TECHNOLOGICAL CAPABILITIES OF COUNTRIES, FIRM RIVALRY AND FOREIGN DIRECT INVESTMENT

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Abstract. Studies on foreign direct investment (FDI) have concentrated on sectoral effects, but rarely on country patterns. In this paper, we use U.S. Department of Commerce data to identify the largest country shares of new FDI entries into the U.S. and the technological motivations for their investments. Based on the technological intensities of major investing countries in manufacturing industries, we conclude that technological industries attract a disproportionate share of FDI entries. However, the acquisition of U.S. technology is not a major motivation. The findings indicate that industry rivalry is an important dimension to understanding FDI.

A striking pattern in international competition by multinational corporations is the dominance by a few countries who have converged in their shares of the world stock of direct investment. Over the course of this century, leadership in direct investment flows has moved from the United Kingdom to the United States, whose leading position has dramatically been eroded in the 1980s. The U.S. outward share of the world stock of direct investment (using balance of payments data) fell from 42% to 33% from 1980 to 1988; its share of inward investment grew from 16% to 27%.[1] The countries outside of the European Union, Japan and the United States had 15.5% of the world stock in 1980; this percentage fell to less than 9% by 1988 [Graham and Krugman 1995]. Foreign direct investment is surprisingly limited to a few industrialized nations. Similarly, a small number of sectors account for a large fraction of total entries. Analysis of the sectoral distribution of FDI entries reveals that the top

five manufacturing sectors accounted for 533 entries out of a total of 1540 by German firms, 1394 out of a total of 4160 entries by Japanese firms and 854 entries out of a total of 2778 entries by UK firms.

An obvious explanation for the growing parity in the shares of direct investment among the wealthiest developed countries is that American firms became less competitive in their home markets during this period. The secular trends in productivity clearly show a decline in relative American competitiveness after the oil shocks of 1970s. The relative stagnation in American real wages made the United States an increasingly attractive production platform for non-American companies endowed with better productive methods or technologies. The weakening of American-based competitors opened the opportunity, in a related sense, for foreign companies to extend world competition to the American market. These investments potentially represent the extension of strategic positions by foreign firms to offset the previous investments by American firms in their home markets [Graham 1978; Brander and Krugman 1983].

The data on the growing presence of multinational production in the United States are impressive statements to the rapidity of change in world markets. More than one-tenth of the American industrial work force was employed by a foreign company in 1991, a four-fold increase from the 1976 share [Kogut and Gittelman 1994]. However, this may indicate no more than the attractiveness of the U.S. as a source of technology. Though global sourcing is influenced by wage and material costs, in locations in advanced industrialized countries, it is particularly influenced by the potential to tap into local knowledge. This knowledge is partly embodied in the skills of workers, and partly captured through spillovers due to proximity to research centers, suppliers, or customers. In international markets, part of the technological resources that a firm possesses are captured through location.[2]

There is abundant evidence that industries intensive in R&D expenditure experience more international investment. As will be shown later, the sectoral distribution of R&D investment is highly correlated among countries. These joint results imply that certain sectors, independent of the countries, should be responsible for international direct investment. It is, however, not clear whether these investments are driven by the existing advantages of the investing firms (a technological "push" effect), or by the technological benefits arising out of the locational advantages of the host country (technological "pull" effects).[3]

There is, in effect, a sectoral and geographic interaction that drives world investment. To sort out their effects, we analyze a unique database consisting of announced new entries into the United States for the period of 1974 to 1991. For reasons of data availability, the analysis is restricted to three countries that dominate investment patterns: the U.K., Germany and Japan.

As the entry data are integer counts, a negative binomial model is specified to estimate the effects of technological capability and industry conditions on foreign entry. The results point to an encouraging robustness in the relationships between the sources of international rivalry and direct investment patterns. There is little evidence that, in the aggregate, relatively higher technological intensity of U.S. sectors draws in new foreign direct investment. These results do not change by country or by type of entry (e.g., joint ventures). Technological rivalry is a primary driver of direct investment entries; technological sourcing, at best, is a secondary motivation.

The results of this paper are of interest to studies on the resource-based view of the firm in an international context. In the international literature, investment behavior has been considered to be influenced by firm-specific intangible resources (e.g., technological knowledge) and industry rivalry. The results of this investigation indicate that standard measures of industry rivalry are robust predictors of foreign investment behavior. To understand global competition requires an analysis of competition among rivals and a decomposition of its underlying elements.

SECTORAL AND GEOGRAPHIC EFFECTS

Home Country Effects: Technological Capabilities and Rivalry

Theories of FDI have emphasized the existence of intangible assets and competitive advantages of the investing firm [Caves 1971; Hymer 1976; Dunning 1977], which can more than offset the disadvantages of operating in a foreign country. A persistent finding has been the importance of "intangible assets" in technological capabilities which embody the firm's competitive advantage over rivals in foreign markets. This advantage permits a firm to engage in direct investment overseas by transferring these intangible and technological assets to new markets.[4] These assets reflect the "ownership advantages" of a firm [Dunning 1977]. Their location is influenced by the size of the market, as well as the importance of scale effects [Helpman and Krugman 1985; Brainard 1993].

