GLOBALIZATION IN THE U.S. AUTO INDUSTRY: INTERNATIONAL MERGERS AND ACQUISITIONS AS DRIVERS OF INFORMATION SHARING

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ABSTRACT

There is growing interest in the role that corporate restructurings play in innovation. Although existing research has looked at the impacts of leveraged buyouts of companies on R&D spending and profits, few studies have looked at the effect that buyouts have on the *output* of R&D, and those studies focus on the impacts of domestic M&As. This paper contributes to the literature by empirically investigating the patenting behavior of "the Big 3" U.S. automobile companies and the effects of international knowledge spillovers from their foreign acquisitions. A log-log regression specification is used to isolate flows of knowledge for 1980-2000 between the country of the acquired subsidiary and the U.S. manufacturer. The Lexis-Nexis patent database is used to count international patent citations and "inventor country of origin" as measures of international information flows. Results indicate that there is a significant difference for the automobile industry in the information flows arising from M&As in two distinct locales: Germany, and the U.K. and Canada, with the latter pair giving greater knowledge spillovers for low levels of M&A, whereas the former gives greater spillovers as the volume of M&A activity increases.

Key words: M&As, innovation, patents, automobile, spillovers.

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I. INTRODUCTION

The U.S. automobile industry is a textbook example of an "old economy" industry that has been struggling under the pressures of globalization. Both Ford and General Motors, once icons of American industry, were downgraded to junk-credit status in mid-2005, and a few months later Delphi became the largest automotive company in U.S. history to declare bankruptcy.

Throughout its history, firms in the U.S. auto industry have been active in undertaking mergers and acquisitions (M&As) with both domestic and foreign companies. These auto manufacturers have also aggressively patented their innovations. But have these M&As helped the companies' innovative process? As the competitive pressure that globalization brings from overseas threatens to decimate the U.S. auto industry, are U.S. automotive manufacturers effective in utilizing information and innovation skills from their foreign counterparts? This paper addresses these pertinent issues.

II. LITERATURE REVIEW

Corporate restructuring, both internal (such as reorganization of company divisions) and external (such as M&As), is generally used as a method to increase company performance. However, the empirical evidence that such performance enhancements are indeed realized is limited[3].

Corporate restructuring is also seen as a key determinant of a company's innovative activity[4]. But, though M&As are thought to positively influence innovation, there are few empirical studies dealing explicitly with this relationship.

Van Beers and Sadowski (2002) analyze the link between M&As and the probability of innovating for Dutch firms. They find that firms that acquire *and* divest assets have a greater probability to innovate but the effect for firms that *only* acquire is not significant. They conclude that firms that buy *and* sell others do so to aid innovation. Similarly, Granstrand and Sjölander (1990) look at Swedish technology firms buying smaller firms to obtain knowledge and find many can only access certain markets by M&As with those having an established presence there.

Other studies indicate that M&As do not reflect a push to enhance innovation – rather another motivation is the impetus and any impact on innovation is secondary. Ghosh (2004) finds a major M&A consideration for U.S. firms is increasing market share. As firms tend to increase R&D spending with market share, this implies that acquisitions indirectly enhance innovation. Sundarsanam (2004) argues instead that the primary motivation is revenue

[3] For example, Ghosh (2001) finds no evidence that a company's operating performance improves after an acquisition.

[4] See, for example, Geroski et al. (1993).

growth. Again, as data show R&D spending increasing with revenue, this also implies that M&As enhance innovation.

Danzon et al. (forthcoming) find mergers in the U.S. pharmaceutical-biotechnology industry to be due to excess capacity concerns in large firms and financial woes in small firms. They show that mergers cause slower growth in R&D for small firms, but have no significant impact on R&D for large firms.

There is scant research on how foreign M&As affect R&D. Belderbos (2001) studies how international M&As by Japanese firms affect their overseas R&D and finds the M&As lead to more foreign patents. This paper differs as the focus is on the impact of foreign M&As on a firm's *domestic* innovative behavior.

Isely and Simons (2002) investigate the impact that international information flows (measured by international trade and foreign patent citations) have on patenting in the U.S. auto industry, and find spillovers to be positive from Germany but negative from Japan. They do not use data on M&As.

