This article was downloaded by: [155.246.103.35] On: 05 April 2017, At: 17:34
Publisher: Institute for Operations Research and the Management Sciences (INFORMS)
INFORMS is located in Maryland, USA

Management Science

Publication details, including instructions for authors and subscription information:
http://pubsonline.informs.org

When Suppliers Climb the Value Chain: A Theory of Value Distribution in Vertical Relationships

Zhixi Wan, Brian Wu

To cite this article:
Zhixi Wan, Brian Wu (2017) When Suppliers Climb the Value Chain: A Theory of Value Distribution in Vertical Relationships. Management Science 63(2):477-496. http://dx.doi.org/10.1287/mnsc.2015.2356

Full terms and conditions of use: http://pubsonline.informs.org/page/terms-and-conditions

This article may be used only for the purposes of research, teaching, and/or private study. Commercial use or systematic downloading (by robots or other automatic processes) is prohibited without explicit Publisher approval, unless otherwise noted. For more information, contact permissions@informs.org.

The Publisher does not warrant or guarantee the article's accuracy, completeness, merchantability, fitness for a particular purpose, or non-infringement. Descriptions of, or references to, products or publications, or inclusion of an advertisement in this article, neither constitutes nor implies a guarantee, endorsement, or support of claims made of that product, publication, or service.

Copyright © 2016, INFORMS

Please scroll down for article—it is on subsequent pages

INFORMS is the largest professional society in the world for professionals in the fields of operations research, management science, and analytics.
For more information on INFORMS, its publications, membership, or meetings visit http://www.informs.org

http://pubsonline.informs.org/journal/mnsc/

MANAGEMENT SCIENCE
Vol. 63, No. 2, February 2017, pp. 477–496
ISSN 0025-1909 (print), ISSN 1526-5501 (online)

When Suppliers Climb the Value Chain: A Theory of Value Distribution in Vertical Relationships

Zhixi Wan,[a] Brian Wu[b]

[a] Lundquist College of Business, University of Oregon, Eugene, Oregon 97403; [b] Strategy Department, Ross School of Business, University of Michigan, Ann Arbor, Michigan 48109

Contact: zwan@uoregon.edu (ZW); wux@umich.edu (BW)

Received: November 19, 2014
Accepted: September 10, 2015
Published Online in Articles in Advance: March 16, 2016, and updated November 21, 2016

https://doi.org/10.1287/mnsc.2015.2356

Copyright: © 2017 INFORMS

Abstract. Although offshore outsourcing has become an important strategy to lower production costs among Western firms, it gives rise to the phenomenon of value chain climbing—suppliers in emerging markets can develop capabilities by supplying, with aspirations to compete with the buyers in the product market. We build an analytical model to study the impact of value chain climbing on value distribution in vertical relationships. The analysis identifies a set of dominant relationships, characterizes how the buyer's optimal choice among these relationships depends on firms' relative competitiveness in the product market and the supplier's speed of capability development, and shows how the optimal choice evolves with the dynamics of the supplier's capability development. The results provide new insights into our understanding of value distribution in vertical relationships across different contexts and over time. By endogenizing the supplier's entry into the product market, our study enriches the literatures on vertical relationships, market entry, and the management of global value chains.

History: Accepted by Bruno Cassiman, business strategy.
Supplemental Material: The online appendix is available at https://doi.org/10.1287/mnsc.2015.2356.

Keywords: value chain climbing • value chain • value distribution • capabilities

1. Introduction

Offshore outsourcing is a key strategy that Western firms use to manage their value chain. By outsourcing, firms (henceforth, *buyers*, to distinguish them from suppliers) can retain high-value-added activities (e.g., research and development (R&D) and marketing) in house, while contracting out low-value-added activities (e.g., manufacturing) to suppliers in emerging economies where labor costs are low. The importance of outsourcing is manifested by its sheer volume. According to the United Nations Conference on Trade and Development (2011), contract manufacturing and service activities, undertaken mostly in developing countries, generated $1.1–$1.3 trillion sales in 2010. Because of its importance, offshore outsourcing has attracted increasing interest among both academics and practitioners over the last two decades (Feenstra 1998, Grossman and Helpman 2005, Gereffi et al. 2005, Elms and Patrick 2013).

Whereas outsourcing reduces a buyer's production costs, it gives rise to the phenomenon whereby the supplier can climb the value chain by supplying.[1] Specifically, outsourcing opens a window of opportunity for the supplier to enter the product market, which is often the more lucrative part of the global value chain controlled by the buyer. As a result of close interactions with the buyer, the supplier can develop technological and marketing capabilities that are necessary to compete in the product market but are difficult to develop independently (Alcácer and Oxley 2014). Despite buyers' efforts to prevent the capability development of suppliers, outsourcing facilitated the transformation of many suppliers into direct competitors across a variety of industries such as electronics, garments, pharmaceuticals, and information technology (IT) (Arruñada and Vázquez 2006, Alcácer and Oxley 2014). One prominent example of this transformation is HTC of Taiwan. Beginning as a contract cell phone manufacturer in the 1990s, HTC entered the smartphone market with its own brand in 2002, and was once among the top five smartphone brands in the world (Paik and Zhu 2014, Yoffie et al. 2012). Sharing a similar path is Galanz in mainland China. Originally a contract manufacturer, Galanz successfully established itself as one of the world's largest microwave oven makers (Zeng and Williamson 2003).

The growth of value chain climbing activities has been catalyzed by several environmental factors. First, increasing disposable income in emerging countries (e.g., China and India) has created sizable domestic markets, which serve as a foothold for local suppliers to enter and become established before they are able to expand globally (Zeng and Williamson 2003, Bartlett and Ghoshal 2000). Second, because of institutional changes, such as trade liberalization, the emerging

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

competitors can start their internationalization journey by selling to other developing countries; having accumulated overseas experience, they are then poised to enter markets in developed countries (Khanna and Palepu 2006). Third, technological advances, including e-commerce, have significantly decreased entry barriers, such as distribution channels, further enabling suppliers' efforts to climb the value chain.[2] Although these suppliers typically begin at the low end of the value chain and many may fail in their endeavor to climb the value chain, some may eventually threaten the incumbent firms' lucrative positions in the global product market. Thus, value chain climbing, facilitated by profound environmental change, can have significant strategic consequences, highlighting the need for both practitioners and academics to reassess the management of global value chains.

Despite the intriguing implications of suppliers climbing value chains, this phenomenon has received little attention in the scholarly research, except for a few practitioner-oriented case studies (e.g., Arruñada and Vázquez 2006) and a recent empirical investigation (Alcácer and Oxley 2014). We aim to fill this gap by developing one of the first analytical models on the role of value chain climbing. In particular, although the phenomenon opens many potential research opportunities, we choose to focus on how value chain climbing affects value distribution in vertical relationships. This focus is relevant because it lies at the intersection of the value chain-climbing phenomenon and a fundamental question in the strategy field: "How does competition among economic actors determine the value each appropriates?" (MacDonald and Ryall 2004, p. 1319). In the context of our study, the supplier is a potential entrant to compete with the buyer, which gives rise to a new form of competition; within this context, the value that each economic actor appropriates, or the value distribution between the buyer and the supplier, is a central concern in the value chain literature (Chatain and Zemsky 2007, de Fontenay and Gans 2008, Chatain 2011, Jia 2013).

Our model complements existing models of buyer–supplier relationships (Chatain and Zemsky 2007, de Fontenay and Gans 2008, Chatain 2011, Jia 2013) by incorporating a novel feature in which the supplier develops capabilities for value chain climbing while supplying the buyer. This novel feature of developing by supplying results in a trade-off for the buyer: Although the supply relationship allows the buyer to leverage the low production cost of the supplier, it can accelerate the supplier's capability development and in turn the supplier's market entry. This trade-off yields equilibrium connections between the supplier's market-entry prospect and the vertical relationship formation—the vertical relationship engenders the supplier's value chain climbing incentives, actions, and outcomes, whereas the anticipation of supplier capability development and competition in turn influences the buyer's choices of relationship structures.

Specifically, we show that a variety of relationship types (accommodating, dumping, and squeezing) can exist in response to the buyer's trade-off, and that the buyer's optimal choice among these relationships depends on the product market competitiveness of the two firms—what each would earn in the product market should the supplier enter (Tirole 1988, Cabral 2014). Intuitively, the buyer can close the window to the supplier's capability development and deter value chain climbing by dumping the supplier (i.e., terminating the relationship). Alternatively, the buyer can also preempt the supplier's entry by offering a value share slightly higher than the supplier's product market competitiveness so that the supplier has no incentive to enter; that is, the buyer can accommodate the supplier.[3] We find that when the supplier's competitiveness is sufficiently low the buyer prefers accommodating to dumping because accommodating is inexpensive.

Interestingly, our analysis shows that accommodating is not the only alternative to dumping. When the supplier's competitiveness is sufficiently high, the buyer may find a novel solution in which it offers the supplier a value share even lower than the supplier's outside option, effectively squeezing or exploiting the supplier. The supplier accepts the squeezing relationship with the goal of developing the desired capabilities to enter the lucrative product market, but leaves the relationship as soon as it has achieved its goal, much like an apprentice who pays "tuition" (e.g., in the form of free labor) to the master in exchange for learning. Unlike dumping, which results in a terminated relationship, or accommodating, which leads to a long-term relationship, squeezing takes the form of a short-term relationship in which both firms are interested to engage. Despite its short-term nature, the squeezing relationship exists in equilibrium over a wide range of parameter space. In contrast, the intuitive strategy of dumping is optimal only when the buyer has low competitiveness (i.e., when it has much to lose upon the supplier's entry) and the supplier's competitiveness is intermediate (i.e., when the supplier is too costly to accommodate but offers too little value to be worth squeezing). The optimal choice between dumping and squeezing also depends on the speed of developing by supplying and the speed of self-developing. When the speed of developing by supplying increases, squeezing becomes less effective—it is better to either accommodate or dump the supplier. In contrast, when the speed of self-developing increases, dumping becomes less effective, because the supplier can independently develop the desired capabilities.

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

Building on these insights into the buyer's trade-off, we further examine how the buyer's optimal strategy and the associated vertical relationships may evolve in response to the dynamics of the supplier's capability development. Capability development processes are typically gradual and undergo milestones that reflect the intermediate stages of capability accumulation (Pacheco-de-Almeida and Zemsky 2007, Dierickx and Cool 1989), raising a number of interesting questions: What determines the buyer's optimal strategy at an intermediate stage, and how does the buyer adjust strategy as the supplier gradually develops capabilities? Will the buyer engage the supplier, then strategically dump it at a certain intermediate stage? If the buyer engages the supplier, what intertemporal patterns (e.g., monotonicity) might emerge in the contract offer?

To explore these questions, we model the supplier's capability development process as a Markov chain and solve the Markov perfect equilibrium of the dynamic game between the two firms. Our analysis reveals the set of intertemporal patterns and characterizes their conditions. The results show that the insights into the buyer's main trade-off are robust. First, the buyer chooses squeezing at all stages if the supplier has sufficiently high market competitiveness and thus can afford high tuition. Second, the buyer always engages the supplier and finally accommodates the supplier at a certain stage if the supplier's competitiveness is sufficiently low. Third, the buyer prefers to dump the supplier at a certain stage if the buyer has low competitiveness and the supplier's competitiveness is intermediate.

More interestingly, the results highlight the dynamic manifestations of the buyer's trade-off, suggesting when and how the buyer could strategically switch the type of vertical relationship in response to the progress of the supplier's capability development. In particular, when planning to accommodate the supplier at a later stage, the buyer may choose squeezing instead of accommodating at the earlier stages in which there is little threat that the supplier can leapfrog over the development stages and directly enter the market. In such a case, the buyer exploits the supplier till the moment the supplier gains a sufficient level of capability to pose an entry threat, and at that moment the buyer switches to accommodating, preempting the entry incentive. Therefore, squeezing at the early stages and accommodating later becomes a dynamic strategic plan of entry preemption, as opposed to relying on dumping to delay the entry, as common wisdom may suggest. By contrast, if there is a desire to dump the supplier, the buyer may strategically choose the right timing depending on the shape of the development process. To explain, the parameters describing the development speed at every stage determine the stages at which the supplier would develop "too fast," and in response, the buyer will dump the supplier at the first of such stages. In this case, the buyer starts by squeezing the supplier and terminates the relationship as soon as the supplier reaches that particular stage.

Our findings generate interesting implications for understanding value distribution in vertical relationships. Cross-sectionally, at a given stage when both accommodating and squeezing exist, our analysis finds an interesting nonlinear relation between product market competitiveness and value distribution. As the supplier's competitiveness increases, its value share will initially increase, if the relationship is in the accommodating regime, because the buyer needs to pay more to retain a more competitive supplier. However, once increasing supplier competitiveness shifts the equilibrium regime to squeezing, the supplier's value share will decrease, because a more competitive supplier needs to pay higher tuition. Thus, the marginal impact of product market competitiveness within the same regime and a switch between regimes jointly generate an (approximated) inverted-U-shaped relationship between the value the supplier captures and its competitiveness. Intertemporally, we find that the supplier's value share may not be monotonic as relationship length increases because its value share depends on the relative speed of self-developing vis-à-vis developing by supplying, which may vary nonmonotonically as time goes.

Our study contributes to the growing body of work that addresses the role of competition among economic actors in determining value appropriation (MacDonald and Ryall 2004). One important stream in this literature focuses on the competition associated with the formation of coalitions among buyers and suppliers (Chatain and Zemsky 2007, de Fontenay and Gans 2008, Chatain 2011, Jia 2013). We enrich this literature by examining a new type of competition that stems from the rapidly changing global market environment. Although outsourcing allows buyers to reduce production costs, this strategy may also enable suppliers to develop capabilities and climb the value chain. Thus, firms have capability development in mind when forming a relationship (Gans 2014, Wakeman 2010). Our study provides one of the first analytical models to investigate how value chain climbing can affect vertical relationships. In this context, the potential entrant has an existing role as a supplier, whose decision to compete is endogenously intertwined with the value distribution between the buyer (incumbent) and the supplier (potential entrant). Moreover, we formalize the gradual process of the supplier's capability development and develop a dynamic structure to study the intertemporal patterns of vertical relationships. Our model identifies a set of dominant relationships and, in particular, highlights squeezing as a novel relationship in the presence

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

of value chain climbing. Our model further demonstrates how these relationships may evolve over time, driven by the evolution of the supplier's capability development. Overall, by endogenizing the supplier's entry into the product market, our study sheds new light on the dynamics of vertical relationships and the management of global value chains.

