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DISENTANGLING THE EFFECT OF SERVICES ON B2B FIRM VALUE: TRADE-OFFS OF SALES, PROFITS, AND EARNINGS VOLATILITY

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ABSTRACT

In the face of declining business and growing pressures from low-cost competitors, many business-to-business (B2B) manufacturers have moved from their previously successful product-centric strategies to more service-oriented business models. Yet despite their substantial investments in services, firms fail to understand the performance ramifications of these offerings. With a longitudinal data set (2001–2016) of 227 B2B manufacturers listed in the S&P 1500 index, this study disentangles the simultaneous effects of financial-based mechanisms that link the service ratio (i.e., share of a firm's revenue generated from selling services) to firm value. The findings reveal significant trade-offs across these mechanisms. Although the service ratio monotonously boosts sales growth, it has U-shaped curvilinear relationships with profitability and earnings volatility. These effects also depend on industry- and firm-level factors. Industry maturity positively moderates the effects of the service ratio on sales growth and profitability. However, business scope has an adverse effect on the service ratio–profitability relationship. Finally, industry turbulence negatively moderates the effect of services on earnings volatility.

Keywords: service ratio, Tobin's q, sales growth, profitability, earnings volatility, B2B services marketing

1. Introduction

In the past two decades, many business-to-business (B2B) manufacturers have evolved from pursuing a predominantly product-based revenue model, toward services. Thus for example, the diagnostic imaging and radiation therapy equipment manufacturer Varian Medical Systems generated approximately 33% of its total US$3.2 billion in revenues in 2016 from services, up from 13% in 2000. Yet venturing into the unfamiliar territories of services creates concerns too (Cisco Systems, 2015). For example, although accessing service-specific resources and capabilities results in a differential competitive advantage, establishing the necessary service-related competencies imposes substantial costs on firms (Fang, Palmatier, & Steenkamp, 2008). Similarly, while delivering tailored services enhances customers' willingness to pay a price premium, lower operational efficiency due to providing customized offerings may adversely influence a vendor's cost structure (Rust & Huang, 2014; Ulaga & Reinartz, 2011). In light of these conflicting considerations, managers need a better understanding of the links from B2B service offerings to their financial outcomes (Anderson, 2006; Lilien, 2016), but extant academic research, as detailed in Table 1, offers only an inconclusive picture.

For example, Fang et al. (2008) identify a U-shaped effect of the *service ratio*, defined as the share of revenue earned from selling services, on firm value, but they do not explore the underlying mechanisms whereby this effect occurs. In addition, services likely influence multiple dimensions of corporate financial performance differently, yet most prior studies focus on a single performance measure (e.g. Eggert, Thiesbrummel, & Deutscher, 2015; Homburg, Koschate, & Hoyer, 2005), "making synthesis across studies and cumulative knowledge development difficult, if not impossible" (Katsikeas, Morgan, Leonidou, & Hult, 2016, p. 1). Further, the magnitude and direction of these effects should be contingent on the stage of the

service strategy implementation, as reflected in a firm's service ratio, which suggests a potentially curvilinear service–performance relationship that has been widely disregarded in prior research (e.g., Josephson, Johnson, Mariadoss, & Cullen, 2016; Worm, Bharadwaj, Ulaga, & Reinartz, 2017).

Against this backdrop, we propose and empirically test a comprehensive framework that disaggregates the curvilinear effects of three parallel mechanisms (i.e., sales growth, profitability, and earnings volatility) that connect the service ratio to firm value and also includes contextual factors that moderate each mechanism. We thus address the trade-offs across simultaneous financial outcomes of moving into services in an integrated framework. To examine this proposed framework, we deploy a panel data set (2001–2016) of 227 B2B manufacturers listed in the S&P 1500 index and thereby contribute insights related to services in industrial markets in three ways.

First, this study is the first to disentangle the simultaneous effects of *sales growth*, *profitability*, and *earnings volatility* in linking the service ratio to firm value. Whereas the service ratio exerts a positive effect on sales growth, following a convex, monotonously increasing function, it has U-shaped, curvilinear relationships with profitability and earnings volatility. A direct implication for managers is that the effects of these mechanisms unfold across service ratio levels, with substantial trade-offs among them. At low levels of the service ratio, emphasizing services expands sales growth, but it reduces profitability and earnings volatility. At high levels, focusing on services instead increases all three mechanisms. Neglecting these trade-offs can lead to misguided managerial expectations about the performance effects of services.

Second, by isolating the factors that enhance or suppress each mechanism, this study provides insights into the critical boundary conditions for the effect of the service ratio on each

mechanism. In particular, industry- and firm-level factors have differential effects. *Industry maturity*, in the form of product commoditization and slowing market growth, positively moderates the effects of the service ratio on sales growth and profitability. Yet the *scope of business*, or the extent to which a firm's business is diversified across markets, hinders the relationship between services and profitability. Finally, *industry turbulence*, or the degree of demand uncertainty in a market, negatively moderates the effect of the service ratio on earnings volatility. Managers should consider these contextual conditions when expanding into services.

Third, by decomposing the indirect effect transmitted through each mechanism across service ratio levels, we offer more granular insights into the interplay between the *service transition*, proxied by changes in the service ratio, and changes in firm value. Accordingly, we identify three stages of service transition. The *exploration stage* (service ratio < 20%) is characterized by substantial investments in new resources and capabilities. In this stage, the negative indirect effect transmitted through profitability overshadows the effects of both other mechanisms. On average, a 10-percentage-point increase in the service ratio changes the Tobin's q, through sales growth, profitability, and earnings volatility, by .04 (1.5%), –.33 (–12%), and .12 (4.5%), respectively. In the *learning stage* (20% < service ratio < 45%), the firm's improved ability to manage its service business gradually offsets the adverse effects observed in the exploration stage. The corresponding effects of a 10-percentage-point increase in the service ratio at this stage are .12 (5%), –.17 (–7%), and .06 (2.5%), respectively. Finally, in the *payoff stage* (service ratio > 45%), both sales growth and profitability contribute positively to firm value. However, the indirect effect of earnings volatility unfavorably affects firm value. The corresponding effects of a 10-percentage-point increase in the service ratio in this stage are .3 (8%), .16 (4%), and –.07 (–2%), respectively.

—Insert Table 1 about here—

2. Services in industrial markets

Many B2B firms add services in response to declining business and increasing competition from offshore, low-cost product manufacturers (Palmatier, Stern, El-Ansary, & Anderson, 2016). The increasing emphasis on services has been fueled by firms' efforts to defend against the commoditization of tangible products (Macdonald, Kleinaltenkamp, & Wilson, 2016; Rai & Sambamurthy, 2006). This is because combining products with services requires accessing specific and unique competences, ranging from an expert sales force to service-related data processing capabilities (Ulaga & Reinartz, 2011). Firms with such capabilities are better positioned to differentiate their offerings and obtain an inimitable competitive advantage. Also, customers perceive customized services as relational processes, because they entail greater supplier–customer interactions, such that they increase customer intimacy and engender more trust in the vendor—a key driver of customer loyalty (Coulter & Coulter, 2003; Tuli, Kohli, & Bharadwaj 2007).

Yet providing services is far from a guaranteed solution. Services require a new set of competencies; developing the necessary service-specific resources and capabilities is associated with substantial upfront investments (Eggert, Hogreve, Ulaga, & Muenkhoff, 2014). It even may require the firm to divert some of the resources it normally devotes to its core manufacturing business, which could lead to a loss of strategic focus (Fang et al., 2008). Similarly, customization is crucial for successful service offerings, but it may result in lower operational efficiency (Rust & Huang, 2014). The idiosyncratic nature of customers' service requirements challenges the standardization of delivery processes, preventing firms from taking advantage of economies of scale (Rai & Sambamurthy, 2006).

In light of these conflicting considerations, "both researchers and practitioners need to better understand how service and marketing efforts affect financial statements and market valuation" (Anderson, 2006, p. 587). Thus far, extant literature has provided mixed findings, largely because these studies focus on single performance metrics or disregard the possibility of a curvilinear relationship between services and their financial outcomes. For example, prior research tends to conceptualize and measure the magnitude of returns to investments in services (e.g., Suarez, Cusumano, & Kahl, 2013), without examining the risk associated with these returns. Although Josephson et al. (2016) take a first step toward addressing this gap, they do not account for the potential curvilinear relationship between services and the associated risk. In addition, they find that the service ratio has positive and negative effects on idiosyncratic and systematic components of stock returns risk, respectively. Managers thus are left without a clear view of the net effect of services on firms' financial risks.

To provide more comprehensive insights into the performance effects of B2B services, we propose a conceptual model with which we capture the simultaneous effects of adding services on different financial outcomes, by decomposing the net effect of the service ratio on firm value into three parallel mechanisms: sales growth, profitability, and earnings volatility.[1] We thereby account for the curvilinear effects on each mechanism across the different levels of the service ratio. By considering the influences of firm- and industry-level factors, we also gain insights into the contextual conditions that moderate each relationship.

[1] To examine service risks, we use earnings volatility as the accounting variable most related to firm total risk (Ryan, 1997).

3. Conceptual model and hypotheses

In exploring the performance effects of services, we focus on the roles of sales growth, profitability, and earnings volatility in linking the service ratio to firm value (see Fig. 1). First, sales growth is a crucial indicator of financial health. Financial analysts use it as a valuation metric; firms with greater sales growth earn higher valuations (Brailsford & Yeoh, 2004). Second, businesses act in the interest of their profit-seeking stockholders, and thus, profit maximization is a primary business goal of many organizations. Third, earnings volatility, of which cash flow is a major component, adversely affects firm valuation (Rountree, Weston, & Allayannis, 2008; Shah, Kumar, Kim, & Choi, 2017). Shareholders perceive firms with more volatile earnings as riskier, because they are likely to suffer cash shortfalls that hinder investments in capital expenditures, R&D, or advertising (Minton & Schrand, 1999; Rountree, et al., 2008).

In addition, we examine contingency factors that may affect the relationships between the service ratio and financial-based mechanisms. In particular, we examine how *industry maturity* moderates the effects of the service ratio on sales growth and profitability. Previous research asserts that services become more important when industries mature and manufacturers can no longer achieve differentiation merely through their tangible products (Cusumano, Kahl, & Suarez, 2015; Teece, 1986). We also examine how a firm's *scope of business* moderates the service ratio–profitability relationship, because it appears to influence the firm's ability to deliver customized services efficiently (Nayyar, 1993). Finally, accessing detailed knowledge about customers' ever-changing demands and locking them in to long-term relationships should be more crucial in volatile markets (Fang, Palmatier, & Grewal, 2011; Nath & Mahajan, 2011), so we explore the potential moderating role of *industry turbulence*.

—Insert Fig. 1 about here—

In developing our hypotheses, we draw on the resource-based theory (Barney, 1991; Kozlenkova, Samaha, & Palmatier, 2014), according to which firms gain sustainable competitive advantages from leveraging their valuable, rare, inimitable, and organizationally exploitable assets. That is, with this theory, we investigate how services can influence the stock and exploitation of a firm's resources and capabilities and thereby affect its performance.