How innovation is measured varies, from industry surveys (as in Van Beers and Sadowski, 2002) to R&D spending (as in Granstrand and Sjölander, 1990). This paper uses patenting as a measure of innovation and R&D output, and foreign patent citations (and inventor location) as a measure of international information flows.

There is substantial research on patents as a measure of innovation and citations as a measure of knowledge spillovers[5]. Jaffe et al. (2000) find that "aggregate citation flows can be used as proxies for knowledge-spillover intensity" (p. 218). Jaffe et al. (1993) find a greater likelihood that U.S. patents will cite other U.S. patents rather than foreign ones and a greater likelihood that these citations and patents will come from the same state and metropolitan statistical area. Jaffe and Trajtenberg (1999) find that a firm's patents have a greater likelihood of citing each other and inventors are 30-80% more likely to cite patents from the same country than from others. With foreign M&As firms can access differentially localized information sets. Given such spatial aspects, international M&As could lead companies to better utilize information from the acquired firms' countries.

To summarize the current literature: (i) there is disagreement as to how important enhanced innovation is in the M&A decision; (ii) there is, however, some indication that a firm's innovation is positively affected by its domestic M&As; and (iii) there is also evidence of spatial relationships in patenting.

The contribution of this paper is in a combination of characteristics which differ from the existing research: (i) empirical analysis of M&As and innovation in an "old economy" industry; (ii) a focus on international M&As and international information flows; and (iii) patent data as a measure of information spillovers.

[5] For example, Jaffe [1986], Pavitt and Soete [1997], Trajtenberg et al. [1997] and Jaffe et al. (1998).

The choice of industry may appear odd – it is frequently newer industries, such as semiconductors or biotech, which are highly competitive in innovation. Indeed, recent studies focus on such sectors for those very reasons[6] and Giedeman et al. (2006) show that innovation in high tech industries follows a different pattern than in the auto industry. However, one would expect high tech competitive industries to readily utilize knowledge from all available sources, including their overseas acquisitions. But does an old economy industry, comprising some of the world's largest companies, harness the innovative potential of foreign acquisitions?

III. DATA AND METHODOLOGY

This study looks at the patenting behavior of "the Big 3" U.S. auto companies – Chrysler Corp., Ford Motor Co. and General Motors Corp. – and tries to capture the effects of knowledge spillovers from their foreign acquisitions/subsidiaries. It is assumed that knowledge flows follow a standard production function where the inputs are the firm's research activities and the operations of its foreign subsidiaries.

R&D spending proxies for a firm's research inputs, with data from COMPUSTAT, a company's automobile production in a foreign country proxy for its exposure to overseas subsidiaries, with data from Ward's Automotive Yearbook (1981-2001). Using such production numbers focuses the study on direct exposure to a particular *country* (e.g. Germany), while profits or revenues reflect sales within a particular *region* (e.g. Europe) and cannot be separated by country with consistency.

The impact of foreign M&As on innovation for each company is measured by the sum of its patents created in the foreign country and its patents that cite that country. The U.S. patent process involves a search of existing patents. Relevant "prior art" is listed on granted patents in the form of citations along with its country of origin. Data on the number of U.S. patents assigned to the Big 3 are obtained from Hall et al. (2001) and the Lexis-Nexis patent database. The Lexis-Nexis database is also used to count international patent citations and patents for which the inventor/co-inventor is in a foreign country.

Research indicates that information flows more easily between countries with a common language[7]. The foreign subsidiaries of the
Big 3 are located in several nations, but their varying concentrations over the time period of this study yield the following language groupings for which the three auto companies have consistent subsidiary exposure: (1) Germany; (2) Australia, Canada, New Zealand and the U.K. However, Australia and New Zealand are dropped because of data inconsistencies.

[6] See Hall and Ziedonis (2001), Bessen and Hunt (2004) and Danzon et al. (forthcoming).
[7] See Jaffe and Trajtenberg (1999).