2. Capability Development by Supplying

In this section, we conceptualize the key theoretical construct in our paper—the supplier's capability development gained by supplying. To begin, consider the well-known smiling curve in the outsourcing literature (Bartlett and Ghoshal 2000). It acquired its name because the two ends of the value curve (creating and marketing the products) command much higher profitability than the middle segment (manufacturing the products). As such, the buyer keeps R&D and marketing activities in house while outsourcing manufacturing to suppliers in emerging markets. If suppliers aspire to move up the value curve, they need to develop the technological and marketing capabilities necessary to become a viable competitor in the product market.

It is challenging for a new player to develop technological and marketing capabilities because of time compression diseconomies (Pacheco-de-Almeida and Zemsky 2007, Dierickx and Cool 1989). Moreover, these capabilities cannot be readily purchased "off the shelf" in the market (Sutton 2012). For example, even if a Chinese firm purchases machines, it may lack capable designers who can create the products or marketers who can create global brand recognition. The Chinese firm could try to acquire an established Western firm with existing technologies or brand, as part of its self-developing process, but this process can be too costly due to ex ante information asymmetry and ex post integration cost. In fact, despite persistent efforts of Chinese firms to make overseas acquisitions, many have failed (Williamson and Raman 2011).

Compared to a self-developing entrant, a supplier has a significant advantage in the effort to develop capabilities, because the supply process opens a window of opportunity for the supplier to closely interact with the buyer. For example, even though the buyer may want to share only a minimum amount of R&D knowledge and design know-how, the supplier can inevitably take this opportunity to gain other relevant knowledge, because different pieces of knowledge are embedded in each other. The supplier can also gain marketing knowledge, because the buyer often needs to show the supplier how the distribution channel works and how the end customers use the product. Whereas the buyer offers this access to help the supplier provide better intermediate inputs, the supplier can come to understand channel providers and end consumers. Furthermore, by working for a branded buyer, the supplier may gain the confidence of consumers and leverage it to build its own brand. Finally, the supplier may not be limited by what it learns from the buyer; it is also in a position to combine and recombine the newly gained knowledge with its other expertise to create stronger capabilities. A good example is the capability development process of Samsung, a former original equipment manufacturer (OEM) supplier.

The above conceptualization has two implications. First, since supplying activities and supplier capability development are intricately connected and hard to disentangle, supplier capability development is inevitable as long as the buyer and the supplier maintain their relationship, even if the buyer seeks to minimize the speed of supplier capability development (Alcácer and Oxley 2014). Second, it is faster for a firm to develop desired capabilities by working as a supplier than pursuing them independently. These two implications underpin the respective trade-offs faced by the buyer and the supplier. The buyer needs to balance leveraging the lower production cost of the supplier and the negative consequences of the supplier developing capabilities. The supplier, on the flip side, can develop capabilities by supplying, but may need to pay tuition to do so.

The concept of capability development by supplying can be further understood by comparing it with two related but distinct concepts: vertical spillovers as described in the foreign direct investment literature and the violation of intellectual property. Vertical spillovers, or the transfer of basic production know-how from the buyer to the supplier, help the supplier improve the quality of the outsourced items to meet a desired standard (Javorcik 2004, Bönte and Wiethaus 2007, Pack and Saggi 2001). Vertical spillovers involve know-how for manufacturing intermediate products, whereas capability development is concerned with technological and marketing capabilities for market competition. Whereas vertical spillovers are mutually beneficial, the supplier benefits at the expense of the buyer through its capability development. As such, the buyer typically voluntarily initiates vertical spillovers, but tries to thwart the supplier's efforts to develop its own technological and marketing capabilities (Alcácer and Oxley 2014). The concept of capability development by supplying is also distinct from the violation of intellectual property. Although the supplier's capability development concerns core technologies, it does not necessarily entail a violation of intellectual property. For example, the supplier may not need to illegally copy the buyer's core technology; rather, by observing and interacting with the buyer, the supplier can innovate around it (Alcácer and Oxley 2014, Arruñada and Vázquez 2006, Khanna and Palepu 2006).

In modeling the supplier's capability development, we recognize that this process is both gradual and

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

uncertain. First, suppliers need to gradually accumulate their stock of resources and capabilities (Dierickx and Cool 1989). Pacheco-de-Almeida and Zemsky (2007) formalize the cumulative process as a number of steps, such as setting up an R&D center, establishing brand recognition, and building a distribution channel. Relatedly, the R&D competition literature has modeled multiple intermediate stages that firms need to pass through before achieving final R&D success (Fudenberg et al. 1983, Grossman and Shapiro 1986). The implications of these models have been applied in the strategy literature to examine alliance relationships (Khanna et al. 1998). We build on this literature to characterize the supplier's capability development. Although developing by supplying helps the supplier develop capabilities necessary for product market competition, the desired capability level cannot be achieved instantaneously. The supplier needs to go through a cumulative process marked by a number of milestones, akin to the number of steps described by Pacheco-de-Almeida and Zemsky (2007) and the intermediate stages characterized by Fudenberg et al. (1983) and Grossman and Shapiro (1986). Following Sutton's (2012) notion of "revealed capabilities," we consider that the supplier's achievement of each milestone reveals the intermediate level of capabilities that the supplier has developed up to that point. If the supply relationship is terminated at a certain milestone, the supplier self-develops from that point on, with the intermediate level of capabilities determining the likelihood and speed of its market entry. In other words, we define the supplier's capability level as the stock of capability after achieving a certain milestone, which is revealed as the speed and success rate at which the supplier can self-develop to enter the buyer's market in case the buyer terminates or the supplier quits the relationship at that stage.

Second, supplier capability development is subject to uncertainties (Lippman and Rumelt 1982). We model this by a Markov chain, assuming that it takes a random amount of time for the supplier to complete each stage (i.e., achieve the next milestone). Staying in the supply relationship can stochastically shorten the time the supplier spends before reaching each milestone. Depending on the state of the supplier's capability development, the buyer can decide whether to terminate the relationship and deprive the supplier of this learning opportunity. With this setup, we model the supplier's development by supplying as the improvement of its capability level per the Markov chain and seek Markov perfect equilibrium (Gans 2014, Segal and Whinston 2007).

Overall, our modeling of how interfirm relationships impact capability development resonates with the recent formal modeling literature on innovation (Gans 2014, Wakeman 2010). In these models, gaining experience in complementary activities, such as production or commercialization, can enhance an entrant's innovation capabilities, which in turn determine its likelihood of success for a future generation of product. Therefore, whether and how to engage an incumbent for complementary activities will not only affect the entrant's current profits, but, more importantly, will have profound dynamic implications.

3. Model Setup

We consider a buyer ("she," subscripted by b) and a supplier ("he," subscripted by s) in an infinite time horizon indexed by period $t = 1, 2, \ldots$. At the beginning of each period t, the buyer proposes a supply chain relationship that offers the supplier value v_t in period t.[4] If the supplier accepts the offer, the supply chain relationship gives the buyer and the supplier value $1 - v_t$ and v_t, respectively, in period t; one can interpret 1 as the total value created by the supply chain in each period. If the supplier rejects the offer, he enters the buyer's market (if he is capable), or the two firms turn to their outside options (if he is incapable). The supplier's outside option gives him value r and the buyer's gives her value $1 - c$ in every remaining period. An incapable supplier (who rejected the offer) develops his capabilities on his own and becomes capable in a future period $\tilde{t} > t$. A capable supplier can choose to enter the buyer's market any time. Once the supplier enters the market, the buyer and the supplier receive value π_b and π_s, respectively, in every remaining period. We assume the time length $\tilde{t} - t$ is stochastic due to development uncertainties, and the probability of $\tilde{t} - t$ being infinity captures the likelihood that the supplier eventually fails to become capable. Let $\beta \in (0, 1)$ denote the discount factor per period of time, and let $\theta_t \equiv E[\beta^{\tilde{t}-t}]$ denote the discount factor associated with the periods in which the supplier develops on his own. Thus, a larger θ_t means a higher speed and success rate at which the supplier can develop to enter the buyer's market, in case the buyer terminates or he quits the relationship in period t. We call it the supplier's *capability level* at the beginning of period t.

During periods 1 to t, if the supplier remains in the relationship with the buyer, he develops his capability by supplying. We model this by assuming θ_t stochastically increases in t, following a Markov chain. In particular, we assume that θ_t takes value in the set $\{s_1, s_2, \ldots, s_M\}$ with $M \geq 1$ and $0 \leq s_1 < s_2 < \cdots < s_M < 1$, by which we consider that the capability development undergoes M milestones; we assume $\theta_1 = s_1$, and let $\theta_t = s_k$ represent that the supplier is at stage k at the beginning of period t. In the main analysis, we consider the capability development as a gradual transition process:[5] If the supplier is at an early stage $k \leq M - 1$ (i.e., $\theta_t = s_k$), then in one period of time he remains at the same stage (i.e., $\theta_{t+1} = s_k$) with probability $\tau_k \in (0, 1)$

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

and reaches the next stage (i.e., $\theta_{t+1} = s_{k+1}$) with probability $1 - \tau_k$; if the supplier is at the final stage (i.e., $\theta_t = s_M$), then in one period of time he remains at the same stage (i.e., $\theta_{t+1} = s_M$) with probability $\tau_M \in (0,1)$ and becomes capable in period t with probability $1 - \tau_M$. The model captures the idea that the supplier spends a random length of time at stage k, denoted by L_k, before reaching the next stage. We can compute the discount factor associated with the time spent at stage k, denoted by $l_k \equiv E[\beta^{L_k}] = \beta(1-\tau_k)/(1-\beta\tau_k)$ (see the appendix for the derivation); namely, there is a one-on-one correspondence between τ_k and l_k. Intuitively, a higher value of l_k means a faster "speed" of development at stage k. As explained in Section 2, the supplier can develop capabilities faster by supplying than doing so independently; we model this by assuming $l_M > s_M$ and $l_k s_{k+1} > s_k$ for $k = 1 \sim M-1$, where $l_k s_{k+1}$ is the supplier's projected capability level at stage k if he stays in the relationship given that it allows him to increase his capability to s_{k+1} at a "speed" l_k.

We consider the supplier's capability level θ_t as the state variable, and we are interested in how the vertical relationship and the value distribution (namely, the buyer's decision variable v_t and the supplier's acceptance/rejection decision) depend on the value of θ_t and its dynamic evolution. All the other parameters (i.e., $c, r, \pi_b, \pi_s, \beta, \{s_k, \tau_k, l_k; k = 1 \sim M\}$) are exogenous and common knowledge. We assume $c \geq 0$; it can be interpreted as the buyer's cost of using her best alternative arrangement, which can be, for example, the cost of running an integrated business, or the cost of using another supplier. To capture the supplier's entry incentive, we assume $\pi_s > r$. The supplier's entry will reduce the buyer's value, namely, $\pi_b < 1 - c$, and the duopoly competition will yield total profits that are lower than the monopoly profit that the supply chain would create, namely, $\pi_b + \pi_s < 1$ (Budd et al. 1993).

We formulate the dynamic game between the two firms. We assume that in each period both firms make decisions to maximize their expected net present value (NPV); namely, we consider only subgame perfect equilibria. Let $u_{s,t}(\theta_t)$ and $u_{b,t}(\theta_t)$ denote, in equilibrium, the respective expected NPV of the supplier and the buyer at the beginning of period t given the state variable θ_t. We must have

$$u_{s,t}(\theta_t) = \max \begin{cases} v_t + \beta E[u_{s,t+1}(\theta_{t+1})], \\ \quad \text{if the supplier accepts;} \\ \theta_t \dfrac{\pi_s}{1-\beta} + (1-\theta_t)\dfrac{r}{1-\beta}, \\ \quad \text{if the supplier rejects.} \end{cases} \tag{1}$$

Note that if the supplier accepts the offer v_t, then both firms remain in the relationship until at least period $t+1$, which yields the discounted payoff $\beta E[u_{s,t+1}(\theta_{t+1})]$;[6] otherwise, if the supplier quits the relationship (and develops capabilities for market entry on his own), his expected NPV equals $E[\sum_{i=t}^{\tilde{t}-1} \beta^{i-t} r + \sum_{i=\tilde{t}}^{\infty} \beta^{i-t} \pi_s] = E[((1-\beta^{\tilde{t}-t})/(1-\beta))r + (\beta^{\tilde{t}-t}/(1-\beta))\pi_s] = \theta_t(\pi_s/(1-\beta)) + (1-\theta_t)(r/(1-\beta))$. Similarly, we must have

$$u_{b,t}(\theta_t) = \max_{v_t} \begin{cases} [1 - v_t] + \beta E[u_{b,t+1}(\theta_{t+1})], \\ \quad \text{if the supplier accepts;} \\ \theta_t \dfrac{\pi_b}{1-\beta} + (1-\theta_t)\dfrac{1-c}{1-\beta}, \\ \quad \text{if the supplier rejects,} \end{cases} \tag{2}$$

where $\theta_t(\pi_b/(1-\beta)) + (1-\theta_t)((1-c)/(1-\beta)) = E[\sum_{i=t}^{\tilde{t}-1} \beta^{i-t}(1-c) + \sum_{i=\tilde{t}}^{\infty} \beta^{i-t}\pi_b]$ is the buyer's expected NPV if the relationship is terminated at the beginning of period t.

