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Jong Kuk Lee

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The Effect of Customer Co-development on Firm Value*

고객참여 제품개발이 기업 가치에 미치는 영향

Jongkuk Lee(이종국)**

Customer participation is a strategic tool to facilitate the process of developing new products. This study distinguishes between two types of customer participation - customer codevelopment and contract development, and examines the benefits of customer codevelopment relative to contract development for firm value through an event study. The analysis of customer participation announcements in the biotechnology and pharmaceutical industries shows that the benefits of customer codevelopment relative to contract development on firm value are contingent upon firm- and relationship- level factors. Specifically, this study finds that the announcement of customer codevelopment contributes better to abnormal stock returns of a firm when the firm has a higher level of R&D relationship experience or when the customer codevelopment is complemented by formal contract terms, such as equity investment. The findings of this study provide important theoretical and managerial implications by revealing the boundary conditions for the benefits of customer codevelopment relative to contract development.

Key words: customer codevelopment, contract development, abnormal stock returns

I. Introduction

Interfirm relationship formation is a vital component of successful new product development (Rindfleisch and Moorman 2001; Sivadas and Dwyer 2000; Wuyts,

Dutta, and Stremersch 2004). In particular, the participation of industrial customers in a firm's new product development process is increasingly common (Bonner and Walker 2004; Fang 2008). As business customers play active roles in developing new

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** Full-time lecturer, Ewha School of Business, Ewha Womans University, Corresponding author

products, firms must understand how customer participation affects new product development outcomes. In this study, I differentiate between two types of customer participation: customer codevelopment and contract development. Customer codevelopment refers to the R&D agreement in which the focal firm collaborates with its customer to jointly develop new product by pooling R&D resources, whereas contract development refers to the R&D agreement in which the focal firm develops new products for its customer without directly pooling R&D resources.

In customer codevelopment compared to contract development, the business customer is more engaged in the focal firm's new product development process by integrating its R&D resources with the focal firm. Previous relationship marketing literature, derived from a resource-based view, suggests the benefits of such joint effort in creating mutually beneficial value (Dyer and Singh 1998; Jap 1999). However, the limitation of such joint effort also has been pointed out. By integrating resources with its customer, the firm likely faces a greater risk of opportunistic behaviors of its customer (Nickerson and Zenger 2004). That is, the close interaction in pooling R&D resources will cause the greater risk of unintended knowledge leakage (Park and

Russo 1996), constraining the potential benefits of customer codevelopment compared to contract development.

Given the benefits and limitations of customer codevelopment relative to contract development, we need to examine when firms benefit more from customer codevelopment and when from contract development. I propose a contingency framework to examine the relative benefits of the two types of customer participation in developing new products. In particular, I examine how firm- and relationship-level factors moderate the outcomes of customer participation type. For the outcomes, I use the abnormal stock market returns resulting from the announcement of customer participation. Stock market returns are recommended to examine the impact of interfirm relationship formation, given the nature of stock market returns as a forward-looking metric (Houston and Johnson 2000; Kalaighnam, Shankar, and Varadarajan 2007; Swaminathan and Moorman 2009).

The analysis of R&D relationship agreements in the biotechnology and pharmaceutical industries shows that the benefits of customer codevelopment relative to contract development are contingent upon firm- and relationship-level factors, such as R&D relationship