Caves has noted recently [1996] the similarity of this approach to the resource-based view of the firm:

> An asset might represent technological knowledge about how to produce a cheaper or better product at given input prices, or how to produce a given product at a lower cost than competing firms. This asset might take the specific form of a patented process or design, or it might simply rest on know-how shared among employees of the firm. It is important that the proprietary asset, however it creates value, might rest on a set of skills or repertory of routines by the firm's team of human (and other) inputs [Nelson and Winter 1982, chapter 5]. It is thus closely related to the concept of the firm's "core competencies"

discussed in business administration, and to that field's debate over the "resource-based view of the firm".

The relationship between the intangible asset and resource-based views has been obscured by the use of industry data in international studies. Since the early work stressed oligopolistic rivalry, the measures of technology, advertising, or scale were usually at the industry level. Some studies have looked at the effect of these assets on foreign investment at the firm level as well. In an early and still important study, Horst [1974] found that food firms with resources in advertising invested overseas; those strong in distribution did not. Not all resources are fungible across borders. Morck and Yeung [1991] analyzed the stock market's valuation of the multinationality of U.S. firms and found greater financial valuation to be associated with the firm's history of expenditures on proprietary assets. Yu and Ito [1988] looked at corporate-level data for U.S. textile and tire companies, finding a strong impact of technological resources on direct investment. Ball and Tshoegl [1982] explained the choice between establishing a branch and subsidiary by Japanese banks in California based on variables that capture firm-specific advantages, including firm experience. Similarly, in a study on the sequential and evolutionary pattern of investment, Kogut and Chang [1996] found also that direct investment by Japanese firms was strongly influenced by corporate intangible assets, as well as by the stock of past entries into the United States.

However potent these resources are, the pendulum has probably swung too far in neglecting industry rivalry as an important influence on investment. For all intents and purposes, it is hard to distinguish between resources and rivalry in

as industry-level characteristics on the modality of investment. Such results are strikingly robust across the many studies done on foreign direct investment.

In sum, we identify two related home country factors that should explain some of the observed patterns in FDI: home based technological advantages and domestic inter-firm rivalry "push" outward FDI. The greater the technological advantages and more intense the rivalry, the greater will be the outward FDI.

Host Country Effects: Technology Sourcing and Market Attractiveness

There is in the international literature a more recent strand of thinking on foreign investment that differs from the focus on intangible assets and resources. This literature concerns the "pull" of geography on attracting foreign investment flows. The empirical statistical studies on this topic were inaugurated principally by Cantwell's thesis, published in 1989. Cantwell found evidence for a path dependence in technological investments for several (but not all) countries. Of more relevance to investment, he found that investments were influenced by the spatial distribution of patenting activity at the industry level.

These findings suggest that ownership advantages are related to geography.[6] Nations differ, obviously, in their advantages. Not only is there a variation in factor prices (such as, labor and materials, with capital costs being rather similar), there is also a difference in the kind of organizational and techno- logical capabilities among countries. In part, these differences are drawn from the effects of the institutional environments, such as links to university research, or to technical centers. They are also due to the historical accumu- lation of capabilities at the firm level. But to a large extent, there are "location" advantages that, though firm-embodied (firms, not countries, compete), are not firm-specific. Location matters because boundaries demarcate a pool of knowledge from which a resident has the opportunity to draw.

A simple expectation is that firms are drawn to geographical locations where there exist market opportunities for expansion. The dynamic expansion of firms is driven by the joint influence of their technological and organizational capabilities and the profit opportunities of their environments. It is not surprising that countries that offer rich market opportunities are populated by firms with rival technological capabilities. As in the domestic case, firms will invest across borders of countries to extend their markets, as they would invest across jurisdictions within a nation. Borders, in this perspective, are only interesting insofar that they represent market segmentation.[7]

Borders will be significant in the sense of delineating resources if they coincide with the boundaries of country capabilities.[8] The geography of technological competition is much more complicated than the story of factor differences or oligopolistic rivalry across segmented national markets. In general, we can think of the capabilities of a country as residing in people, firms, or industrial

networks, inclusive of public institutions of research and education. In the domestic case, we often ignore the important role played by resources common among firms, and embodied in individuals or in national industrial networks. In an international case, the focus must be broadened to understand competition as arising not only from the resources within the firm, but also from those shared among firms from the same locality.

Why technical knowledge should be spatially bounded is not well understood. Despite some scepticism [Krugman 1991], there is increasing evidence that knowledge is locally specific. Jaffe, Trachtenberg and Henderson [1993] found, for example, that firms located near university research centers that pioneered patents are more likely to patent subsequently in a related field. In a subsequent study using a similar methodology, Almeida and Kogut [1994] found that design knowledge was particularly localized for the semiconductor industry, and the mobility (or the absence of mobility) of engineers influenced the dissemination of ideas. Kogut and Chang [1991] found that direct investment by Japanese firms into the U.S. was driven largely by technological capabilities of Japanese firms. Patel and Pavitt [1991] have similarly found that the technological activities of large firms are concentrated in their home markets, and strongly influenced by the growth of the home economy.