Following Gans (2014) and Segal and Whinston (2007), we use the solution concept of the Markov perfect equilibrium, which is the type of subgame perfect equilibrium that depends only on the Markov chain state variable θ_t. In a Markov perfect equilibrium, the time variable t affects the firms' NPV only through θ_t, and therefore we can drop the t subscript from $u_{s,t}$ and $u_{b,t}$ and replace them with $u_s(\theta_t)$ and $u_b(\theta_t)$ in Equations (1) and (2).

Our analysis starts by examining a baseline model with a single stage (i.e., $M = 1$) in Section 4. The single-stage setup allows us to highlight the main trade-offs of the firms, controlling for the intertemporal complexities resulting from the dynamic development of supplier capability θ_t. Meanwhile, the results can apply directly to the final stage in the general setting of multiple stages (i.e., $M \geq 2$). Building on the base model results, our analysis in Section 5 examines how the main trade-offs are manifested at the early stages and characterizes the intertemporal patterns of the vertical relationship evolution.

4. Main Trade-offs: Base Model with a Single Stage

Consider that the supplier is at stage M at the beginning of period t and the buyer offers v_t. Equation (1) describes the supplier's trade-off as follows. If accepting the buyer's offer and developing his capabilities by supplying, his NPV, denoted by $\underline{u}_s$, satisfies $\underline{u}_s = v_t + \beta[\tau_M \underline{u}_s + (1-\tau_M)\max\{\pi_s/(1-\beta), \underline{u}_s\}]$. In this equation, the term $\tau_M \underline{u}_s$ means that with probability τ_M the supplier remains at the current stage (being incapable of entry, $\theta_{t+1} = s_M$) at the beginning of period $t+1$. The term $(1-\tau_M)\max\{\pi_s/(1-\beta), \underline{u}_s\}$ means that with probability $1-\tau_M$ the supplier becomes capable of entering the market by the end of period t and, if so, he chooses between entry (which gives NPV $\pi_s/(1-\beta)$) and remaining in the relationship (if $\underline{u}_s \geq \pi_s/(1-\beta)$). In contrast, if rejecting the offer and

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

developing his capabilities on his own, he has an NPV equal to $s_M(\pi_s/(1-\beta)) + (1-s_M)(r/(1-\beta))$. Comparing it with $\underline{u}_s$, he will accept the buyer's offer only if $v_t \geq \underline{v}_M \equiv r - ((l_M - s_M)/(1-l_M))(\pi_s - r)$; see the derivation in the appendix. Given that $l_M > s_M$ (i.e., capability development is faster by supplying), we must have $\underline{v}_M < r < \pi_s$. The insight is that the supplier is willing to accelerate capability development at the cost of accepting some offer lower than his outside option value r.

Given the supplier's strategies, Equation (2) implies that the buyer's optimal choice of v_t lies in a small set of three options, and all other options are dominated by one of these three options. Option 1 is to offer (slightly above) $v_t = \pi_s$ so that the supplier will accept the offer and never enter the market, regardless of his current or future capabilities. We refer to this option as the accommodating strategy. Any choice of $v_t > \pi_s$, despite achieving the same goal, gives the buyer lower value and hence is dominated by $v_t = \pi_s$. Option 2 is to offer (slightly above) $v_t = \underline{v}_M$ such that the supplier will accept it but will enter if he becomes capable in the period. We refer to this option as the squeezing strategy because $\underline{v}_M$ is lower than the supplier's reservation value r, and therefore, if used, the buyer squeezes value from the incapable supplier through the relationship. Similarly, any choice of $v_t \in (\underline{v}_M, \pi_s)$ achieves the same goal but gives lower value to the buyer and hence is dominated by the choice of $v_t = \underline{v}_M$. Option 3 is to offer any $v_t < \underline{v}_M$ so that the supplier will reject the offer regardless of his capabilities. This option is equivalent to the buyer's choice of terminating the relationship with the supplier. We refer to this option as the dumping strategy. Let $u_b^{(j)}$ and $u_s^{(j)}$ denote the expected NPV of the buyer and the supplier, respectively, under each of the three options $j = 1, 2, 3$.

Lemma 1. *If the supplier is at the final stage of capability development at the beginning of period t, the buyer chooses among three options regarding v_t, which together dominate all other options.*

- *Option $j = 1$: accommodating; i.e., $v_t = \pi_s$. In response, the supplier does not enter the market even if becoming capable in period t, and thus $(1-\beta)u_b^{(1)} = 1 - \pi_s$, and $(1-\beta)u_s^{(1)} = \pi_s$.*
- *Option $j = 2$: squeezing; i.e., $v_t = \underline{v}_M$. In response, the supplier accepts the offer but enters the market if becoming capable in period t, and thus $(1-\beta)u_b^{(2)} = (1-l_M)\cdot(1-\underline{v}_M) + l_M\pi_b$, and $(1-\beta)u_s^{(2)} = (1-l_M)\underline{v}_M + l_M\pi_s$.*
- *Option $j = 3$: dumping; i.e., $v_t < \underline{v}_M$. In response, the supplier rejects the offer and enters the market as soon as becoming capable. We have $(1-\beta)u_b^{(3)} = (1-s_M)(1-c) + s_M\pi_b$, and $(1-\beta)u_s^{(3)} = (1-s_M)r + s_M\pi_s$.*

We compare the three options to identify the buyer's optimal strategy. Accommodating is qualitatively different from squeezing and dumping in terms of the equilibrium outcome. If the buyer chooses accommodating, the supplier will never enter; however, in the other two options the supplier will enter at some point, despite the difference of the expected entry timing. Therefore, we first discuss when it is optimal for the buyer to preempt entry by accommodating, and then examine how she chooses between squeezing and dumping.

4.1. When to Preempt Entry?

The option of accommodating benefits the buyer by maintaining her monopoly profit, but it costs her the value transfer $v_t = \pi_s$, which is higher than that in the other two options. Therefore, intuitively, it is optimal to accommodate when π_s is sufficiently low, compared with the prospective loss due to the supplier's entry in the other two options.

Specifically, we compare $u_b^{(1)}$ and $u_b^{(2)}$ and find the former is larger if and only if

$$\pi_s < \pi_s^{(12)}(\pi_b) \equiv \frac{l_M(1-\pi_b) + (1-s_M)r}{l_M + (1-s_M)}.$$

We compare $u_b^{(1)}$ and $u_b^{(3)}$ and find the former is larger if and only if

$$\pi_s < \pi_s^{(13)}(\pi_b) \equiv s_M(1-\pi_b) + (1-s_M)c.$$

Both thresholds $\pi_s^{(12)}(\pi_b)$ and $\pi_s^{(13)}(\pi_b)$ are always lower than $1-\pi_b$ given the model assumptions $r < \pi_s < 1-\pi_b$ and $c < 1-\pi_b$. This implies that accommodating can never completely dominate squeezing or dumping as π_s increases from 0 to $1-\pi_b$. However, as π_s increases, should the buyer prefer dumping or squeezing? We examine this question next.

4.2. Squeezing or Dumping?

To analyze the trade-off in the choice between squeezing and dumping, we compare the two options by decomposing the difference

$$\begin{aligned}(1-\beta)u_b^{(3)} &- (1-\beta)u_b^{(2)} \\ &= \underbrace{(l_M - s_M)(1-c-\pi_b)}_{\text{benefit}} - \underbrace{(1-l_M)(c-\underline{v}_M)}_{\text{opportunity cost}}. \qquad (3)\end{aligned}$$

The benefit of dumping is that it delays the supplier's entry by a time period $(l_M - s_M)$, during which the buyer enjoys the monopoly profit $1-c$ as opposed to duopoly profit π_b. Thus, the benefit is measured as $(l_M - s_M)(1-c-\pi_b)$. However, if choosing dumping over squeezing, the buyer foregoes the opportunity to "exploit" the supplier. In the squeezing relationship, the buyer pays the supplier value $\underline{v}_M$ rather than incurring the outside option cost c for a period $(1-l_M)$, meaning an opportunity of cost saving $(1-l_M)(c-\underline{v}_M)$.

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

Equation (3) suggests that it is better to use the squeezing strategy when the opportunity cost is sufficiently high. In particular, the opportunity cost term in Equation (3) includes $(1-l_M)(-\underline{v}_M) = (l_M - s_M)\pi_s - (1-s_M)r$, and so increases with $(l_M - s_M)\pi_s$, which is the benefit that the supplier can obtain from his expedited entry measured by time length $(l_M - s_M)$. The supplier wants to develop necessary capabilities by supplying, akin to an apprentice who needs to pay tuition to the master to learn. The benefit $(l_M - s_M)\pi_s$ minus the outside option cost $(1-s_M)r$ is analogous to the *tuition* that the supplier pays the buyer in exchange for faster entry. From the perspective of the buyer, she chooses squeezing over dumping when dealing with a supplier who can pay sufficiently high tuition, namely, one with high competitiveness π_s.

Formally, Equation (3) implies that squeezing is preferred to dumping if and only if

$$\pi_s > \pi_s^{(32)}(\pi_b) \equiv 1 - \pi_b - \frac{(1-s_M)(c-r)}{l_M - s_M}.$$

4.3. Full Picture of the Optimal Choice Among the Three Options

We now combine the pairwise comparisons of the three options and produce a full picture of the buyer's optimal choice. It is easy to verify that all three threshold curves $\pi_s^{(12)}(\pi_b)$, $\pi_s^{(13)}(\pi_b)$, and $\pi_s^{(32)}(\pi_b)$ intersect when $\pi_b = \underline{\pi}_b \equiv 1 - c - (c-r)/(l_M - s_M)$ and $\pi_s = \underline{\pi}_s \equiv c + s_M(c-r)/(l_M - s_M)$. Note that $c < r$ implies $\pi_s^{(32)}(\pi_b) > 1 - \pi_b$, and therefore for all $\pi_s < 1 - \pi_b$, dumping dominates squeezing. In other words, the condition $c > r$ is a necessary condition for the squeezing relationship to exist. We discuss the scenario with $c > r$ in Proposition 1, and report the scenario with $c \le r$ in Proposition 2.

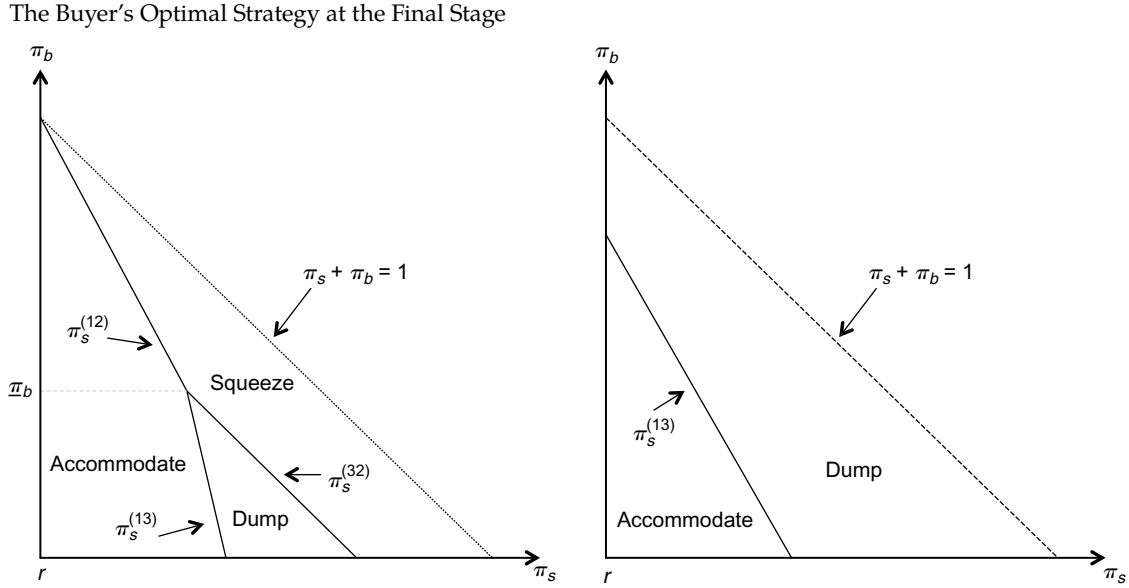
Proposition 1. *If $c > r$, the buyer's optimal strategy is characterized as follows. When $\pi_b > \underline{\pi}_b$, it is optimal to accommodate if $\pi_s \le \pi_s^{(12)}(\pi_b)$, and it is optimal to squeeze otherwise. When $\pi_b \le \underline{\pi}_b$, it is optimal to accommodate if $\pi_s \le \pi_s^{(13)}(\pi_b)$, it is optimal to squeeze if $\pi_s > \pi_s^{(32)}(\pi_b)$, and it is optimal to dump otherwise.*

Figure 1(a) illustrates Proposition 1. As discussed earlier, when the supplier's competitiveness π_s is small, and hence accommodating is not too costly, the buyer finds it optimal to accommodate and preempt the supplier's entry incentive. Furthermore, when π_s is sufficiently high and the supplier can pay high tuition, the buyer finds it optimal to squeeze rather than to dump the supplier.

The new insight in Proposition 1 centers on the condition under which dumping is optimal. Dumping is an intuitive choice when the buyer expects the supplier to rebel but finds it too costly to preempt this behavior by accommodating him. Although this intuition may be valid under certain conditions (to be further examined in Proposition 2), Figure 1(a) shows that dumping is never optimal when π_b is sufficiently high ($\pi_b > \underline{\pi}_b$): When π_b is large, the benefit term in Equation (3) is low, and thus dumping is not worthy of consideration. Dumping is optimal only when the buyer's own competitiveness is low ($\pi_b \le \underline{\pi}_b$, and hence she has much to lose upon the supplier's entry) and the supplier's competitiveness π_s is intermediate, in which case the supplier is not only too costly to accommodate but also offers tuition that is too low to be worth squeezing.