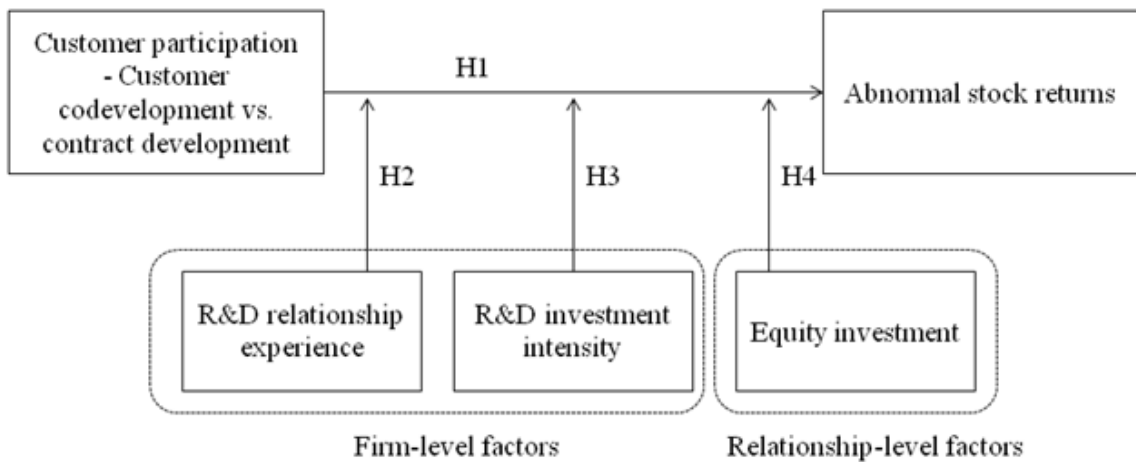
experience, R&D investment intensity, or equity investment. This study shows that the announcement of customer codvelopment contributes better to abnormal stock returns of a firm when the firm has a higher level of R&D relationship experience or when the customer codevelopment is complemented by formal contract terms, such as equity investment. Thus, this study highlights the risks associated with customer codevelopment, which should be mitigated for successful new product development and firm value gains.

In the following section, I develop a set of hypotheses to be tested in this study. I then present research method, followed by results. I finally discuss the theoretical and managerial implications of this study.

II. Conceptual Framework and Hypotheses

2.1 The Effect of Customer Participation

Figure 1 illustrates the conceptual framework of this study. Regarding the main effect of customer codevelopment relative to contract development, interorganizational relationship marketing literature emphasizes the benefits of customer codevelopment superior to those of contract development in creating value (Dyer and Singh 1998; Jap 1999). Accordingly, the announcement of customer participation in developing new products will send a signal to marketplace regarding the future performance expected from the customer participation (Kale, Dyer, and



<Figure 1> Conceptual Framework

singh 2002). Specifically, customer codevelopment provides at least two types of benefits compared to contract development. First, customer codevelopment will be more effective than contract development in dealing with complex knowledge. In particular, new product development often involves tacit knowledge, which is difficult to document. At the same time, new product development involves the integration of interdependent components, which operate in conjunction with other components (Teece 1986; Winter 1987; Zander and Kogut 1995). Such tacit and interdependent knowledge make new product development task more complex (Killing 1988). Customer codevelopment, which involves more extensive interactions for joint R&D efforts between partners, will therefore be more effective than contract development in creating and transferring complex knowledge. Second, new product development often requires the investment of significant amount of resources for a long period of time in the high-technology industries. Pooling R&D resources with customer will facilitate the investment of resources up to a threshold required for successful new product development (Dussauge, Garrette, and Mitchell 2004). Therefore, the market will respond more

positively to the announcement of customer codevelopment than the announcement of contract development. By following the interorganizational relationship literature, I therefore propose a baseline hypothesis regarding the effect of customer codevelopment relative to contract development on the abnormal stock returns of the firm.

H₁: A firm's announcement of customer codevelopment will have a positive effect on the abnormal stock returns of the firm.

2.2 The Moderating Effects of Firm- and Relationship-Level Factors

Even though customer codevelopment is expected to better facilitate the process of developing new products than contract development, customer codevelopment can be exposed to operational issues. In particular, customer codevelopment is likely to require more comprehensive coordination that covers operations between partners in greater detail and therefore needs the commitment of more managerial resources compared to contract development (Killing 1988; Park and Russo 1996). At the same time, pooling resources for customer codevelopment makes firms vulnerable to the risk of unintended knowledge leakage

(Gulati and Singh 1998; Park and Russo 1996; Teece 1986).

