Firm- and Country-Level Trade-offs and Contingencies in the Evaluation of Foreign Investment: The Semiconductor Industry, 1994–2002

Witold J. Henisz

The Wharton School, 3115 Steinberg Hall–Dietrich Hall, University of Pennsylvania, Philadelphia, Pennsylvania 19104-6370,
henisz@wharton.upenn.edu

Jeffrey T. Macher

McDonough School of Business, G-04 Old North, Georgetown University, Washington, D.C. 20057,
jtm4@georgetown.edu

This paper examines the joint impact of firm- and country-level factors on the international plant location decisions of semiconductor firms from 1994–2002. We find that these factors interact to influence the location decisions of firms investing abroad in a given host country. Firms with more advanced technological capabilities are more likely to make investments in countries with greater technological sophistication but not in politically hazardous countries where they face greater expropriation hazards. Firms with less-advanced technology are more willing to accept a trade-off between country-level political hazards and technological sophistication. Firms also trade off own- versus other-firm experience as sources of critical knowledge regarding the foreign investment environment.

Key words: foreign direct investment; technology; political risk; institutional environment; technological environment; competitive environment

1. Introduction

Firms' decisions to locate manufacturing facilities abroad involve careful considerations of their own existing capabilities and the characteristics of potential host-country markets. However, not all firms perceive the costs and benefits of entering a particular market in the same light. Firms face greater or fewer hazards with entry, and differ in their abilities to mitigate those hazards. Host countries similarly offer greater or fewer opportunities for potential entrants, and firms again differ in their abilities to capture those returns. We examine the joint influence of firm- and country-level factors on the manufacturing plant location decisions of semiconductor firms from 1994 to 2002. We exploit variation within the population of firms and markets over time to address several questions at the core of strategic management, with greater precision than is generally feasible in the more heterogeneous populations of firms or markets that characterize much of the extant research.

We examine geographic diversification, an important and growing research topic in strategic management (Greve 2000, Henisz and Delios 2001). In particular, we concentrate on the establishment of manufacturing facilities in host countries that are different from firms' home countries. Although firms' prior activities in their home country and in other markets are important factors in geographic diversification decisions, those activities provide limited guidance in new markets because

of resource constraints or informational challenges (Haveman 1993). Other factors, including internal technological capabilities and the technological, institutional, and competitive environments of potential host country markets, are also likely to influence geographic diversification decisions.

In our approach, we highlight the importance of and connections between firm-level experience and technological capabilities, and country-level institutional, technological, and competitive environments. Specifically, we demonstrate the partial substitutability of information obtained from firms' own experience and information obtained from observing peer firms. We also demonstrate that the assessment of a particular country's suitability for foreign investment differs according to the technological sophistication of the investing firm. Firms at or near the technological frontier are drawn to those countries at or near the technological frontier that also have stable and predictable policy environments. Firms lagging behind the technological frontier make trade-offs between a country's level of technological sophistication and policy predictability.

2. Hypothesis Development

Traditional examinations of cross-national location decisions tend to emphasize the role of country-level variation in market attractiveness (e.g., size, income, and

similarity to home-country tastes and preferences) and factor intensities that influence the costs of crucial inputs to production (Markusen and Maskus 1999a, Wheeler and Mody 1992). Although these economic forces are undoubtedly important in explaining foreign investment decisions, this approach generally does not consider the institutional, technological, and competitive environments that also influence these decisions. Firms considering investments abroad need to assess their capabilities to overcome the liabilities of foreignness and use local factors of production in a cost-efficient manner. Their long-term success depends on their ability to anticipate the stability of the policy environment and the decisions of competitors, as well as to augment their existing technological skills and capabilities to enhance future profitability (Branstetter 2000, Chang 1995). As a result of and in addition to the more commonly featured economic drivers of overseas investment, a variety of other factors—including firms' own past experience in the host country, the tacitness of the technology involved (Martin and Salomon 2003), the predictability of the policy environment, the sophistication of the technological environment, and the previous investment decisions of peer firms—also have a strong influence on plant location decisions.

2.1. Industry Context

We investigate these issues using the global semiconductor industry as our empirical setting. The global semiconductor industry is well suited to examine the confluence and interaction of firm-level experience and technological capabilities and host-country institutional, technological, and competitive environments on firms' foreign investment strategies. The industry is characterized by significant global competition, which is manifested in price declines of 25%–30% per year and product life cycles measured in months (Smith and Reinertsen 1991). The widespread licensing of patents and holding of open symposia early in the history of the industry led to the extensive diffusion of its core technologies both within and across countries (Langlois and Steinmueller 2000, Tilton 1971).