In summary, we identify two classes of host country characteristics that would complement the host country factors in explaining the observed sectoral concentration of FDI. First, resident technology of the host country, i.e., due to the technology-seeking motive, sectors in which the host country has superior technology would "pull" FDI entries. Second, FDI entries will be positively related to the market attractiveness of host country measured by its size, growth and competition in its market.

In this paper, we look at a rich data set of foreign direct investment entries to

EMPIRICAL MODEL

Measures

The considerations above lead to a very simple test. We gathered data, as explained below, on foreign entries into the United States at the four-digit level. Alternative data, such as plant and equipment expenditures by foreign subsidiaries, are more aggregated. However, we found the correlations between our measure of FDI (entry counts) and dollar flows measured at the two-digit SIC code level for major investing countries to be high: 0.878 for France, 0.717 for Germany, 0.702 for Japan, 0.562 for the U.K., and a mean of 0.649. The question we pose is whether the sectoral distribution of these entries is explained by the relative technological capabilities of countries, market attractiveness and rivalry between firms.

To measure technological capabilities and rivalry, we relied on R&D expenditure data from an unpublished series collected by the OECD for the investing countries; these data were normalized by the value of shipments. U.S. R&D data were drawn from the FTC line of business survey of 1977, which has the merit of giving a more disaggregated series. Since R&D expenditures among countries are highly correlated, we used a method utilized by Kogut and Chang [1991] to sum and subtract the R&D measures for the investing country and U.S. sectors. The sum represents a measure of the overall degree of technological intensity and rivalry; the subtraction of the foreign R&D expenditure from the U.S. figure indicates a pull or push effect of R&D on direct investment flows. If the coefficient should be positive, then this result implies that the U.S. R&D intensity pulls foreign investment; in other words, foreign investment is driven by technology sourcing motives.

We use several standard variables to measure market attractiveness of the host country. To capture potential barriers to entry, concentration rates and advertising measures were collected at the four-digit level; these variables should be negatively related to entry.[9] In addition, a variable measuring the dollar value of shipments is used to control for the expected positive effect of the size of the industry on entry. An import variable was included to measure the degree of import penetration; we should expect this variable to be negatively related to entry. For Japan, we also added an import barrier dummy to indicate if the sector was subject to a voluntary export restraint.

The major investing countries into the U.S. are Japan (4160 entries), the U.K. (2778 entries), Canada (2316 entries), Germany (1540 entries), France (924 entries), The Netherlands (745 entries), and Switzerland (556 entries). For Germany, the United Kingdom and Japan, we were also able to collect disaggregated data on "home concentration," that is, concentration in the domestic markets.[10]

As shown in Figure 1, there are clear differences among the three countries in

FIGURE 1
FDI Entries into the U.S., 1974–1991
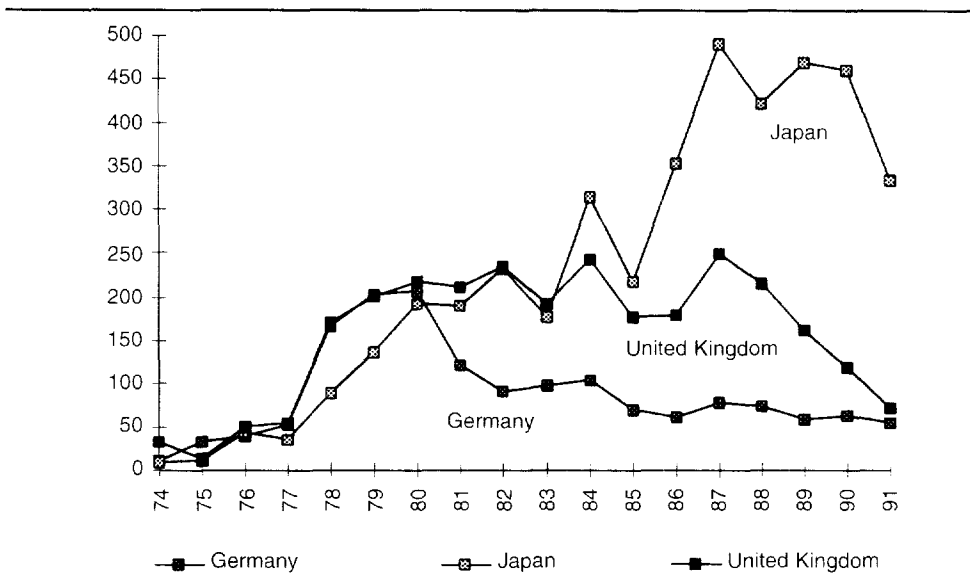
our sample regarding their intertemporal direct investments in the United States. The series shows a secular increase for Germany, Japan and the U.K., though the periodicity looks different especially for Japan. These patterns suggest that different country effects are operative. Exchange rate effects are unlikely to account for these sizeable differences, as the U.S. dollar has moved similarly against all these currencies. For the purpose of looking at the sectoral pattern of investments, temporal effects appear less important (in any case, we are using common measures of independent variables for the time period); they obviously will be more important for explaining absolute levels of direct investment.