Proposition 2. *If $c \le r$, $\pi_s^{(32)}(\pi_b)$ exceeds $1 - \pi_b$. As a result, it is never optimal for the buyer to squeeze. In particular, it is optimal to accommodate when $\pi_b \le \pi_s^{(13)}(r)$ and $\pi_s \le \pi_s^{(13)}(\pi_b)$, and it is optimal to dump, otherwise.*

Figure 1. The Buyer's Optimal Strategy at the Final Stage



(a) When $c > r$ (b) When $c \le r$

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

Figure 1(b) illustrates Proposition 2, which shows that the buyer chooses only between accommodating and dumping. To see why dumping always dominates squeezing when $c \le r$, we rearrange Equation (3) and obtain

$$(1-\beta)u_b^{(3)} - (1-\beta)u_b^{(2)} = (l_M - s_M)[1-\pi_b-\pi_s-(c-r)] - (1-l_M)(c-r). \quad (4)$$

As opposed to Equation (3), which focuses on the cost–benefit analysis from the buyer's perspective, Equation (4) offers a different view, which focuses on the value creation potential of the value chain system formed by the two firms. In particular, if squeezing occurs, the value system enters the duopoly status earlier by time length $(l_M - s_M)$, during which the system creates the sum of the duopoly value $(\pi_b + \pi_s)$ per period as opposed to the monopoly value 1; therefore, $(1 - \pi_b - \pi_s)$ is the value loss per period. In contrast, dumping avoids such a loss by foregoing the cost difference $(c - r)$, creating a net benefit to the supply chain at rate $[1-\pi_b-\pi_s-(c-r)]$ for time length $(l_M - s_M)$, which explains the term $(l_M - s_M)[1-\pi_b-\pi_s-(c-r)]$ in Equation (4). This is compared with the benefit squeezing can generate for the supply chain, the cost reduction $(c - r)$ per period before the supplier's entry (i.e., for time length $1 - l_M$). Accordingly, the squeezing regime can exist only if the value system can create some positive value $(1 - l_M)(c - r)$; namely, c needs to be greater than r. Otherwise, squeezing is always dominated by dumping.

4.4. Cross-Sectional Analysis: Capacity Development Speeds and Regime Shifts

Proposition 1 offers the opportunity to conduct comparative analyses. Our dependent constructs are the equilibrium relationship types (discrete) and the associated share of value distribution (continuous), which are the core interests of our model. For the independent constructs, we focus on the speed of capability development and firms' product market competitiveness. We choose these two factors because they are, respectively, key characteristics of firms' underlying capabilities and manifested products. Although sometimes considered separately in different literatures, examining the factors together provides a more complete perspective for us to understand firm strategy (Wernerfelt 1984) in dynamic environments (Pacheco-de-Almeida and Zemsky 2012). Note that Proposition 1 has already examined the impact of product market competitiveness on the choice of relationships and the impact of the speed of capability development on value share distribution. Therefore, in the following analysis, we focus on how the speed of capability development influences the choice among different relationship types and how product market competitiveness influences value share distribution.

The speed of capability development can vary significantly across different contexts (industries or institutions), depending on the nature of the knowledge that underlies the development of technological and marketing capabilities. For example, in contexts where knowledge is tacit, it is more difficult for the supplier to imitate the buyer from outside the supply relationship than from within, which affords intimate interactions with the buyer, facilitating the acquisition of tacit knowledge (Winter 1987). In such contexts, capability development by supplying is much faster than independent development, equivalent to increasing l_M while holding s_M constant. Conversely, in contexts with abundant public knowledge or skilled workers, perhaps due to a well-developed public infrastructure (e.g., universities or government research labs), self-developing becomes easier relative to capability development by supplying. This is equivalent to increasing s_M while holding l_M constant. Below we analyze how varying speeds of capability development can affect the thresholds of different regimes in Figure 1.

Corollary 1. *The threshold $\pi_s^{(12)}$ increases in both l_M and s_M, the threshold $\pi_s^{(13)}$ increases in s_M, and the threshold $\pi_s^{(32)}$ increases in l_M and decreases in s_M.*

One can easily verify the monotonicity of the thresholds $\pi_s^{(12)}$, $\pi_s^{(13)}$, and $\pi_s^{(32)}$ by examining their first-order derivatives with respect to l_M and s_M. Below we briefly explain the economic intuition. The variations of l_M and s_M shift the thresholds because they affect the buyer's expected value under each of the three options in different ways. Under the accommodating option, per Lemma 1, neither l_M nor s_M affects the buyer's expected value $u_b^{(1)}$, because these two capability development speed parameters are irrelevant when the supplier does not plan for entry. Similarly, under the dumping option, the speed of capability development by supplying l_M is irrelevant, and hence does not affect the buyer's expected value $u_b^{(3)}$; however, as the self-developing speed s_M increases, the buyer suffers sooner from the supplier's entry, and hence $u_b^{(3)}$ decreases.

Finally, under the squeezing option, as either l_M or s_M increases, the buyer derives lower value $u_b^{(2)}$. Specifically, as s_M increases, the supplier's self-developing option becomes more attractive, so the buyer has to offer a higher $\underline{v}$, namely, to squeeze less. As l_M increases, there are two opposing effects, namely, a lower $\underline{v}$ (i.e., to squeeze more in amount) but a shorter squeezing duration (i.e., to squeeze less in time). We find that the former (positive) effect is proportional to π_s because the tuition amount $(-\underline{v})$ is linear in π_s, whereas the latter (negative) effect is proportional to $(1 - \pi_b)$, which is the buyer's marginal loss per time unit due to the supplier's earlier entry. Since $(1 - \pi_b) > \pi_s$, the negative effect always dominates the positive

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

effect, and therefore the buyer overall obtains less from squeezing as l_M increases.

Therefore, as l_M or s_M increases, accommodating becomes more attractive than squeezing, and hence $\pi_s^{(12)}$ increases. As s_M increases, accommodating becomes more attractive than dumping, and hence $\pi_s^{(13)}$ increases. As l_M increases, dumping becomes more attractive than squeezing, and hence $\pi_s^{(32)}$ increases. However, as s_M increases, the buyer finds both squeezing and dumping less attractive, and so her preference between the two options is not straightforward. Equation (3) suggests that the benefit of dumping diminishes faster than the opportunity cost as s_M increases, which implies that, relatively, dumping is less preferable to squeezing; namely, $\pi_s^{(32)}$ decreases.

In a nutshell, when the speed of developing-by-supplying l_M increases, the squeezing region in Figure 1 shrinks—it is better to preempt the supplier's entry or to simply "fire" the supplier. In contrast, when the speed of self-developing s_M increases, the dumping region shrinks—dumping becomes less effective, because the supplier can independently develop his capabilities. In particular, when l_M and s_M are sufficiently close, the threshold $\underline{\pi}_b$ is lower than r, causing the dumping region to disappear.

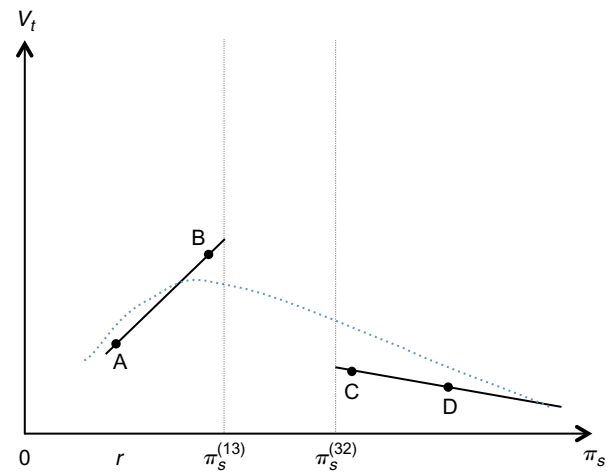
4.5. Cross-Sectional Analysis: Product Market Competitiveness and Value Distribution

Firms exhibit various degrees of product market competitiveness in different contexts. For example, π_s is higher in industries where customers are price sensitive and prone to poaching by suppliers-turned-competitors who provide low-priced offerings. In particular, when competition resides in domestic markets in China or India, π_s can increase significantly because domestic suppliers are more familiar with the local consumer tastes and distribution channels, and they may receive government support. The following corollary characterizes an interesting nonlinear relationship between product market competitiveness and value distribution.

Corollary 2. *As π_s increases, the offered value v_t increases if (π_b, π_s) is in the accommodation region, and it decreases if (π_b, π_s) is in the squeezing region.*

As shown in Figure 2, as π_s increases, the supplier's value share v_t will first increase, if (π_b, π_s) is in the accommodating region ($\pi_s \le \pi_s^{(13)}(\pi_b)$, e.g., from point A to point B), because the buyer needs to pay more to retain a more competitive supplier. However, once (π_b, π_s) moves out of the accommodating region and into the squeezing region ($\pi_s > \pi_s^{(32)}(\pi_b)$, e.g., from point C to point D), v_t will first drop and then decrease with π_s, because the buyer wants to squeeze more to compensate for the future loss due to a very competitive supplier-turned-entrant. In other words, this nonlinearity is driven jointly by a switch in regime and by the marginal impact of product market competitiveness on value distribution within the same regime. Empirically, as shown in Figure 2, we should expect an (approximated) inverted-U shape between the value the supplier appropriates and the supplier's competitiveness. Note that the gap between $\pi_s^{(13)}$ and $\pi_s^{(32)}$ corresponds to the dumping region, in which the two firms do not form a vertical relationship with a defined v_t.

Figure 2. (Color online) Supplier's Value Share and Product Market Competitiveness



5. Intertemporal Analysis

The base model analysis focuses on the buyer's choice of vertical relationship at a single stage (i.e., the final stage) of the supplier's capability development process. It helps identify three types of dominant relationship and examine the buyer's trade-offs and optimal choice, yielding rich cross-sectional predictions regarding the characteristics of the vertical relationship. However, if the supplier's capability development exhibits noticeably different stages, how does the buyer intertemporally adjust the relationship? To explore this question, we now study the general setting with multiple stages ($M \ge 2$) by examining the early stages.

Let $\underline{v}_k$ denote the supplier's minimum acceptable offer when he is at stage $k < M$; namely, the supplier would be indifferent between accepting $\underline{v}_k$ and rejecting it. We can derive

$$\underline{v}_k = r - \frac{(l_k s_{k+1} - s_k)(\pi_s - r)}{1 - l_k}, \quad \text{for } k = 1 \sim M-2 \tag{5}$$

and

$$\underline{v}_{M-1} = r - \frac{(l_{M-1}\tilde{s}_M - s_{M-1})(\pi_s - r)}{1 - l_{M-1}}, \tag{6}$$

where $\tilde{s}_M = 1$ if (π_b, π_s) is in the accommodating region of the final stage and $\tilde{s}_M = s_M$, otherwise; see the derivation in the appendix. It is worth noting that $\underline{v}_k$ is always

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

less than the supplier's outside option value r, similar to $\underline{v}_M < r$. In other words, the notion of a "squeezing offer" prevails at all stages of the supplier's development process. Like Lemma 1 for the base model, Lemma 2 shows that the buyer's optimal strategy at any early stage k lies in a small set of undominated options: either squeezing or dumping. Let $u_i^{(2)}(s_k)$ and $u_i^{(3)}(s_k)$ denote the expected NPV of firm $i = b, s$, if the buyer chooses squeezing and dumping, respectively, as defined in Lemma 2.

Lemma 2. *If the supplier is at stage $k < M$ of capability development at the beginning of period t, the buyer chooses between two options regarding v_t:*

- *Squeezing: i.e., $v_t = \underline{v}_k$. In response, the supplier accepts the offer; we have $(1-\beta)u_s^{(2)}(s_k) = (1-s_k)r + s_k\pi_s$, and $(1-\beta)u_b^{(2)}(s_k) = (1-l_k)(1-\underline{v}_k) + l_k u_b(s_{k+1})$, where $u_b(s_{k+1}) \equiv \max\{u_b^{(2)}(s_{k+1}), u_b^{(3)}(s_{k+1})\}$.*
- *Dumping: i.e., $v_t < \underline{v}_k$. In response, the supplier rejects the offer, and the two firms turn to their outside options; we have $(1-\beta)u_s^{(3)}(s_k) = (1-s_k)r + s_k\pi_s$ and $(1-\beta)u_b^{(3)}(s_k) = (1-s_k)(1-c) + s_k\pi_b$.*

As opposed to Lemma 1, the new insight in Lemma 2 is that the buyer does not need to accommodate the supplier at his early stages of capability development if the development is gradual, i.e., the buyer faces no risk that the supplier can enter the market by the end of the current period.[7]

However, which is the buyer's optimal strategy at an early stage k: squeezing or dumping? To answer this question we follow the standard approach of backward induction, which yields a simple rule described in the following inequality (8). While relegating the technical details to the appendix, we outline the analysis as follows. In the backward induction to stage k, given the equilibrium of the subgame (i.e., stage k and onward), define γ_k as the discount factor associated with the time from a stage k period till the supply chain relationship termination if the buyer does not terminate it at stage k. We can compute γ_k for all possible situations. If there is a future stage at which the buyer dumps the supplier in the equilibrium, let $d(k)$ denote the nearest one of such stages, and we have $\gamma_k = l_k l_{k+1} \cdots l_{d(k)-1}$. If no such stage exists, let $s_{d(k)}$ denote 1 for notational convenience, and there are only two possibilities: (1) the buyer squeezing at all future stages, in which case we have $\gamma_k = l_k l_{k+1} \cdots l_M$, and (2) the buyer accommodating at the final stage and squeezing at all the other future stages, in which case we have $\gamma_k = 0$ (because the relationship will never be terminated). Given γ_k and $s_{d(k)}$, we find the following:

$$\begin{aligned}&(1-\beta)u_b^{(3)}(s_k) - (1-\beta)u_b^{(2)}(s_k)\\ &= (\gamma_k s_{d(k)} - s_k)[1-\pi_b-\pi_s-(c-r)] - (1-\gamma_k)(c-r). \quad (7)\end{aligned}$$

Equation (7) is similar to Equation (4), confirming the robustness of the insights. Specifically, of the two strategies, the buyer prefers the one that creates more value to the value chain system formed by the two firms. In particular, by dumping the supplier at stage k, the buyer delays the supplier's entry by time $(\gamma_k s_{d(k)} - s_k)$ in which the supply chain net benefit accrues at rate $[1-\pi_b-\pi_s-(c-r)]$ per period; otherwise, if not dumping, it would take time $(1-\gamma_k)$ before reaching the relationship termination stage $d(k)$, and till then the supply chain receives cost reduction rate $(c-r)$ per period.