The industry also exhibits rapid technological progress in both products and manufacturing processes (Methe 1992), in the direction of a well-articulated frontier (Hayes et al. 1996). Semiconductor firms place great weight on research and development (R&D) and technological development because they are important drivers of competitiveness and sustained performance. Despite the emphasis placed on technological capability, the degree to which firms in the industry operate at or near the technological frontier varies, generating substantial variation in technological sophistication among the population of firms and the countries in which they operate.

Although the industry has a global scope in terms of exports and strong disconnects between manufacturing location and local product markets (Martin and Salomon 2003), semiconductor firms vary in their degree of multinationality. Several semiconductor firms set their sights globally from the onset of the industry and possess decades of international manufacturing experience, whereas others are either entirely domestic or just beginning to venture abroad. From its origins in the United States in the 1960s, production has subsequently dispersed across 28 countries in fabrication facilities (fabs) owned by firms from 22 countries.

Finally, manufacturing facilities involve significant up-front fixed costs in both plant and equipment, and in embodied technical knowledge and know-how, leading even the largest firms to have limited profiles of overseas assets and ensuring diversity in the population of investing firms with respect to their international experience profiles. Furthermore, although a large portion of these investments are mobile—in particular, manufacturing equipment and personnel—the up-front costs of buildings, related infrastructure, and the hiring and training of employees is at risk in unstable or uncertain policy and market environments. Political hazards, including threats to fixed capital and—perhaps more important in an industry that places a premium on innovation and research and development—intellectual property, are highly salient.

2.2. Firm-Level Factors

Experience. Geographic expansion into host-country markets imposes demands on firms that can require skills different from their current resource or capability base. Especially in the international arena, new host-country markets can differ significantly from the home-country market or other host-country markets in which these firms have prior operating experience. It is often thought that firms accumulate the necessary skills to facilitate market entry via their previous experience operating in a given foreign market or in other foreign markets (Barkema et al. 1996). Greater host-country experience helps to develop multinational expansion capabilities by reducing the overall liability of foreignness—whether defined in social, economic, or political dimensions (Zaheer 1995). Host-country experience and more general international expansion capabilities developed through a sequence of overseas investments also influence decisions about subsequent foreign investments (Chang 1995, Chang and Rosenzweig 2001, Henisz and Delios 2001, Kogut 1983).

For instance, the international experience gained by entry into Europe led many U.S. semiconductor firms to make subsequent foreign investments both in Europe and in other regions, particularly in Asia and the Pacific. In contrast to U.S. firms, Japanese semiconductor firms have not located a similar amount of fabrication capacity outside Japan until recently.[1] Several multinational semiconductor firms have recently expanded their

global reach and entered China, Malaysia, and Singapore. Although these countries are more politically hazardous compared with countries where many semiconductor multinationals had invested before, the semiconductor firms that have entered these countries (e.g., NEC, Motorola, and Intel) are among the most internationally experienced. We therefore expect to observe a positive relationship between semiconductor firms' plant location decisions and prior experience operating either in the potential host country or internationally.

HYPOTHESIS 1A. *Semiconductor firms with more experience in a host country are more likely to invest in foreign production facilities in that country, ceteris paribus.*

HYPOTHESIS 1B. *Semiconductor firms with more international experience are more likely to invest in foreign production facilities, ceteris paribus.*

Technological Capabilities. Geographic expansion into new host-country markets by multinational firms might occur so firms can access low-cost factors of production, serve local markets, or access new technologies and supplement current knowledge bases in ways not possible in home-country or current host-country markets (Cantwell 1989). Multinational firms might use knowledge acquired in host countries either to catch up to their competitors or, if they are already technological leaders, to stay ahead of those competitors (Cantwell and Janne 1999, Chung and Alcacer 2002). We concentrate here on the leader firms who seek to stay ahead, but we subsequently consider the mechanisms available to laggard firms who wish to improve their technological position in the industry.

The proposition that more technologically advanced firms are more likely to engage in foreign direct investment than their less-advanced counterparts has found strong support in the literature (Buckley and Casson 1976, Caves 1996). Because growth and performance require the accumulation and creation of new knowledge as well as the replication of existing knowledge in multiple locations (Martin and Salomon 2003), technologically advanced multinationals often replicate their accumulated (knowledge-based) assets into foreign locations to out-compete rivals (Mitchell et al. 1992). Firms (and industries) that are more research intensive are generally found to have higher levels of multinational investment activity (Kogut and Chang 1991). One rationale for this observed relationship is that the greater differentiation of technological paths pursued by increasingly independent foreign affiliates of technologically sophisticated firms that enter new host countries allows them to extend their technological advantage first by undertaking home-base enhancing, and later by home-base augmenting activities (Cantwell 1989, Cantwell and Janne 1999). International diversification is desirable in this regard because it

not only facilitates the transfer of information compared with what can typically be accomplished through the market (Kogut and Zander 1992), but it also broadens intellectual portfolios and enhances the development of firm-level technological capabilities (Alcacer and Chung 2002).

