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Transplanting Keiretsu

Empirical Evidence from Southeast Asia's Auto Industry

For decades, Japanese manufacturers that assemble machinery such as computers and automobiles have cultivated close, longstanding, and mutually reinforcing ties with suppliers who, in most cases, produce high quality parts and deliver them to the assembler on time. While they create opportunity costs by neglecting price signals, these vertical ***keiretsu***, or supply networks, often yield net gains through greatly reduced transaction costs, and thus may serve as a significant source of competitive advantage.[1] We should not be surprised, then, to learn that Japanese assemblers have asked their most valued subcontractors to follow them as they expand into overseas markets with new production facilities.

In Southeast Asia, for example, Japanese automakers have established their own supply networks in each host country market in which they operate, and across the region as a whole.[2] Overseas affiliates of parts manufacturers headquartered in Japan usually occupy the central positions in these networks, supplying everything from wire harnesses to seat upholstery, from alternators to

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brake systems. Indigenous firms (that is, firms capitalized largely with local equity) occupy peripheral positions, and usually supply only very low value-added parts.

For example, Toyota Motors Thailand (TMT), tightly controlled by the giant automaker in Japan, did not rely on non-Japanese suppliers to supply any of the critical components for vehicles it assembled there in the late 1990s. This was cause for envy among rival executives at the Nissan affiliate in Thailand, even though they themselves relied on only one indigenous firm—a producer of tailpipes—for Nissan vehicles assembled there.[3] TMT's supply club, the Kyōhō-kai of Thailand, was completely dominated by Japanese affiliates—thirty-two altogether, only four of which are "offspring" of parent firms who do not belong to Toyota's home-based supply club, the Kyōhō-kai of Japan.[4] Table 1 lists all of these club members. ***<<Table A renamed Table 1, OK?>>***

Despite this apparent replication of relationships, many observers believe overseas auto markets are more "open" than domestic networks in Japan; that is, they are held together by "looser" (or less restrictive, less exclusionary) ties between assembler and supplier.[5] Indeed, one can find the local affiliates of Toyota suppliers producing parts in Bangkok and Jakarta for Nissan's affiliates in those two cities, and vice versa.

But this empirical fact may reflect nothing more than the relatively small size of automobile markets in Southeast Asia; in 2005, the Thai market, for example, was only 8 percent as big as Japan's, while Indonesia's was 6.8 percent as large.[6] As a result of this, suppliers are unable to achieve economies of scale (and thus are unable to operate at maximum efficiency) without selling their parts to a wider circle of assembly customers. According to this logic, then, Japanese automakers have encouraged their key subcontractors in Japan to come to Southeast Asia, establish local production facilities, and supply parts to them as well as to other assemblers—at least for the time being.

If the difference in market size does in fact explain the difference between Japanese supply ***keiretsu*** in Southeast Asia and Japanese ***keiretsu*** in Japan, we should naturally expect such variation

to decline gradually as automobile markets in host countries throughout the region get larger and larger—as they did in Southeast Asia from 1990 through 1996, before a regional financial crisis caused those markets to contract dramatically. (The number of vehicles manufactured in the Thailand, Indonesia, Malaysia, and the Philippines jumped from 822,000 to 1,417,000, a 72 percent increase over those six years.[7]) That is, the economic need (measured in cost savings) to engage in extra-***keiretsu*** transactions in Southeast Asia would lessen as suppliers begin to achieve economies of scale by manufacturing parts for one primary customer. And by implication, then, intra-***keiretsu*** transactions should increase as the markets in those countries reach a sufficient scale.

The preceding set of assumptions can by restated as a pair of hypotheses to be tested with an ordinary least squares (OLS) multiple regression analysis of both firm- and country-level data:

1. As Japanese automobile assemblers increasingly regionalize their production activities (that is, expand manufacturing in Southeast Asia relative to Japan), their affiliated subcontractors do the same.

2. This correlation between the regionalization of ***keiretsu*** assemblers and subcontractors grows stronger over time as automobile markets in Southeast Asia increase in size.

Collecting Data

Of the four leading automakers in Japan, three (Toyota, Nissan, and Mitsubishi Motors) agreed to provide the author with lists of (a) their ***keiretsu*** suppliers (here "subcontractors") in Japan; (b) the ***keiretsu*** suppliers of their affiliates in Thailand; and (c) the ***keiretsu*** suppliers of their affiliates in Indonesia. (A Honda representative initially indicated his firm would cooperate, but in the end—after numerous requests—chose not to produce any lists.)