3.1. Effect of service ratio on sales growth

Services have several positive effects on sales growth. First, tailored combinations of products and services enable sustainable, value-based differentiation for a manufacturer's offering, by providing superior value to customers, in the form of productivity enhancements or cost reductions (Ulaga & Eggert 2006; Ulaga & Reinartz, 2011). Preventive maintenance services help customers avoid costly product breakdowns, for example. The sales force can leverage this differentiation to attract customers and gain market share. Because not all of the firm's competitors possess the specific resources required to provide service offerings (Ulaga & Reinartz, 2011), augmenting tangible products with services can increase the inimitability of the manufacturer's offerings, allowing it to establish value-based differentiation as a source of sustainable competitive advantage (see Barney, 1991).

Second, collaboration and joint problem solving during service delivery establish trust and commitment, which should facilitate relationship building (Cusumano et al., 2015). Relational assets are financially valuable, in that they encourage customers to repurchase, reduce their sourcing of products from competitors, cross-buy, or purchase add-ons (Palmatier, Scheer, Evans, & Arnold, 2008). Continuous interactions in intimate relationships also help manufacturers obtain granular insights into customers' idiosyncratic requirements. Firms can

leverage this knowledge to identify broader unmet customer needs and thereby grow their sales by developing novel offerings that satisfy these needs (Kastalli & Van Looy, 2013). In summary, the value-based differentiation and relationship building facilitated by services should enhance competitive advantages, drive market share, and thereby, increase sales growth.

H_1: The service ratio has a positive effect on sales growth.[2]

3.2. Effect of service ratio on profitability

We expect the service ratio to exert an initially negative effect on profitability, for two reasons. First, resources and capabilities in industrial markets traditionally are geared toward manufacturing (Eggert et al., 2014), so firms compete on the basis of operational efficiency or product excellence (Worm et al., 2017). But service providers require very different resources to succeed, such that firms must make substantial investments to become ready to sell services (Nijssen, Hillebrand, Vermeulen, & Kemp, 2006). Firms usually have limited financial resources though, so redirecting their investments toward services may also constrain their ability to invest in core, production-related assets or product excellence, with a concurrent loss of strategic focus (Fang et al., 2008).

Second, to increase their operational efficiency, manufacturers typically pursue product and process standardization. But offering services entails trade-offs between productivity and service quality (Rust & Huang, 2012; Rust & Chung, 2006), because services often demand intensive personnel resources and customization efforts, to suit customers' idiosyncratic needs (Anderson, Fornell, & Rust, 1997). In turn, standardization of service delivery processes is

[2] We caution the reader, however, that this effect could diminish as the service ratio converges to 1. This is because, for example, pure service providers may lack access to manufacturing-related assets, and thus, be at a competitive disadvantage relative to manufacturers that augment their products with services (Ulaga and Reinartz 2011). Yet our sample covers only a small number of such complete transitions, preventing us from observing whether the effect of services on sales growth diminishes as former manufacturing firms become pure service providers and stop selling products altogether.

difficult, such that process efficiency is limited by the lack of mass production and firms' inability to exploit scale economies (Rai & Sambamurthy, 2006; Rust & Huang, 2014).

These negative effects likely persist until firms make the necessary organizational changes and achieve the required competencies and capabilities. With greater service ratios, manufacturers learn to manage their operations efficiently and economize on the costs of providing services (Fang et al., 2008). In parallel, the service offerings' positive effects on profits increasingly prevail at higher service ratio levels. Delivering productivity gains or cost reductions through tailored services should boost customer satisfaction—a key antecedent of customer loyalty and willingness to pay a price premium (see Anderson, Fornell, & Lehmann, 1994). Manufacturers also can better leverage their accumulated stock of inimitable, service-related resources and capabilities to obtain a sustainable competitive advantage over rivals (see Peteraf, 1993; Wernerfelt, 1984). Thus, services enable firms to minimize the cost of customer retention while also avoiding price competition, both of which should enhance profit margins.

In summary, we predict a U-shaped, curvilinear effect of the service ratio on profitability. At low levels, the necessary but costly investments in services and decreased operational efficiency jointly reduce profitability. However, the customer satisfaction and competitive advantages obtained from delivering services outweigh these disadvantages at high levels of the service ratio, allowing firms to enhance their profitability.

> **H_2**: The service ratio has a U-shaped, curvilinear effect on profitability, such that it decreases at low levels of the service ratio but increases at high levels.

We caution the reader that, despite the positive slope of this U-shaped curve after it reaches its minimum, it remains an empirical question whether a firm's profitability at high levels of the service ratio exceeds its profitability observed at low levels.

3.3. Effect of service ratio on earnings volatility

Service offerings can help shield firms from fluctuations in their earnings. In particular, providing services typically requires increased customer-seller interaction levels (Fang et al., 2008). Relational assets built during relationship-intensive service delivery processes engender attitudinal customer loyalty, thereby stabilizing the firm's customer base (Coulter & Coulter, 2003; Mani, Barua, & Whinston, 2006).

Further, close collaboration and joint problem solving during service delivery lead to customer intimacy and more detailed knowledge of customer needs (Kastalli & Van Looy, 2013). With this knowledge, manufacturers are better positioned to deliver higher value through predicting and adapting to shifting customer preferences. Not only do services provide value-based differentiation, but their intangibility and inseparability (i.e., simultaneous production and consumption) also make these offerings more difficult and costly to evaluate. This combination of higher perceived value and the difficulty of trying other offerings magnifies customers' switching costs (Nayyar, 1992; Wuyts, Verhoef, & Prins, 2009).

Finally, service offerings (e.g., maintenance, repair) often lock customers in to long-term contracts (Choudhary & Vithayathil, 2013). Thus, service revenues can result in persistent, lasting earnings, even years after the product has been sold or discontinued (Potts, 1988). Similarly, contractual commitments prevent customers from switching to other suppliers, so firms can remove some of the market from the competitive arena (Bharadwaj, Varadarajan, & Fahy, 1993).

However, the negative effect of services on earnings volatility may diminish as the service ratio increases. This is because, for example, firms that rely heavily on services in their business models must move beyond basic offerings, to focus on delivering more specialized,

customized services (Ulaga & Reinartz, 2011). Yet the complexity and uncertainty inherent in these services may lessen the predictability and control of their costs (Worm et al. 2017), thereby increasing earnings volatility. For example, software firms moving from on-premise to software-as-a-service offerings face new risk dynamics associated with consistent availability, information security, and disaster recovery (PwC, 2014).

Together, enhanced customer loyalty, increased switching costs, and contractual commitments result in a more stable customer base that is less vulnerable to competitive and environmental shocks, with a steadier stream of earnings (Srivastava, Shervani, & Fahey, 1998). Yet the negative effect of services on earnings volatility diminishes as the service ratio increases.

H_3: The service ratio has a negative but diminishing effect on earnings volatility.

3.4. Moderating effect of industry maturity

An increase in industry maturity, or the extent to which products become commoditized and market growth slows (Suarez et al., 2013), makes services an even more powerful source of revenue growth and profit. In highly competitive, mature industry environments, the lack of technological differentiation among manufacturers leads to fierce price competition (Cusumano et al., 2015). Similarly, the increased substitutability of technology-based products due to standardization increases customers' bargaining power, with downward pressure on prices (Aaker & Day, 1986; Reimann, Schilke, & Thomas, 2010).

Under such circumstances, providing services offers the promise of even greater competitive advantages for manufacturers. First, the value-based differentiation that results from selling services makes a manufacturer's overall offering less susceptible to commoditization, helping the firm avoid the cutthroat price competition of mature markets (Fang et al., 2008). Even in the presence of other service providers, the specificity of relational assets built during

service provision makes the obtained value-based differentiation inimitable and increases customers' switching costs, which are typically low in mature markets. Also, due to their intangibility and inseparability, customers find evaluating services more difficult and costly. They thus economize on these costs "by favoring current service providers with whom they are satisfied" (Nayyar, 1992, p. 988).

Further, providing superior value to customers, in the form of productivity enhancements or cost reductions, encourages customers to repurchase, cross-buy, or purchase add-ons and enhances their willingness to pay a price premium (Kastalli & Van Looy, 2013). These additional sources of revenue growth and profit become more important when industries mature. This is because, in the face of slowing market growth and competitors that fiercely defend their turf, growth and profitability are more difficult, both to earn and to sustain (Sawhney, Balasubramanian, & Krishnan, 2003). In summary, the inimitable value-based differentiation as well as additional revenue sources generated from selling services are more important in mature markets where product commoditization leads to fierce price competition and low switching costs.

H_4: Industry maturity positively moderates the effect of the service ratio on sales growth.

H_5: Industry maturity positively moderates the effect of the service ratio on profitability.

3.5. Moderating effect of business scope

A firm's business scope reflects the extent to which it operates across various, independent industries (Lee, Sridhar, Henderson, & Palmatier, 2015). A broader business scope should negatively moderate the effect of the service ratio on profitability. First, implementing a successful, service-led growth strategy requires the substantial accumulation of new skills and competencies (Ulaga & Reinartz, 2011). Asset specificity constrains opportunities for redeploying these resources across business segments though, limiting scale economies (see

Penrose, 1959). "Rather than being fungible in nature, intangible resources often tend to be 'sticky' and difficult to transfer across markets…[, because] these resources involve a tacit component" (Kumar, 2009, p. 101). Thus, a firm with a broader business scope needs to invest more to develop a more diverse set of industry-specific, service-related resources and capabilities. Second, the heterogeneous technical challenges that firms face when they adopt more diversified businesses imply that they may have trouble exploiting the learning or modularity benefits, making it even more difficult to attain scale economies (Weigelt & Sarkar, 2009). Third, firms with more diversified businesses face the risk of spreading their managerial resources and attention too far (Morgan, Anderson, & Mittal, 2005), diminishing service-related benefits, such as obtaining detailed knowledge about customer needs.

H_6: Business scope negatively moderates the effect of the service ratio on profitability.

3.6. Moderating effect of industry turbulence

A turbulent industry features an unstable economic climate, changing customer needs, and ongoing technological changes (Fang et al., 2011). Accessing accurate, timely information about customers' preferences thus is crucial for determining the demand trajectory in volatile markets (Nath & Mahajan, 2011). Otherwise, firms face the risk of instability in their earnings. In such circumstances, detailed knowledge about customers' needs, obtained from intimate relations during service provision, becomes even more valuable (Fang et al., 2008).

In addition, from a customer perspective, technological uncertainty in turbulent markets induces higher levels of risk, associated with the compatibility of technological standards and the availability of upgrades (Worm et al., 2017). To cope with this uncertainty, customers favor suppliers that guarantee productivity enhancements and/or cost reductions through their service offerings (Cusumano et al., 2015). The greater economic incentives for customers to remain loyal and engage in future transactions thus lead to more repurchases and a steadier revenue

stream. Finally, contractual lock-in will be more valuable for securing stable earnings in turbulent markets in which product-based customers can easily defect.

> **H_7:** Industry turbulence negatively moderates the effect of the service ratio on earnings volatility.