Statistical Specification[11]

The dependent variable is an integer count of entry into the U.S. made by one of the three countries into a four-digit industry. Due to the bounded and integer nature of our dependent variable, the assumption of a normal distribution will not be appropriate. Since some of the counts take the lower limit of zero, the proper specification is a limited dependent variable technique suitable for integer data. One common specification is a Poisson regression. However, the Poisson distribution contains the strong assumption that sets the mean to be equal to a function of the covariates. This distributional assumption forces the mean and variance to be equal, a condition too strong for social science data that tend toward overdispersion, making it somewhat inappropriate for our analysis.

Consequently, we use a negative binomial specification. The negative binomial allows for overdispersion by allowing for unexplained heterogeneity in the

TABLE 1
Descriptive Statistics for Independent Variables, Pooled over All Countries

Variable	Mean	Std Dev.	Min.	Max.
U.S. R&D	0.016	0.031	0.0000	0.462
HOME R&D	0.017	0.023	0.0000	0.187
R&D Sum (SUM)	0.034	0.050	0.001	0.649
R&D Difference (DIFF)	−0.000	0.022	−0.099	0.346
U.S. Conc. (US CONC)	37.646	20.931	6.000	99.00
U.S. Advt. (US ADVT)	1.771	2.632	0.000	20.200
Shipments (US SHIP)	6242.10	16187.00	48.72	209900.00
Imports (IMP)	511.40	1772.30	0.033	22500.00
Growth (GROWTH)	0.018	0.048	−0.162	0.408

data; that is, it allows the residual error to vary by a *gamma* distribution. In the specification we use, the variance is a function of the mean, with an estimated coefficient (*alpha*) representing the degree of overdispersion. Therefore, a high value of *alpha* justifies the use of a negative binomial specification instead of a Poisson model.[12]

Descriptive Statistics

Table 1 provides descriptive statistics of the raw data for the three countries in the sample. Table 2 shows correlations on the industry distribution pooled among countries. As can be seen, the transformation of the R&D series by adding and subtracting has reduced the collinearity.

Another way to look at the correlations is by country. We find that Japan behaves differently regarding its entry patterns, with Germany and the U.K. showing the greatest similarity. The correlations in entries across sectors are 0.908 between U.K. and Germany, but only 0.826 and 0.761 between Japan and these two countries respectively. The R&D expenditures are much more closely correlated, with the correlations between the R&D expenditures of the three countries consistently about 0.95.

To give insight to these correlations, we identified the five manufacturing sectors for each country with the highest number of entries into the U.S. Though the order differs, three sectors appear consistently in this list: electronics, chemicals and industrial machinery. Of course, this pattern is not surprising given that these are raw entries and not normalized for industry size. (Control for industry size is made in the regression.)

TABLE 2
Correlations between Independent Variables

	U.S.R&D	HOME R&D	SUM	DIFF	US CONC	US ADVT	IMP	US SHIP	GROWTH	HOME CONC
U.S. R&D	1.000									
HOME R&D	0.687	1.000								
SUM	0.942	0.891	1.000							
DIFF	0.654	-0.077	0.372	1.000						
US CONC	0.132	0.084	0.121	0.092	1.000					
US ADVT	-0.039	0.030	-0.010	-0.087	0.114	1.000				
IMP	0.044	0.054	0.053	-0.002	0.101	-0.070	1.000			
US SHIP	0.067	0.076	0.077	0.009	-0.030	-0.069	0.745	1.000		
GROWTH	0.221	0.214	0.237	-0.055	-0.015	0.111	0.111	0.084	1.000	
HOME CONC	0.175	0.164	0.185	0.054	0.223	0.021	0.102	0.027	0.025	1.000

TABLE 3
Negative Binomial Results for Pooled Entries into United States
All Countries, All Periods, All Modes – Pooled

	(a)	(b)
Intercept	−0.474***	−.021
	(−3.995)	(−.161)
R&D Sum	5.607***	5.881***
	(4.808)	(5.235)
R&D Difference	−.484	−.731
	(−.190)	(−.300)
US Concentration	−0.021***	−0.021***
	(−10.100)	(−9.777)
US Advertising	0.052***	0.046***
	(3.779)	(3.175)
US Shipment($\times 10^{-5}$)	2.778***	2.460
	(7.322)	(6.752)
US Shipment Growth	3.824***	3.699***
	(4.910)	(4.620)
Imports($\times 10^{-4}$)	1.898***	1.940***
	(5.871)	(6.351)
Home Concentration	0.014***	0.013***
	(8.8254)	(7.381)
Dummy (1974–80)		−.815***
		(−8.158)
Dummy (1981–85)		−.445***
		(−4.875)
α	2.229***	2.036***
	(19.339)	(17.911)
Log Likelihood	−2851.1	−2817.0
N	457	1371

Note: t statistics are in parentheses.
*p = 0.10; **p = 0.05; ***p = 0.01

REGRESSION ANALYSIS

Pooled Data

The regressions in Table 3 present the results for the sample pooled over countries, time periods and modes of entry. A positive sign means that an increase in a coefficient leads to more entry; a negative sign indicates a decrement. The pooled data are constructed by stacking the country samples. Dummies are used to capture period effects corresponding to clear breaks in the dollar exchange rate regime. (The results are not sensitive to changes in small changes in the period definitions.) The results of both regressions are consistent and can be easily summarized by looking at the estimates based on the pooled data. The overall results are impressive for the significance of almost all the coefficients. The results are not changed when period dummies are included.

