) in regressions that both exclude (Columns (5) and (7)) and include (Columns (6) and (8)) the interaction variable *Rank*(*CC*) $*$ *LINKAGE* incorporating relationship life-cycle effects. In Columns (5) and (7), the effect of contemporaneous changes in *Rank*(*CC*) on changes in *ROA* and *SGA* are consistent with the static analysis presented earlier: Increases in customer concentration tend to initially decrease *ROA* and increase *SGA* expenses. However, once again, we find that life-cycle effects change these results. Columns (6) and (8) report that as the age of the relationship increases, *ROA* changes increase, and *SGA* changes decline.[16] These results are consistent with the evidence on customer concentration and firm performance presented earlier; early in the relationship, life-cycle increases in customer concentration lead to both higher selling, general, and administrative costs and lower profitability in

[14] We find that cash holdings increase with customer-base concentration. This finding is consistent with high customer concentration firms holding higher precautionary cash balances, which impairs their cash turnover.

[15] Although they do not address dynamic effects, Ak and Patatoukas (2016) provide confirmatory evidence on the association of customer concentration on contemporaneous valuation.

[16] Patatoukas (2012) also finds a positive relation between changes in customer concentration and changes in *ROE*. We do not include *ROE* changes because the specification in Patatoukas (2012) contains no leverage control. When we estimate the Table 8 regressions for changes in *ROE* with a leverage control variable, the coefficients on changes in customer concentration are insignificantly negative.

TABLE 7

Impact of Changes in Customer-Base Concentration on Firm Performance

Panel A: Change in Customer-Base Concentration, Stock Returns, and Future Performance

	(1) $BHAR_t$	(2) $BHAR_t$	(3) $BHAR_{t+1}$	(4) $BHAR_{t+1}$	(5) ΔROA_{t+1}	(6) ΔROA_{t+1}	(7) ΔSGA_{t+1}	(8) ΔSGA_{t+1}
Intercept	−0.219	−0.182	−0.077	−0.088	0.002	−0.036	0.014	0.063
	(−2.36)	(−2.00)	(−0.65)	(−0.76)	(0.22)	(−3.26)	(0.80)	(1.85)
$Rank_t(\Delta CC)$	0.072	0.086	0.015	−0.030	−0.007	−0.012	0.017	0.031
	(3.46)	(6.26)	(1.38)	(−1.63)	(−2.22)	(−2.56)	(6.07)	(6.93)
$Rank_t(\Delta CC) * LINKAGE$		−0.024		0.029		0.004		−0.007
		(−3.18)		(1.59)		(1.82)		(−3.79)
PM_t	0.207	0.134	−0.138	0.052	−0.076	−0.042	0.047	0.028
	(1.35)	(1.46)	(−0.97)	(1.20)	(−1.50)	(−11.37)	(1.86)	(0.71)
ATO_t	0.053	0.083	0.010	−0.002	−0.010	−0.009	−0.002	−0.002
	(2.65)	(4.43)	(0.50)	(−0.15)	(−12.71)	(−4.52)	(−1.04)	(−0.63)
ΔPM_t	0.049	0.199	0.222	−0.024	0.021	−0.023	0.024	0.073
	(1.06)	(1.38)	(1.06)	(−0.87)	(0.78)	(−3.02)	(0.97)	(1.00)
ΔATO_t	0.290	0.250	−0.004	0.028	0.003	0.009	0.000	−0.001
	(5.70)	(15.20)	(−0.23)	(1.75)	(1.10)	(2.77)	(0.08)	(−0.30)
Industry F. E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Avg. R^2	0.174	0.207	0.132	0.164	0.120	0.134	0.191	0.207
n	35,488	17,494	31,716	15,603	35,668	17,160	35,419	17,054

Panel B: Firms with New Major Customer Links Compared to Similar Firms with No Major Customers