3.7. Effects of sales growth, profitability, and earnings volatility on firm value

Prior finance and accounting research explores the relevance of sales growth, profitability, and earnings volatility as drivers of firm value. For example, Davis (2002) finds that revenue announcements are closely associated with market returns. Stagnant firms cannot attract new investors, because generating more sales over time is fundamental for long-term viability. Similarly, Varaiya, Kerin, and Weeks (1987) and Cho and Pucik (2005) find positive relationships between firm profitability and firm value. More profitable firms reward shareholders with larger returns on their investments, so they attract further funds from investors enticed by this promise. Firms also can use their profits as internal sources of financing to expand their businesses. Finally, corporate risk management theory suggests that stockholders assign a premium to firms that maintain smooth earnings, because volatility increases firms' dependence on costly external financing (Froot, Scharfstein, & Stein, 1993) and limits their ability to invest in capital expenditures (Minton & Schrand, 1999). Considering how well documented the effects of sales, profitability, and earnings volatility on firm value are in prior literature, we do not hypothesize any direct relationships. Rather, to examine their roles in linking the service ratio to firm value, we test for these effects.

4. Methodology

4.1. Sample and data sources

To test our hypotheses, we compiled a panel data set of B2B manufacturers listed in the S&P 1500 index, from 2001 to 2016. We assembled this longitudinal data set from multiple

archival sources. First, the Financial Accounting Standards Board (FASB) requires publicly held companies to disclose revenues from their operating activities (see FASB Statement No. 14 at www.fasb.org). Accordingly, in their 10-K annual reports, many B2B manufacturers break down their revenues into service and product sales. For example, in its 2016 annual report, Cisco Systems listed total revenue of US$49.24 billion, comprised of US$11.99 billion in service sales and US$37.25 billion in product sales.[3] We thus draw on information available in firms' annual reports to operationalize the service ratio measure (Josephson et al., 2016). Second, our financial data come from the merged Compustat–Center for Research in Security Prices (CRSP) database maintained by Wharton Research Data Services. Third, we obtain data on firms' business segments from the Compustat Business Segments database.

By merging these databases, we obtain a final sample of 1995 firm–year observations about 227 B2B manufacturers listed in the S&P 1500 index over a 16-year period (2001–2016; average panel length = 8.8 years). The sample covers a wide range of manufacturing industries, including chemicals and allied products (SIC 28), the primary metal industry (SIC 33), fabricated metal products (SIC 34), industrial and commercial machinery and computer equipment (SIC 35), electronic and other electrical equipment and components (SIC 36), transportation equipment (SIC 37), measuring, analyzing, and controlling instruments (SIC 38), and business services (SIC 73).

4.2. Operationalization

Table 2 summarizes the construct definitions and operationalizations. We use Tobin's q as a capital market–based measure of *firm value*. This forward-looking measure adjusts for expected market risk, captures long-term performance, and applies across industries (Germann,

[3] https://www.sec.gov/Archives/edgar/data/858877/000085887716000117/csco-2016730x10k.htm

Ebbes, & Grewal, 2015). We compute *sales growth* as the logged ratio of sales at time *t* to those at time *t – 1* (Tuli, Bharadwaj, & Kohli, 2010). We operationalize *profitability* as the operating margin (or return on sales), calculated as the operating income divided by sales. Unlike net margins, operating margins are not influenced by other financial factors (e.g., taxation) that do not correspond to firms' operating activities (Suarez et al., 2013). For *earnings volatility*, we use the coefficient of variation of the quarterly earnings from operations, or the standard deviation of the quarterly operating earnings over a given year, divided by its mean over the same time period (Minton & Schrand, 1999; Rountree et al., 2008). This volatility measure accounts for differences in firms' level of earnings.

For the *service ratio*, we manually collected data on firms' service and product revenues from their 10-K annual reports. We compute a firm's service ratio in a given year as its service revenue divided by its total revenue (Josephson et al., 2016; Suarez et al., 2013). For example, Cisco System's service ratio in 2016 is $\frac{\text{Cisco}'\text{s service revenue in 2016}}{\text{Cisco}'\text{s total revenue in 2016}} = \frac{\text{US\$11.99 billion}}{\text{US\$49.24 billion}} =$ 24.4%.

To measure *industry maturity*, we apply Suarez et al.'s (2013) approach, which captures the evolution of industry density (i.e., number of firms operating in an industry). As long as an industry is in the growth stage, its density increases while it continues to attract new entrants. However, the onset of maturity occurs in tandem with a shakeout in the remaining competitors, as firms start exiting the market (Agarwal, Sarkar, & Echambadi, 2002). We identify the onset of maturity as the peak of industry density. Denoting the density of industry *i* in year *t* by density_{it}, we compute industry maturity as $(-1/\text{density}_{it}) \times 100$ for the years before the onset of maturity and $(1/\text{density}_{it}) \times 100$ for the years after its onset. Thus, our measure is negative and increasing before the onset of maturity but positive and increasing thereafter. To operationalize a firm's

scope of business, we use an entropy measure of business diversification (Jacquemin & Berry, 1979; Palepu, 1985). For each firm in a given year, we first divide the revenue of each of its business segments by its total revenue. Then we multiply each ratio by the natural logarithm of its inverse. To compute the entropy measure, we sum these weighted ratios. The resulting entropy measure of diversification takes into account both the number of business segments in which a firm operates and the relative importance of each segment for the firm's total revenue. *Industry turbulence* reflects the coefficient of variation of the quarterly market volume (in sales revenues) over a given year (Fang et al., 2008).

To rule out rival explanations, we include several control variables in our models. To account for the effect of past performance on a firm's current performance, we include the lagged dependent variable as control in each model (Germann, Ebbes, & Grewal, 2015). We also control for *firm size*, operationalized as logged total assets, because it is associated with a firm's productivity, profitability, and survival (Beck, DemirgüçKunt, & Maksimovic, 2005). We further control for *R&D intensity*, or the ratio of R&D expenditures to total sales, because firms with higher emphasis on R&D earn higher future risk-adjusted returns (Josephson et al., 2016). Also, inflexibility of absorbed slack prevents firms from allocating their resources to new service-related investments (Josephson et al., 2016). Therefore, we control for *working capital* and *operating expenses*, both normalized by total sales (Singh, 1986). Moreover, because some firms may rely on mergers and acquisitions to grow their service businesses, we include *acquisition expenditure,* normalized by total assets, as an additional control variable.[4]

To account for industry factors, we control for *competitive intensity*, operationalized as 1 minus the Herfindahl index. This is because in the face of intense rivalry, a firm is more likely to

[4] We thank an anonymous reviewer for suggesting this additional control variable.

move into services as a new source of differentiation (Fang et al., 2008). Similarly, emphasis on intangible assets in an industry is a key determinant of firm performance (Tuli et al., 2010). We thus control for *industry intangible intensity*, computed as the industry average of log-transform of 1 minus the ratio of plant, property, and equipment to total assets. Finally, we include year dummies as controls to capture the effect of global shocks on firms' financial performance. In Table 3, we provide descriptive statistics and correlations for all the variables.

—Insert Tables 2 and 3 about here—

4.3. Model specification

We estimate the following equations to disentangle the mechanisms that link the service ratio to firm value:

(1) $SG_{it} = \alpha_{10} + \alpha_{11} SG_{i(t-1)} + \alpha_{12} SR_{it} + \alpha_{13} SR_{it}^2 + \alpha_{14} SR_{it} \times Ind\_MAT_{it} + \alpha_{15} SR_{it}^2 \times Ind\_MAT_{it} + \alpha_{16} Ind\_MAT_{it} + \alpha_{17} SCOPE_{it} + \alpha_{18} IND\_TURB_{it} + \boldsymbol{\alpha_{19}} \mathbf{Z_{it}} + \eta_{1i} + \varepsilon_{1it}$;

(2) $PROF_{it} = \alpha_{20} + \alpha_{21} PROF_{i(t-1)} + \alpha_{22} SR_{it} + \alpha_{23} SR_{it}^2 + \alpha_{24} SR_{it} \times Ind\_MAT_{it} + \alpha_{25} SR_{it}^2 \times Ind\_MAT_{it} + \alpha_{26} SR_{it} \times SCOPE_{it} + \alpha_{27} SR_{it}^2 \times SCOPE_{it} + \alpha_{28} Ind\_MAT_{it} + \alpha_{29} SCOPE_{it} + \alpha_{2,10} IND\_TURB_{it} + \boldsymbol{\alpha_{2,11}} \mathbf{Z_{it}} + \eta_{2i} + \varepsilon_{2it}$;

(3) $EV_{it} = \alpha_{30} + \alpha_{31} EV_{i(t-1)} + \alpha_{32} SR_{it} + \alpha_{33} SR_{it}^2 + \alpha_{34} SR_{it} \times IND\_TURB_{it} + \alpha_{35} SR_{it}^2 \times IND\_TURB_{it} + \alpha_{36} Ind\_MAT_{it} + \alpha_{37} SCOPE_{it} + \alpha_{38} IND\_TURB_{it} + \boldsymbol{\alpha_{39}} \mathbf{Z_{it}} + \eta_{3i} + \varepsilon_{3it}$; and

(4) $FV_{it} = \alpha_{40} + \alpha_{41} FV_{i(t-1)} + \alpha_{42} SR_{it} + \alpha_{43} SR_{it}^2 + \alpha_{44} SG_{it} + \alpha_{45} PROF_{it} + \alpha_{46} EV_{it} + \boldsymbol{\alpha_{47}} \mathbf{Z_{it}} + \eta_{4i} + \varepsilon_{4it}$,

where *SG* is sales growth; *PROF* denotes profitability; *EV* represents earnings volatility; *FV* is firm value; *SR* and SR^2 are the linear and squared terms of the service ratio, respectively; *Ind_MAT* represents industry maturity; *SCOPE* denotes business scope; and *IND_TURB* is

industry turbulence. The vector ***Z*** in each model represents the control variables.[5] Finally, η and ε in each model represent unobserved time-invariant and time-variant variables, respectively.

5. Estimation and results

As our estimation strategy, we use alternative econometric procedures. We perform fixed-effect (FE) and system generalized method of moments (GMM) regression models to estimate Equations 1 to 4.

5.1. Fixed-effects estimation

We use FE models to control for unobserved heterogeneity in Equations 1–4; the estimation results are in Table 4. The negative and insignificant linear term of the service ratio (β = –.318, *n.s.*) and its positive and significant quadratic term (β = .310, $p < .05$) in Model 1 indicate that the service ratio has a positive effect on sales growth, in line with H_1. Whereas the linear term of the service ratio in Model 2 is negative and significant (β = –.304, $p < .01$), its quadratic term is positive and significant (β = .292, $p < .01$), implying that the service ratio has a U-shaped, curvilinear effect on profitability, as predicted in H_2. Similarly, the negative and significant linear term of the service ratio (β = –2.691, $p < .05$) and its positive and significant quadratic term (β = 2.198, $p < .05$) in Model 3 reveal a U-shaped effect on earnings volatility, in partial support of H_3.

The positive and significant interaction of industry maturity with the linear term of the service ratio (β = .016, $p < .05$) in Model 4 suggests that industry maturity positively moderates the service ratio–sales growth relationship, in line with H_4. Similarly, we find a positive and significant interaction of industry maturity with the quadratic term of the service ratio (β = .008,

[5] An increase or decrease in earnings growth can make earnings stream more volatile. We thus control for earnings growth in the models with earnings volatility as the dependent variable (see Tuli et al., 2010).