As illustrated in Figure 1, I therefore further examine firm- and relationship-level factors to safeguard customer codevelopment from coordination difficulty and opportunistic behaviors of partners. Specifically, I examine R&D relationship experience and R&D investment intensity as firm-level moderating factors, which provide internal capability to effectively manage collaborative relationships (Anand and Khanna 2000; Cohen and Levinthal 1990). For a relationship-level moderating factor, I examine equity investment, which serves as a formal mechanism to govern relationships (Gulati and Singh 1998).

The Moderating Effect of R&D Relationship Experience. Firms learn how to manage collaborative interfirm relationships (Gulati, Nohria, and Zaheer 2000; Li, Boulding, and Staelin 2010). Relationship experience generates two types of benefits in initiating and managing a new alliance. First, by accumulating relationship experience, firms develop skills to coordinate relationships with other firms (Ahuja 2000; Anand and Khanna 2000; Westney 1988). Through the accumulated relationship experience, firms develop and strengthen the capability to absorb

resources from partners (Powell, Koput, and Smith-Doerr 1996). Second, relationship experience will generate capability to identify what causes unintended knowledge leakage or appropriation. Firms with more relationship experience can better avoid the unintended knowledge leakage. Such learning effect of relationship experience will be particularly critical for customer codevelopment than for contract development, given the greater complexity of coordination and the higher risk of opportunism associated with customer codevelopment compared to contract development. That is, relationship experience is expected to complement the limitation of customer codevelopment for creating value.

H₂: The R&D relationship experience of a firm will positively moderate the effect of customer codevelopment announcement on the abnormal stock returns of the firm.

The Moderating Effect of R&D Investment Intensity. Internal investments in R&D will complement customer participation as accumulated knowledge through internal R&D investments produces absorptive capacity, that is, the ability to “recognize the value of new information,

assimilate it, and apply it to commercial ends” (Cohen and Levinthal 1990, p. 128). First, a firm that more extensively invests in internal R&D activities will have a greater capability to track trends or unexpected changes in technologies and better identify potential business customers who have greater technological capabilities. Second, firms will be more effective in integrating and utilizing external R&D resources gained from customers, as they invest more in R&D (Lee, Lee, and Pennings 2001). Given the task complexity associated with customer codevelopment, the role of internal R&D investment intensity as an absorptive capacity will be more critical for customer codevelopment than for contract development. Thus, a firm will benefit more from customer codevelopment as it invests more internal resources in R&D activities.

H₃: The R&D investment intensity of a firm will positively moderate the effect of customer codevelopment announcement on the abnormal stock returns of the firm.

The Moderating Effect of Equity Investment. Firms can also rely on a more formal governance mechanism to support the efficient creation and transfer of

firm-specific knowledge and to minimize the opportunistic behaviors of partners (Sampson 2004). In particular, I examine the choice between equity investment and non-equity investment in forming interfirm relationships (Gulati and Singh 1998; Oxley 1997; Pisano 1989). Business customer’s investment in the firm’s equity creates a governance structure that protects relationship-specific investments and increases incentives for sharing knowledge-based assets between partners (Pisano 1989). Shared ownership also increases the commitment of partners to the collaborative relationships (Oxley 1997). Given the task complexity and the risk of opportunism associated with customer codevelopment, I suggest that equity investment will provide greater benefits for customer codevelopment than for contract development. Thus,

H₄: The use of equity sharing will positively moderate the effect of customer codevelopment announcement on the abnormal stock returns of the firm.