Equation (7) implies a simple rule: The buyer dumps the supplier at stage k if and only if

$$\frac{\gamma_k s_{d(k)} - s_k}{1-\gamma_k}[1-\pi_b-\pi_s-(c-r)] > c-r. \quad (8)$$

Applying this in the backward induction, we determine how the buyer's optimal strategy at stage k depends on the firms' market competitiveness π_b and π_s, and discover all possible intertemporal patterns. We present the results in Propositions 3 (for scenario $c > r$) and 4 (for scenario $c \le r$) . The proof details are provided in the online appendix.

Proposition 3. *Consider the scenario with $c > r$.*

(i) *The buyer's optimal strategy at each early stage k is characterized as follows. There exists a threshold $\underline{\pi}_b^k$. When $\pi_b > \underline{\pi}_b^k$, it is optimal to squeeze; when $\pi_b \le \underline{\pi}_b$, it is optimal to dump if $\min\{\pi_s^{(12)}(\pi_b), \pi_s^{(13)}(\pi_b)\} < \pi_s < \pi_s^k(\pi_b)$, where $\pi_s^k(\pi_b) \equiv \underline{\pi}_b^k + \min\{\pi_s^{(12)}(\underline{\pi}_b^k), \pi_s^{(13)}(\underline{\pi}_b^k)\} - \pi_b$, and it is optimal to squeeze, otherwise.*

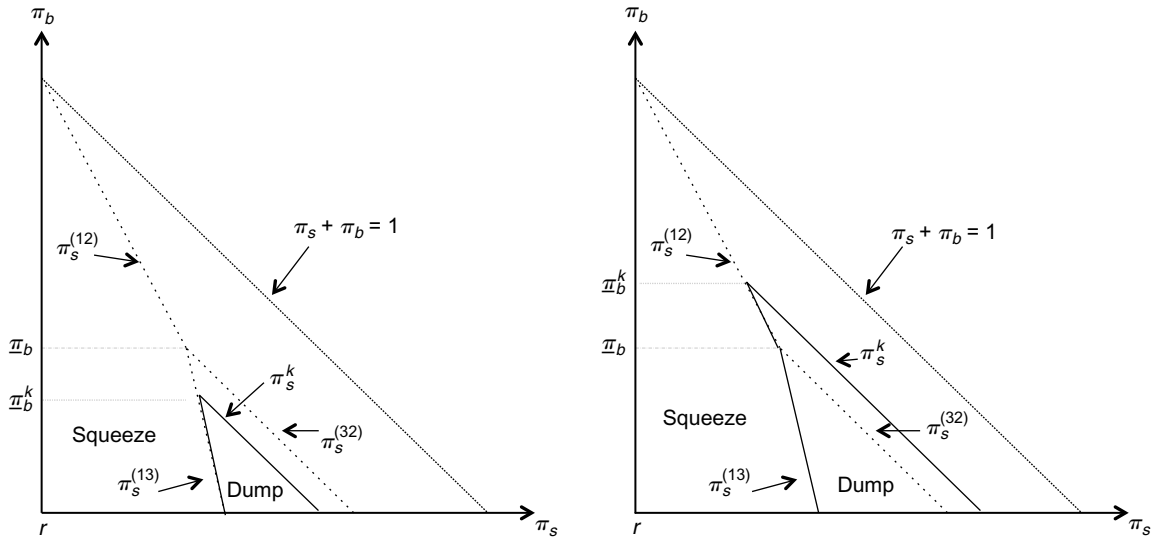
(ii) *The buyer's optimal strategy exhibits the intertemporal patterns characterized as follows. If $\pi_s \le \min\{\pi_s^{(12)}(\pi_b), \pi_s^{(13)}(\pi_b)\}$, the buyer squeezes at all early stages and accommodates at the final stage; if $\pi_s \ge 1-\pi_b+r-c$, the buyer squeezes at all stages; otherwise, i.e., in the region where $\min\{\pi_s^{(12)}(\pi_b), \pi_s^{(13)}(\pi_b)\} < \pi_s < 1-\pi_b+r-c$, all the following patterns are possible depending on π_b, π_s, and $(l_k, s_k; k = 1 \sim M)$: never engaging the supplier; squeezing at early stages and dumping before or until the supplier reaches the final stage; squeezing at all stages.*

Figure 3 illustrates the buyer's stage k optimal strategy described in Proposition 3(i). The threshold $\underline{\pi}_b^k$ may be higher or lower than $\underline{\pi}_b$ (which is the final-stage threshold such that $\pi_s^{(12)}(\underline{\pi}_b) = \pi_s^{(13)}(\underline{\pi}_b)$, defined before Proposition 1 and illustrated in Figure 1(a)), and thus the dumping region at stage k may be larger or smaller than that at the final stage; nevertheless, the location of the dumping region at all stages is similar, reinforcing the following findings: there is no need to dump the supplier if the buyer expects low damage (i.e., high π_b) from the supplier's entry, or can inexpensively accommodate the supplier at the final stage (i.e., very low π_s), or can squeeze high tuition from the supplier (i.e., very high π_s).

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

Figure 3. The Buyer's Optimal Strategy at an Early Stage k When $c > r$



Notes. The thresholds $\pi_s^{(12)}, \pi_s^{(13)}, \pi_s^{(32)}$, and $\underline{\pi}_b$ are defined in Section 4; $\underline{\pi}_b^k$ and π_s^k are defined in Proposition 3. The left panel assumes $\underline{\pi}_b^k \le \underline{\pi}_b$, and the right panel assumes $\underline{\pi}_b^k > \underline{\pi}_b$.

Proposition 3(ii) describes the intertemporal patterns, suggesting how the buyer might strategically adjust the vertical relationship as the supplier gradually develops capability. First, if it is optimal to accommodate the supplier at the final stage, then $\gamma_k = 0$ for all early stage k, which implies inequality (8) never holds; i.e., the buyer never finds it optimal to dump the supplier at stage k. The intuition is that if the buyer plans to preempt the supplier entry at the final stage (because the supplier is inexpensive to accommodate), then she expects no threat (i.e., $\gamma_k = 0$), but only benefits from engaging the supplier because of the opportunity to squeeze the supplier (i.e., $\underline{v}_k < r$) and to leverage the supplier's lower cost (i.e., $r < c$).

Second, if the supplier can afford very high tuition, i.e., $\pi_s \ge 1 - \pi_b + r - c$, Proposition 1 suggests that the buyer will prefer to squeeze at the final stage regardless of development speeds l_M and s_M. This insight extends to any early stage k because the condition $\pi_s \ge 1 - \pi_b + r - c$ implies the left side of inequality (8) is always negative. Thus, we conclude the robustness of the following result despite the dynamics of supplier capability development. As long as the supplier is sufficiently competitive in the market (i.e., very high π_s), the buyer can always charge tuition to compensate for her future loss due to the supplier's entry; as a result, the buyer will never dump the supplier.

Finally, Proposition 3(ii) identifies the region $(\min\{\pi_s^{(12)}(\pi_b), \pi_s^{(13)}(\pi_b)\} < \pi_s < 1 - \pi_b + r - c)$ in which the vertical relationship on the equilibrium path may be terminated at the very first stage, some early stage, or the final stage, or perhaps not terminated until the supplier eventually enters the market. When should the buyer strategically terminate the relationship? Technically, as the rule of inequality (8) suggests, she should do so at the first stage k where the ratio $(\gamma_k s_{d(k)} - s_k)/(1 - \gamma_k)$ exceeds the ratio $(c - r)/(1 - \pi_b - \pi_s - (c - r))$. Since the former ratio is not exogenous (i.e., depending on the subgame equilibrium in the backward induction), we illustrate various intertemporal patterns through the following Example 1 and formalize the general results in Corollary 3.

Example 1. The supplier's capability development undergoes three milestones ($M = 3$) with $s_1 = 0.1$, $s_2 = 0.2$, and $s_3 = 0.5$. The parameters ($\pi_b = 0.35$, $\pi_s = 0.45$, $c = 0.2$, $r = 0.15$) reside in the region of discussion: $\pi_s^{(13)}(\pi_b) = 0.425 < \pi_s < 1 - \pi_b + r - c$.

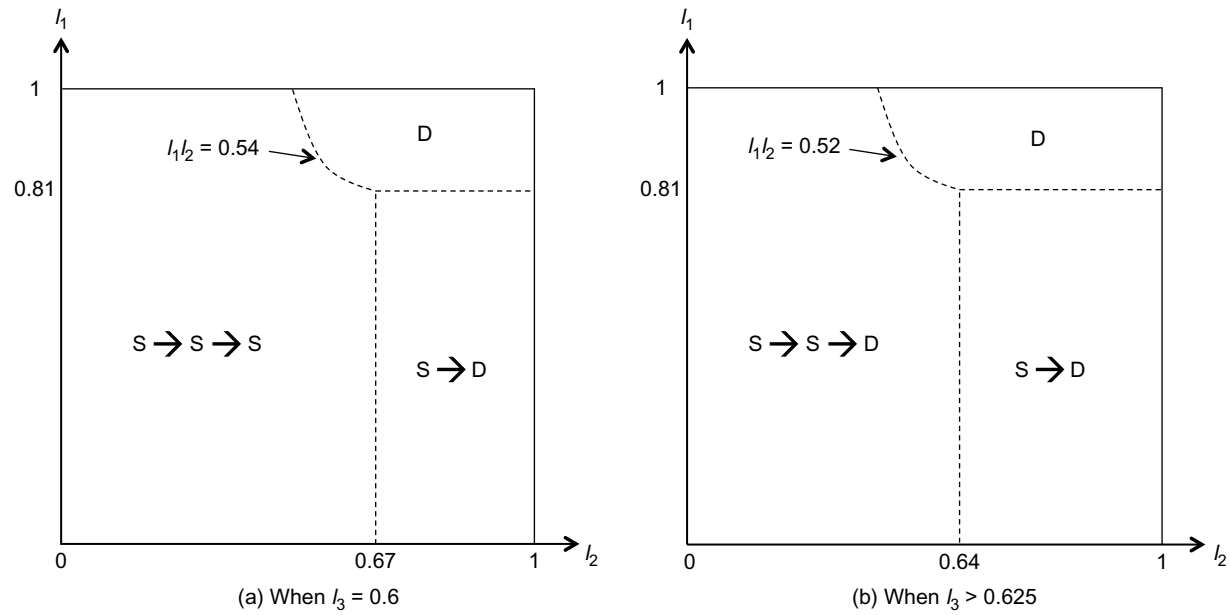
Given the fixed milestone capability levels (s_1, s_2, s_3), we vary the developing-by-supplying speed parameters (l_1, l_2, l_3) to examine how they affect the buyer's optimal strategy and the associated intertemporal patterns. We do so by applying the rule of inequality (8), i.e., comparing $(\gamma_k s_{d(k)} - s_k)/(1 - \gamma_k)$ with $(c - r)/(1 - \pi_b - \pi_s - (c - r)) = \frac{1}{3}$. Figure 4 presents the results.

Figure 4 illustrates the rich dynamics possible in the buyer's intertemporal strategy (as Proposition 3(ii) implies) and reveals that at each stage the buyer may strategically terminate the relationship (by dumping the supplier) if the supplier would develop too fast at that stage, namely, if l_k exceeds a certain threshold. Furthermore, the threshold may be affected by (i.e., decreasing in) the speeds of future stages $l_{k+1}, \ldots, l_M$. The overall finding is that the entire shape of the capability development process (characterized by $l_k, s_k; k = 1 \sim M$) determines the ratio $(\gamma_k s_{d(k)} - s_k)/(1 - \gamma_k)$ of each stage and therefore the timing of the buyer's strategic termination. We formalize this finding in Corollary 3, which follows from the monotonicity

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

Figure 4. The Buyer's Optimal Strategy in Example 1



Notes. The notations D, S → D, S → S → D, and S → S → S represent not engaging the supplier at all, dumping at stage 2, dumping at stage 3, and squeezing at all three stages, respectively.

of the ratio $(\gamma_k s_{d(k)} - s_k)/(1-\gamma_k)$. The proof details are provided in the online appendix.

Corollary 3. *Consider the scenario with $c > r$. At stage k, the dumping region defined in Proposition 3 expands, i.e., the threshold $\underline{\pi}_b^k$ weakly increases, and hence the line $\pi_s^k(\pi_b)$ shifts upward, if $l_k, l_{k+1}, \ldots$, or l_M increases or if s_k decreases.*

Similarly, we study the scenario with $c \le r$. Proposition 2 shows that the buyer would either accommodate (if $\pi_b \le \pi_s^{(13)}(r)$ and $\pi_s \le \pi_s^{(13)}(\pi_b)$) or dump the supplier at the final stage (otherwise). In the former case, $\gamma_k = 0$ holds for any early stage k, and hence the rule of inequality (8) implies that it is optimal to squeeze if and only if $s_k \ge (r-c)/(1-\pi_b-\pi_s+r-c)$; in the latter case, $(\gamma_k s_{d(k)} - s_k)/(1-\gamma_k) > 0$ holds for any early stage k and the inequality always holds because of negative $c-r$, which implies dumping at all stages. We summarize these results in Proposition 4.