$p < .05$) in Model 5, in support of our prediction in H_5 regarding the positive moderating role of industry maturity on the effect of the service ratio on profitability. The negative, significant interaction of business scope with the quadratic term of the service ratio ($\beta = -.056$, $p < .05$) in Model 5 further implies that an increase in a firm's business scope has an adverse effect on the service ratio–profitability linkage, consistent with H_6. In Model 6, the negative, significant interaction of industry turbulence with the quadratic term of the service ratio ($\beta = -20.742$, $p < .05$) indicates that industry turbulence negatively moderates the effect of the service ratio on earnings volatility, in line with H_7.

Finally, the results in Model 7 show that sales growth ($\beta = .252$, $p < .05$) and profitability ($\beta = 1.460$, $p < .05$) enhance firm value, yet earnings volatility reduces it ($\beta = -.018$, $p < .05$). The negative and significant linear term of the service ratio ($\beta = -1.781$, $p < .01$) and its positive and significant quadratic term ($\beta = 2.774$, $p < .01$) in Model 8 further imply that the service ratio has a U-shaped effect on firm value. After controlling for the financial-based mediators in Model 9, the effects of the linear ($\beta = -1.690$, *n.s.*) and quadratic ($\beta = 2.667$, *n.s.*) terms of the service ratio on firm value disappear, yet the effects of sales growth ($\beta = .240$, $p < .05$), profitability ($\beta = 1.357$, $p < .05$), and earnings volatility ($\beta = -.012$, $p < .05$) remain significant.

—Insert Table 4 about here—

5.2. System GMM estimation

The FE models are not equipped to deal with several challenges that may arise in our estimations. In our model specification, each equation's error term likely includes time-invariant unobserved variables η_i. These variables do not change over time, so they will correlate with the lagged dependent variable. Although FE models remove η_i by first-differencing each equation, the differenced lagged dependent variable in the transformed equation remains correlated with the first-differenced error (Arellano & Bond, 1991), and a failure to account for this source of

endogeneity could bias the estimates. Furthermore, the ε_i in each equation includes unobserved time-varying variables that may correlate with the service ratio. For example, a firm's organizational structure might change over time and influence the effectiveness of its service strategy (i.e., firms that offer services may gain more value if they adopt customer-centric organizational structures; Lee et al., 2015). Because the FE models do not remove ε_i, the linear and quadratic terms of the service ratio and their interactions with the moderators in each equation could be endogenously determined.

To address these issues, we employ Blundell and Bond's (1998) dynamic panel estimation, or system GMM, which relies on the panel nature of the data and uses lags and the lagged first differences of the endogenous variables, along with the exogenous variables, as instruments in the level and first-differenced models. With the assumption that errors are not serially correlated, Arellano and Bond (1991) suggest that lagged values are suitable instruments for differenced endogenous variables. In addition, Arellano and Bover (1995) argue that if errors are serially uncorrelated, it is possible to use first-differenced lagged variables as exogenous instruments in the levels equation. Blundell and Bond's (1998) system GMM estimator specifies a system of stacked regressions and exploits the new moment conditions for the data in levels, while retaining Arellano and Bond's (1991) original conditions for the transformed equation. Following Blundell and Bond (1998), we thus use the lags and lagged differences of the endogenous variables as instruments in our estimations—a widely adopted approach in the marketing literature (e.g., Feng, Morgan, & Rego, 2015; Germann et al., 2015; Rego, Morgan, & Fornell, 2013; Tuli et al., 2010). The suggested instruments must satisfy both the relevance condition (i.e., correlate with the endogenous variables) and the exclusion restriction (i.e., not correlate with the error terms).

We argue that embracing a service-centered business model is a strategic move aimed at creating a sustainable competitive advantage (Macdonald et al., 2016), which depends substantially on the firm's accumulation of new resources and capabilities (Ulaga & Reinartz, 2011). Thus, a firm's reliance on services as a source of revenue is a function of the service-related skills and competencies that it has developed thus far. That is, firms that exhibited a greater emphasis on services in the past are better positioned to access service-related resources and competencies and then generate more service revenues in the future. The service ratio reflects the emphasis on services in a firm's business model, so its value likely correlates with its lags and lagged first differences. Therefore, our instruments appear to meet the relevance condition.

To satisfy the exclusion condition, each equation's error term should not be serially correlated. Otherwise, the presence of persistent unobserved variables in the error terms will lead to correlation between the differenced error terms and the lags or lagged differences of the endogenous variables, violating the exclusion restriction (see Arellano & Bond 1991).

Therefore, we follow Pang, Tafti, and Krishnan (2015) and conduct several specification tests to assess the validity of our instruments. First, we perform Hansen's (1982) overidentification test, which examines the overall validity of the instruments by analyzing the sample analog of the moment conditions deployed in the estimation process (Bhargava & Mishra, 2014). Then, we perform Arellano and Bond's (1991) autocorrelation test, which examines whether the differenced error terms are serially correlated. Across all the equations, we cannot reject the null hypotheses for the Hansen (1982) and Arellano and Bond (1991) tests, which confirms the validity of our instruments.

Table 5 shows the system GMM estimation results for Equations 1–4. In Model 1, we find evidence of a positive effect of the service ratio on sales growth, in support of H_1. The linear term of the service ratio is insignificant ($\beta = -.367$, *n.s.*); its quadratic term is positive and significant ($\beta = .383$, $p < .05$). The resulting functional form is convex and strictly monotonically increasing (Fig. 2, Panel A). In Model 2, we find support for the U-shaped, curvilinear effect of the service ratio on profitability, as predicted in H_2. The linear term is negative and significant ($\beta = -.433$, $p < .05$), but its quadratic term is positive and significant ($\beta = .399$, $p < .05$). The curve reaches its minimum at a service ratio of 54% (Fig. 2, Panel B). In Model 3, the significant negative linear term ($\beta = -3.326$, $p < .05$) and its positive and significant quadratic term ($\beta = 3.312$, $p < .05$) imply that the service ratio has a U-shaped, curvilinear effect on earnings volatility: decreasing at low levels of the service ratio, then increasing for the service ratios greater than 50% (Fig. 2, Panel C). Thus, we find partial support for H_3.

—Insert Fig. 2 about here—

To test H_4–H_7, we ran Models 4–6. The interaction of industry maturity with the linear term of the service ratio in Model 4 is positive and significant ($\beta = .044$, $p < .05$); it positively moderates the effect of the service ratio on sales growth (Fig. 3, Panel A), in support of H_4. The interaction of industry maturity with the linear term of the service ratio in Model 5 is positive and significant ($\beta = .028$, $p < .05$), in support of H_5. Therefore, industry maturity positively moderates the service ratio–profitability relationship (Fig. 3, Panel B). The negative, significant interaction of business scope with the quadratic term of the service ratio ($\beta = -.190$, $p < .05$) in Model 5 confirms its role in negatively moderating the effect of the service ratio on profitability, in support of H_6 (Fig. 3, Panel C). Finally, we find a negative, significant interaction of industry turbulence with the quadratic term of the service ratio ($\beta = -8.021$, $p < .05$) in Model 6,

indicating that industry turbulence negatively affects the relationship between the service ratio and earnings volatility, as we predicted in H_7 (Fig. 3, Panel D).

—Insert Fig. 3 about here—

With Model 7, we examine the effects of the mediators on firm value. Although sales growth (β = .813, $p < .01$) and profitability (β = 1.299, $p < .01$) enhance firm value, earnings volatility has an adverse effect on it (β = –.201, $p < .01$). In Model 8, we replicate Fang et al.'s (2008) finding of a U-shaped, curvilinear effect of the service ratio on firm value. The significant, negative linear term (β = –2.796, $p < .05$) and the significant, positive quadratic term (β = 3.950, $p < .01$) show that the service ratio initially reduces firm value, but then beyond a value of 35%, the effect of the service ratio becomes increasingly positive.

After controlling for the mediating mechanisms in Model 9, the linear (β = –.207, *n.s.*) and quadratic (β = .523, *n.s.*) terms of the service ratio are insignificant. Yet the effects of sales growth (β = .739, $p < .05$), profitability (β = 1.424, $p < .01$), and earnings volatility (β = –.198, $p < .01$) remain significant. Sobel tests (Sobel, 1982) confirm the role that each mechanism has in mediating the relationship between the service ratio and firm value. Taken together, our findings suggest that these three mechanisms fully mediate the effect of the service ratio on firm value.

—Insert Table 5 about here—

5.3. Robustness and sensitivity analyses

To model the curvilinear effects, we included the squared term of the service ratio in our regression models. However, a significant quadratic term does not always signal a U- or inverted U-shaped relationship (Albers, 2012; Lind & Mehlum, 2010).[6] To ensure that the observed U-shaped effects of the service ratio on profitability and earnings volatility are not artifacts of our

[6] We thank two anonymous reviewers for highlighting this insightful point.

model specification, we use the "two-line test" proposed by Simonsohn (2016) and estimate two separate regression models for low and high levels of the service ratio when examining each U-shaped effect. The results appear in Table 6. As Models 1 and 2 show, the effect of the service ratio on profitability is negative and significant ($\beta = -.131$, $p < .05$) at low levels of the service ratio, but it becomes positive and significant ($\beta = .119$, $p < .05$) at high levels. Similarly, the results in Models 3 and 4 indicate that the service ratio has negative, significant ($\beta = -4.932$, $p < .05$) and positive, significant ($\beta = 3.065$, $p < .05$) effects on earnings volatility at low and high levels of the service ratio, respectively. These findings provide strong evidence of the observed U-shaped effects of the service ratio on profitability and earnings volatility.

—Insert Table 6 about here—

6. Discussion

In the face of increased product commoditization and shrinking profit margins, many B2B manufacturers have undergone remarkable shifts toward services, as a new source of growth. A survey of more than 300 executives reveals that 70% of manufacturing firms use services to differentiate their offerings, and more than half (56%) intend to establish services as a profit center (Oxford Economics, 2013). Yet many companies still fail to understand the performance ramifications of combining tangible products with services (Cisco Systems, 2015). This study provides a comprehensive framework that disaggregates the parallel, curvilinear roles of sales growth, profitability, and earnings volatility in linking the service ratio to firm value. We thus offer clear theoretical and managerial insights by illuminating the process of value creation through delivering services.

Our findings show that the service ratio has a convex, monotonously increasing effect on sales growth. The value-based differentiation and relationship building that result from providing

services help firms boost their sales. This is of direct importance to B2B manufacturers. Managers may have serious concerns about substituting products with services; services prolong existing products' lifetime, thereby postponing product replacement and hurting sales (Kastalli & Van Looy, 2013). However, our results reveal a positive relationship between services and sales growth. It is interesting to note that the effect of services on sales strengthens when industries mature and firms find product differentiation challenging. Under such circumstances, services function as a means of differentiation that can mitigate the adverse effects of product commoditization.