As in Jaffe (1986) a log-log specification is used. The estimation equation is:

$$\begin{aligned} \text{TOTAL}_{it} = {} & \alpha + \beta_1(R\&D_{it}) + \beta_2(PRODUCTION_{ijt}) + \\ & \beta_3(PATENTS_{it}) + \beta_4(R\&D_{it})(PRODUCTION_{ijt}) + \\ & \beta_5(YEAR) + \beta_6(PRODUCTION_{ijt})(GERMANY_{it}) + \beta_7(GERMANY_{it}) \\ & + \beta_8(FORD_{jt}) + \beta_9(CHRYSLER_{jt}) \end{aligned} \quad (1)$$

where the variables are defined as follows[8]:

$TOTAL_{it}$ is the number of patents granted to firm i in year t that either originated in the target country or cited the target country

$R\&D_{it}$ is firm i's monetary contribution to the creation of new products in year t, deflated by firm i's total patents.

$PRODUCTION_{ijt}$ is the number of automobiles produced by firm i in country j in year t, deflated by firm i's total patents.

$PATENTS_{it}$ is the total patents granted to firm i in year t (regardless of country of origin or citations)

$YEAR$ is a trend variable equal to the calendar year.

$GERMANY_{it}$ is a dummy variable set to one if the country of production is Germany for firm i in year t.

$FORD_{jt}$ is a dummy variable set to one if production in country j in year t is by Ford.

$CHRYSLER_{jt}$ is a dummy variable set to one if production in country j in year t is by Chrysler.

Subscript i designates firms; j countries; and t years. All monetary amounts are measured in real millions of dollars using the implicit price deflator with a base year of 1996, and non-dummy variables are measured using natural logarithms.

The time frame is 1980-2000, chosen for years with consistent data reporting in COMPUSTAT and Lexis-Nexis. Although final decisions on patent applications are made by the U.S. Patent and Trademark Office within 2 years on average now, the process can take much longer. The end date of 2000 allows for the inclusion of patents granted in 2001-2006. The summary statistics are given in

[8] The regression was also run with a GERMANY*R&D*PRODUCTION variable to fully interact German production. This gave no qualitative change in the estimated relative elasticities.

Table 1. Summary Statistics:

Variable (not logged)	Observations	Mean	Std. Dev.
TOTAL	120	43.47	28.22
R&D	118	21.45	11.80
PRODUCTION	120	2448.80	2776.05
PATENTS	120	226.07	135.24
YEAR	120	1989.55	5.87
GERMANY	120	0.5	0.50
FORD	120	0.35	0.48
CHRYSLER	120	0.3	0.46
GM	120	0.35	0.48

Table 2. Expected Signs of Coefficients:

Coefficient on variable	Expected Sign
R&D	+
PRODUCTION	+
PATENTS	+
R&D*PRODUCTION	+
YEAR	+
PRODUCTION*GERMANY	?
GERMANY	-
FORD	?
CHRYSLER	?

Table 2 gives expected signs of coefficients reflecting the following rationales: (i) The positive sign on R&D is because increases in R&D spending per patent imply "larger" patents encompassing more information and thereby providing greater information flows; (ii) the positive sign on PRODUCTION is because greater exposure in a country relative to the number of patents means greater exposure to the knowledge of that work force; (iii) the positive sign on PATENTS is because the greater a company's patenting activity, the more likely it uses information from other sources, including those overseas; (iv) the positive sign on R&D*PRODUCTION is because of synergies between exposure to international ideas and investment in research; (v) the positive sign on YEAR is because over time electronic search capabilities have improved leading to more patent citations; (vi) the negative sign on GERMANY is because of the language mismatch with the home company in the U.S.; (vii) there is insufficient information for a reasonable expectation for the PRODUCTION*GERMANY, FORD and CHRYSLER coefficients.

IV. EMPIRICAL RESULTS

Table 3. Regression Results:

	Regression Coefficient
Intercept	58.18 (1.65)
R&D	2.52 (59.85)**
PRODUCTION	0.88 (4.71)*
R&D*PRODUCTION	-0.30 (5.21)*
PATENTS	1.23 (3.28)+
YEAR	-0.03 (1.85)
PRODUCTION*GERMANY	0.15 (3.49)+
GERMANY	-1.12 (3.58)+
FORD	0.43 (3.31)+
CHRYSLER	0.26 (0.42)
R-square	.936
Observations	97
Number of Companies	3
Absolute value of t statistics in parentheses + significant at 10%; * significant at 5%; ** significant at 1% Regression uses standard errors adjusted for company-level heteroskedasticity.	