My original plan was to collect data on these subcontractors for 1990, when the regionalization activities of Japanese automobile subcontractors began to accelerate, and 1996, when these activities reached their peak. But this proved to be too narrow a target;

Table 1

Japanese Members of Toyota Supply Club in Thailand

Name of Thai affiliate	Parts produced	Year established in Thailand	Name of Japanese parent	Parent in J Kyōhō-kai?
Aoyoma Thai	Metal fasteners	1965	Aoyama	Y
Bangkok Foam	Interior trim	1971	Inoac Corporation	Y
Thai Bridgestone	Tires, tubes	1969	Bridgestone	Y
CI-Hayashi	Carpeting	1993	Hayashi	Y
Denso Thailand	Alternators, regulators	1974	Denso	Y
Enkei Thai	Aluminum wheels	1987	Enkei	N
Siam GS Battery	Batteries	1970	Nihon Denchi	Y
Inoue Rubber Thailand	Industrial rubber parts	1970	Inoac Corporation	Y
Kallawis Autoparts	Wheels	1973	Chuo Hatsujo	Y
NHK Spring Thailand	Seats, springs	1963	Nihon Hatsujo	Y
Nippon Paint Thailand	Paint	1968	Nippon Paint	Y
National Thai Co.	Car radios	1961	Matsushita	Y
Ogihara Thailand	Pressed parts	1990	Ogihara	N
Pioneer Electronics Thailand	Car stereos	1991	Pioneer	Y
Sunstar Chemical Thailand	Pressed parts	1989	Sunstar Engineering	N

Siam Aishin	Brake drums	1996	Aishin	Y
Siam Furukawa	Battery	1992	Furukawa Denchi	Y
Siam Kayaba	Shock absorbers	1996	Kayaba	Y
SNC Soundproof	Soundproofing	1994	Nihon Tokushu Toryo	Y
Thai Auto Works	Body parts	1988	Toyota Autobody	Y
Thai Arrow Products	Wire harness	1963	Yazaki	Y
TCH Suminoe	Upholstery	1995	Suminoe Orimono	Y
TG Pongpara	Steering wheels	1995	Toyoda Gosei	Y
Thai Koito	Headlamps	1986	Koito	Y
Thai Kansai Paint	Paint	1970	Kansai Paint	Y
Thai Parkerizing	Metal coating	1979	Nihon Parkerizing	N
Thai Seat Belt	Seatbelts	1994	Tokai Rika Denki	Y
Thai Steel Cable	Control cables	1981	Nihon Cable Systems	Y
Thai Stanley Electric	Signal lamps	1981	Stanley	Y
Thai Safety Glass	Windshield, windows	1988	Asahi	Y
Toa Shinto	Paint	1989	Shinto Toryo	Y
Yuasa Battery Thailand	Batteries	1963	Yuasa	Y

Source: Toyota Motor Company.

data on sales by the overseas affiliates of Japanese firms are occasionally included in a statistical volume published annually by Tōyō Keizai shinpōsha (***Kaigai Shinshutsu Kigyō Sōran***)—but only when firms agree to supply it. Indeed, I quickly discovered that data on sales in Thailand or Indonesia were spotty; that is, when they were available at all, they often were available for 1989 or 1991, rather than 1990, or for 1995 or 1997, rather than 1996. So I decided to collect as much firm-level data as possible for all six years, relying not only on the Tōyō Keizai volume mentioned above, but also on published records in the two host countries,[8] and on responses to a survey I submitted to some affiliates in Thailand and Indonesia. Still, a number of holes remain in these data for host-country sales by subcontractors.

Coverage is also incomplete for data on some of the firm-level control variables, especially the R&D intensity and export intensity of subcontractors in Japan. These are sometimes included in and sometimes omitted from the annual reports (***Yūka Shōken Hōkokusho***) filed by individual firms with the Tokyo Stock Exchange (if listed firms) and the Ministry of Finance (if unlisted). In a limited number of cases, I was able to fill holes by relying on Teikoku Databank's ***Kaisha Nenkan***. On the other hand, the annual reports filed by the companies almost invariably include data on sales in Japan, as well as number of employees.[9]

Country-level data on wages, interest rates, and the size of different automobile markets were, by comparison, easy to obtain. For wage data, I relied on International Labor Organization, ***International Labor Statistics***, as well as Government of Japan, ***Japan Statistical Yearbook***, and Government of Indonesia, ***Indonesian Statistical Yearbook***. For data on interest rates (as well as the consumer price index, which was used to deflate those nominal rates), I relied on International Monetary Fund, ***International Financial Statistics***. For data on market size, I relied on a handout from Automotive Resources Asia, a private consulting company based in Bangkok, and the Web pages of the Japan Automobile Manufacturers Association and Japan Automobile Dealers Association.