Further, the service ratio has a U-shaped, curvilinear relationship with profitability. Moving into services initially imposes substantial costs on firms, which manufacturers regard as a "necessary evil" (Suarez et al., 2013, p. 427). Thus, before they can reap the lucrative payoffs of offering services, firms may become frustrated and forgo service investments prematurely. Importantly, even beyond the threshold where the effect of services on profitability becomes increasingly positive, firms may have trouble accelerating profitability growth and exceeding the levels of profitability observed in the early transition stages. Managers thus need to consider the contextual factors that help them accelerate profitability growth. For example, the value-based differentiation obtained from providing services boosts profitability in the later transition stages more significantly when industries mature and products become highly commoditized.

Finally, the magnitude and risk of investment returns are equally important dimensions of firm performance (Andersen, Denrell, & Bettis, 2007; Ferreira & Laux, 2007). Managers thus need a better understanding of the effect of services on firms' financial risks, to ensure that the returns from services offer adequate compensation for the inherent level of risk. Our findings indicate that the service ratio exerts a U-shaped, curvilinear effect on earnings volatility. At low

service ratio levels, enhanced customer loyalty, increased switching costs, and contractual commitments obtained from delivering services help firms stabilize their customer bases, and therefore, reduce their earnings volatility. But beyond some threshold, further emphasis on services harms the stability of earnings streams. Interestingly, our moderation analyses reveal that industry turbulence negatively impacts the service ratio–earnings volatility linkage and increases this threshold.

In summary, managers should notice that services affect multiple dimensions of corporate financial performance differently, while the effects are contingent on a firm's service ratio level. Ignoring the substantial trade-offs of sales growth, profitability, and earnings volatility can lead to misguided managerial expectations about the performance outcomes of services.

6.1. Decomposing the indirect effect of the service ratio on firm value across transition stages

In our model specification, we link a firm's service ratio level to its financial performance level. Yet managers need actionable insights into how *service transition*, as reflected in changes to the service ratio, translates into changes in firm value, through sales growth, profitability, and earnings volatility. Therefore, in a series of supplementary analyses, we use the estimation results obtained from the levels equations to simulate the indirect effect of service transition on changes in firm value through each financial-based mediating mechanism (see Hayes & Preacher, 2010). In the curvilinear service ratio-performance relationship, the size and direction of each indirect effect depend on both the level of and change in the service ratio. Accordingly, compared to a linear difference-in-difference estimation that disregards the effect's contingency on the service ratio level, Hayes and Preacher's (2010) approach is more suitable for investigating the effects of service transition.

Fig. 4 shows the frequency distribution of percentage-point changes in the service ratios of the firms in our sample over their observation period. For the sake of comparison, we calculate the indirect effect transmitted through each mechanism, based on a 10-percentage-point increase in the service ratio at each of its levels. Fig. 5 depicts the results. For a given service ratio, the corresponding values on the vertical axis reflect the average change in firm value through the mediating mechanisms, were the service ratio to increase by 10-percentage-points. For example, at a service ratio of 20%, the indirect effect of service transition transmitted through sales growth, profitability, and earnings volatility, respectively, would change the Tobin's q by .08 (3%), –.25 (–10%), and .09 (3.5%) if the service ratio were to increase by 10-percentage-points. According to the trade-offs of sales growth, profitability, and earnings volatility, along with their relative roles in driving the impact of service transition on firm value, we identify three service transition stages.

—Insert Fig. 4 and Fig. 5 about here—

The ***exploration stage*** (service ratio < 20%) is characterized by substantial upfront investments in service-specific competencies and necessary organizational transformations. In this stage, a 10-percentage-point increase in the service ratio, on average, changes Tobin's q through sales growth, profitability, and earnings volatility by .04 (1.5%), –.33 (–12%), and .12 (4.5%), respectively. The loss of profitability is thus the primary mediating mechanism that links service transition to firm value; its negative effect overwhelms the other mechanisms. Managers thus need to assess the potential consequences of service transition well in advance, and prepare their firms to overcome the investment hurdles they may face. For example, maintaining a narrow business scope allows manufacturers to reduce the initial costs of industry-specific,

service-related investments, exploit learning or modularity benefits, and thereby, mitigate the adverse effect transmitted through profitability.

In the ***learning stage*** (20% < service ratio < 45%), a 10-percentage-point increase in the service ratio changes Tobin's q through sales growth, profitability, and earnings volatility by .12 (5%), –.17 (–7%), and .06 (2.5%), respectively. Thus, before they can expect positive effects on firm value, firms must build a critical mass in service sales (Fang et al., 2008). Capitalizing on the service-specific assets helps firms expand their customer base and encourage customers to repurchase, cross-buy, or buy add-ons. This in turn magnifies the positive indirect effect of sales growth. It also helps firms spread the upfront costs of service-related investments over more transactions, enabling them to improve their operational efficiency, realize scale economies, and thus, mitigate the initial adverse effect of profitability.

Finally, in the ***payoff stage*** (service ratio > 45%), a 10-percentage-point increase in the service ratio changes Tobin's q through, respectively, sales growth and profitability by .3 (8%) and .16 (4%). However, the corresponding indirect effect through earnings volatility reduces Tobin's q by –.07 (–2%). In this stage, firms rely heavily on services to create a sustainable competitive advantage and differentiate their offerings, and services account for a large portion of their overall sales. Manufacturers thus must move beyond basic offerings like maintenance and support that customers consider as a "must have", and focus on delivering more specialized, tailored offerings (Ulaga and Reinartz, 2011, p.15). Yet to maintain the stability of their earnings streams, firms must develop execution risk assessment and mitigation capabilities that can support the provision of such complex services with less predictable cost streams (Ulaga & Reinartz, 2011).

6.2. Limitations and research directions

Some limitations of this study provide opportunities for research. First, our estimation approach relies on lags of endogenous variables to address endogeneity, which limits our sample to observations for which we have adequate (i.e., at least two) lags. Then again, it enables us to estimate our parameters efficiently by employing the information contained in the moment conditions. Second, data constraints prevented us from examining some theoretical mechanisms (e.g., customer satisfaction) that might link service transition strategies to financial outcomes. Although our findings are consistent with the predictions of the theoretical arguments, further research might collect data through self-reported, perceptual measures, though obtaining such data for a large sample of B2B firms, covering multiple industries and multiple years, would be extremely challenging. Third, we focus on the financial outcomes of service strategies; the tactics that firms should use to address the challenges of implementing these strategies remain largely unexplored. For example, managers need a better understanding of which organizational structure is most suitable for supporting their service transition strategies and facilitating collaboration. Similarly, services are relationship intensive, so research should identify ways to mitigate the potentially negative effects of cultural differences in service expansions to international markets. Research that sheds light on these topics would be valuable.

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Table 1
Illustrative research into effects of B2B services on performance

Reference	Context	Focal Construct	Firm Performance Metrics (Direction of the Effect)				Account for	
			Sales	Profitability	Risk	Firm Value	Curvilinear Relationship(s)	Endogeneity
Antioco et al. (2008)	Survey of 137 manufacturing firms	Service business orientation	Product sales (+)	N/A	N/A	N/A	No	No
Eggert et al. (2014)	Survey of 513 German mechanical engineering companies	Number of services supporting the products vs. services supporting the clients' actions	Revenue (+)	Profitability (-, but diminishing)	N/A	N/A	Yes	No
Fang et al. (2008)	477 U.S.-based, publicly traded manufacturing firms	Service ratio (percentage of firm's total revenues that correspond to services)	N/A	N/A	N/A	Tobin's q (U-shaped)	Yes	No
Homburg et al. (2003)	Survey of 271 senior sales manager in industrial sectors	Breadth of service portfolio	N/A	Return on sales (+)	N/A	N/A	No	No
Josephson et al. (2016)	168 publicly traded manufacturing firms	Service ratio (the ratio of service revenue to total revenue)	N/A	N/A	Idiosyncratic risk (+) Systematic risk (-)	N/A	No	No
Suarez et al. (2013)	399 manufacturing firms operating in prepackaged software products industry	Service ratio (percentage of revenue that comes from selling services)	N/A	Return on sales (U-shaped)	N/A	N/A	Yes	Yes
Worm et al. (2017)	Survey of 175 solution providers	Solutions offering (continuous and dummy coding)	N/A	Return on sales growth (+)	N/A	N/A	No	Yes
Current study	**227 B2B manufacturers listed in the S&P 1500 between 2001-2016**	**Service ratio (share of a firm's revenue generated from selling services)**	**Sales growth**	**Operating margin (Return on sales)**	**Earnings volatility**	**Tobin's q**	**Yes**	**Yes**

Table 2
Constructs, definitions, and operationalizations

Construct	Definition	Operationalization (Reference)
Firm value	Market value of a firm, compared to replacement value of its assets	Tobin's q (Germann et al., 2015)
Sales growth	Rate of growth of firm's sales over a given period	Log transformation of ratio of sales at time t to sales at time t - 1 (Tuli et al., 2010)
Profitability	The degree to which a firm is profitable	Operating margin (Suarez et al., 2013)
Earnings volatility	The extent to which earnings fluctuate	Coefficient of variation of quarterly earnings (Minton & Schrand, 1999)
Service ratio	Share of a firm's sales revenue generated by services versus products	Firm's service revenue divided by its total sales (Josephson et al., 2016)
Industry maturity	A stage of industry life cycle characterized by product commoditization and slowing sales growth	Inverse of industry density multiplied by either -100 (for the years prior to onset of maturity) or 100 (for the years after onset of maturity) (Suarez et al., 2013)
Business scope	The extent to which a firm's business is diversified	The entropy measure of diversification (Jacquemin & Berry, 1979; Palepu, 1985)
Industry turbulence	Volatility of demand in a market	Coefficient of variation of quarterly market volume (Fang et al., 2008)
Firm size	Size of a firm	Log transformation of firm's total assets (Lee et al., 2015)
R&D intensity	Firm's emphasis on R&D	Ratio of R&D expenditure to total sales (Rountree et al., 2008)
Working capital	The capital available for daily operations	Ratio of working capital to total sales (Singh, 1986)
Operating expenses	Daily expenses not directly associated with the production of goods or services	Ratio of operating expenses to total sales
Acquisition expenditure	Firm's emphasis on acquisition activities	Acquisition expenditure normalized by total assets (Bates et al., 2009)
Competitive intensity	Level of rivalry among competitors	1 minus sum of squared market shares of firms operating in market (Fang et al., 2008)
Industry intangible intensity	The degree to which firms in an industry emphasize on intangible assets	Industry average of log transformation of 1 minus the ratio of plant, property, and equipment to total assets (Tuli et al., 2010)