III. Research Methods

3.1 Research Context

The context to test the proposed hypotheses is biotechnology firms’ R&D

relationship agreements with pharmaceutical firms. This provides an ideal context to examine the impact of customer participation on firm value. First, pharmaceutical firms are key business customers of biotechnology firms (Wuyts, Dutta, and Stremersch 2004). Biotechnology firms are an important source of materials or compounds, based on which pharmaceutical firms further develop new drugs (Rothaermel and Thursby 2007). Second, biotechnology firms collaborate with pharmaceutical firms in various ways, such as codevelopment or contract development.

I used Recap database to collect R&D relationship agreements between biotechnology and pharmaceutical firms. I gathered daily stock price and return information of firms from Center for Research in Security Prices (CRSP), and other financial information of firms from COMPUSTAT.

To generate sample for this study, I used the following steps. First, R&D relationships that are initiated from 1998 to 2006 between biotechnology firms (SIC 2836) and pharmaceutical firms (SIC 2834) were retrieved from Recap. I focused only on publicly traded biotechnology firms whose stock price information is available from CRSP. Second, given the criticality of the accurate announcement date for the

validity of event studies (Anand and Khanna 2000; Brown and Warner 1985), I cross-validated the announcement date through Lexus-Nexus, which provides access to extensive documents from various legal, news, and business sources. I eliminated relationship agreements with no clear announcement date and those that could not be cross-verified across multiple sources. Finally, relationship announcements made by the same firm in the overlapping event windows, where abnormal stock returns were measured, were eliminated to avoid overestimated or compounded returns among multiple announcements (Kalaignanam, Shankar, and Varadarajan 2007). This procedure left 154 R&D relationship agreements between biotechnology and pharmaceutical firms for this study.

3.2 Dependent variable

Abnormal stock returns: To calculate a focal firm's abnormal stock returns with the announcement of a relationship formation with a business customer, I used the standard residual analysis method based on a market model (for details, see Brown and Warner 1985). Let day "0" denote the announcement date of a specific relationship formation. Consistent with previous studies (Anand and Khanna 2000;

Swaminathan and Moorman 2009), I used 240 daily return observations ending 10 days before the event day (-250 through -11) to estimate the market model:

$$r_{it} = \alpha_i + \beta_i r_{mt} + \varepsilon_{it}$$

where r_{it} = daily returns for firm i on day t , r_{mt} = daily returns on the equally weighted stock portfolio in the stock market in which the focal firm is included, α_i and β_i are firm i 's parameters, ε_{it} is error term. I then used the estimates from this model to predict the daily returns of each firm for the event day. That is, the predicted daily returns become

$$\hat{\alpha}_i + \hat{\beta}_i r_{mt}$$

where $\hat{\alpha}_i$ and $\hat{\beta}_i$ are the model estimates. Daily abnormal stock returns of firm i at day t (AR_{it}) becomes

$$r_{it} - (\hat{\alpha}_i + \hat{\beta}_i r_{mt})$$

Consistent with Kalaignanam, Shankar, and Varadarajan (2007), I used 3 day event windows around the announcement date (-1 through 1). The cumulative average abnormal returns of firm i during the event window (CAR_i), the dependent variable for this study, becomes

$$CAR_i = \sum_{t=-1}^1 AR_{it}$$

The cumulative abnormal returns capture the daily unanticipated movements in the stock price of firm i over the event

window, and reflect the expected value that the market believes the firm i will capture by entering into the particular relationship (Anand and Khanna 2000).

3.3 Independent and Moderating Variables

Customer codevelopment: A relationship agreement in which the focal firm jointly perform R&D with its customer firm for R&D by pooling R&D resources (i.e., joint R&D) is coded to be a customer codevelopment, i.e., customer codevelopment =1; otherwise, a relationship agreement in which only the focal firm performs R&D for its customer firm is coded to be a contract development, i.e., customer codevelopment=0. Customer codevelopment represents a more comprehensive form of customer participation than contract development.

R&D relationship experience: Consistent with previous studies, I measured a firm's R&D relationship experience by the number of relationship formed in the last five years (Ahuja 2000).