For the reasons stated earlier, I collected data for two sets of years: 1989, 1990, and 1991; and 1995, 1996, and 1997.

Building a Model

The dependent variable in this model, which I refer to here as "regionalization of subcontracting," is defined as the annual sales by a Japanese auto parts manufacturing affiliate in Thailand and/or Indonesia (the host countries), divided by the annual sales of its parent firm, the auto parts manufacturer in Japan (the home country). This gives us a measure, expressed in percentage terms, of the intensity of a subcontractor's regional production.

The following is a list of independent variables (the key explanatory variable, three country-level variables, and four firm-level variables) that may contribute to the regionalization of automobile subcontracting.[10]

• Regionalization (or regionalization of automobile assembly). This is the annual sales by a Japanese automobile assembling affiliate in the host countries, divided by the annual sales of its parent firm, the automaker in Japan, the home country. As in the case of the dependent variable, this test variable gives us a measure, in percentage terms, of the intensity of the assembler's regional production. If my hypotheses are correct, regionalization (that is, regionalization of automobile assembly) should have a positive and statistically significant impact on the dependent variable (regionalization of subcontracting), particularly in later years.

• Wages (or wage level). This is the ratio of wage levels in host and home countries in a given year. Subcontractors may be inclined to produce more in locations offering relatively cheap wages. Therefore, we can expect the sign here to be negative. (Note: ideally, we would adjust wage data to account for productivity differentials. But because I was unable to obtain comparable productivity figures for the automobile industry in different countries, that adjustment was not made here.)

• Irate (or interest rate). This is the difference between real interest rates in host and home countries in a given year. Each country's real interest rate is obtained by subtracting the change in the consumer price index during a given year from the nominal lending rate (i.e., the short- and medium-term rate) for that year. Although they obtain much of their capital in Japan and offshore

financial markets such as Singapore and Hong Kong, subcontractors do borrow in the host country. Thus, higher real interest rates in Thailand and/or Indonesia, relative to Japan, should have a negative impact on the regionalization of subcontracting.

• MktSize (or market size). This is the size of the market for automobiles in the host country in a given year, divided by the size of the Japanese market. Market size is measured by the total number of new vehicles sold per year. We should expect the sign to be positive.

• RDInt (or R&D intensity). This is the amount of money spent on research and development by the subcontractor in Japan in a given year, divided by total sales in Japan. We cannot predict the outcome here. Although it seems logical to expect innovating firms to be more capable of investing overseas, it also seems quite likely that Japanese subcontractors are becoming less internationally competitive and pursuing a regionalization strategy in lieu of making domestic investments in R&D. In addition, because ***it is could be*** multicollinear with V-added, we must be cautious in predicting the sign.

< < d o you want to say "it is" or "it c o u l d be"?>>

• V-added (or value-added). This is the sum of the subcontractors' personnel expenses, rent and tax payments, patent royalties, depreciation, and operating income in a given year. We can predict that the sign of the coefficient will be positive. But because it might be multicollinear with RDInt, we have to be cautious about predicting the size of the coefficent.

• ExInt (or export intensity). This is measured by the ratio of a subcontractor's exports from Japan divided by its total sales in Japan. It is assumed that export-oriented firms will be more likely to engage in FDI, and that the sign will thus be positive.

• FirmS (or firm size). This is based on the number of workers employed by the subcontractor in Japan. It is assumed that larger firms will be more capable of investing overseas, and that the sign will therefore be positive.

Results

Five different tests were conducted using a two-way, fixed-effect model with panel data.[11] Test results are displayed in Tables 2–6.

Table 2

All Years (no. 1)

Variable	Coefficient	Standard error	***T***-statistic	Probability
Constant	0.0065	0.0046	1.4163	0.1570
Regionalization	0.0018	0.0007	2.7941	0.0053
Wages	–0.0421	0.0503	–0.8370	0.4028
Irate	–0.0006	0.0003	–1.9704	0.0491
MktSize	–0.0353	0.0353	–1.0020	0.3166
RDInt	–6.52E-06	1.63E-06	–3.9984	6.84E-05
V-added	1.13E-06	9.84E-07	1.1509	0.2500
ExInt	0.0026	0.0043	0.6049	0.5454
FirmS	1.37E-07	1.22E-07	1.1213	0.2624

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R^2: 0.048.
Adj. R^2: 0.041.
Number of observations: 1,031.

