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Suppliers' Roles and Their Impact on Knowledge Transfer in Auto Manufacturing Supply Chain

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Abstract

Earlier research on firms' gaining benefits through acquiring resources from the supply chain had paid attention upon the importance of knowledge, and found upstream suppliers can increase their knowledge creation through knowledge transfer from downstream buyers. In this paper, we analyze this issue in auto manufacturing industry and test whether such positive relations between a supplier's knowledge creation performance and its acquiring knowledge from auto makers is dissimilar among different suppliers. According to research on suppliers' roles, we classify suppliers by two characters which are their accumulation of knowledge acquiring from auto makers and the accumulation of their own created knowledge. Through analyzing by split subsamples, we find that suppliers who are more familiar with auto makers' knowledge, can more significantly enhance its own knowledge creation capability through acquiring knowledge from auto makers. And suppliers with whether more or less knowledge creation capabilities, can benefit from simultaneous knowledge transfer from auto makers, while suppliers with more knowledge creation capability, than those with less of knowledge creation capability, can more easily gain benefit from previous knowledge transfer from auto makers.

Key words: Supply Chain Management, Knowledge Transfer, Suppliers' Role, Auto Industry, Patent Data

1 Introduction

In a supply chain, knowledge may be an important source of coordination and thus be central to chain functioning. Knowledge transfer in the supply chain has been focused on recently, and most of which viewed from downstream member's standpoint, for example, researchers

discussed the crucial role of information processing and knowledge transfer from his upstream suppliers to enhancing a firm's operational performance, high quality products, and knowledge creation. Based on these analyses, some powerful firms cannily enhance their suppliers' capabilities by sharing knowledge with them, and finally gain benefits.

In the supply chain context, knowledge transfer not only benefits downstream members, suppliers also may increase their competitiveness by building close relationship and transferring more valuable knowledge with downstream partners. Especially, in the context that we discussed in this paper (i.e. the auto manufacturing supply chain), comparatively, the downstream members (auto makers) are larger in size, older in age, closer to the end market, and they have more capabilities to stock and create knowledge than downstream suppliers. Thus, suppliers are more inclined to learn from auto makers, in other words, more knowledge a supplier acquired from auto makers, more knowledge he can create. Kotabe, Martin, and Domoto have discussed this issue and verified suppliers can be cultured through knowledge acquiring from downstream partners in auto manufacturing industry [1].

However, if all suppliers are indiscriminately in learning from auto makers? Certainly it's not, suppliers with different roles may possess of different capabilities to learn from auto makers. But unfortunately, there is scarce empirical study emphasized this issues. Thus existing research can not make clear which type of suppliers can benefit conveniently from knowledge transfer from auto makers.

This paper aims to explore the impact of suppliers' roles on knowledge transfer from auto makers to suppliers. Basing on traditional research on suppliers' roles, and using criteria that distinguish different suppliers' roles, we focus on several characters of suppliers and discuss their influence on the effect of suppliers'

acquiring knowledge from auto makers.

2 Theory Development

During 1980s, managers had shifted their viewpoint on supply chain participants' roles. Earlier research drew contradictory between a firm and its buyers or suppliers and described the search for competitive advantage as a distributive game [2]. Later research found there were not only contractual trading relations, but also more intimate embeddedness between a firm and its suppliers [3]. Studies in supply chain relationship have verified it is important for a firm to build proper relations with its suppliers [4], and it is also important to let suppliers act proper roles [5-6]. The pioneer work of Kamath and Liker discussed differences of suppliers should be paid attention on, and they developed the classification of suppliers' roles.

Under the knowledge-based view, organizations are viewed as social communities specializing in efficient knowledge creation and transfer [7-8]. Knowledge transfer and knowledge creation are the main discussion issues in studies of knowledge management, and the linkage of this two concepts is intrinsic, so sometimes they can not be distinguished [9].

In the supply chain context, some scholars suggests that a firm can benefit from harnessing knowledge transfer with its suppliers, among which, some focused on enhancing of the firm's operations performance [10-11]; some emphasized the products quality [12]; and also some scholars links action of knowledge transfer with the possibility of knowledge creation, Malhotra, Gosain and El Sawy verified elaborate information sharing and knowledge transfer from suppliers lead to effective partner enabled market knowledge creation [13].