We argue that firm-level differences in technological capabilities influence firms' decisions regarding international expansion within the semiconductor industry. Several leading-edge semiconductor firms expanded internationally early on, in part to continue to improve on and monitor their technological portfolios. More recently, some of the most technologically sophisticated contract manufacturing firms have established manufacturing locations outside their home countries (Macher et al. 2002). We therefore expect to observe that more technologically advanced semiconductor firms are more likely to make investments abroad.

HYPOTHESIS 1C. *Technologically sophisticated semiconductor firms are more likely to invest in foreign production facilities, ceteris paribus.*

2.3. Country-Level Factors

Institutional Environment. Although multiple host-country factors likely influence firms' foreign investment decisions, we first highlight the impact of the institutional environment. Managerial surveys on the determinants of foreign direct investment almost universally cite the level of political risk as the most important factor in their consideration (Kobrin 1979). Policy makers in host countries who have the autonomy to act unilaterally or who have support from subservient (or allied) legislatures or judiciaries are more likely to introduce new policies in response to exogenous shocks or changes in the composition or preferences of policy makers. Potential investors who are aware of the associated uncertainties over future regulations, rates of taxation, or macroeconomic or other relevant policies should be less likely to make long-term capital investments (Gastanaga et al. 1998, Wei 2000) or more technologically advanced investments in the given host country (Mansfield 1995, Oxley 1999). These effects should be particularly pronounced among the population of foreign investors (Delios and Henisz 2003, Henisz and Delios 2001). We define a country whose political institutions fail to constrain policy makers from altering the status quo regime, thereby creating uncertainty over the future policy environment for domestic and foreign investors, as being politically hazardous.

Empirical work to date provides strong support for the hypothesis that long-lived or politically salient (or both) investments are particularly sensitive to the level of political hazards (Levy and Spiller 1994). Research that extends this logic to a panel dataset in telecommunications (telecomm) (Henisz and Zelner 2001) also finds

strong support for the hypothesis that political institutions that fail to constrain arbitrary behavior by political actors dampen the incentive for infrastructure providers to deploy capital and yield lower levels of per capita infrastructure investment, ceteris paribus. The semiconductor industry has some similarities to these infrastructure sectors, despite the shorter operational lives of semiconductor facilities and the fact that saleable output is usually targeted for export rather than for local consumption. Analogous to electricity generation and to telecomm, the capital investment required in semiconductor fabs is enormous, ranging as high as $2 billion per fab (ICE 2001). The scale of the required investment in manufacturing facilities—some of which is site specific—also requires large investments in R&D and human capital. Finally, the gestation lags that exist between capital investment and saleable output, which are especially pronounced in the electricity sector, are also exhibited in the semiconductor industry. The confluence of host-country perceptions regarding the direct and indirect benefits (i.e., spillovers) of attracting these large-scale facilities and the competitive nature of the industry indicates political intervention—especially in emerging markets and in the form of investment incentives—is common. Specific policies that are subject to reversion include such benefits as land use at no rent; complete infrastructure development, including power, heating, telecomm, and water and sewerage systems; matching government investment for physical capital; discounts from loan interest rates; and preferential taxation policies. Based on the magnitude of these potential benefits, we argue that the effect of political hazards on investment in the global semiconductor industry is comparable to that found in infrastructure sectors.

HYPOTHESIS 2A. *Semiconductor firms are less likely to invest in foreign production facilities in countries with high political hazards, ceteris paribus.*

Technological Environment. Another important dimension of a country's investment environment is its innovative capacity (i.e., its ability to produce and commercialize flows of innovation over the long term) (Furman et al. 2002). Differences in national approaches to innovation—so-called national innovation systems—help determine countries' national innovative capacities (Mowery and Nelson 1999, Nelson and Rosenberg 1993). Research suggests technology seeking is an important rationale for multinational firms considering expanding abroad. Foreign direct investment takes place partly to draw on host countries' national innovative capacities that either enhance or augment the R&D activities of multinational enterprises (Caves 1996). Certain host countries' can possess superior technical capabilities that are embodied in educated and skilled workforces, design or manufacturing capacity or knowhow, related technology infrastructure, other