		Sales Growth$_t$			Sales Growth$_{t+1}$		
Year	n	New Suppliers	Matching Firms	Difference	New Suppliers	Matching Firms	Difference
1981	79	0.238	0.148	0.089	0.064	0.029	0.033
1982	75	0.188	0.077	0.111	0.136	0.049	0.111
1983	88	0.436	0.219	0.231	0.244	0.172	0.080
1984	91	0.238	0.322	−0.084	0.108	0.060	0.051
1985	114	0.166	0.145	0.020	0.132	0.201	−0.074
1986	114	0.345	0.170	0.175	0.323	0.194	0.205
1987	88	0.319	0.420	−0.100	0.243	0.119	0.127
1988	92	0.284	0.172	0.109	0.168	0.083	0.096
1989	92	0.334	0.113	0.221	0.170	0.027	0.156
1990	93	0.292	0.143	0.148	0.112	0.050	0.081
1991	99	0.187	0.077	0.110	0.142	0.156	−0.012
1992	123	0.219	0.128	0.090	0.258	0.236	0.006
1993	136	0.321	0.094	0.227	0.280	0.274	0.032
1994	110	0.394	0.173	0.181	0.304	0.095	0.175
1995	120	0.400	0.199	0.201	0.193	0.204	0.013
1996	143	0.304	0.231	0.073	0.227	0.264	0.016
1997	127	0.483	0.198	0.285	0.263	0.153	0.119
1998	174	0.300	0.200	0.101	0.134	0.138	0.004
1999	144	0.326	0.210	0.117	0.300	0.244	0.041
2000	160	0.486	0.220	0.305	0.093	0.066	0.043
2001	141	0.165	0.100	0.063	−0.030	0.013	−0.044
2002	177	0.045	0.091	−0.046	0.149	0.081	0.058
2003	130	0.120	0.117	0.003	0.272	0.182	0.064
2004	114	0.274	0.164	0.110	0.196	0.182	0.021
2005	104	0.245	0.125	0.120	0.166	0.114	0.042
2006	97	0.236	0.113	0.131	0.210	0.164	0.068

(continued on next page)

TABLE 7 (continued)

		Sales Growth$_t$			Sales Growth$_{t+1}$		
Year	**n**	**New Suppliers**	**Matching Firms**	**Difference**	**New Suppliers**	**Matching Firms**	**Difference**
2007	82	0.350	0.123	0.226	0.204	0.142	0.062
Mean		0.284	0.169	0.116	0.185	0.138	0.054
t-stat				(6.15)			(5.03)

Panel A presents Fama and MacBeth (1973) regressions of the impact of changes in customer-base concentration on stock returns and future firm performance. The dependent variables are contemporaneous one-year buy-and-hold abnormal return in year t ($BHAR_t$); future one-year buy-and-hold abnormal return in year t+1 ($BHAR_{t+1}$); and changes in return on assets (ΔROA_{t+1}) and SG&A expenses (ΔSGA_{t+1}) in year t+1. The decile ranks of the annual change in customer-base concentration and control variables are calculated in year t. We run annual regressions of year t to year t+1 changes in *ROA* and *SGA*, as well as *BHAR*s calculated in year t and t+1 on *Rank*(ΔCC), the decile rank of annual change in customer-base concentration from year $t-1$ to year t, and on year t values of the control variables. Means of annual coefficients are reported in the first rows and the corresponding Newey-West adjusted t-statistics below in parentheses. In Panel B, we compare the future sales growth of firms that recently have acquired their first-ever major customer with a matched sample of firms that have no major customers. At the bottom of Panel B, we average the coefficients over time and report the means in the first row, and the corresponding Newey-West adjusted t-statistics in the row below in parentheses. Link age (*LINKAGE*) is the weighted average of the duration of the relationships between a firm and its major customers, where the weights are sales shares to each respective customer. Other control variables are profit margin (PM_t); asset turnover (ATO_t); annual change in profit margin (ΔPM_t); and annual change in asset turnover (ΔATO_t). Our sample includes firms from 1977 to 2007. In both panels, n is the number of firm-year observations used in the regression.

the next period. These results support our hypothesis that it is necessary to understand the relationship life cycle in order to interpret the effects of customer concentration on firm profitability.

Panel B of Table 7 attempts to provide an answer to two puzzles suggested by the Panel A results. Why are contemporaneous returns positive when customer concentration increases, and why are initial costs high enough to induce a negative relation between *Rank*(*CC*) and operating performance early in the relationship? We calculate the change in sales for Initial relationships, those years in which a firm acquires its first major customer. To control for confounding characteristics that might influence our results, we match each Initial firm to a firm with no major customers by matching each Initial and comparable firm by firm age, size, book-to-market ratio, and sales growth. We present year-by-year results of Initial firm sales growth, comparable firm sales growth, and calculate the difference. In 25 of the 27 years that we can estimate, Initial firms have higher sales growth than do comparable firms. This advantage averages 11.6 percent for Initial firms (t-statistic = 6.41). In the following year, Initial firms average 18.6 percent sales growth, 5.6 percent more than comparable firms. This sales growth evidence reconciles the results observed on contemporaneous returns in Panel A with the evidence presented earlier in the paper. Initiating major customer relationships for the first time produces economically significant sales gains. This increase in cash flow is apparently recognized by the equity investors, who provide the firm with higher contemporaneous returns.