View on the downstream supplier' standpoint, acquiring knowledge from the downstream partners can gain benefits too. Kotabe, Martin, and Domoto showed technical exchanges and technology transfer form the downstream auto makers to their upstream suppliers could lead to performance improvement of these suppliers. Their measure of suppliers' performance not only includes reduction of lead time and improvement of product quality, but also includes some items which reflect knowledge-based activities, such

as improvement of product design and process design [1].

In auto manufacturing industry, knowledge transfer from auto makers can benefit suppliers, so it seems that a supplier can increase his knowledge creation through acquiring auto makers' knowledge. However, we predict that there are differences in absorbing auto maker's knowledge among different suppliers, especially among suppliers acting different roles.

When Kamath and Liker discussed the suppliers' different roles in auto manufacturing industry, two guidelines to express various roles are a certain supplier's capability and his interaction with auto makers [5].

For reflecting these suppliers' roles, two characters of suppliers will be taken advantage of to analyze suppliers' knowledge creation impacted by their acquiring knowledge from automakers, which are the accumulation of knowledge acquiring from auto makers and the accumulation of their own created knowledge. The former character expresses the quantity of a supplier's familiarity with auto makers' skills, technique, technology, and other knowledge, while the latter character images a supplier's own innovative capabilities. In the supply chain context, these two characters also can reflect the supplier's role. Accumulation of his own created knowledge can indicate a supplier's capability; and accumulation of knowledge acquiring from auto makers can indicate a supplier's interaction with auto makers.

Furthermore, two effect of knowledge transfer has been emphasized in this paper. The first one is called instantaneous effect which measures the impact of simultaneous knowledge acquiring from auto makers on a supplier's knowledge creation. The second is called postponement effect which measures the impact of past knowledge acquiring from auto makers on a supplier's current knowledge creation. The principal purpose of this paper is revealing whether and how these two effects are impacted by supplier's characters.

From above discussion, this paper bases the two characters of supplier and analyzes their impact on knowledge transfer effects, both the instantaneous one and the postponement one. Firstly, we should discuss if there is difference in the instantaneous effect between suppliers who are classified according to their accumulation of knowledge acquiring from auto makers, which is indicated as ① in Figure 1.

Then, we should also analyze the postponement effect according to suppliers' accumulation of knowledge acquiring from auto makers, which is indicated as ② in Figure 1. And we should analyze if there is difference in the instantaneous effect between suppliers who are classified according to their accumulation of their own created knowledge, which is indicated as ③ in Figure 1. Finally, we also discuss the postponement effect according to suppliers' accumulation of their own created knowledge, which is ④ in Figure 1.

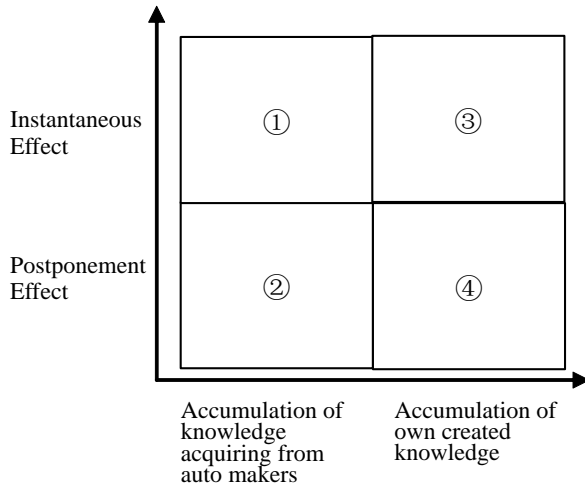


Figure 1. Main issues of this paper

3 Methodology

Using auto suppliers operating in USA auto market as sample and using patent citations from auto makers to them as measure of knowledge transfer, we initiate empirical analyses to test our hypotheses.

The USPTO's USA patents database gives us convenience to construct index, which can be treated as proxies to indicate knowledge creation and knowledge transfer.

Supplier's Knowledge Creation Performance

The dependent variable, knowledge creation performance of a certain supplier i during a given year t is measured as the count of USPTO patents applied for by the supplier in that year, and is indicated by $SUPCREA_{it}$.

Independent Variables

Early research had treated patent citations as perfect measure to express knowledge flow and knowledge diffusion. In this paper, we construct new patent citations based indicators to express

the inclination of a supplier acquiring auto makers' knowledge.