Equity investment: Consistent with prior studies (Oxley 1997; Pisano 1989), equity investment=1 for a relationship agreement that included equity investment as a part of

the relationship agreement; otherwise, equity investment=0 for a purely contractual agreement without equity investment.

R&D investment intensity: To measure R&D investment intensity, I took the firm's R&D expenditures, divided by its total assets (Lavie and Miller 2008).

3.4 Control Variables

To control for the size effect, whereby large firms' stock prices tend to be less sensitive to the announcements of relationship formation than small firms' stock prices (e.g., Anand and Khanna 2000; Kalaignanam, Shankar, and Varadarajan 2007), I included a firm's *totalasset* as a control variable. I also controlled for *relationshipslope*, the number of functional activities in a collaboration agreement: research, development, manufacturing, and marketing (Kalaignanam, Shankar, and Varadarajan 2007). I also included dummy variables for relationship formation year.

The characteristics of firms that are included in this study, such as total assets, R&D relationship experience, and R&D investment intensity, can also affect the choice of partners, and cause a sample selection bias, which can occur "when the criterion for selecting the observations is

not independent of the outcome variables" (Kalaignanam et al. 2007, p. 365). Therefore, it is necessary to control for the potential bias that can be caused by the partner selection process. To obtain unbiased estimates, I used a Heckman selection correction model, and for more details to estimate selection correction model, see Kalaignanam, Shankar, and Varadarajan (2007) and Swamithan and Moorman (2009). I included the selection correction term, λ , as a control variable to avoid any bias related to sample selection.

IV. Model Estimation and Results

The dependent variable, i.e., the cumulative abnormal stock returns, is continuous, and I therefore used the Ordinary Least Square method to test the proposed hypotheses. The sample includes multiple relationship agreements initiated by the same firms. To control for possible autocorrelation resulting from unobserved characteristics of focal firms, we used robust standard errors, clustered by focal firms (Rogers 1993).

Table 1 presents descriptive statistics and correlations between variables. The mean variance inflation factor is 1.97 and the maximum variance inflation factor is

3.15, which indicate no evidence of multicollinearity in the sample for this study. Table 2 presents the effect of customer codevelopment announcement on abnormal stock returns. The coefficients are not standardized in this study. Model 1 is a baseline model without moderating effects, and Model 2 is a full model with moderating effects. Model 1 shows that customer codevelopment has a positive effect on abnormal stock returns ($b=6.605$, $p<.05$), whereas this main effect turned marginally negative when moderating

variables are included in Model 2 ($b=-11.880$, $p<.10$), failing to support Hypothesis 1. However, this negative effect is positively moderated by R&D relationship experience, R&D investment intensity, and equity investment. Specifically, Model 2 shows that a firm's R&D relationship experience has a positive moderating effect on abnormal stock returns ($b=.569$, $p<.05$). As a firm has more relationship experience, the effect of customer codevelopment on abnormal stock returns becomes more positive, in support