However, the benefits from acquiring a major customer do not immediately become apparent in operating performance. We suggest that the growth in Initial firm sales is economically large and, thus, requires considerable customer-specific investment in the early years of the relationship. These investments are initially costly, but they provide long-term benefits (Jap and Anderson 2007) that eventually improve operating performance and increase profitability.

Firm Benefits Along the Relationship Life Cycle

We document that sales increase following the establishment of major customer relationships, but there are other benefits that are more subtle and, thus, become apparent only gradually. Sometimes these benefits reflect difficult-to-measure concepts such as trust or information sharing. This section explores how some of the benefits of major customer relationships deepen over time.

Cost of Debt

Large, customer-specific investments early in the relationship life cycle increase operating leverage and the likelihood of negative earnings, but we show that these impairments reverse over time as the major customer relationship matures. In this section, we investigate how the relationship life cycle affects the interaction of the firm with the credit markets. To show this, we first examine the *ex ante* probability of default using the Altman (1968) Z-score and the Ohlson (1980) O-score. In Panel A of Table 8 we regress both measures of default risk on *Rank*(*CC*) and, as before, we interact *Rank*(*CC*) with the relationship age dummy variables *LA_Q2, LA_Q3, LA_Q4,* and *LA_Q5* to test if the effect of major customers on the credit market changes as the relationship matures. In several specifications, we also include the set of independent variables used to predict default in the Campbell, Hilscher, and Szilagyi (2008) model of default prediction. We include these variables to incorporate advances in

TABLE 8

Customer-Base Concentration and Credit Risk

Panel A: Customer-Base Concentration and Credit Risk as Measured by Z-Score and O-Score

	(1) Z-Score	(2) Z-Score	(3) Z-Score	(4) Z-Score	(5) O-Score	(6) O-Score	(7) O-Score	(8) O-Score
Intercept	−2.390	−3.342	−2.045	−4.530	−1.516	−5.729	−1.600	−5.487
	(−8.80)	(−10.97)	(−6.69)	(−6.33)	(−13.26)	(−24.59)	(−13.75)	(−26.29)
Rank(CC)	−2.565	−0.711	−4.200	−1.170	0.359	0.098	0.640	0.160
	(−7.09)	(−3.05)	(−7.52)	(−4.68)	(8.94)	(4.18)	(12.13)	(10.21)
*Rank(CC) * LA_Q2*			0.198	0.247			−0.179	−0.032
			(1.32)	(1.61)			(−3.22)	(−1.47)
*Rank(CC) * LA_Q3*			0.869	0.273			−0.246	−0.047
			(5.94)	(3.18)			(−5.60)	(−1.09)
*Rank(CC) * LA_Q4*			1.672	0.303			−0.316	−0.097
			(4.52)	(2.37)			(−8.67)	(−3.84)
*Rank(CC) * LA_Q5*			2.901	0.320			−0.405	−0.063
			(6.60)	(5.34)			(−14.00)	(−1.69)
CASHMTA		−3.286		−2.451		−1.647		−1.692
		(−4.83)		(−3.03)		(−22.32)		(−20.22)
EXRET		−0.469		−0.375		0.076		0.078
		(−2.46)		(−1.06)		(4.08)		(2.25)
MB		−0.638		−0.630		0.038		0.026
		(−5.56)		(−6.32)		(7.73)		(3.77)
NIMTA		−0.578		−2.786		−29.165		−29.181
		(−0.09)		(−0.44)		(−33.75)		(−33.90)
RSIZE		0.027		0.008		−0.368		−0.365
		(0.86)		(0.19)		(−91.06)		(−119.21)
SIGMA		−0.350		−0.191		−0.056		−0.082
		(−1.53)		(−1.02)		(−1.33)		(−2.14)
TLMTA		10.230		10.488		1.606		1.598
		(10.98)		(8.93)		(77.52)		(65.89)
Industry F. E.	No	Yes	No	Yes	No	Yes	No	Yes
Avg. R^2	0.034	0.595	0.074	0.620	0.012	0.791	0.024	0.806
n	41,224	41,224	19,310	19,310	48,310	48,310	22,516	22,516