We introduce a variable $INDEX_{it}$ refers to the instantaneous effect of knowledge transfer, i.e. the supplier i 's inclination to acquire knowledge from auto makers in year t , when is the same year we consider supplier's knowledge creation performance. $INDEX_{it}$ is constructed as

$$INDEX_{it} = \frac{(CITEAUTO_{it}/TOTAUTO_t)}{(CITEEXT_{it}/TOTEXT_{it})}$$

Where, $CITEAUTO_{it}$ refers to in year t , times of supplier i cited auto makers' patents;

$TOTAUTO_t$ refers to before year t , the number of granted patents of auto makers;

$CITEEXT_{it}$ refers to in year t , times of supplier i cited external patents which are all its citations made besides its own patents.

$TOTEXT_{it}$ refers to before year t , the number of all granted patents besides those with assignee as supplier i .

We also need an expression of postponement effect of knowledge transfer, so we use the average of 5 years period $INDEX_{it}$ to express the inclination of past knowledge transfer from auto makers. We define this variable as:

$$PREINDEX_{it} = \frac{\sum_{k=1}^5 INDEX_{i(t-k)}}{5}$$

Where, $k=1, 2, \dots, 5$

Controls

Some other factors that influence suppliers' knowledge creations should be controlled. First we examine the supplier's prior innovative capabilities, by measuring its **knowledge stock**, which is measured by the total number of patents the supplier has applied for in the previous 5 years up to and including the year $t-1$.

Knowledge creation activities is often path dependent, we measure the **path dependence** as the ratio of the number of self citations (citations that a supplier makes to its own previous patents) to the total number of citations it made in the year we discussed.

We also include **technological value**, which is measured as the average of claims of all patents applied by the supplier in the certain year.

A firm specific factor, patent performance, should be controlled accounting for unobserved

heterogeneity. We construct the firm level variable *patents performance* as the average citations received by all patents applied by a certain supplier during the whole 12-year period we discussed from 1985 to 1996.

Finally, we should control the technological diversity, which captures the breadth of the technological knowledge contained in the supplier. Our measure of *technological diversity*

is calculated as $1 - [(\sum_k f_{ikt}^2)^{1/2}]$, where f_{ikt} is

the is the proportion of supplier i 's patents in technological class k in year t .

Methods

We choice a sample includes 58 suppliers and during 12 years period (from 1985 to 1996), so the sample is a panel that cross-sectional time series data involving repeated observations of our set of suppliers over time, so the unit of analysis is a supplier year. We follow the approach suggested by Hausman et al. in their analysis of patent data [14], and use the negative binomial regression for panel data to analyze the issue.

Two characters of suppliers we conclude in above content are used as criteria to classify different suppliers. We based on each character to split the whole samples into two parts and compare the difference of the knowledge transfer effects between these two parts.

Firstly, to evaluate our expectations we split

our sample into two subsamples, based on the supplier's acquiring knowledge from automakers, which is ascertained by the summed amount of citations from auto makers' patents from 1985 to 1996. Suppliers in our sample had accumulation of citations from auto makers range from 0 to 526, with an average of 61.72 and the median 13. We divided our sample equally among the two subsamples; using a cut off 13 citations from auto makers, suppliers cited 13 or fewer times from auto makers' patent in this 12 year period, were considered less accumulation of KT form auto makers, while those who cited more than 13 times from auto makers' patent in this period, were classified as more accumulation of KT form auto makers.

Secondly, we split our sample into two subsamples, based on the supplier's accumulation of knowledge creation, which can be measured by the summed amount of a supplier's applied patents from 1980 to 1996. Suppliers in our sample had accumulation of the summed amount of a supplier's applied patents range from 1 to 2457, with an average of 220.06 and the median 40. We divided our sample equally among the two subsamples; using a cut off 40 patent applied during this period, suppliers applied fewer than 40 patents in this period, were considered less accumulation of knowledge creation, while those who applied 40 or more than 40 patents during this period, were classified as more accumulation of knowledge creation.

4 Results

Table 1 Comparison of Supplier's Characters Effects, dependent variable: $SUPCREA_{it}$.