Proposition 4. *Consider the scenario with $c \le r$.*

(i) *The buyer's optimal strategy at each early stage k is characterized as follows: It is optimal to squeeze if $\pi_b \le \pi_s^{(13)}(r)$, $\pi_s \le \pi_s^{(13)}(\pi_b)$, and $s_k \ge (r-c)/(1-\pi_b-\pi_s+r-c)$; otherwise, it is optimal to dump.*

(ii) *The buyer's optimal strategy exhibits the following intertemporal patterns: If $\pi_b \le \pi_s^{(13)}(r)$, $\pi_s \le \pi_s^{(13)}(\pi_b)$ and $s_1 \ge (r-c)/(1-\pi_b-\pi_s+r-c)$, then the buyer squeezes at all early stages and accommodates at the final stage; otherwise, the buyer never engages the supplier.*

Proposition 4(i) is consistent with Proposition 2. When the loss due to supplier entry is low (i.e., $1-\pi_b-\pi_s$ is low) or the threat is low (i.e., s_k is low), there is no need to engage the supplier; otherwise, it is better to engage the supplier and preempt his entry (by squeezing at the early stages and accommodating at the end). The interesting new result is that squeezing becomes possibly optimal at stage k as long as the buyer plans to use accommodation in the end. In this case, squeezing at stage k is an entry delay/preemptive strategy, even though common wisdom may suggest dumping as the entry delay strategy. This result shows the impact of dynamic strategic planning.

As Proposition 4(i) suggests, the squeezing region (requiring $s_k \ge (r-c)/(1-\pi_b-\pi_s+r-c)$) is smallest at stage 1 among all early stages. For this reason, Proposition 4(ii) states that on the equilibrium path, the intertemporal pattern does not depend on the early-stage capability development process parameters l_k and s_k, except for s_1.

However, it is worth noting that if the buyer engages the supplier, her offer $\underline{v}_k$ does depend on the values of l_k, s_k and s_{k+1}, as shown by the closed-form expressions of $\underline{v}_k$ in Equations (5) and (6). In particular, the supplier's value share $\underline{v}_k$ increases in s_k (the speed of self-developing) because if the supplier can self-develop the desired capabilities faster, dumping becomes less effective from the perspective of the buyer, who then needs to make a more attractive offer. By contrast, $\underline{v}_k$ decreases in l_k (the speed of developing by supplying) because the supplier is willing to accept a lower offer in exchange for faster learning provided by the relationship. We formalize these results in Corollary 4, which holds for both scenarios $c > r$ and $c \le r$.

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

Corollary 4. *As π_s increases, the offered $\underline{v}_k$ decreases if (π_b, π_s) is in the squeezing region. The offered $\underline{v}_k$ increases in s_k and decreases in l_k.*

For empirical studies on the intertemporal behavior of value distribution, Corollary 4 cautions the use of relationship length as an independent variable. Intuitively, relationship length is a good proxy for the supplier's capability stage index k and the supplier's intermediate capability level s_k, and thus one might expect a positive coefficient when regressing the supplier's value share on relationship length (because $\underline{v}_k$ increases in s_k). However, such a positive coefficient may not be empirically found because the net effect of relationship length is the convolution of the effects of both s_k and l_k, and may vary nonmonotonically as k increases. In other words, to tease apart the relationship between the supplier's value share and intermediate supplier capability levels, one should find direct measures (e.g., the supplier's setting up an R&D center, establishing brand recognition, and building a distribution channel); alternatively, one could still use relationship length as a proxy, but then need to control for the effect of the speed of developing by supplying.

6. Extensions

6.1. Leapfrogging and the Possibility to Directly Achieve Full Capability

In this subsection, we extend our model to the possibility that the supplier can leapfrog stages in his development process. We model this by assuming that the supplier's capability level θ_t follows a Markov chain with a one-period transition probability matrix Γ with M rows and $M+1$ columns, where the element at kth row and gth column, denoted by $\tau_{k,g}$, is the probability that the supplier's capability level transits from s_k to s_g in one period of time, and, in particular, $\tau_{k,M+1}$ denotes the probability that he can achieve the full capability needed for market entry (i.e., a home run) in one period. Such a home run might be a small possibility, for example, if an acquisition allows the supplier to sweep all barriers in technology and distribution. To model that any stage $k < M$ is "earlier" than stage $k+1$, namely, that it takes a stochastically longer time from stage k to full capability than from stage $k+1$, we assume $\tau_{k,g} = 0$ for all $g < k$ and that the $k+1$st row of Γ is stochastically larger than the kth row, namely, $\sum_{g=\hat{g}}^{M+1} \tau_{k,g} < \sum_{g=\hat{g}}^{M+1} \tau_{k+1,g}$ holds for all $\hat{g} = k+1, \ldots, M+1$. Alternatively, this means it is more likely for the supplier to leap to any higher stage from stage $k+1$ than from stage k. To model that developing by supplying is faster than self-developing, it is necessary for $\beta\Gamma_k S > s_k$ to hold for all $k = 1, \ldots, M$, where Γ_k denotes the kth row of Γ, and S is the column vector $(s_1, s_2, \ldots, s_M, 1)$. Our analysis yields the following proposition. The proof details are provided in the online appendix.

Proposition 5. *Suppose that the supplier's capability development follows the Markov chain with the transition probability matrix Γ as described above.*

(i) *Propositions 3 and 4 hold if $\tau_{k,M+1} = 0$, $\forall\, k < M$.*

(ii) *If $\tau_{k,M+1} > 0$ at stage $k < M$, the buyer's optimal strategy is characterized as follows: There exists a threshold $\pi_s^{k,(1)}(\pi_b)$ such that it is optimal to accommodate if $\pi_s \le \pi_s^{k,(1)}(\pi_b)$, where $\pi_s^{k,(1)}(\pi_b) \le \pi_s^{k+1,(1)}(\pi_b) \le \cdots \le \pi_s^{M,(1)}(\pi_b)$; there exist a set of thresholds $\{\underline{\pi}_b^{k,k}, \underline{\pi}_b^{k,k+1}, \ldots, \underline{\pi}_b^{k,M}\}$ such that it is optimal to dump if $\max\{\pi_s^{g,(1)}(\pi_b), \pi_s^{k,g}(\pi_b)\} \le \pi_s < \pi_s^{g+1,(1)}(\pi_b)$ holds for some $g \in \{k, \ldots, M-1\}$, where $\pi_s^{k,g}(\pi_b) \equiv \underline{\pi}_b^{k,g} + \pi_s^{g,(1)}(\underline{\pi}_b^{k,g}) - \pi_b$, or if $\pi_s \ge \max\{\pi_s^{M,(1)}(\pi_b), \pi_s^{k,M}(\pi_b)\}$, where $\pi_s^{k,M}(\pi_b) \equiv \underline{\pi}_b^{k,M} + \pi_s^{M,(1)}(\underline{\pi}_b^{k,M}) - \pi_b$.*

Proposition 5(i) focuses on the case where leapfrogging occurs only across early stages (i.e., if $\tau_{k,M+1} = 0$, $\forall\, k < M$), and it establishes the robustness of the results in Section 5 (which assume the supplier's capability development is gradual). The results are robust because Lemma 2 holds even if the supplier can leapfrog over some early development stages. During his early stages of development, there is no need to accommodate the supplier as long as he cannot directly achieve full capability needed for entry starting from those stages; given this condition, the buyer will choose between squeezing and dumping per the same rule of inequality (8).

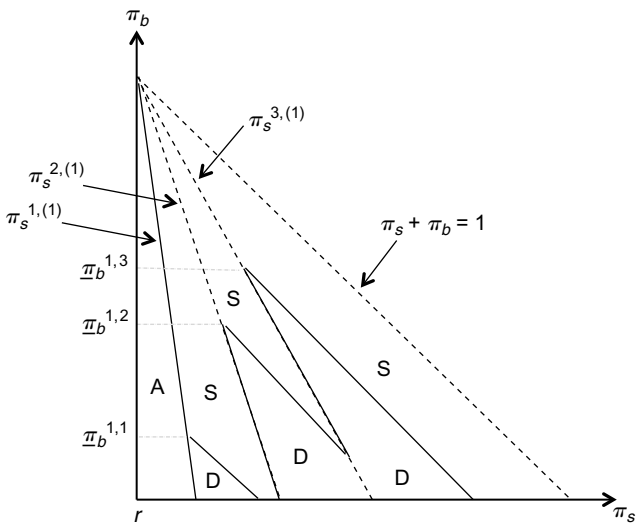
Proposition 5(ii) characterizes the case where there is a (small) possibility that the supplier can achieve full capability at stage $k < M$ (i.e., if $\tau_{k,M+1} > 0$). In such a case, Lemma 2 does not hold. In particular, it may be optimal for the buyer to accommodate the supplier at that stage for the same reason to use accommodation at the final stage (Lemma 1). In other words, if the supplier can reach full capability at stage k, then that stage k is possibly the final stage of the development process. In this case, the final-stage results in Section 4 (based on the single-stage analysis) apply to stage k in that there exists a region of accommodation characterized by a small value π_s (i.e., $\pi_s \le \pi_s^{k,(1)}(\pi_b)$). As the stage index k increases, the accommodation region expands (i.e., $\pi_s^{k,(1)}(\pi_b)$ increases in k) because the threat of the supplier directly achieving full capability increases (i.e., the assumptions about Γ implies $\tau_{k+1,M+1} > \tau_{k,M+1}$). Overall, this suggests that together the probabilities for the supplier to directly achieve full capability ($\tau_{k,M+1}$'s) and the firms' market competitiveness (π_b, π_s) determine the optimal timing of accommodating.

Outside the accommodation region, the buyer's trade-off between squeezing and dumping remains the same as prescribed by inequality (8). However, when applying the inequality rule to determine her preference, there are complications arising from the more complex development dynamics. Given (π_b, π_s), the value of γ_k (the discount factor associated with the

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

Figure 5. Buyer's Optimal Strategy at Stage 1 of $M = 3$; this Illustrates Proposition 5(ii)



time from a stage k period until the termination of the supply chain relationship) depends on at which later stage $(g+1)$ the buyer plans to accommodate in the subgame equilibrium. As a result, the boundary line that divides the squeezing and dumping regions, defined as $\pi_s^{k,g}(\pi_b)$ in Proposition 5(ii), depends on the index g such that $\pi_s^{g,(1)}(\pi_b) \le \pi_s \le \pi_s^{g+1,(1)}(\pi_b)$. We illustrate Proposition 5(ii) in Figure 5, assuming $k = 1$ and $M = 3$. Finally, we note that if the accommodation region exists at stage k, then the inverted-U-shape result depicted in Figure 2 holds at that stage.

6.2. Multiple Value Chain Climbers

Our main analysis focuses on studying how the prospect of a supplier climbing the value chain affects the dyad relationship (i.e., a buyer and a given supplier). When multiple suppliers compete for the buyer's contract, it is reasonable to postulate that as the competition increases (e.g., the number of suppliers increases), the buyer sees a lower outside option cost c, and the suppliers possess a lower outside option value r. In other words, the model parameters r and c can capture this type of supplier competition.

In this subsection, we extend our analysis to a different type of supplier competition that is more pertinent to the theme of our paper, one in which multiple suppliers compete to climb the value chain by developing their individual capabilities. We refer to it as "the competition" in the remainder of this subsection. The competition is analogous to multiple entrants racing to develop a new innovation to compete with the incumbent in the product market. We build a model similar to the setup in Wakeman (2010), which considers multiple identical product firms and a single technology firm. For simplicity, we focus on the one-stage setup ($M = 1$), controlling for the multistage development complications.

Assume at the outset there are $N+1$ identical firms in the supply market, each attempting to enter the buyer's market by developing the necessary capabilities. If such a firm develops the capabilities on its own, it becomes capable of entry in a period of time with probability $\rho > 0$. In contrast, if the buyer selects a firm as a supplier, the supplier can develop the capabilities stochastically faster, becoming capable of entry in a period of time with probability $\lambda > \rho$. However, because of uncertainties of capability development, any of the $N+1$ firms has the potential to be the first to become capable of entry, even though the selected supplier has a greater chance than any other N competitors. Similar to Gans (2014) and Wakeman (2010), we assume that the demand market can admit a limited number of profitable firms; in particular, for simplicity, we assume at most two profitable firms (i.e., the buyer and the first entrant). Our results do not hinge on this assumption. As long as each firm's profitability in the demand market decreases as more firms enter, the firms are better off if they enter the market earlier than others, which creates the competition in capability development. In the base model, the discount factors s_M (for self-developing) and l_M (for developing by supplying) capture the spent time and the probability for the supplier to become capable of entry. In this model with multiple value chain climbers, ρ and λ replace the roles of s_M and l_M. All other assumptions about c, r, π_b and π_s are the same as in Sections 3 and 4. We present the results in Proposition 6, which shows that the main insights from the base model continue to hold: The buyer strategically chooses among accommodating, squeezing, and dumping, depending on π_b and π_s; furthermore, the structures of Propositions 1 and 2 hold. We provide the proof details in the online appendix.

Proposition 6. *Suppose the buyer can select a supplier from $N+1$ identical candidate firms, all of whom attempt to climb the value chain. There exist threshold lines $\pi_s^{(12)}(\pi_b, N)$, $\pi_s^{(13)}(\pi_b, N)$, and $\pi_s^{(32)}(\pi_b, N)$. Propositions 1 and 2 hold, with the threshold lines $\pi_s^{(12)}(\pi_b)$, $\pi_s^{(13)}(\pi_b)$, and $\pi_s^{(32)}(\pi_b)$ replaced by $\pi_s^{(12)}(\pi_b, N)$, $\pi_s^{(13)}(\pi_b, N)$, and $\pi_s^{(32)}(\pi_b, N)$. All the three threshold lines decrease as N increases.*

Nevertheless, the competition in capability development yields several major implications for the buyer's strategic trade-offs. First, the option of not engaging any supplier (i.e., dumping) becomes less effective as the competition increases. Intuitively, as more firms attempt to climb up, it takes less time for the first one to succeed, leaving a shorter time horizon for the buyer's monopoly.