Table 3

Descriptive statistics and correlations

Constructs	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.
1. Firm value	1.000														
2. Sales growth	.262	1.000													
3. Profitability	.267	.310	1.000												
4. Earnings volatility	.007	.059	.069	1.000											
5. Service ratio	.152	.063	.097	.029	1.000										
6. Industry maturity	-.140	-.051	-.002	.004	-.076	1.000									
7. Business scope	-.221	-.061	.100	.010	-.122	.213	1.000								
8. Industry turbulence	-.057	-.059	-.113	.034	-.146	.285	.008	1.000							
9. Firm size	-.181	-.023	.298	.012	-.117	.161	.482	-.049	1.000						
10. R&D intensity	-.034	-.083	-.622	-.036	-.092	-.163	-.296	-.004	-.249	1.000					
11. Working capital	-.043	-.074	-.335	-.028	-.304	-.046	-.177	.074	-.164	.347	1.000				
12. Operating expenses	-.261	-.305	-.969	-.060	-.136	.017	-.103	.127	-.334	.569	.337	1.000			
13. Acquisition expenditure	-.039	.171	.079	.004	.057	-.031	.054	-.058	.045	-.012	-.113	-.111	1.000		
14. Competitive intensity	.194	.084	.009	.012	.229	-.543	-.292	-.284	-.251	.278	.025	-.041	.044	1.000	
15. Industry intangible intensity	.201	.111	.123	.041	.347	-.356	-.207	-.245	-.084	.199	-.162	-.149	.046	-.019	1.000
Mean	2.058	.069	.075	.331	.368	1.082	.585	.068	6.913	.143	.194	.866	.034	.870	-.125
SD	1.486	.228	.199	2.221	.276	4.135	.642	.051	1.653	.124	.398	.180	.068	.131	.066

Note: $p < .050$ if $|r| > .050$

Table 4

Effect of the service ratio on firm value through sales growth, profitability, and earnings volatility (FE models)

Model	**1**	**2**	**3**	**4**	**5**
Dependent variable	**Sales Growth**	**Profitability**	**Earnings Volatility**	**Sales Growth**	**Profitability**
	Estimate (SE)	**Estimate (SE)**	**Estimate (SE)**	**Estimate (SE)**	**Estimate (SE)**
Intercept	.560 ** (0.173)	.510 ** (0.109)	.635 (1.257)	.560 ** (.170)	1.192 ** (.023)
Main effects					
Service ratio	-.318 (0.201)	-.304 ** (0.111)	-2.691 * (1.237)	-.325 (.203)	-.058 * (.031)
Squared service ratio	.310 * (0.182)	.292 ** (0.114)	2.198 * (1.183)	.314 * (.187)	.058 * (.032)
Sales growth					
Profitability					
Earnings volatility					
Moderating effects					
Industry maturity × Service ratio				.016 * (.007)	-.005 (.004)
Industry maturity × Squared service ratio				-.100 (.007)	.008 * (.004)
Business scope × Service ratio					.051 (.032)
Business scope × Squared service ratio					-.056 * (.034)
Industry turbulence × Service ratio					
Industry turbulence × Squared service ratio					
Control variables					
Lag of dependent variable	-.052 (0.050)	.078 * (0.037)	.332 ** (.050)	-.052 (.050)	.014 ** (.004)
Industry maturity	-.001 (0.002)	.002 (0.002)	-.004 (.019)	-.001 (.001)	.001 (.001)
Business scope	.019 (0.018)	.001 (0.009)	.132 (.190)	.019 (.018)	-.002 (.005)
Industry turbulence	.016 (0.113)	-.033 (0.069)	.211 (1.474)	.007 (.115)	.037 (.024)
Firm size	-.019 (0.022)	-.009 (0.013)	.178 (.134)	-.019 (.022)	-.025 ** (.002)
R&D intensity	-.017 (0.183)	-1.273 ** (0.145)	.359 (1.435)	-.021 (.182)	-.087 ** (.018)
Working capital	.029 (0.056)	-.026 (0.034)	.085 (.204)	.029 (.056)	.024 ** (.002)
Operating expenses	-.419 * (0.207)	-.086 ** (0.034)	.305 (.703)	-.418 * (.207)	-1.036 ** (.010)
Acquisition expenditure	.422 ** (0.071)	.055 (0.337)	1.816 ** (.713)	.420 ** (.071)	.005 (.013)
Competitive intensity	.063 (0.039)	.017 (0.019)	.527 * (.296)	.065 * (.038)	.009 (.006)
Industry intangible intensity	-.085 (0.276)	.305 (0.203)	1.925 (1.707)	-.090 (.277)	.114 (.051)
Earnings growth	–	–	-.506 ** (.129)	–	–
Year dummies	Included	Included	Included	Included	Included
R^2	.162	.830	.119	.153	.893
Number of observations	1995	1995	1995	1995	1995

* Significant at 5% level (one-sided).

** Significant at 1% level (one-sided).

Table 4 (cont.)

Model	**6**	**7**	**8**	**9**
Dependent variable	**Earnings Volatility**	**Firm Value**	**Firm Value**	**Firm Value**
	Estimate (SE)	**Estimate (SE)**	**Estimate (SE)**	**Estimate (SE)**
Intercept	1.177 (1.304)	4.156 ** (1.215)	5.864 ** (.555)	4.274 ** (1.226)
Main effects				
Service ratio	-3.828 ** (1.314)		-1.781 ** (.641)	-1.690 (1.620)
Squared service ratio	3.731 ** (1.403)		2.774 ** (.650)	2.667 (1.648)
Sales growth		.252 * (.127)		.240 * (.125)
Profitability		1.460 * (.671)		1.357 * (.654)
Earnings volatility		-.018 * (.008)		-.012 * (.007)
Moderating effects				
Industry maturity × Service ratio				
Industry maturity × Squared service ratio				
Business scope × Service ratio				
Business scope × Squared service ratio				
Industry turbulence × Service ratio	15.915 (9.773)			
Industry turbulence × Squared service ratio	-20.742 * (12.195)			
Control variables				
Lag of dependent variable	.331 ** (.049)	.367 ** (.055)	.361 ** (.017)	.357 ** (.051)
Industry maturity	-.015 (.017)	-.016 (.018)	-.015 (.020)	-.015 (.017)
Business scope	.126 (.182)	-.107 (.085)	-.078 (.071)	-.088 (.075)
Industry turbulence	-2.319 (2.124)	-.107 (.488)	-.125 (.601)	-.255 (.485)
Firm size	.175 (.136)	-.357 ** (.081)	-.405 ** (.048)	-.374 ** (.084)
R&D intensity	.467 (1.436)	1.194 (.821)	1.033 ** (.409)	1.167 (.796)
Working capital	.079 (.203)	.208 * (.115)	.228 ** (.072)	.187 (.117)
Operating expenses	.210 (.708)	-.043 (.812)	-1.542 ** (.242)	-.096 (.795)
Acquisition expenditure	1.887 ** (.711)	-.824 ** (.290)	-.725 * (.325)	-.832 * (.295)
Competitive intensity	.596 * (.295)	.109 (.144)	.023 (.141)	.002 (.140)
Industry intangible intensity	2.884 * (1.734)	-.994 (1.371)	-1.192 (1.252)	-1.382 (1.418)
Earnings growth	-.504 ** (.127)	–	–	–
Year dummies	Included	Included	Included	Included
R^2	.112	.467	.427	.446
Number of observations	1995	1995	1995	1995

* Significant at 5% level (one-sided).

** Significant at 1% level (one-sided).

Table 5

Effect of the service ratio on firm value through sales growth, profitability, and earnings volatility (system GMM)

Model	**1**		**2**		**3**		**4**		**5**	
Dependent variable	**Sales Growth**		**Profitability**		**Earnings Volatility**		**Sales Growth**		**Profitability**	
	Estimate	**(SE)**	**Estimate**	**(SE)**	**Estimate**	**(SE)**	**Estimate**	**(SE)**	**Estimate**	**(SE)**
Intercept	.256	(.186)	.119	(.246)	1.461	(2.336)	.108	(.163)	.505 **	(.123)
Main effects										
Service ratio	-.367	(.244)	-.433 *	(.226)	-3.326 *	(1.752)	-.211	(.158)	-.552 *	(.327)
Squared service ratio	.383 *	(.225)	.399 *	(.223)	3.312 *	(1.701)	.272 *	(.159)	.597 *	(.306)
Sales growth										
Profitability										
Earnings volatility										
Moderating effects										
Industry maturity × Service ratio							.044 *	(.024)	.028 *	(.015)
Industry maturity × Squared service ratio							-.046	(.030)	-.033	(.022)
Business scope × Service ratio									.181	(.130)
Business scope × Squared service ratio									-.190 *	(.091)
Industry turbulence × Service ratio										
Industry turbulence × Squared service ratio										
Control variables										
Lag of dependent variable	.081	(.057)	.108 **	(.041)	.374 **	(.083)	.077	(.072)	.006	(.026)
Industry maturity	-.075 **	(.028)	.001	(.007)	.022	(.028)	-.014 *	(.007)	-.010 *	(.004)
Business scope	.074 *	(.040)	-.005	(.045)	-.220	(.378)	.015 *	(.008)	-.146 *	(.071)
Industry turbulence	.937 **	(.401)	.381	(.733)	4.699 *	(2.442)	.134	(.148)	.183 *	(.100)
Firm size	-.013	(.018)	.008	(.021)	-.084	(.150)	-.005	(.014)	.026 *	(.015)
R&D intensity	.358	(.276)	-.917 **	(.335)	-.980	(2.386)	-.167	(.314)	-1.456 **	(.206)
Working capital	-.022	(.054)	-.275 **	(.059)	.120	(.523)	-.009	(.053)	-.073	(.084)
Operating expenses	-.257 *	(.143)	.072	(.152)	-.620	(1.445)	-.094 *	(.049)	-.138 **	(.056)
Acquisition expenditure	.741	(.396)	.356	(.282)	1.040	(1.978)	.315	(.211)	.221	(.154)
Competitive intensity	-.002	(.026)	.016	(.024)	.874	(1.237)	-.005	(.007)	.052 **	(.016)
Industry intangible intensity	.281	(.454)	.322	(.425)	-.858	(2.845)	.282	(.199)	.561 **	(.145)
Earnings growth	–		–		-.342 *	(.202)	–		–	
Year dummies	Included		Included		Included		Included		Included	
Arellano-Bond test: p -value	.116		.109		.337		.137		.208	
Difference-in-Hansen test: p -value	.321		.319		.207		.785		.976	
Number of observations	1995		1995		1995		1995		1995	

* Significant at 5% level (one-sided).

** Significant at 1% level (one-sided).

Table 5 (cont.)