Panel B: Customer-Base Concentration and Bank Loan Spreads

	(1) *SPREAD*	(2) *SPREAD*	(3) *SPREAD*	(4) *SPREAD*
Intercept	4.927	7.290	4.762	7.392
	(112.12)	(30.67)	(95.56)	(32.17)
Rank(CC)	0.303	0.055	0.740	0.111
	(12.07)	(2.70)	(9.62)	(3.40)
*Rank(CC) * LA_Q2*			−0.165	−0.107
			(−2.08)	(−2.07)
*Rank(CC) * LA_Q3*			−0.199	−0.141
			(−2.07)	(−2.77)
*Rank(CC) * LA_Q4*			−0.216	−0.114
			(−3.73)	(−2.82)
*Rank(CC) * LA_Q5*			−0.529	−0.210
			(−4.77)	(−4.04)
AT		−0.114		−0.125
		(−7.14)		(−5.59)

(continued on next page)

TABLE 8 (continued)

	(1) *SPREAD*	(2) *SPREAD*	(3) *SPREAD*	(4) *SPREAD*
TLTA		0.673		0.584
		(13.98)		(11.12)
RETVAR		0.002		0.002
		(4.92)		(4.59)
MATURITY		−0.002		−0.003
		(−0.10)		(−0.16)
LOANAMT		−0.105		−0.101
		(−10.17)		(−8.10)
RF		−0.071		−0.077
		(−6.21)		(−5.04)
DEF		0.266		0.254
		(3.28)		(2.47)
TERM		−0.050		−0.066
		(−2.13)		(−2.56)
VIX		0.003		0.004
		(1.25)		(1.50)
Rating F. E.	No	Yes	No	Yes
R^2	0.014	0.534	0.042	0.603
n	10,075	10,075	4,785	4,785

Table 8 reports results for Fama and MacBeth (1973) regressions of the impact of customer concentration on credit risk. In Panel A, the dependent variable used in Columns (1)–(4) is Altman's (1968) Z-score, while in Columns (5)–(8), we use Ohlson's (1980) O-score. Control variables for Panel A include *Rank*(*CC*), the decile rank of customer concentration; leverage (*TLMTA*); scaled net income (*NIMTA*); the standard deviation of the daily stock returns over the past three months (*SIGMA*); market-to-book ratio (*MB*); a firm's relative size to the S&P 500 index (*RSIZE*); a firm's cash holdings to its market value of assets (*CASHMTA*); and the average of monthly log excess returns (*EXRET*), calculated as in Campbell et al. (2008). Coefficient averages are reported with corresponding Newey-West adjusted t-statistics in parentheses below. n is the number of firm-year observations used in the regression. In Panel B, we run annual loan-level cross-sectional regressions of the log of bank loan spreads (*SPREAD*) on *Rank*(*CC*); the log of total assets (*AT*); leverage (*TLTA*); equity return volatility (*RETVAR*); the log of loan maturity (*MATURITY*); the log of loan amount issued (*LOANAMT*); risk-free rate (*RF*); default (*DEF*); and term (*TERM*) factors; and the implied volatility of the S&P 500 index (*VIX*). Firms are sorted into five portfolios based on the average age of their customer relationships (*LINKAGE*). *LA_Q2, LA_Q3, LA_Q4,* and *LA_Q5* are dummy variables that equal 1 if *LINKAGE* falls into a particular quintile. n is the number of bank loan issuances used in the regression, and t-statistics are reported in the rows below regression coefficients in parentheses.

default prediction since the Z-score and the O-score were originally developed. The tendency of early-stage relationships to induce negative earnings in supplier firms is apparent in the significant coefficients on *Rank*(*CC*). *Rank*(*CC*) estimates the baseline effect of customer concentration for firms in the youngest major customer relationship. In all eight specifications, we find that customer concentration significantly impairs both the Z-score and the O-score. In Columns (3), (4), (7), and (8), we include the relationship age dummy variables and find that as the relationship matures, both measures of credit risk improve significantly. Although the coefficients on the interactive dummy variables *LA_Q2, LA_Q3, LA_Q4,* and *LA_Q5* do not always reject the null individually, a joint F-test reveals that as a group, the coefficients reject the null of no effect in both Column (4) ($p = 0.018$) and Column (8) ($p = 0.001$). The F-test shows that the relationship age covariates do have a significant effect on both the Z-score and the O-score measures of credit risk.