The sum of R&D intensity is positive and significant; the difference in R&D has little effect (the negative coefficients indicate greater entry in industries

with greater R&D intensity in the investing country). These results indicate that technological intensity and rivalry, as almost all studies have found, is an important driver of foreign direct investment flows. The coefficient of R&D difference is negative: FDI flows respond more to technological intensity of the originating country ("push" effect) than to the U.S. technological capability ("pull" effect).

The remaining variables are correctly signed and largely significant when period dummies are included. Concentrated industries in the U.S. tend to deter entry; foreign concentration encourages entry. These results are consistent with almost all previous work on direct investment and demonstrate the importance of concentration in explaining FDI.

An important observation is the effect of shipment growth on entry; faster growing industries pull in foreign entry, much like it is found to pull in domestic entry [Acs and Audretsch 1989]. Market opportunity has an important influence on pulling direct investment. When compared to the negative finding on the pull of resident technology, this result suggests that it is the demand side, as opposed to the resource side, that influences direct investment patterns on a sectoral basis. Industries that have high levels of import penetration tend to have more entries.

It is important to retain some modesty in these results. The estimated coefficient to heterogeneity in the sample (captured by *alpha*) is large and very significant. There is substantial dispersion across industries that is not accounted by the specified variables.

Entry by Investment Mode

The previous analysis explored determinants of outward flows, regardless of how the investment was made. However, determinants of entry vary by entry type. We used the classification from the Department of Commerce to distinguish between new plants, joint ventures and acquisitions. A new plant is defined as a wholly owned new facility, a joint venture as a business enterprise with shared ownership and control, and an acquisition as gain of control of an existing enterprise. A standard finding had been that joint ventures relative to new plants are discouraged if proprietary technology is involved; acquisitions are drawn to concentrated industries (especially in durable goods) where entry by other means would likely evoke strategic responses.[13] However, if the motivation is sourcing technology, and if the technology is proprietary to resident firms, joint ventures or acquisitions might be the modes of choice.

An overview of the raw data reveals interesting country patterns. The differences are most apparent in the Japanese and U.K. comparison, where it can be seen that Japanese companies rely more heavily on new plant (744 entries) and joint ventures (437 entries) with the relatively fewer acquisitions (929), while the U.K. relies more on acquisitions (1335 entries) and fewer new plants (174)

TABLE 4(a)
Negative Binomial Results for Entry Mode with Period Dummies

	Acquisitions	JVs	New Plants
Intercept	−0.222	−2.582***	−1.878***
	(−1.436)	(−6.116)	(−7.642)
R&D Sum	4.116***	.138	7.072***
	(3.702)	(.040)	(3.778)
R&D Difference	0.588	−.786	−6.466
	(0.291)	(0.091)	(−1.450)
US Concentration	−0.029***	−0.026***	−0.018***
	(−9.939)	(−3.427)	(−4.477)
US Advertising	0.072***	−0.036	−0.028
	(4.288)	(−.648)	(−0.897)
US Shipment($\times 10^{-5}$)	1.186**	3.231***	2.690***
	(2.493)	(2.825)	(4.488)
US Shipment Growth	6.364***	1.680	1.419
	(6.287)	(.647)	(.856)
Imports($\times 10^{-5}$)	8.214*	1.013	26.186***
	(1.614)	(1.021)	(5.029)
Home Concentration	0.007***	0.027***	0.018***
	(3.031)	(4.680)	(5.556)
Dummy (1974–80)	−1.198***	−1.764***	−0.696***
	(−9.280)	(−5.052)	(−3.775)
Dummy (1981–85)	−0.616***	−0.382	−0.142
	(−5.322) (1.465)	(−0.891)	
α	2.008***	5.941***	3.928***
	(10.139)	(5.472)	(10.697)
Log Likelihood	−1639.4	−555.29	−1243.7
N	137	1371	1371

Note: *t* statistics are in parentheses.
*p = 0.10; **p = 0.05; ***p = 0.01

and joint ventures (102 entries). Germany shows a pattern similar to the U.K. (410 acquisitions, 75 joint ventures and 255 new plants), though clearly the emphasis on new plants is greater.

Tables 4(a) and 4(b) report the results by entry mode. The results for acquisition and new plants are similar, except for a striking difference in the effects of R&D difference and advertising. The R&D difference coefficient in the new plant results is not counterintuitive. While acquisitions and joint ventures may capture some mixed effects of motives to acquire resident assets, new plants ('build' instead of 'buy') are more likely to reflect exploitation of existing home-based advantages. Acquisitions tend to be drawn to industries where advertising is important, a finding that corresponds to the anecdotal evidence on the difficulty of transferring brand labels to foreign markets and on the role of acquiring distribution channels in consumer product industries (see, also, Caves and Mehra [1986] for statistical evidence). The significant and negative coefficient to the dummy period variables indicate the growth in overall entries in the later time period (i.e., 1986 to 1991). However, the growth in the period 1981 to 1985 is mainly due to an increase in acquisitions.