Model	**6**		**7**		**8**		**9**	
Dependent variable	**Earnings Volatility**		**Firm Value**		**Firm Value**		**Firm Value**	
	Estimate	**(SE)**	**Estimate**	**(SE)**	**Estimate**	**(SE)**	**Estimate**	**(SE)**
Intercept	2.093	(1.332)	.303	(.589)	3.335 **	(1.219)	.174	(.661)
Main effects								
Service ratio	-2.851 *	(1.522)			-2.796 *	(1.454)	-.207	(1.260)
Squared service ratio	3.245 *	(1.579)			3.950 **	(1.482)	.523	(1.256)
Sales growth			.813 **	(.296)			.739 *	(.324)
Profitability			1.299 **	(.493)			1.424 **	(.508)
Earnings volatility			-.201 **	(.033)			-.198 **	(.032)
Moderating effects								
Industry maturity × Service ratio								
Industry maturity × Squared service ratio								
Business scope × Service ratio								
Business scope × Squared service ratio								
Industry turbulence × Service ratio	5.337	(3.540)						
Industry turbulence × Squared service ratio	-8.021 *	(4.035)						
Control variables								
Lag of dependent variable	.393 **	(.081)	.636 **	(.062)	.683 **	(.087)	.634 **	(.059)
Industry maturity	.005	(.029)	-.026	(.024)	.005	(.037)	-.031	(.029)
Business scope	-.111	(.289)	.192	(.212)	.347	(.277)	.216	(.215)
Industry turbulence	-3.872	(2.996)	-.408	(1.839)	-.994	(2.987)	-.161	(1.950)
Firm size	.022	(.096)	-.079	(.070)	-.160	(.118)	-.087	(.068)
R&D intensity	-.036	(1.415)	1.547 *	(.889)	-2.482	(1.872)	1.649 *	(.891)
Working capital	-.111	(.400)	.101	(.147)	-.704	(.723)	.127	(.145)
Operating expenses	.068	(1.059)	.428	(.322)	-.011	(.557)	.381	(.312)
Acquisition expenditure	-.329	(2.103)	-1.614	(1.288)	-2.459 **	(.688)	-1.681	(1.217)
Competitive intensity	-.088	(.096)	.145 **	(.056)	-.249	(.156)	0.096	(.060)
Industry intangible intensity	1.736	(3.213)	1.605	(1.168)	7.717 *	(3.649)	.731	(1.356)
Earnings growth	-.428 **	(.183)	–		–		–	
Year dummies	Included		Included		Included		Included	
Arellano-Bond test: p -value	.367		.874		.448		.837	
Difference-in-Hansen test: p -value	.992		1.000		.107		1.000	
Number of observations	1995		1995		1995		1995	

* Significant at 5% level (one-sided).
** Significant at 1% level (one-sided).

Table 6

Sensitivity analyses: testing the functional forms

Model	**1**	**2**	**3**	**4**
Dependent variable	**Profitability (service ratio < .54)**	**Profitability (service ratio > = .54)**	**Earnings Volatility (service ratio < .50)**	**Earnings Volatility (service ratio > = .50)**
	Estimate (SE)	**Estimate (SE)**	**Estimate (SE)**	**Estimate (SE)**
Intercept	-.105 (.308)	-.029 (.990)	-.962 (6.186)	-37.840 * (17.861)
Main effect				
Service ratio	-.131 * (.078)	.119 * (.070)	-4.932 * (2.207)	3.065 * (1.814)
Control variables				
Lag of dependent variable	.248 ** (.034)	.506 ** (.097)	.114 (.125)	.847 ** (.172)
Industry maturity	.002 (.004)	.006 (.010)	.044 (.141)	.670 * (.361)
Business scope	-.036 (.025)	.047 (.038)	.214 (.861)	.258 (.444)
Industry turbulence	-.367 * (.211)	-2.091 (1.705)	4.896 * (2.701)	2.427 (4.319)
Firm size	.015 (.016)	-.015 (.014)	.083 (.367)	.317 (.201)
R&D intensity	-.828 ** (.284)	.164 (.481)	.233 (4.356)	.412 (3.676)
Working capital	-.088 * (.041)	.002 (.053)	-.103 (.968)	1.731 (1.418)
Operating expenses	-.159 ** (.058)	.021 (.088)	-.494 (2.113)	-.355 (2.300)
Acquisition expenditure	-.042 (.098)	-.258 (.185)	-3.942 (3.659)	.611 (2.485)
Competitive intensity	.506 * (.261)	.603 (.802)	3.645 (4.496)	37.877 * (17.564)
Industry intangible intensity	.101 (.361)	-.837 (.870)	8.776 (7.816)	-39.951 * (18.466)
Earnings growth	–	–	-.271 (.219)	-1.124 * (.547)
Year dummies	Included	Included	Included	Included
Arellano-Bond test: *p* -value	.916	.163	.385	.234
Difference-in-Hansen test: *p* -value	1.000	.174	.117	.408
Number of observations	1485	510	1406	589

* Significant at 5% level (one-sided).

** Significant at 1% level (one-sided).

Fig. 1
Decomposing the effect of the service ratio on firm value

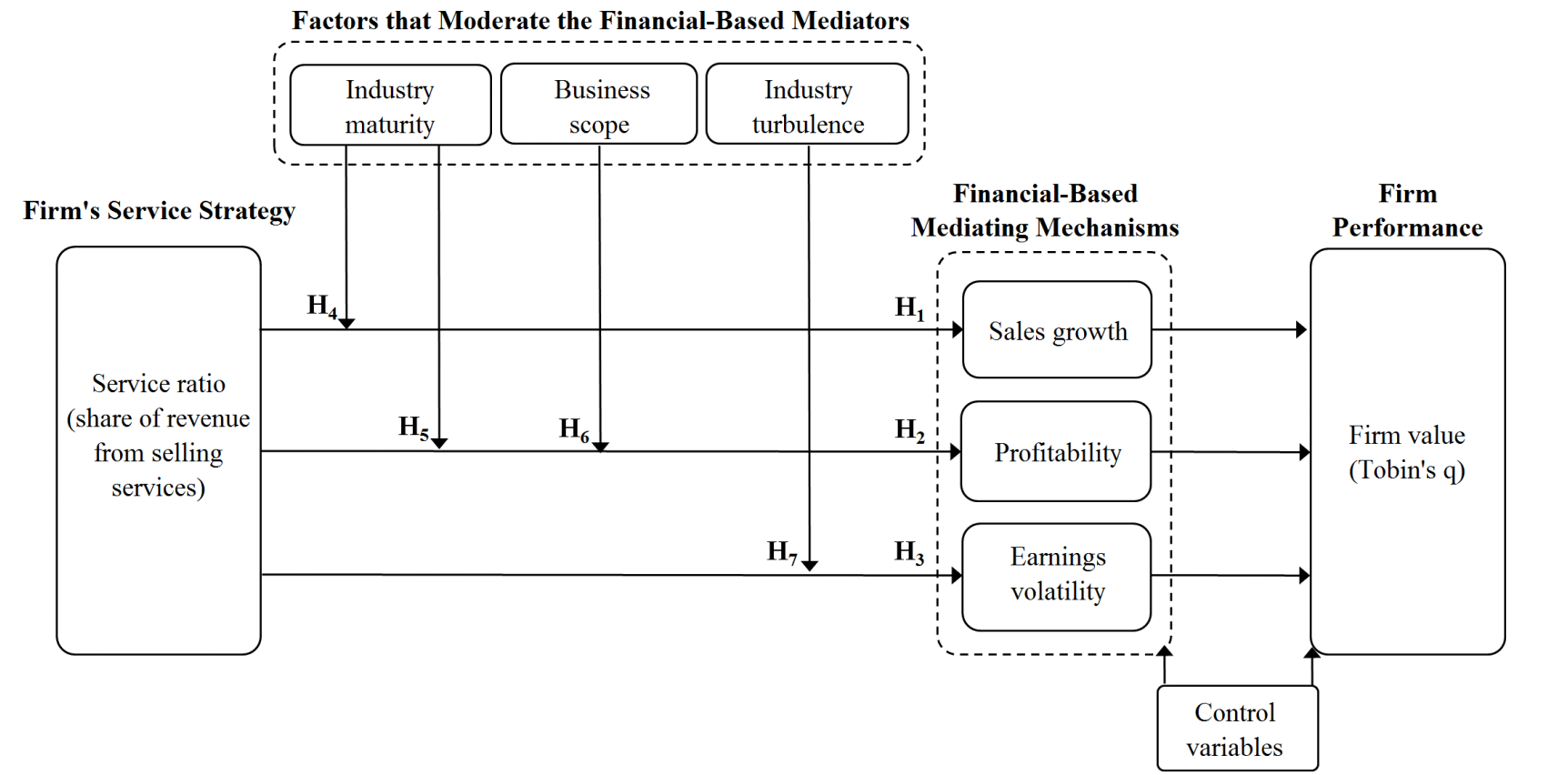


Fig. 2
Graphical and theoretical decomposition of the effect of the service ratio across the financial-based mediators

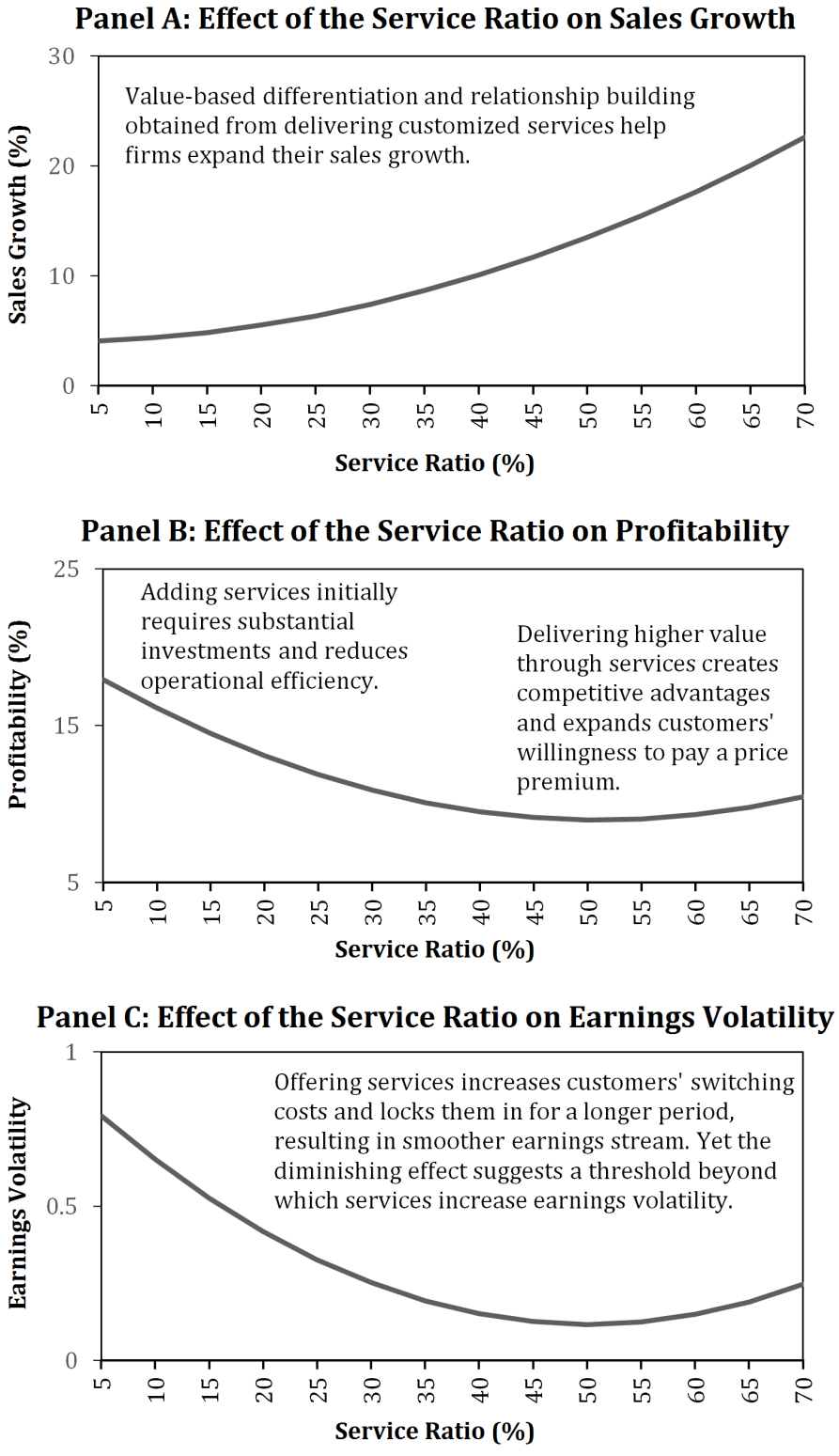
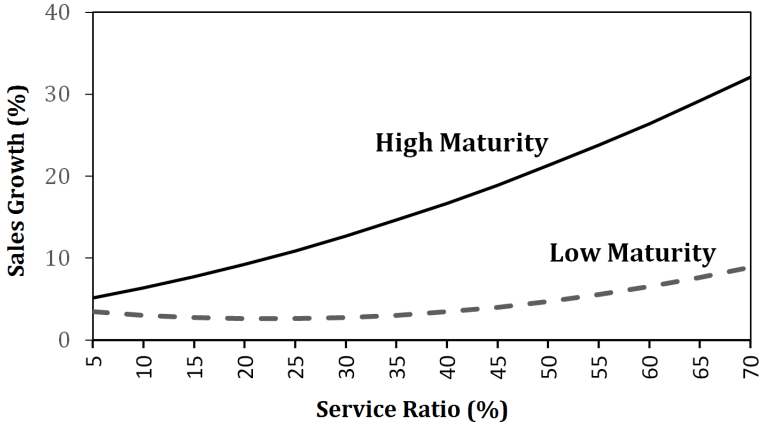
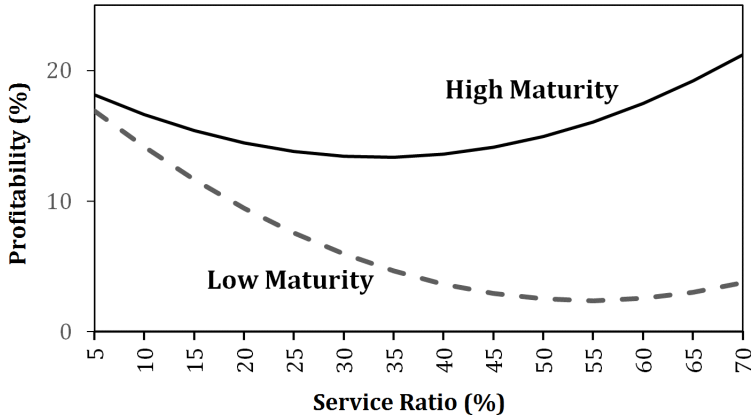