supporting industries, and so on. This argument is consistent with the capability-seeking view of the product life-cycle framework, which argues that production plant location decisions are influenced by product novelty (McKendrick et al. 2000, Vernon 1966). In particular, because new products often require new capabilities, accessing these capabilities influences firms' subsequent location decisions. As products become more established, firms' location decisions are based more on cost. In the same vein, we argue that multinational firms make foreign direct investments in particular host countries to source technological capabilities that might not be resident, not cost-effectively available, or not available in adequate supply in their home countries. Several empirical studies demonstrate that firms expand abroad to seek technology or gain access to knowledge that is not resident in their home-country or current host-country markets (Chung and Alcacer 2002, Kogut and Chang 1991).

We argue that that country-level differences in technological capabilities influence firms' decisions regarding international expansion within the semiconductor industry. Because of the technological and economic demands in the industry, semiconductor firms place great weight on accessing the most advanced product and process technologies. Technologically advanced semiconductor firms expand abroad in part to maintain or improve on their current technological positions, whereas technology-lagging firms expand abroad to moderate or eliminate shortcomings in their technological portfolios. All else being equal, multinational firms should be more attracted to those countries that possess superior technological environments compared with other countries.

HYPOTHESIS 2B. *Semiconductor firms are more likely to invest in foreign production facilities in technologically sophisticated countries, ceteris paribus.*

Competitive Environment. Independent of political institutions or technological capabilities, potential foreign investors are also concerned with the availability of high-skilled labor and other local factor endowments resident in potential host countries (Markusen and Maskus 1999a, Wheeler and Mody 1992). Firms' motivations in entering foreign locations can go beyond cost minimization, and include more competitive and strategic considerations such as preempting or maintaining cost parity with their peers, or both.

Prior entry by competitors encourages firms to enter foreign locations for two reasons. First, follower firms might react out of concern that early entrants could gain additional information about a potential market and use their first-mover status as an advantage (Knickerbocker 1973). Explanations for this observed pattern of imitation range from social arguments of legitimacy or the establishment of rules of thumb (DiMaggio and Powell 1983) to rational calculation in light of herd behavior

among competitors (Abrahamson and Rosenkopf 1993). Whether this motivation is rationally or socially driven, firms considering foreign market entry could decide that the best tactic is to imitate the actions of earlier entrants or role models (Greve 1998, 2000; Guillen 2001; Martin et al. 1998). Second, firms might replicate the foreign location decisions of competitors to tap into the potential knowledge spillovers present (Chung and Alcacer 2002, Shaver et al. 1997). Because of the intangible nature of technical knowledge in particular, technological spillovers are often localized and thus require physical proximity (Almeida and Kogut 1999).

An important consideration is whether multinational firms base their foreign location decisions more on the actions of similar or dissimilar firms. Similarity often facilitates communication and improves understanding, which might prove necessary in capturing potential knowledge spillovers within a particular host country (Feinberg and Majumdar 2001). Although prospective foreign entrants receive informational signals or gain legitimacy around investment from both foreign and domestic firms operating in a particular host country, greater emphasis is likely placed on the actions of those firms more similar to the focal firm (Levitt and March 1988). Foreign producers have greater commonality with other foreign producers than their domestic counterparts because they share a common foreign status, or the same country of origin (Feinberg and Gupta 2003), among other characteristics. Because of the emphasis placed in the semiconductor industry on continued technological advancement, we anticipate that the forces pushing semiconductor firms to imitate other firms, either for social or rational reasons, are significant drivers of foreign investment decisions. Furthermore, building on Feinberg and Gupta (2003), we seek to separately identify the effect of previous entries by other foreign producers and other foreign producers from the same home country.

HYPOTHESIS 2C. *Semiconductor firms are more likely to invest in foreign production facilities in countries in which other foreign producers possess greater experience operating preexisting fabs, ceteris paribus.*

HYPOTHESIS 2D. *Semiconductor firms are more likely to invest in foreign production facilities in countries in which other producers from the same home country possess greater experience operating preexisting fabs, ceteris paribus.*

2.4. Trade-offs and Contingencies

Own- vs. Other-Firm Experience. Whereas firms learn about the attractiveness of potential host-country markets both from their own experience and the experience of preexisting firms, these two information sources are unlikely to be additive (Shaver et al. 1997). As indicated above, firms new to or considering investment

in particular host countries look for the presence of (Levitt and March 1988) and their similarity to (Feinberg and Gupta 2003) peer investors. The foreign activities of peer investors related to sourcing, infrastructure development, production, and so on, represent important information sources for other potential investors. As this information diffuses and becomes public knowledge, other firms can learn from the mistakes made and successes had and subsequently make better-informed decisions on potential investment opportunities and pitfalls (Mitchell et al. 1994).