Table 3

All Years (no. 2: rerun to address multicollinearity)

Variable	Coefficient	Standard error	T-statistic	Probability
Constant	0.0022	0.0014	1.6627	0.0966
Regionalization	0.0020	0.0005	3.8722	0.0001
Irate	–0.0003	0.0002	–1.7874	0.0741
RDInt	–5.89E-07	1.17E-06	–0.5021	0.6157

R^2: 0.013.
Adj. R^2: 0.010.
Number of observations: 1,163

One unavoidable conclusion is that the model is, to be charitable, imperfect. First, it leaves far too much unexplained; even the most robust test produces an ***R***-squared of only 0.079. Second, it contains a large amount of "noise;" that is, there is a great deal of multicollinearity between independent variables. For example, R&D intensity and value-added were highly correlated.

Table 4

1989–1991

Variable	Coefficient	Standard error	T-statistic	Probability
Constant	0.0027	0.0012	2.2021	0.0282
Regionalization	–3.09E-05	0.0003	–0.1054	0.9161
Wages	–2.43E-07	4.45E-06	–0.0547	0.9564
Irate	–9.01E-05	7.08E-05	–1.2726	0.2039
MktSize	–0.0432	0.0208	–2.0782	0.0383
RDInt	–5.20E-08	3.95E-07	–0.1319	0.8952
V-added	–1.03E-07	2.67E-07	–0.3876	0.6985
ExInt	–0.0009	0.0012	–0.7180	0.4732
FirmS	7.45E-09	2.75E-08	0.2713	0.7863

R^2: 0.018.
Adj. R^2: –0.002.
Number of observations: 409.

Table 5

1995–1997 (no. 1)

Variable	Coefficient	Standard error	T-statistic	Probability
Constant	0.0083	0.0069	1.1933	0.2332
Regionalization	0.0019	0.0010	1.8438	0.0657
Wages	–2.17E-05	2.91E-05	–0.7472	0.4552
Irate	–0.0008	0.0005	–1.6187	0.1060
MktSize	–0.0327	0.0729	–0.4480	0.6543
RDInt	–1.01E-05	2.46E-06	–4.1186	0
V-added	–2.66E-06	1.83E-06	–1.4511	0.1473
ExInt	0.0002	0.0062	0.0354	0.9718
FirmS	8.69E-07	2.61E-07	3.3242	0.0009

R^2: 0.079.
Adj. R^2: 0.067.
Number of observations: 622.

Despite these problems, however, the model does lend limited support for both of my hypotheses:

1. For the entire time period under study (1989–97), the key explanatory variable (regionalization of Japanese automobile assembly)

Table 6

1995–1997 (no. 2: re-run to address multicollinearity)

Variable	Coefficient	Standard error	***T***-statistic	Probability
Constant	–0.0021	0.0011	–1.9553	0.0510
Regionalization	0.0017	0.0007	2.5465	0.0111
RDInt	–1.05E-05	2.39E-06	–4.3805	1.39E-05
FirmS	5.15E-07	8.08E-08	6.3716	3.66E-10

R^2: 0.071.
Adj. R^2: 0.066.
Number of observations: 622.

had a positive and statistically significant impact on the dependent variable (regionalization of Japanese automobile subcontracting). This is evident in the test for "All Years." "Regionalization" was one of only three variables that proved reliable; and when the test was rerun with fewer variables (to control for multicollinearity), it was the ***only*** variable that actually became more reliable.

2. The correlation between these two variables grows stronger in time with an increase in the size of the host country automobile market. Whereas the test for 1989–91 showed that the regionalization of automobile assembly did not then contribute to the regionalization of subcontracting, the test for 1995–97 showed that it had a positive impact. Indeed, when I dropped "noisy" variables from the first test for 1995–97 and ran another test to control for multicollinearity, the ***T***-statistic for "regionalization" (the key explanatory variable) jumped rather sharply.

Notes

1. This article does not analyze the welfare effects of vertical ***keiretsu***—a field that has been well tilled by economists and management scholars. I refer interested readers to Imai and Kaneko (1988), Nishiguchi (1994), Dyer (1997), and Fujimoto (2004).

2. The creation of region-wide networks in particular industries, especially the automobile industry, has been facilitated by the Association of Southeast Asian Nations (ASEAN), acting principally on behalf of Japanese manufacturers.