Fig. 3
Factors that moderate the financial-based mediators

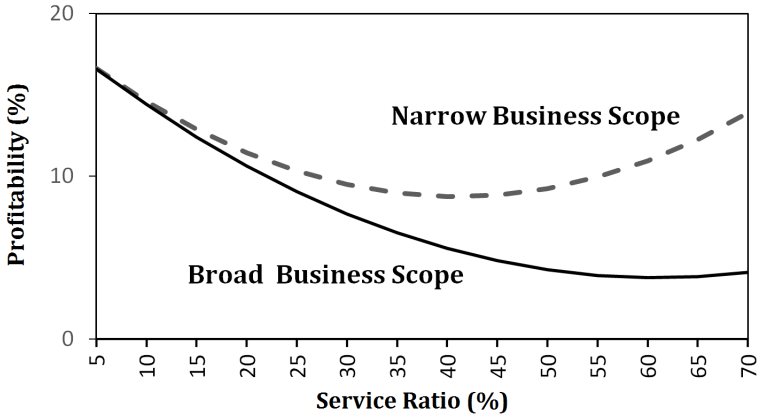
Panel A: Effect of the Service Ratio on Sales Growth, Moderated by Industry Maturity



Panel B: Effect of the Service Ratio on Profitability, Moderated by Industry Maturity



Panel C: Effect of the Service Ratio on Profitability, Moderated by Business Scope



Panel D: Effect of the Service Ratio on Earnings Volatility, Moderated by Industry Turbulence

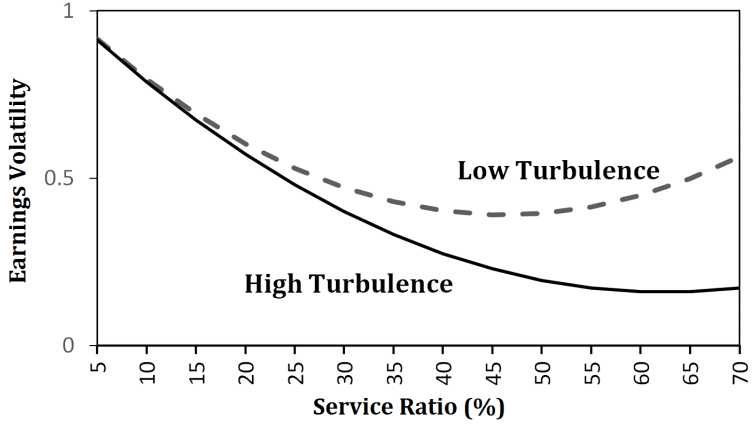


Fig. 4
Frequency distribution of percentage-point changes in firms' service ratios over their observation period

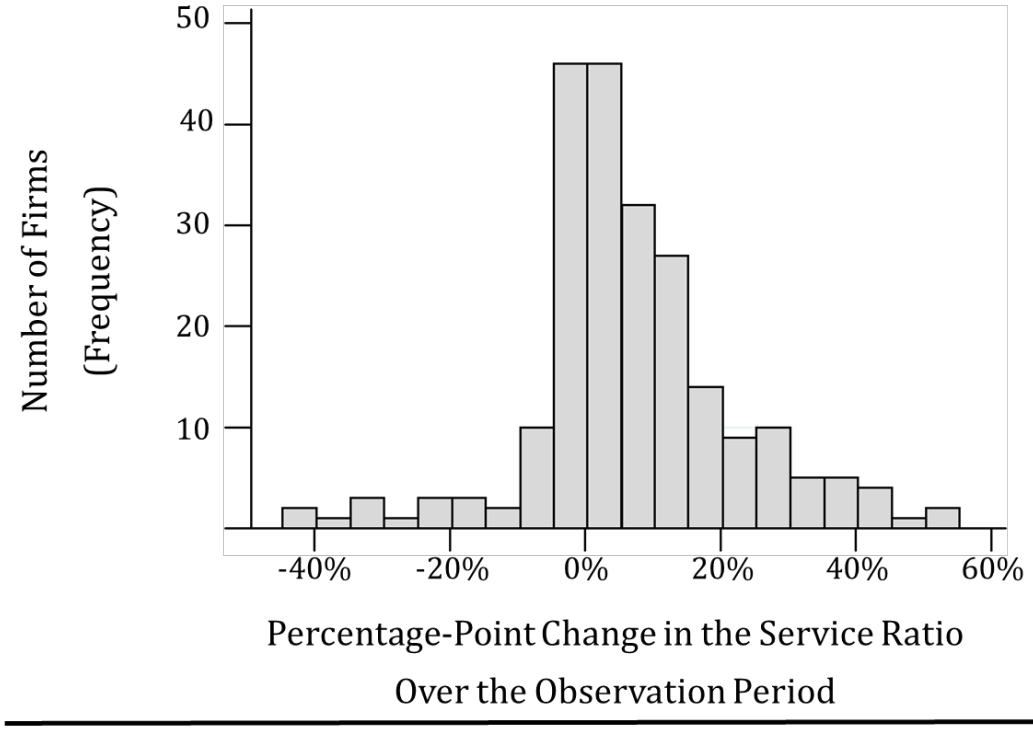
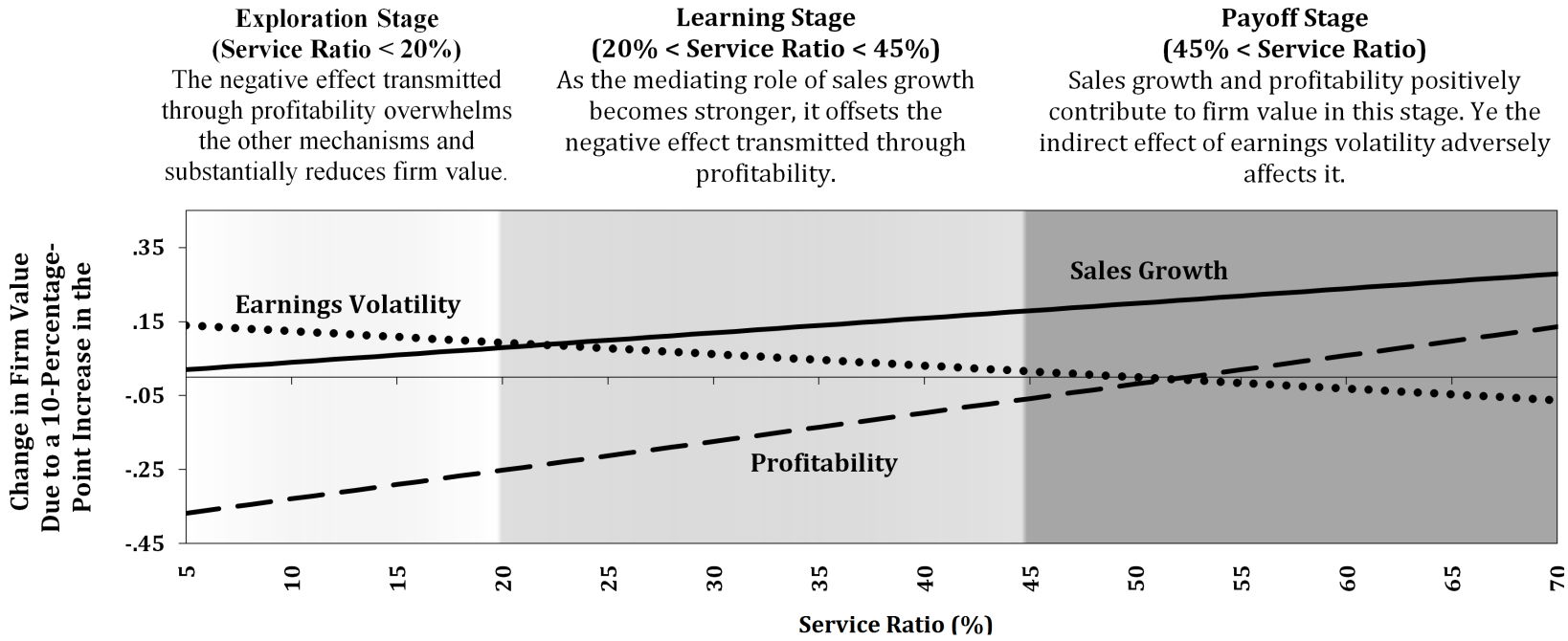


Fig. 5
Indirect effects of service transition on firm value



Note: For a given service ratio, the corresponding values on the vertical axis reflect the average changes in firm value through the mediating mechanisms, were the service ratio to increase by 10-percentage-points. For example, at a service ratio of 20%, the indirect effect transmitted through sales growth, profitability, and earnings volatility, respectively, would change the Tobin's q by .08 (3%), –.25 (-10%), and .09 (3.5%) if the service ratio were to increase by 10-percentage-points.