Table 8, Panel B uses data on bank loan spreads from DealScan from 1982–2007 to estimate whether the reductions in the probability of default along the relationship life cycle are reflected in the costs of actual loans that were completed and offered to investors.[17] Using data on up to 10,075 loans that were available for our sample of firms, we find results that are consistent with the results on accounting measures of credit risk in Panel A. In Columns (1) and (2), we find that customer concentration significantly increases bank loan spreads on completed transactions; the *Rank*(*CC*) coefficient is positive and significant in all four regression specifications. However, when we analyze 4,785 transactions where data on *LINKAGE* are available, we find that relationship life-cycle effects confound a simple monotonic explanation for the relation between customer concentration and the cost of debt. Specifically, as the relationships mature and customer-specific investments fall, bank loan spreads

[17] We thank an anonymous referee for this suggestion.

significantly decline. These results outline the importance of the relationship life cycle in understanding the impact of customer concentration in the credit markets.

Innovation

Since Dwyer et al. (1987), the ability of firms to share information about processes and technology has been seen as a key driver of value in major customer relationships. However, information sharing is inherently difficult to measure, so little empirical evidence on information sharing as a driver of relationship value exists. We attempt to fill this gap by drawing on the innovation literature to determine whether information sharing improves as the relationship matures. The innovation literature recently introduced patents and patent citation analysis as a key measure of innovative output, rather than the traditional input measure of research and development expenses (Kogan, Papanikolaou, Seru, and Stoffman 2014; Hirshleifer, Hsu, and Li 2013; Chemmanur, Loutskina, and Tian 2014).

We follow this literature and examine the research and development (R&D) productivity of firms in major customer relationships by analyzing both the total number of new patents issued by the firm (*PATENTS*) and the number of new firm patents that cite at least one patent belonging to their major customers (*RELATEDPATENTS*). The total number of new patents measures the research and development productivity of the firm, while the number of patent citations belonging to major customers measures the effectiveness of direct information sharing in major customer relationships. These data enable us to determine whether there is information sharing in crucial patentable technology associated with major customer relationships and whether this information sharing improves as the relationship matures. The key independent variables in this analysis capture the innovative activity of major customers. *CustNewPatents* measures the recent success of major customers in issuing patents, and *CustTotalPatents* records major customer's total patent activity over the last 20 years. We interact both of these variables with *LINKAGE* to determine whether the major customer's patent activity significantly affects the innovative activity of the firm as the relationship matures. We expect that as the relationship matures, trust between the parties increases, and the firm is more likely to benefit from the sharing of information about customer technological innovation. The regression specifications in Table 9 also control for the firm's cumulative R&D expenses (*R&D*), firm size (*MV*), firm growth opportunities (*BTM*), and firm leverage (*LEVERAGE*).

The results of our patent analysis in Table 9 provide significant evidence of information sharing in major customer relationships. In Column (1), the regression results show that the recent research productivity of major customers, as measured by *CustNewPatents,* is significantly positively related to the patent activity of the firm. Column (2), using the interaction variable *LINKAGE,* finds that relationship age is the driving factor in these technology spillovers. The results show that the patent activity of the firm significantly increases over the relationship life cycle. The long-term nature of the relationship facilitates the information sharing that benefits the firm's R&D productivity. Columns (3) and (4) document that the firm benefits from the customer's full patent portfolio and that information sharing is not limited to recent customer innovation.

Columns (5) through (8) of Table 9 investigate the direct link between the *R&D* productivity of firms and the *R&D* productivity of their major customers by regressing the number of new firm patents that directly cite at least one patent belonging to their major customers (*RELATEDPATENTS*). In all four regressions, the number of patents issued by the major customer significantly contributes to the patent activity of the firm. In these regressions, the coefficient on the interaction variable *LINKAGE* reveals that these information transfers significantly increase over the relationship life cycle. These results present powerful and new evidence of technology transfers in major customer relationships. These technology transfers significantly increase as the relationship matures, presumably as the parties generate greater trust in each other through continued interactions, and contribute to the value that major customer relationships create for the firm.