TABLE 4(b)
Negative Binomial Results for Entry Mode with Period and Country Dummies

	Aquisitions	JVs	New Plants
Intercept	.124	-2.734***	-2.173***
	(.811)	(-6.355)	(-8.552)
R&D Sum	4.714***	4.274	7.568***
	(3.836)	(1.231)	(4.504)
R&D Difference	-2.462	-3.630	-6.102
	(-.915)	(-.476)	(-1.542)
US Concentration	-0.028***	-0.020***	-0.016***
	(-9.813)	(-3.041)	(-4.157)
US Advertising	0.069***	-0.0426	-0.028
	(4.174)	(-0.843)	(-0.957)
US Shipment($\times 10^{-5}$)	9.020**	1.671**	2.630***
	(2.100)	(2.016)	(4.716)
US Shipment Growth	6.384***	1.888	1.710
	(6.849)	(0.839)	(1.290)
Imports($\times 10^{-4}$)	0.895*	1.183	1.867***
	(1.936)	(1.481)	(3.699)
Home Concentration	0.008***	0.003	0.004
	(2.874)	(.474)	(1.211)
Dummy (1974–80)	-1.175***	-1.714***	-0.545***
	(-9.174)	(-5.070)	(-2.824)
Dummy (1981–85)	-0.640***	-0.248	-0.043
	(-5.485)	(-1.014)	(-0.260)
Germany	-1.063***	-0.169	0.539***
	(-8.789)	(-0.509)	(2.881)
Japan	-0.432**	1.970***	1.416***
	(-2.770)	(6.310)	(6.507)
α	1.625***	3.267***	3.259***
	(9.579)	(4.523)	(9.616)
Log Likelihood	-1603.1	-521.76	-1217.7
N	4113	4113	4113

Note: t statistics are in parentheses.
*$p = 0.10$; **$p = 0.05$; ***$p = 0.01$

Entry by joint venture is the least well explained of the three modes. Not only is the likelihood much lower, but the measure of heterogeneity bears a large coefficient. At the same time, the number of joint ventures is substantially smaller than the other two modes. Especially intriguing is the poor result for the technological and advertising variables. Unlike estimates derived from a sample of only Japanese joint ventures ending in 1987 [Kogut and Chang 1991], there is no indication that joint ventures are pulled into the U.S. for sourcing American technology.

In Table 4(b), we give the results for entry count with country dummies. The signs on the coefficients are as expected. Japan has a high share of joint ventures and new plants, and a low share of acquisitions. Germany has a significantly high share of new plants corresponding to the large proportion of British acquisitions.

TABLE 5
Negative Binomial Results for Pooled Entry by Country

	Germany	U.K.	Japan
Intercept	−.777***	.112	.161
	(−3.023)	(.590)	(.544)
R&D Sum	7.650***	3.898**	15.211***
	(3.774)	(2.442)	(4.231)
R&D Difference	−2.025	−3.524	−4.900
	(.935)	(−1.094)	(−0.784)
US Concentration	−0.014***	−0.028***	0.019***
	(−3.480)	(−7.476)	(−5.275)
US Advertising	0.036	0.079***	0.014
	(1.194)	(3.999)	(0.416)
US Shipment($\times 10^{-5}$)	4.061***	3.259***	0.169
	(4.835)	(5.602)	(.327)
US Shipment Growth	1.640	6.497***	2.690*
	(.847)	(4.702)	(1.934)
Imports($\times 10^{-4}$)	−0.205	−0.233	3.486***
	(−0.210)	(−0.039)	(6.804)
Home Concentration	0.004	0.008*	0.015***
	(.934)	(1.923)	(4.140)
Dummy (1974–80)	0.188	−0.433***	−1.962***
	(.951)	(−2.751)	(−11.893)
Dummy (1981–85)	0.078	−0.097	−0.976***
	(0.415)	(−0.634)	(−6.570)
Trade Barriers			0.551***
			(2.744)
α	1.36156***	2.16478***	1.38590***
	(8.681)	(8.146)	(9.656)
Log Likelihood	−831.58	−931.55	−954.64
N	1371	1371	1371

Note: t statistics are in parentheses.
$^*p = 0.10$; $^{**}p = 0.05$; $^{***}p = 0.01$

Individual Country Effects[14]

In Table 5, we show the results for the data partitioned by country. Since Japan was cited significantly as a target for voluntary export restraints, we include also a dummy variable scored as one in those industries where the U.S. has an announced non-tariff trade barrier.

The results are fairly robust: the principal result is the consistent effect of R&D spending on entry into the United States. Firms from all countries tend to enter U.S. industries that display higher expenditures on R&D. Larger industries draw more entries.

Home concentration is particularly significant for Japan, but also for the U.K. This result is quite interesting insofar as it points to the weakness of analyzing the effects on rivalry of concentration in individual European countries. U.S. concentration deters entry from all countries.

The results for Japanese entries differ in the temporal investment pattern (see the negative coefficients to the period dummies). Because of the important role

played by voluntary export restraints on Japanese exports, it is important to control for the effect of tariff (or barrier) hopping on direct investment patterns. Not surprisingly in the light of past studies [Kogut and Chang 1991], the coefficient to trade barriers is positive and significant.