<Table 1> Descriptive Statistics and Correlations

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Abnormal stock returns	1.00																
2. Year 1998	-0.08	1.00															
3. Year 1999	0.01	-0.07	1.00														
4. Year 2000	-0.02	-0.08	-0.08	1.00													
5. Year 2001	-0.03	-0.07	-0.07	-0.08	1.00												
6. Year 2002	0.01	-0.10	-0.10	-0.11	-0.10	1.00											
7. Year 2003	-0.02	-0.12	-0.12	-0.13	-0.12	-0.17	1.00										
8. Year 2004	-0.07	-0.10	-0.10	-0.11	-0.10	-0.14	-0.17	1.00									
9. Year 2005	-0.01	-0.12	-0.12	-0.13	-0.12	-0.17	-0.20	-0.17	1.00								
10. Year 2006	0.18	-0.10	-0.10	-0.12	-0.10	-0.15	-0.18	-0.15	-0.18	1.00							
11. R&D relationship experience	-0.03	-0.09	-0.12	-0.01	0.02	-0.08	0.07	0.18	0.02	-0.05	1.00						
12. Total asset	-0.09	-0.04	-0.08	-0.06	-0.03	0.24	0.01	0.02	-0.06	-0.06	0.18	1.00					
13. R&D investment intensity	0.20	0.00	0.25	0.04	-0.18	-0.07	-0.01	-0.16	0.10	0.04	-0.22	-0.21	1.00				
14. Relationship scope	-0.04	-0.04	0.18	-0.06	-0.04	0.10	-0.17	-0.04	-0.07	0.17	-0.16	0.14	0.04	1.00			
15. Equity investment	0.07	-0.11	0.19	-0.05	0.04	0.01	-0.04	0.02	-0.08	0.05	-0.09	-0.06	0.06	0.23	1.00		
16. Relationship formation stage	0.10	-0.11	-0.11	-0.07	0.12	-0.04	0.11	0.03	0.04	-0.02	0.18	-0.18	0.07	-0.47	0.03	1.00	
17. Customer codevelopment	0.12	-0.10	-0.05	-0.37	0.07	-0.07	-0.03	0.17	0.16	0.11	0.14	-0.12	-0.08	0.14	0.24	0.12	1.00
Mean	7.32	0.06	0.06	0.08	0.06	0.13	0.17	0.12	0.17	0.14	14.98	344.53	0.33	1.27	0.14	0.69	0.68
Std. Dev.	20.89	0.25	0.25	0.27	0.25	0.34	0.38	0.33	0.38	0.34	12.15	975.08	0.29	0.50	0.35	0.46	0.47
N=154																	

of hypotheses 2. Similarly, R&D investment intensity also has a marginally positive moderating effect, in support of hypothesis 3 ($b=30.912$, $p<.10$). Finally, while equity investment has a negative main effect on the abnormal stock returns ($b=-23.414$, $p<.05$), it positively moderates the effect of customer codevelopment on abnormal stock returns ($b=25.095$, $p<.01$). Therefore hypothesis 4 is supported.

Model 2 shows that selection correction (λ) is not significant ($b=15.430$, $p>.10$), providing no evidence for sample selection

bias in the sample for this study. The results show that equity investment has a negative effect on abnormal stock returns ($b=-23.414$, $p<.05$), implying that equity investment by customers may be perceived negatively by investors, partly because the firm loses a future opportunity to claim firm value gains.

V. Discussion

Customer participation represents a strategic

(Table 2) The Effect of Customer Codevelopment Announcement on Abnormal Stock Returns

	Model 1		Model 2	
Constant	-16.280	(16.835)	-7.114	(15.608)
Year 1999	-0.618	(9.412)	0.210	(9.178)
Year 2000	4.151	(5.357)	5.856	(4.761)
Year 2001	1.071	(6.150)	3.979	(6.592)
Year 2002	6.866*	(4.507)	6.392*	(4.573)
Year 2003	1.618	(5.869)	2.292	(5.315)
Year 2004	0.216	(4.635)	1.098	(4.556)
Year 2005	-0.230	(5.508)	-1.917	(5.900)
Year 2006	11.815*	(8.731)	13.430*	(9.075)
Total asset	-0.000	(0.001)	-0.000	(0.001)
Relationship scope	-4.111	(4.308)	-4.012	(4.328)
Relationship formation stage	1.501	(3.654)	3.352	(3.709)
R&D relationship experience	0.095	(0.145)	-0.387	(0.243)
R&D investment intensity	16.029*	(12.409)	0.505	(5.002)
Equity investment	1.689	(6.135)	-23.414**	(10.281)
Customer codevelopment	6.605**	(3.906)	-11.880*	(7.842)
Customer codevelopment*R&D relationship experience			0.569**	(0.290)
Customer codevelopment*Equity investment			25.095***	(9.480)
Customer codevelopment*R&D investment intensity			30.912*	(23.474)
Selection correction (λ)	14.242	(14.086)	15.430	(14.527)
R ²	0.109		0.158	
Observations	154		154	