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

Second, the competition makes it more expensive to accommodate the selected supplier. In particular, our analysis finds that the minimum offer to accommodate the supplier equals $\pi_s + \beta N\rho(\pi_s - r)/(1-\beta)$ (see the proof of Proposition 6 for the derivation). The offer must be higher than π_s, the amount that an entrant firm can obtain, because the selected supplier knows that he will lose the chance to enter the market if any of the other N firms successfully enter the market, and should this happen, the buyer would withdraw the accommodating offer. In other words, the buyer must pay a premium $\beta N\rho(\pi_s - r)/(1-\beta)$ to compensate the supplier for his future loss, where $(\pi_s - r)/(1-\beta)$ measures the amount of the loss, and $\beta N\rho$ reflects how quickly this would occur. It is clear that the premium increases in the number of competitors N, rendering accommodating a less effective option for the buyer as the competition intensifies.

Third, whereas the competition surely reduces the effectiveness of the other two options, it can generate a pair of offsetting effects when the buyer chooses the squeezing option, making it relatively preferable over the other two options. On one hand, if any of the N unselected firms successfully enters before the selected supplier becomes capable of doing so, the squeezing relationship between the buyer and the selected supplier is terminated because the supplier losing the entry opportunity has no incentive to be squeezed any longer. Thus, the competition reduces the length of time in which the buyer can squeeze the supplier. On the other hand, as the number of firms increases, each firm has a lower chance of becoming the first to successfully enter the market, which implies a lower NPV if the supplier rejects the buyer's squeezing offer. As a result, the buyer can extract a larger share as the competition increases. As Proposition 6 shows, as N increases, the threshold lines dividing the regions of the three options all shift to the left (i.e., the squeezing region expands).

7. Conclusion and Discussion

In this paper, we study the phenomenon of value chain climbing in the context of offshore outsourcing. Although offshore outsourcing is a key strategy to lower production costs among Western firms, it may also enable the suppliers to climb the value chain. Suppliers from emerging markets may accumulate technological and marketing capabilities by supplying, with aspirations to compete with buyers in the product market. This shadow of future competition opens a new set of issues regarding how firms manage their value chain activities. Our paper represents an initial attempt to explore the implications of these issues, identifying a set of optimal relationships and demonstrating how these relationships may evolve over time. This study contributes to our understanding of how competition affects value chain relationships, a central topic in the strategy literature (Chatain and Zemsky 2007, Chatain 2011, de Fontenay and Gans 2008, Jia 2013, MacDonald and Ryall 2004).

Our study has implications for several other related literatures as well. It contributes to the research on how knowledge and capabilities complement the traditional focus on transaction costs in managing vertical relationships (Argyres and Zenger 2012). Recent research in this area shows that the consideration of knowledge spillovers beyond the focal transaction may significantly affect the governance of the focal transaction (Mayer 2006, Kang et al. 2009). To expand our understanding of this area, we examine how the management of buyer–supplier relationships is influenced by the interplay between capability development and product market competition, an intersection that has gained increasing attention in the formal modeling literature in the strategy field (Pacheco-de-Almeida and Zemsky 2012). In doing so, we formalize cumulative capability development, one of the central constructs in the strategy field, as a multistage Markov process, offering an analytical framework for future work along this line.

Our study also adds to a long-standing literature concerning the challenges new entrants pose to incumbents in the industry evolution process (Schumpeter 1934). Whereas early work in this stream outlined the impact of economic incentives and organizational capabilities (Tushman and Anderson 1986, Gilbert and Newbery 1982, Henderson 1993, Reinganum 1983), more recent studies deepened the analysis by capturing emerging issues such as licensing (Gans and Stern 2000), innovation trajectories (Cabral 2002), and platform-based competition (Zhu and Iansit 2011). Building on this momentum, we study a new type of market entry that stems from the rapidly changing global integration process. In this context, market entry is not exogenously generated by environmental change such as a technological breakthrough; rather, since the potential entrant already has an existing role as a supplier to multinational corporations, market entry is endogenously determined by the value distribution between the buyer (incumbent) and the supplier (potential entrant). The unique feature of this type of market entry thus points to the importance of examining alternative preemptive strategies (Cabral 2014).

As a further implication of our study, the identification of the squeezing relationship sheds new light on how firms can appropriate value from their tacit know-how. The most direct approach of value appropriation is to manufacture products in-house applying the know-how, but this approach may entail undesirably high manufacturing costs. A second approach is to sell the know-how on the market for technologies,

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

realizing value up front; yet, the market for technologies is known to be imperfect (Arora et al. 2001). Given these constraints, when in-house manufacturing costs are high, and when no market is available to price the transaction of know-how, our model suggests an alternative approach. The buyer can "sell" its *intangible* knowledge by entering a buyer–supplier transaction relationship based on *tangible* products. In effect, the buyer permits its tacit knowledge to spill over to the supplier. In return for this spillover, however, the buyer can appropriate value by squeezing the supplier.

Our study can provide insights into a broader set of issues. Governments in some emerging markets, such as China, intentionally adopt a policy of using markets to exchange for technologies, encouraging local firms to acquire advanced knowledge by working for foreign firms. Despite awareness of this intent, foreign firms typically accept the deal. One explanation for their acceptance could be dynamic capabilities—foreign firms can keep innovating for the next generation of products, and thus are less concerned with imitation. Our study reveals the existence of a squeezing relationship as an alternative explanation for this paradoxical phenomenon. Future research could empirically tease apart these two alternative explanations, dynamic capabilities versus the squeezing relationship, and find conditions (e.g., different industry life cycles or institutional environments) under which different explanations work better.

Our study also suggests that we need to carefully analyze when dumping is preferred. Such analysis can help evaluate the common suggestion that Chinese suppliers should be dumped when their value chain climbing threatens the buyer, who should then bring the manufacturing back on-shore or switch to suppliers in other emerging markets. Although dumping appears to be intuitive, our model shows that it is optimal only under certain conditions. Buyers or policy makers need to assess firms' relative outside options before considering the dumping strategy. For example, low-cost advantages associated with Chinese manufacturing result not only from cheap labor, but more fundamentally from the skills embodied in experienced workers and a reliable public infrastructure (e.g., utilities and transportation). Because a long period of time may be needed to accumulate these low-cost advantages, it may be difficult for alternative sources to catch up immediately.

On the empirical front, future work can follow the approach of the Yale or Carnegie Mellon surveys on industrial R&D in the U.S. manufacturing industries (Levin et al. 1987, Cohen et al. 2000) to classify different industries or institutional environments in emerging markets, basing this classification on characteristics that determine value chain climbing, such as the speed of capability development and product market competitiveness. Research can also conduct firm-level surveys to obtain more detailed data on relationship types, value distribution, and market entry. Given that such data are more concerned with changing conditions in the global context, they can expand the focus of prior work on issues related to value appropriation in advanced economies (Levin et al. 1987, Cohen et al. 2000). Such an empirical effort can not only test the predictions made by the current model, but also facilitate the design and adaptation of the global value chain.

To make our analytical model tractable, we make several simplifying assumptions. The first assumption is best explained by how our approach relates to, but differs from, the existing strategy literature on buyer–supplier relationships. The existing literature takes the role of suppliers as given and uses formal models of bargaining to study how strategic interactions among multiple buyers and suppliers (e.g., one buyer and multiple suppliers) endogenize firms' value appropriation abilities (Chatain and Zemsky 2007, de Fontenay and Gans 2008, Chatain 2011, Jia 2013). In contrast, we endogenize the supplier's switch from the existing role of a supplier to one of a competitor in the product market, to highlight the possibility that the supplier can climb the value chain. To this end, we make the simplifying assumption that the buyer can make a take-it-or-leave-it offer and hence extract most of the surplus. Whereas this setup is grounded in the specific empirical context where global buyers tend to possess disproportionally high bargaining power (Moran 2001, Harrison and Scorse 2010), helping us focus on certain key mechanisms, future research can generalize the analysis by endogenizing both the value appropriation ability of various firms and the potential change of their existing roles. Furthermore, we analyze the competition of multiple suppliers in climbing the value chain with the primary focus on the dyadic relationship; future research could push this further and examine the case of the buyer dual sourcing due to operational considerations.

Acknowledgments

The authors thank Bruno Cassiman; Aseem Kaul; Kyle Mayer; Jeff Reuer; Todd Zenger; the associate editor; two anonymous reviewers; participants at the Academy of Management Conference, the Atlanta Competitive Advantage Conference, the Strategic Management Society Conference, the Midwest Strategy Meeting, and the Management and Organization Review Research Frontiers Conference; as well as seminar participants at Columbia University, the University of Hong Kong, the University of Michigan, and Scuola Superiore Sant' Anna for valuable comments. Z. Wan gratefully acknowledges the support of the College of Business and the Center for International Business Education and Research of the University of Illinois at Urbana–Champaign as well as the Lundquist College of Business of the University

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

of Oregon. B. Wu gratefully acknowledges the support of the Ross School of Business Research Initiatives, the Lieberthal-Rogel Center for Chinese Studies, and the Center for International Business Education and Research, all at the University of Michigan. Both authors contributed equally and are listed in alphabetical order.

Appendix

Derivation of l_k. The random time length L_k follows the geometric distribution, where the probability of $L_k = L$ equals $\tau_k^{(L-1)}(1-\tau_k) = \tau_k^L((1-\tau_k)/\tau_k)$ for any $L = 1, 2, \ldots$. By definition,

$$l_k = E[\beta^{L_k}] = \sum_{L=1}^{\infty} \beta^L \tau_k^L \frac{1-\tau_k}{\tau_k} = \frac{\beta\tau_k}{1-\beta\tau_k}\frac{1-\tau_k}{\tau_k} = \frac{\beta(1-\tau_k)}{1-\beta\tau_k}.$$

Derivation of $\underline{v}_M$. By definition, $\underline{v}_M$ is such that

$$\underline{u}_s = \underline{v}_M + \beta\left[\tau_M \underline{u}_s + (1-\tau_M)\max\left\{\frac{\pi_s}{1-\beta}, \underline{u}_s\right\}\right], \tag{9}$$

where

$$\underline{u}_s = s_M \frac{\pi_s}{1-\beta} + (1-s_M)\frac{r}{1-\beta}. \tag{10}$$

Plugging $\underline{u}_s$ from Equation (10) into Equation (9), we solve $\underline{v}_M = r - ((l_M - s_M)/(1-l_M))(\pi_s - r)$.

Derivation of $\underline{v}_k$, Proof of Lemma 2, and Proof of Equation (7). First, we characterize $\underline{v}_k$ and prove Lemma 2. In a Markov perfect equilibrium, if it is at stage $k < M$ at the beginning of period t and the supplier accepts v_t, Equation (1) implies $u_s(s_k) = v_t + \beta[\tau_k u_s(s_k) + (1-\tau_k)\cdot u_s(s_{k+1})]$, and Equation (2) implies $u_b(s_k) = 1 - v_t + \beta[\tau_k u_b(s_k) + (1-\tau_k)u_b(s_{k+1})]$. Rearranging the two equations by moving $u_s(s_k)$ and $u_b(s_k)$ to the left-hand side, we have $u_s(s_k) = v_t/(1-\beta\tau_k) + (\beta(1-\tau_k)/(1-\beta\tau_k))u_s(s_{k+1}) = (1-l_k)(v_k/(1-\beta)) + l_k u_s(s_{k+1})$ and $u_b(s_k) = (1-v_t)/(1-\beta\tau_k) + (\beta(1-\tau_k)/(1-\beta\tau_k))u_b(s_{k+1}) = (1-l_k)((1-v_k)/(1-\beta)) + l_k u_b(s_{k+1})$. Let $u_{s,k}$ and $u_{b,k}$ denote $u_s(s_k)$ and $u_b(s_k)$, respectively, for convenience. We can rewrite Equations (1) as

$$u_{s,k} = \max\begin{cases} u_{s,k}^{(2)} \equiv (1-l_k)\dfrac{v_k}{1-\beta} + l_k u_{s,k+1} & \text{if supplier accepts;} \\ u_{s,k}^{(3)} \equiv s_k \dfrac{\pi_s}{1-\beta} + (1-s_k)\dfrac{r}{1-\beta} & \text{if supplier rejects.} \end{cases} \tag{11}$$

By definition, $\underline{v}_k$ is such that $u_{s,k}^{(2)} = u_{s,k}^{(3)}$; namely, the supplier accepts the offer if and only if $v_t \geq \underline{v}_k$. In equilibrium, the buyer chooses between offering $v_t = \underline{v}_k$ (i.e., squeezing) and offering $v_t < \underline{v}_k$ (i.e., dumping). As a result, $u_{s,k} = u_s^{(3)}(s_k)$ holds for all $k < M$. Regarding the final stage $k = M$, Lemma 1 implies that if (π_b, π_s) is in the squeezing or the dumping region of the final stage, then $u_{s,M} = s_k(\pi_s/(1-\beta)) + (1-s_k)\cdot(r/(1-\beta))$, and if (π_b, π_s) is in the accommodating region, then $u_{s,M} = \pi_s/(1-\beta)$. Therefore, Lemma 2 follows.

Second, we derive the closed-form expressions of $\underline{v}_k$. Note that $u_{s,k}^{(2)} = u_{s,k}^{(3)}$ implies $\underline{v}_k = (1/(1-l_k))[s_k(\pi_s/(1-\beta)) + (1-s_k)(r/(1-\beta)) - (1-\beta)l_k u_{s,k+1}]$. Plugging in $u_{s,k+1} = s_{k+1}(\pi_s/(1-\beta)) + (1-s_{k+1})(r/(1-\beta))$ (or $u_{s,M} = \pi_s/(1-\beta)$ if accommodating at the final stage), we have $\underline{v}_k = r - (l_k s_{k+1} - s_k)(\pi_s - r)/(1-l_k)$ for $k = 1 \sim M-2$ and $\underline{v}_{M-1} = r - (l_{M-1}\tilde{s}_M - s_{M-1})(\pi_s - r)/(1-l_{M-1})$, where $\tilde{s}_M = 1$ if (π_b, π_s) is in the accommodating region of the final stage and $\tilde{s}_M = s_M$ otherwise.