An interesting insight is provided by a comparison of the U.K. and Japanese results in relation to industry growth. British investment appears to follow more closely a model in which growth attracts investment, some of which may be foreign [Grossman and Helpman 1990]. Inclusion of home market conditions or shipment growth differentials between home and host countries may provide additional insights into the effect of this variable (e.g., the effect of maturation of home country demand).

The results suggest a preference by U.K. and German firms for the more technologically-sophisticated as well as advertising-oriented industries. Japanese entries are also steered toward industries where technological rivalry is important. There is weak evidence that German firms avoid industries in which the U.S. rivals have invested more in research and development. The sign to R&D difference for Germany is both negative and significant.

In all, technological rivalry is the common factor among the three countries. There are important differences between Japanese and European firms in terms of the other intangible assets that influence the competitive roles they play in the evolution of the American economy. In particular, home market concentration appears to be especially important for Japanese companies.

The findings on industry growth suggest that the British and American economies are more integrated, especially relative to Japan. The British sectoral patterns appear to be more sensitive to the location of relative technological strengths of the two nations and to the market opportunities of growing American industries. The Japanese sectoral evidence suggests that home market rivalry is an important force in influencing their direct investment patterns.

DISCUSSION AND CONCLUSIONS

Over the past fifteen years, direct investment has risen sharply in the United States. The origins of this investment have been, as we have noted, surprisingly dominated by a few nations. This simultaneous increase of direct investment from a few nations provides a unique opportunity to investigate the commonality, and heterogeneity, in the industry motivations for the decisions of firms to invest across national borders.

The results show a remarkable similarity in the importance of technological rivalry and the role of U.S. oligopolistic rivalry as a deterrent to entry or as a signal of superior capabilities. There was little indication that new foreign

direct investment is pulled to sectors where the U.S. has higher R&D expenditures relative to other nations.[15] Unquestionably, a more disaggregated analysis would generate important exceptions. For example, foreign investments in biotechnology have the appearance of being technology-seeking, especially given the absence of current sales of many of the smaller companies that have received foreign investment [Shan and Song 1997]. However, it must also be noted that such studies focus exclusively on the acquisition entry mode, which is, in any case, more strongly associated with the technology-seeking motive. Inclusion of other entry modes would provide a more unbiased test of the technology-seeking hypothesis.

Our study focuses on FDI entries. It is also possible that the role of the established subsidiary changes with time after the initial entry: subsidiaries may evolve from the role of exploiting the ownership advantages of the parent to being effective sources of new technology. However, a recent study by Frost [1996] found very limited evidence of this evolution. Only when the subsidiaries were established in technologies distinct from home technology did they increase sourcing of local technology over time.

Our results also help in interpreting previous results on the relative performance of different entry modes. Woodcock, Beamish and Makino [1994] reported that new plants achieved the best level of financial performance, while acquisitions achieved lowest levels of performance among Japanese subsidiaries in North America, with joint ventures falling somewhere in between. We have shown that new plants are frequently designed to exploit the existing home country-based technological advantages, whereas other modes may be used for acquiring new host country-based technology.

Yet, there are also important country differences that our statistical analysis ignores. One difference is the proportion of entries going to non-manufacturing sectors. Clearly, the U.K. stands out as revealing a strong preference for the financial service sector. Another difference is the propensity of British and Japanese firms to invest in faster-growing sectors while the non-British European firms showed a preference for larger and relatively slower-growing industries. Similarly, firms from other countries (e.g., developing countries) may have their own distinct motivations.

The most current data on foreign investment in the United States show a surprising convergence in country shares over time, with still remarkable differences in the sectoral pattern (unpublished data, U.S. Government Bureau of Economic Analysis). Foreign investments control almost 20% of manufacturing assets, with the share of the chemical industry assets standing at 40%. A large proportion of the chemical industry's foreign share is attributable to European firms in general, and German firms in particular. The auto sector, which stands at around 15% foreign share of assets, reveals a high rate of Japanese penetration relative to other countries.

Consequently, the U.S. market is increasingly influenced by the extension of foreign competition that reflects the strengths of the national origins of companies. But since there is a strong bias toward technologically intensive sectors, a few industries, e.g., electronics, capital equipment and chemicals, have become multinational in character. It is the push of international rivalry into a rich market, rather than strong evidence for the pull of American technological resources, that explains the rapid rise of direct investment into the United States.

These results indicate that industry rivalry and market opportunity are important features to international competition. Heterogeneity of firm resources surely matters, but their employment is shaped by the evolution of industry conditions and of the erosion of national borders. One suspects that the lesson that industry conditions and firm resources are jointly interactive in determining competition in international markets is applicable to rivalry in general. The international case is especially interesting because firms' resources are influenced by their country of origin. The findings on rivalry and market opportunity are robust across time spans, industries and countries. They are pivotal factors in the evolution of industries, and competition across and within national borders.