One tailed test for all parameters: * $p<.10$, ** $p<.05$, *** $p<.01$

thrust for new product developments by incorporating customer inputs into the process of new product development. In this study, I examined the relative benefits of two different types of customer participation - codevelopment and contract development. The results of this study show that the benefits of customer codevelopment relative to contract development are contingent upon firm- and relationship-level factors, such as R&D relationship experience, R&D investment intensity, and equity investment.

These findings of this study contribute to the relationship marketing and new product development literature. Even though customer codevelopment may provide advantages in closely cooperating with business customers, firms should be cautious about the risks associated with such close cooperation. Specifically, the close cooperation with customer by pooling R&D resources may cause the risk of opportunistic behaviors of the customer, that is, a dark side of close cooperation as discussed by Anderson and Jap (2005). The results of this study indicate that these concerns can be effectively mitigated by equity investment or R&D relationship experience. Equity investment represents a formal mechanism to constrain opportunism by aligning incentives of customers with the focal firm,

whereas relationship experience represents a control mechanism based on a firm's internal capability without relying on a formal governance mechanism (Li, Boulding, and Staelin 2010).

The findings of this study also provide some important managerial implications. Managers should be cautious about the limitation of customer co-development in a sense that close cooperation with business customer does not necessarily lead to positive abnormal stock returns, that is, firm value gains. The firm value gains are obtained only when some specific conditions are met, such as the use of equity investment, a high level of R&D relationship experience, or a high level of internal R&D investment intensity. Specifically, when a firm has relationship experience, it can benefit from customer codevelopment. Through the R&D relationship experience, the firm will have a greater internal capability to control the negative aspect of codevelopment. When the firm has no such an internal capability, it can still rely on other contract terms, such as equity investment, to control for the concerns associated with customer codevelopment. Finally, firms that intensively invest in R&D can also benefit from customer codevelopment as the internal R&D investment provides an

absorptive capacity to effectively form R&D relationships and utilize R&D resources from customers.

This study also provides future research opportunities to address the limitation of this study. First, in this study, I tried to minimize sample heterogeneity by testing the proposed hypotheses in the fairly homogeneous industrial context, i.e., biotechnology and pharmaceutical industries. To improve our knowledge about this topic, however, we need to further examine how customer codevelopment creates value in the more diverse industrial contexts. Second, even though stock market returns are an important performance indicator, future research can examine more diverse performance metrics associated with customer participation in the process of new product development, such as patents, new products, or profits. Third, even though I examined three specific factors that moderate the link between customer codevelopment and the abnormal stock returns, it will be a promising research direction to further examine other moderators to clarify the boundary conditions of customer participation in creating firm value.

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고객참여 제품개발이 기업 가치에 미치는 영향*

이 종 국**

국문초록

기업의 신제품 개발과정에서 고객참여는 중요한 전략적 역할을 한다. 본 연구는 고객참여를 고객 공동개발 (customer co-development) 과 계약개발 (contract development) 로 구분하고, 고객참여 발표가 기업 가치에 미치는 영향을 이벤트 연구를 통해 분석한다. 바이오 및 제약 산업에 대한 분석을 통해, 본 연구는 계약개발 대비 고객공동 개발이 기업 가치에 미치는 영향은 기업 및 관계 변수에 의해 조절됨을 밝힌다. 특히, 본 연구는 연구개발 협력경험이 많을 때 또는 지분투자를 동반할 때, 고객공동개발이 계약개발에 비해 기업 가치에 양의 영향을 미침을 보여준다.

핵심개념: 고객공동개발, 계약개발, 기업가치

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** 이화여자대학교, 경영대학, 전임강사(jongkuk@ewha.ac.kr)