Third, we move on to examine the buyer's optimal choice between squeezing and dumping. We can rewrite Equation (2) as

$$u_{b,k} = \max\begin{cases} u_{b,k}^{(2)} \equiv (1-l_k)\dfrac{1-\underline{v}_k}{1-\beta} + l_k u_{b,k+1} & \text{if supplier accepts;} \\ u_{b,k}^{(3)} \equiv s_k \dfrac{\pi_b}{1-\beta} + (1-s_k)\dfrac{1-c}{1-\beta} & \text{if supplier rejects.} \end{cases} \tag{12}$$

Let $V_k^{(2)} = u_{s,k}^{(2)} + u_{b,k}^{(2)}$ and $V_k^{(3)} = u_{s,k}^{(3)} + u_{b,k}^{(3)}$ denote the two-firm chain's NPVs discounted to a stage k period if the buyer chooses squeezing and dumping, respectively. Because $u_{s,k}^{(2)} = u_{s,k}^{(3)}$ in equilibrium, $u_{s,k}^{(2)} \geq u_{s,k}^{(3)}$ is equivalent to $V_k^{(2)} \geq V_k^{(3)}$; namely, in equilibrium, the buyer's optimal choice between squeezing and dumping also maximizes the chain's NPV.

Fourth, we derive Equation (7) in the paper. In the backward induction up to stage k, Equations (11) and (12) imply $V_k^{(2)} = (1-l_k)(1/(1-\beta)) + l_k \max\{V_{k+1}^{(2)}, V_{k+1}^{(3)}\}$ and $V_k^{(3)} = s_k((\pi_b + \pi_s)/(1-\beta)) + (1-s_k)(1-c+r)/(1-\beta)$. If $V_{k+1}^{(2)} < V_{k+1}^{(3)}$, then $V_k^{(2)} = (1-l_k)(1/(1-\beta)) + l_k V_{k+1}^{(3)}$; otherwise, we plug in the expression of $V_{k+1}^{(2)}$ and obtain $V_k^{(2)} = (1-l_k)(1/(1-\beta)) + l_k V_{k+1}^{(2)} = (1-l_k)(1/(1-\beta)) + l_k(1-l_{k+1})(1/(1-\beta)) + l_k l_{k+1}\max\{V_{k+2}^{(2)}, V_{k+2}^{(3)}\} = (1-l_k l_{k+1})\cdot(1/(1-\beta)) + l_k l_{k+1}\max\{V_{k+2}^{(2)}, V_{k+2}^{(3)}\}$. This derivation continues till stage $d(k)$ or the final stage. In any case, with the definitions of $d(k)$ and γ_k as in the paper, we obtain

$$(1-\beta)V_k^{(2)} = (1-\gamma_k)\cdot 1 + (\gamma_k - \gamma_k s_{d(k)})(1-c+r) + \gamma_k s_{d(k)}(\pi_b + \pi_s) \quad \text{and} \tag{13}$$

$$(1-\beta)V_k^{(3)} = (1-s_k)(1-c+r) + s_k(\pi_b + \pi_s), \tag{14}$$

which together imply Equation (7) because $u_{b,k}^{(3)} - u_{b,k}^{(2)} = V_k^{(3)} - V_k^{(2)}$.

Endnotes

[1] Recent literature also recognizes other concerns with offshore outsourcing, including its potential to undermine the development of new technologies by Western firms (Pisano and Shih 2009, Fuchs and Kirchain 2010).

[2] The catalyst role of technological advances is illustrated by the experience of a former IKEA supplier, Joyme, in China (the following description is constructed based on public information and the authors' field interviews). After Joyme quit the supply relationship with IKEA in 2012, it simultaneously opened a showroom store near a subway station in Beijing and an online store at Alibaba (China's e-commerce giant, equivalent to a combination of Amazon, eBay, and PayPal). A consumer can begin her shopping by visiting an IKEA store to find the furniture she likes and then go to Joyme's showroom store to check product differences (often minor) and price differences (often major). She can then go home to place orders at Joyme's online store at Alibaba, and the furniture will be shipped to her home in a few days. Thanks to this business model, which would have been inconceivable without e-commerce, Joyme's venture quickly took off after its founding.

RIGHTSLINK

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.

[3] The accommodating strategy bears similarity to the insight in Byford and Gans (2014a, b), whereby an incumbent may accommodate a competitor by reducing competitive intensity, preventing it from being acquired by a more competitive entrant, thus denying the entrant access rights to the market. In this way, the incumbent retains the less competitive competitor rather than facing the more competitive new competitor.

[4] We assume that the buyer can make a take-it-or-leave-it offer and extract most of the surplus, given that buyers tend to have disproportionally high bargaining power in the offshore outsourcing setting with respect to OEM suppliers (Moran 2001, Harrison and Scorse 2010).

[5] We examine the scenario where the supplier can leapfrog over stages in Section 6.1.

[6] The expectation accounts for the uncertainty of θ_{t+1}; for example, the gradual transition process implies that $E[u_{s,t+1}(\theta_{t+1})] = \tau_k u_{s,t+1}(s_k) + (1-\tau_k)u_{s,t+1}(s_{k+1})$, if $\theta_t = s_k$ for some $k < M$.

[7] On the contrary, this would also suggest that the buyer should still consider accommodating the supplier at an early stage, if the supplier can possibly leapfrog over the development stages and become capable of entry by the end of the current period. We explore this possibility in Section 6.1.

References

Alcácer J, Oxley J (2014) Learning by supplying. *Strategic Management J.* 35(2):204–223.

Argyres NS, Zenger TR (2012) Capabilities, transaction costs, and firm boundaries. *Organ. Sci.* 23(6):1643–1657.

Arora A, Fosfuri A, Gambardella A (2001) *Markets for Technology: The Economics of Innovation and Corporate Strategy* (MIT Press, Cambridge, MA).

Arruñada B, Vázquez XH (2006) When your contract manufacturer becomes your competitor. *Harvard Bus. Rev.* 84(9):135–145.

Bartlett CA, Ghoshal S (2000) Going global: Lessons from late movers. *Harvard Bus. Rev.* 78(2):132–142.

Bönte W, Wiethaus L (2007) Knowledge disclosure and transmission in buyer-supplier relationships. *Rev. Indust. Organ.* 31(4): 275–288.

Budd C, Harris C, Vickers J (1993) A model of the evolution of duopoly: Does the asymmetry between firms tend to increase or decrease? *Rev. Econom. Stud.* 60(3):543–573.

Byford MC, Gans JS (2014a) Exit deterrence. *J. Econom. Management Strategy* 23(3):650–668.

Byford MC, Gans JS (2014b) Permission to exist. NBER Working Paper 20512, National Bureau of Economic Research, Cambridge, MA.

Cabral LMB (2002) Increasing dominance with no efficiency effect. *J. Econom. Theory* 102(2):471–479.

Cabral LMB (2014) *Introduction to Industrial Organizationl*, 2nd ed. (MIT Press, Cambridge, MA).

Chatain O (2011) Value creation, competition, and performance in buyer-supplier relationships. *Strategic Management J.* 32(1): 76–102.

Chatain O, Zemsky P (2007) The horizontal scope of the firm: Organizational tradeoffs vs. buyer-supplier relationships. *Management Sci.* 53(4):550–565.

Cohen WM, Nelson RR, Walsh JP (2000) Protecting their intellectual assets: Appropriability conditions and why U.S. manufacturing firms patent (or not). NBER Working Paper 7552, National Bureau of Economic Research, Cambridge, MA.

de Fontenay CC, Gans JS (2008) A bargaining perspective on strategic outsourcing and supply competition. *Strategic Management J.* 29(8):819–839.

Dierickx I, Cool K (1989) Asset stock accumulation and sustainability of competitive advantage. *Management Sci.* 35(12):1504–1512.

Elms DK, Patrick L (2013) *Global Value Chains in a Changing World* (World Trade Organization Publications, Geneva).

Feenstra RC (1998) Integration of trade and disintegration of production in the global economy. *J. Econom. Perspect.* 12(4):31–50.

Fuchs E, Kirchain R (2010) Design for location? The impact of manufacturing offshore on technology competitiveness in the optoelectronics industry. *Management Sci.* 56(12):2323–2349.

Fudenberg D, Gilbert R, Stiglitz J, Tirole J (1983) Preemption, leapfrogging and competition in patent races. *Eur. Econom. Rev.* 22(1):3–31.

Gans JS (2014) Negotiating for the market. NBER Working Paper 20559, National Bureau of Economic Research, Cambridge, MA.

Gans JS, Stern S (2000) Incumbency and R&D incentives: Licensing the gale of creative destruction. *J. Econom. Management Strategy* 9(4):485–511.

Gereffi G, Humphrey J, Sturgeon T (2005) The governance of global value chains. *Rev. Internat. Political Econom.* 12(1):78–104.

Gilbert RJ, Newbery DMG (1982) Preemptive patenting and the persistence of monopoly. *Amer. Econom. Rev.* 72(3):514–526.

Grossman G, Shapiro C (1986) Optimal dynamic r&d programs. *RAND J. Econom.* 17(4):581–593.

Grossman GM, Helpman E (2005) Outsourcing in a global economy. *Rev. Econom. Stud.* 72(1):135–159.

Harrison A, Scorse J (2010) Multinationals and anti-sweatshop activism. *Amer. Econom. Rev.* 100(1):247–273.

Henderson R (1993) Underinvestment and incompetence as responses to radical innovation: Evidence from the photolithographic alignment equipment industry. *RAND J. Econom.* 24(2): 248–270.

Javorcik BS (2004) Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages. *Amer. Econom. Rev.* 94(3):605–627.

Jia N (2013) Competition, governance, and relationship-specific investments: Theory and implications for strategy. *Strategic Management J.* 34(13):1551–1567.

Kang M-P, Mahoney JT, Tan D (2009) Why firms make unilateral investments specific to other firms: The case of OEM suppliers. *Strategic Management J.* 30(2):117–135.

Khanna T, Palepu KG (2006) Emerging giants: Building world-class companies in developing countries. *Harvard Bus. Rev.* 84(10): 60–69.

Khanna T, Gulati R, Nohria N (1998) The dynamics of learning alliances: Competition, cooperation, and relative scope. *Strategic Management J.* 19(3):193–210.

Levin RC, Klevorick AK, Nelson RR, Winter SG (1987) Appropriating the returns from industrial research and development. *Brookings Papers on Econom. Activity* 3:783–833.

Lippman S, Rumelt R (1982) Uncertain imitability: An analysis of interfirm differences in efficiency under competition. *Bell J. Econom.* 13(2):418–438.

MacDonald GM, Ryall M (2004) How do value creation and competition determine whether a firm appropriates value? *Management Sci.* 50(10):1319–1333.

Mayer KJ (2006) Spillovers and governance: An analysis of knowledge and reputational spillovers in information technology. *Acad. Management J.* 49(1):69–84.

Moran TH (2001) *Parental Supervision: The New Paradigm for Foreign Direct Investment and Development* (Institute for International Economics, Washington, DC).

Pacheco-de-Almeida G, Zemsky PB (2007) The timing of resource development and sustainable competitive advantage. *Management Sci.* 53(4):651–666.

Pacheco-de-Almeida G, Zemsky PB (2012) Some like it free: Innovators' strategic use of disclosure to slow down competition. *Strategic Management J.* 33(7):773–793.

Pack H, Saggi K (2001) Vertical technology transfer via international outsourcing. *J. Development Econom.* 65(2):389–415.

Paik Y, Zhu F (2014) The impact of patent wars on firm strategy: Evidence from the global smartphone market. Working paper, Harvard Business School, Boston.

Pisano G, Shih W (2009) Restoring American competitiveness. *Harvard Bus. Rev.* 87(7/8):114–125.

RIGHTSLINK

Reinganum JF (1983) Uncertain innovation and the persistence of monopoly. *Amer. Econom. Rev.* 73(4):741–748.

Schumpeter JA (1934) *The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle* (Harvard University Press, Cambridge, MA).

Segal I, Whinston MD (2007) Antitrust in innovative industries. *Amer. Econom. Rev.* 97(5):1703–1730.

Sutton J (2012) *Competing in Capabilities: The Globalization Process* (Oxford University Press, Oxford, UK).

Tirole J (1988) *The Theory of Industrial Organization* (MIT Press, Cambridge, MA).

Tushman ML, Anderson P (1986) Technological discontinuities and organizational environments. *Admin. Sci. Quart.* 31(3): 439–465.

United Nations Conference on Trade and Development (UNCTAD) (2011) World investment report 2011: Non-equity modes of international production and development. Report, UNCTAD, Geneva. http://unctad.org/en/docs/wir2011_embargoed_en.pdf.

Wakeman S (2010) Profiting from technological capabilities: Technology commercialization strategy in a dynamic context. ESMT Working Paper 08-008(R2), European School of Management and Technology, Berlin.

Wernerfelt B (1984) A resource-based view of the firm. *Strategic Management J.* 5(2):171–180.

Williamson PJ, Raman AP (2011) How China reset its global acquisition agenda. *Harvard Bus. Rev.* 89(14):109–114.

Winter SG (1987) Knowledge and competence as strategic assets. Teece D, ed. *The Competitive Challenge: Strategies for Industrial Innovation and Renewal* (Ballinger Publishing, Cambridge, MA), 159–184.

Yoffie DB, Alcacer J, Kim R (2012) HTC Corp. in 2012. HBS Case 712-423, Harvard Business School, Boston.

Zeng M, Williamson PJ (2003) The hidden dragons. *Harvard Bus. Rev.* 81(10):92–99.

Zhu F, Iansit M (2011) Entry into platform-based markets. *Strategic Management J.* 33(1):88–106.

CORRECTION

In this article, "When Suppliers Climb the Value Chain: A Theory of Value Distribution in Vertical Relationships" by Zhixi Wan and Brian Wu (first published in *Articles in Advance*, March 16, 2016, *Management Science*, DOI:10.1287/mnsc.2015.2356), panel (b) of Figure 4 has been corrected. (Due to a printer's error, $S \rightarrow S \rightarrow D$ incorrectly appeared as $S \rightarrow S \rightarrow S$.)

Downloaded from informs.org by [155.246.103.35] on 05 April 2017, at 17:34 . For personal use only, all rights reserved.