Variable	Less accumulation of KT form auto makers		More accumulation of KT form auto makers		Less accumulation of knowledge creation		More accumulation of knowledge creation	
	Model a1	Model a2	Model a3	Model a4	Model a5	Model a6	Model a7	Model a8
Knowledge stock	0.002325 (0.005626)	0.003678 (0.005746)	0.001427*** (0.000302)	0.001394*** (0.000307)	0.021102** (0.010133)	0.014695 (0.010697)	0.001414*** (0.000282)	0.001334*** (0.000287)
Technological value	0.029253*** (0.005305)	0.030680*** (0.005204)	0.030564*** (0.006400)	0.030282*** (0.006158)	0.039984*** (0.006439)	0.041422*** (0.006312)	0.021906*** (0.005277)	0.022387*** (0.005236)
Patents performance	0.506997 (0.378566)	0.523092 (0.382552)	0.187185* (0.103622)	0.195719* (0.108341)	0.881535 (0.544616)	0.867658 (0.774808)	0.080160 (0.106905)	0.126068 (0.109737)
Path	0.335941	0.387144	1.501845**	1.145691*	3.73874***	3.778097***	0.750306*	0.630772

dependence	(0.576596)	(0.564825)	(0.628822)	(0.639931)	(0.982014)	(0.971918)	(0.452221)	(0.456240)
Technological diversity	3.353496***	3.374565***	2.177847***	2.148241***	3.264871***	3.176909***	2.233373***	2.260279***
	(0.307472)	(0.305981)	(0.293693)	(0.293915)	(0.381169)	(0.383529)	(0.249141)	(0.247195)
INDEX	0.021704		0.01023**		0.011807**		0.012035**	
	(0.013775)		(0.004090)		(0.005172)		(0.005324)	
PREINDEX		-0.000519		0.03873***		0.027395*		0.032832***
		(0.040984)		(0.010106)		(0.016423)		(0.011652)
Intercept	0.082092	0.012653	-0.893472**	-0.972001**	-1.802999**	-1.611783	-0.123385	-0.370653
	(1.160395)	(1.14543)	(0.415448)	(0.433621)	(0.790795)	(1.007972)	(0.478528)	(0.491587)
Log-likelihood	-290.15	-291.36	-723.94	-720.23	-250.11	-251.08	-766.88	-765.67
N	297	297	296	296	293	293	300	300
Chi-squared (p-value)	2.40	0.00	5.70	13.13	4.57	2.62	4.75	7.16
	(0.1212)	(0.9899)	(0.0170)	(0.0003)	(0.0324)	(0.11)	(0.0293)	(0.0074)

Notes:

legend: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

1. The method of estimation is maximum likelihood for the negative binomial model applied for panel data.

2. Standard errors are shown in parentheses.

3. The chi-squared of models are likelihood-ratio test versus their respective baseline model, which only contains control variables.

The regression results give us evidences that only suppliers with more accumulation of knowledge transfer from auto makers can easily benefit from acquiring knowledge from auto makers, both instantaneously and postponed. From the model a1 to model a4 in Table 1, there are significant differences between these two subsamples. The model a1 and the model a2 include suppliers with less accumulation of KT from auto makers, and the model a3 and the model a4 include suppliers with more accumulation of KT from auto makers.

These reveal that suppliers, who are more familiar with auto makers' knowledge, can more significantly enhance own knowledge creation capability through acquiring knowledge from auto makers.

The model a5 and the model a6 include suppliers with less accumulation of knowledge creation, and the model a7 and the model a8 include suppliers with more accumulation of knowledge creation. The test results argue that suppliers with whether more or less accumulation of knowledge creation, can benefit from simultaneous knowledge transfer from auto makers (i.e. the instantaneous effect is not sensitive to supplier's accumulation of knowledge creation). While suppliers with more knowledge creation capability, than those with

less of knowledge creation capability, can more easily gain benefit from previous knowledge transfer from auto makers (i.e. the postponement effect is sensitive to supplier's accumulation of knowledge creation).

5 Conclusion

In this paper, we analyze whether such positive relations between a supplier's knowledge creation performance and its acquiring knowledge from auto makers is dissimilar among different suppliers, and the classification of which are their accumulation of knowledge acquiring from auto makers and the accumulation of their own created knowledge.

Through analyses by split subsamples, we find that suppliers who are more familiar with auto makers' knowledge, can more significantly enhance its own knowledge creation capability through acquiring knowledge from auto makers, both in instantaneous effect and in postponement effect.

We also find suppliers with whether more or less knowledge creation capabilities, can benefit from simultaneous knowledge transfer from auto makers (instantaneous effect); while suppliers with more knowledge creation

capability, than those with less of knowledge creation capability, can more easily gain benefit from past knowledge transfer from auto makers (postponement effect).

In this paper, we classify suppliers by their characters of knowledge accumulation. More precise criteria should be constructed to indicate suppliers' roles in future studies.

Relationship, especially social ties among persons are important factors influence knowledge transfer. Future studies should consider kinds of relationship between suppliers and auto makers in discussion of knowledge transfer in the supply chain context.

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