Table 3 gives regression results. The positive significant coefficient on R&D indicates that the greater the level of R&D spending per patent the greater the international information flows. In essence, a "big" research project pulls in more information from overseas sources. The average firm's R&D elasticity is 0.204, indicating positive, diminishing returns to R&D spending[9] from

[9] Calculated by the R&D coefficient, plus the R&D*PRODUCTION coefficient times the mean of the PRODUCTION term.

knowledge spillovers. The negative significant coefficient on R&D*PRODUCTION indicates that as a firm produces more, the returns to R&D (from information flows) decreases.

The positive significant coefficient on PATENTS shows that the more patents a firm gets, the more information it uses from other countries; the positive significant coefficient on PRODUCTION shows that the more a firm produces abroad (relative to overall patenting), the greater the information flows from that country.

Chrysler is not significantly different from General Motors as the coefficient is on CHRYSLER is not significant and GM is the dropped dummy variable. However, the positive and significant coefficient on FORD shows a statistical difference between Ford's and GM's information flows. This could be because Ford's smaller R&D program causes it to rely more on using ideas from its acquisitions.

The intercept term and the GERMANY dummy show that flows from Germany start with a disadvantage but increased production there leads to greater information flows compared to the same level of production from Canada/U.K. (as seen by the PRODUCTION*GERMANY coefficient). This yields an elasticity of additional production per patent on information flows from Germany[10] of 0.138, compared to -0.009 on information flows from Canada/U.K.

V. CONCLUSION

The above results show that international M&As do indeed facilitate information sharing, as a greater amount of manufacturing exposure in any of the countries leads to larger utilized knowledge spillovers to the home company. Thus, M&As by U.S. auto manufacturers cause them to use inventions from the countries of their acquisitions more intensively than before in their own innovation process.

However, the size of the impact on the U.S. firms' innovation differs if the acquisitions are in Germany rather than Canada/U.K. M&As in Canada/U.K. start with an advantage in knowledge flows to the U.S. compared to those in Germany, perhaps due to the shared language. This fits with Jaffe and Trajtenberg (1999) who find that information flows more easily between countries with a common language.

Language commonality is only one determinant of the flow of information between countries. The relative advantage that Canada/U.K. begins with erodes over time with a firm's increased exposure to Germany, so that if a U.S. auto

[10] Calculated by the PRODUCTION coefficient, plus the R&D*PRODUCTION coefficient times the mean of the R&D term, plus the PRODUCTION*GERMANY coefficient.

manufacturer were to increase its production presence in Germany through M&As, the resulting benefits to its own innovation process will be greater than if the manufacturer undertook a similar expansion in Canada/U.K..

This implies that having *more* M&As in another country might have a greater long term impact on a U.S. firm's innovation than a shared language. For this study, business involvement in Germany, with its relatively large stock of technical knowledge in automobile production and engineering, eventually offsets any language difficulties for a U.S. auto manufacturer. Though enhanced information flows might not be a primary motivation in the international M&A decision, it does show that such corporate restructuring can have a significant impact on the international information available for a manufacturer's innovative capabilities and that the location of the "target" firm exerts a strong influence on the size of the benefit to the home firm's innovation.

Isely and Simons (2002) find that the more U.S. auto manufacturers cite patents from Germany, the more patents the U.S. company obtains. Taken together with the above results, this indicates that international M&As might lead to a greater overall volume of innovation by the acquiring firm.

This research adds to the debate over issues that U.S. auto manufacturers face today. For example, in 2006 General Motors considered a merger with Renault-Nissan. Would it be beneficial for GM or its U.S. competitors to undertake such M&As in the future? The above findings indicate that if a company's goal is to enhance its innovative capabilities then it can do so by increasing its manufacturing exposure by merging with or acquiring companies in other countries regardless of any language barrier. Whether this improved information flow leads to an increase in the firm's bottom line and future global competitiveness is a question for future research.

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