VI. CONCLUSION

All supplier firms face the dilemma of whether to cater to a few dominant customers or seek a more diversified customer base. Research since Galbraith (1952) suggests that major customers are threats to firms' operating profits because, as important customers with significant bargaining power, they can demand price discounts and other concessions from suppliers. Patatoukas (2012) challenges this view by creating a firm-specific measure of customer concentration and documenting that profitable firms with high customer concentration benefit from customer-specific investments through improved operating efficiencies and reduced SG&A expenses.

This paper uses a recently expanded dataset of sales to major customers to study the economics of supplier firms. We outline a relationship life-cycle hypothesis to investigate *when* customer concentration improves profitability rather than *whether* customer concentration improves profitability. We develop a relationship life-cycle hypothesis wherein firms early in the relationship life cycle face significant operating risks. These risks arise because establishing and maintaining relationships with major customers requires large, fixed investments early in the relationship. As the relationship matures, these costs decline and firms are able to benefit from many of the operating efficiencies documented in Patatoukas (2012).

TABLE 9

Impact of Customers' Innovativeness on Firm Innovation over the Relationship Life Cycle

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$PATENTS_{t+1}$				$RELATEDPATENTS_{t+1}$			
Intercept	−0.754	−0.733	−0.761	−0.743	−0.446	−0.423	−0.452	−0.432
	(−3.07)	(−3.02)	(−3.06)	(−3.02)	(−3.19)	(−3.17)	(−3.11)	(−3.10)
CustNewPatents	0.074	0.019			0.17	0.119		
	(6.71)	(1.10)			(3.10)	(2.68)		
CustNewPatents ∗ *LINKAGE*		0.044				0.041		
		(2.51)				(2.66)		
CustTotalPatents			0.077	0.031			0.161	0.118
			(8.82)	(1.56)			(2.98)	(2.71)
CustTotalPatents ∗ *LINKAGE*				0.038				0.034
				(2.28)				(2.57)
R&D	0.326	0.326	0.327	0.327	0.123	0.122	0.124	0.124
	(26.86)	(27.14)	(26.40)	(26.65)	(16.55)	(16.44)	(16.49)	(16.39)
MV	0.163	0.161	0.163	0.161	0.054	0.052	0.054	0.052
	(9.34)	(8.92)	(9.35)	(8.91)	(5.13)	(5.18)	(5.14)	(5.22)
BTM	0.085	0.078	0.084	0.077	0.039	0.034	0.039	0.034
	(11.68)	(9.90)	(11.64)	(9.96)	(3.58)	(3.41)	(3.56)	(3.42)
LEVERAGE	0.073	0.069	0.071	0.067	0.032	0.028	0.031	0.027
	(4.30)	(4.25)	(4.12)	(4.00)	(2.61)	(2.49)	(2.69)	(2.59)
Industry F. E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Avg. R^2	0.555	0.556	0.555	0.556	0.340	0.343	0.336	0.339
n	19,419	19,419	19,419	19,419	19,419	19,419	19,419	19,419

Table 9 reports Fama and MacBeth (1973) regression results. In Columns (1) to (4), the dependent variable measures the research and development productivity of the firm as the log of 1 plus the number of new patents filed by the firm in year t+1 ($PATENTS_{t+1}$). In Columns (5) to (8), the dependent variable, $RELATEDPATENTS_{t+1}$, is log of 1 plus the number of new patents granted to the firm that cite at least one patent belonging to its major customers. *CustNewPatents* is the weighted average of major customers' R&D productivity ranks, where each customer is ranked in its industry based on the number of new patents granted to it in year *t*. *CustTotalPatents* is the weighted average of major customers' R&D productivity, where each customer is ranked in its industry based on the total number of patents granted to it over the last 20 years. For both measures, the weights are sales shares to each customer. All control variables are measured in year *t*. *LINKAGE* is the weighted average of the duration of the links between the firm and its major customers; *R&D* is the log of accumulated R&D spending of the firm over years *t*–4 to *t; MV* is the log of market capitalization; *BTM* is the log of the book-to-market ratio; and *LEVERAGE* is the log of 1 plus the total liabilities scaled by total assets. We average the coefficients over time and report the means in the first rows and the corresponding Newey-West adjusted t-statistics in the rows below in parentheses. n reports the number of firm-year observations used in the regressions.

Thus, customer concentration brings significant costs and benefits to the firm. Identifying these costs and benefits over the full range of the relationship life cycle allows us to reconcile conventional wisdom, which views major customers as a threat to firm profitability, with Patatoukas' (2012) results.

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