APPENDIX
Data Sources

All entries are counted at the four-digit SIC level; many of the independent variables were collected at the three-digit or two–digit level. From previous work on Japanese entry, we have established that aggregating the entry count to the three-digit level leads to few changes in the results; we have also shown that the series correlates highly with balance of payment series and with unpublished Bureau of Economic Analysis data on plant and equipment expenditures made in the U.S. by Japanese firms. The count data were constructed by calculating the total number of entries into the United States by the three countries for the period of 1974–1991.

The raw data were collected by the International Trade Administration at the Department of Commerce, published annually in *Foreign Direct Investment in the United States*. U.S. R&D and Advertising are constructed from the Federal Trade Commission Line of Business Report for 1977. (We know from the OECD data that there is a very high serial correlation in the R&D series over time, despite a positive general trend.) Shipment and import data came from unpublished reports of the Department of Commerce for the period of 1975 to 1985. U.S. Concentration are eight-firm concentration ratios for 1972, 1977 and 1982; we matched them to the entries of the nearest years.

The R&D values were obtained from unpublished data collected by the OECD and were derived from the ANBERD data set. (BERD stands for Business Enterprise Research and Development; AN is a prefix indicating the suitability of these data for analysis.) These data are available for twenty-six countries, from which we used the data for the three countries. These data cover the period 1973–1990, though 1988 or 1989 was the last year of reporting. In our study, the measures are in monetary value; we normalized them by dividing by industry size (the production figures are obtained from published OECD statistics). For each country, the R&D data had been aggregated into forty industrial classes. They were reclassified into U.S. SIC codes, and then matched with the four-digit line of business data from the U.S. Missing values, which were not very frequent for these countries, were estimated by a routine provided in the BMDP statistical package. Cases missing data for other variables were eliminated, thus generating some difference in the number of records across countries.

The cross-sectional data were stacked by customized programs; this procedure allowed us to use time-varying data in the cases when such data were available (i.e., count data, U.S. concentration, shipment and import data). The negative binomial estimations were performed through the statistical package LIMDEP.

NOTES

1. Estimates based on sales data show a similar trend, but show that the U.S. still has a sizeable surplus. Recent estimates of industrial sales data shows that U.S. foreign subsidiaries made $542 billion in sales in twenty-seven of the largest countries; foreign affiliates were responsible for $380 billion of sales in the U.S. [Brainard 1993].

2. It is important to distinguish between such location factors as low wage labor and technological spillovers. The key issue is to recall the origins of the debate on the resource-based view of the firm, namely, the homogeneity implied in the standard production function treatment of the firm and the observed heterogeneity across firms. Any firm can hire low-cost labor. To capture spillovers requires complementary firm resources.

3. Analyzing only Japanese entry into the U.S., Kogut and Chang [1991] found that Japanese direct investment was only pulled in the case of joint ventures; technological push effects largely dominated overall flows.

4. See Caves [1996] for a summary of these findings.

5. See the superb summary given in Schmalensee [1989]. A seminal article that shows the endogeneity of research and investment on competition is Dixit [1980].

6. See, also, Dunning [1988].

7. For example, the formalization of Graham's exchange of threat model by Brander and Krugman [1983] treats borders as only interesting in setting up the initial spatial distribution of fixed investments; they do not reflect persisting institutional differences.

8. See the discussion on the permeability of firm and country borders by Kogut [1990], as well as the concept of "national systems of innovation" of Freeman [1987] and Nelson [1993].

9. See Caves [1996] for an exhaustive review of the extensive literature using the control variables. The effect of concentration on direct investment was first extensively explored by Knickerbocker [1973].

10. The Netherlands is also a major investor, but since its investments are dominated by three firms (Philips, Unilever, and Shell), the R&D data are not released for enough sectors to allow testing. Canada is also a major investor, but we expect a substantial part of Canadian foreign investments to be made by U.S. subsidiaries. Additionally, locational contiguity and the free trade agreement raise distinct issues that merit their own analysis. The initial runs included French data. Because of the highly aggregated classification of the French concentration data, the results were generally poor (even if tending towards the predicting relationships) and hence we dropped this analysis.

11. The data are described in greater detail in the Appendix.

12. The use of foreign entry counts as a dependent variable is anlaogous to the use of patent counts studies in Economics (e.g., Hausman, Hall and Griliches [1984]). In this literature the use of a Poisson regression is common. However, a negative binomial regression is more suitable for foreign entry studies (see Kogut and Chang [1991] for a detailed explanation). The use of this regression is now common in social sciences and management, and several statistical packages provide this as a standard feature.

13. See Caves and Mehra [1986] and Caves [1996].

14. Because of the unbalanced design of the data, it is difficult to sort out heterogeneity in the sectoral and temporal dimensions. To determine the potential misspecification, we ran several pooling tests. Using Chow tests [Chow 1960] based on linear regressions of the independent

variables on entry counts, we found significant differences between time periods and countries in terms of intercepts as well as slopes.

15. In order to make sure that the nonsignificance of the R&D difference coefficient was not due to a few industrial sectors with large negatively signed values of R&D difference cancelling out the positive values in other industrial sectors, we also ran models only with a sign dummy for the R&D difference variable. The results were unchanged. We are grateful to Tony Frost for this suggestion.

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