For example, the organization adopted the Brand-to-Brand Complementation (BBC) scheme in 1988 and the ASEAN Industrial Cooperation (AICO) scheme in 1996; both schemes dramatically reduced tariffs on the intraregional and intra-industry trade of certain products, such as auto parts.

3. Interviews, Siam Motors and Nissan Co., Bangkok, September 23, 1997.

4. Some authors use the term "parent firm" to refer to the assembler (vis-à-vis the subcontracting "child") in a vertical ***keiretsu***. For clarity, I avoid that usage here. Instead, I use this term exclusively to refer to the home company in Japan (or ***honsha***; that is, the capitalizing firm, or primary headquarters operation) that controls and/or capitalizes an overseas manufacturing affiliate—whether an assembler or parts supplier.

5. See, for example, Kamo (1997, 77), and Guiheux and Lecler (2000, 13–16).

6. This is based on total sales of all vehicles: 5.85 million in Japan; 468,000 in Thailand; and 397,000 in Indonesia. See the Web site of the U.S. Commerce Department, International Trade Association, www.ita.doc.gov/td/auto/asean402.pdf, and the Web site of the Japan Automobile Manufacturers Association, www.jama.org/statistics.

7. Nikkan Jidôsha Shinbunsha, ***Jidôsha Sangyô Handobukku***, ***<<are those supposed to be macrons over the "o"? translation of publication?>>*** various years. For more on changes in the Asian automobile market, see Maruyama (1997).

8. Two sources in Thailand proved useful: ***Thailand Company Information*** (an annual report published by Advanced Research Group, a consulting firm in Bangkok) and ***1,000 Companies*** (an annual report published by the Nation Publishing Company, a Bangkok media group). I am grateful to Professor Suehiro Akira at the University of Tokyo for introducing me to these sources. For additional data on firms in Indonesia, I used: ***Profiles of 800 Major Non-Financial Companies in Indonesia*** (prepared by P.T. CISI Raya Utama, a member of the CIC Consulting Group in Jakarta). I am grateful to Sato Yuri of Ajia Keizai Kenkyûjo ***<<should "u" have a macron?>>*** for pointing me toward this source.

9. They do not, however, include data on value-added. For these, I relied on Nihon Keizai Shinbunsha, ***Nikkei Keiei Shihyô <<macron?>>*** [Nikkei Financial Index].

10. Many of the independent variables in this list (as well as the dependent variable) are money values initially stated in baht or rupiah (but later converted to dollars) divided by money values initially stated in yen (and then converted to dollars). As a consequence, I was compelled to drop from the model a variable designed to measure the influence of relative exchange rates.

11. With this methodology, the panel data are organized by year, stacked end-on-end, and then analyzed jointly. See Green (2000).

References

Dyer, Jeffrey H. 1997. "Effective Interfirm Collaboration: How Firm Minimize Transaction Value." ***Strategic Management Journal*** 18, no. 7: 535–56.

Fujimoto, Takahiro. 2004. ***Nihon no Mono-tsukuri Tetsugaku*** [The Philosophy of Japanese Manufacturing]. Tokyo: Nihon Keizai Shinbunsha.

Green, William H. 2000. ***Econometric Analysis***, 4th ed. New York ***<<OK? s/b Upper Saddle River, NJ?>>***: Prentice Hall (fourth edition).

Guiheux, Gilles, and Yveline Lecler. 2000. "Japanese Car Manufacturers and Parts Makers in the ASEAN Region: A Case of Expatriation under Duress or a Strategy of Regionally Integrated Production?" In ***Global Strategies and Local Realities: The Auto Industry in Emerging Markets***, ed. John Humphrey, Yveline Lecler and Mario Salerno, ***<<page nos. of chapter?>>***. London: Macmillan.

Imai, Ken'ichi, and Ikuyo Kaneko. 1988. ***Nettowāku soshiki-ron*** [Theory of the Network System]. Tokyo: Iwanami Shoten.

Kamo, Kineko. 1997. Nihon Jidōsha Kigyō no Gurō baru Sneryaku to Ajia Keizai Ken" [The Global Strategies of Japanese Automobile Firms and the Asian Economic Zone]. In ***Ajia no Jidōsha Sangyō*** [Asia's Automobile Industry], ed. Yoshinari Maruyama, ***<<page nos. of chapter?>>***. Tokyo: Akishōbo.

Maruyama, Yoshinari. 1997. ***Ajia no Jidōsha Sangyō*** [Asia's Automobile Industry]. Tokyo: Akishōbo.

Nishiguchi, Toshihiro. 1994. ***Strategic Industrial Sourcing***. New York: Oxford University Press.