Firms with greater host-country experience, however, are less likely to depend on or factor in the experience of others as an information source. Experienced firms can instead draw from their own internal operating experience to assess the unique host country's institutional, technological, and competitive environments (Barkema et al. 1996, Chang and Rosenzweig 2001, Delios and Henisz 2000, Henisz and Delios 2001). Due to their existing knowledge bases and understanding, these firms gain less new information from the prior operating experience of other foreign entrants (Argote et al. 1990, Shaver et al. 1997). We therefore expect that the positive effect of other foreign firms' operating experience in the host country on the probability of entry by the focal firm will be diminishing in the host-country operating experience of the focal firm.

HYPOTHESIS 3A. *The positive effect of the prior experience of other foreign firms operating in a potential host country on the likelihood of investment in that country is moderated by the investing firm's own operating experience in that country, ceteris paribus.*

HYPOTHESIS 3B. *The positive effect of the prior experience of other firms from the same home country operating in a potential host country on the likelihood of investment in that country is moderated by the investing firm's own operating experience in that country, ceteris paribus.*

Political Hazards vs. Technological Sophistication. The attractiveness of a potential host-country market should influence the entry decisions of all firms, but firms with different levels of technological capabilities can perceive the same country quite differently. The effect of country-level factors, such as the level of political hazards and technological sophistication on the propensity to establish foreign production facilities, should not be constant across the population of firms. For instance, prior research indicates that firms with superior technical capabilities locate away from other firms or industry clusters to prevent knowledge spillovers to competitors (Shaver and Flyer 2000). In the same light, firms with more valuable assets at risk and greater bargaining leverage with host-country governments are more sensitive to the specific institutional environment in which they operate (Oxley 1999).

Political hazards pose a greater threat to firms with superior technological capabilities, not only because their production facilities are more expensive to construct, but also because of the potential loss of intellectual property. These firms are therefore wary of the threat of government expropriation and would likely choose not to invest in hazardous countries. Furthermore, because of their leadership position in the industry and the bargaining power that is associated with that position, they are potentially able to extract sufficient concessions from the governments of even the most technologically advanced and politically stable environments to make investment a worthwhile proposition.

Although we previously argued that political hazards deter foreign direct investment (Hypothesis 2a), we now highlight that this effect should be increasing in the investing firm's technological sophistication. In comparison to firms with relatively low technological capabilities, firms at or near the technological frontier face additional hazards in countries where policy uncertainty is high. These firms must consider not only exogenous policy changes that detract from profitability, but also the threat of endogenous policy changes by local competitors who manipulate any existing play in the political system to their advantage in an attempt to divert the technology of the multinational firm to their own control via public sector intervention (Henisz 2000a, Henisz and Williamson 1999). For these reasons and others, technologically advanced firms might find that low labor costs or other assets of politically hazardous potential host countries are less compelling, ceteris paribus.

HYPOTHESIS 4A. *The negative effect of political hazards on the propensity to invest in a foreign production facility in a country is increasing in the technological sophistication of the investing firm, ceteris paribus.*

By contrast, firms not at the frontier of technological sophistication might be forced to make trade-offs between political hazards and other country-level factors. Although these firms would also prefer to enter technologically sophisticated markets, particularly as they seek to catch up to other firms at the technological frontier (Chung and Alcacer 2002, Kogut and Chang 1991), they lack the bargaining power to extract favorable investment terms from the most technologically advanced and politically stable countries. Instead, they often turn to more hazardous institutional environments whose technological sophistication provides the potential to catch up, should the government of the host country not renege on its initial policy commitment. These firms are thus adopting a higher risk and higher return entry strategy compared with their competitors who are already at the technological frontier.

For example, many firms are contemplating or establishing manufacturing locations in China to take advantage of burgeoning market demand and a cheap but increasingly educated labor force. These moves come with certain risks, however, in regard to the exporting of leading-edge technical and manufacturing expertise. To in part mitigate these risks, many technologically sophisticated semiconductor firms are either avoiding semiconductor fabrication in China or putting less technologically sophisticated production facilities in place there.[2] This observation further supports the proposed contingency between country-level political hazards and firm-level technological sophistication described above (Hypothesis 4a). It also points to a further hypothesis that links the country-level technological sophistication to the country-level institutional environment and the firm-level technological environment. Specifically, less technologically sophisticated firms should find a country with high technological sophistication and high political hazards relatively more attractive, compared with their technologically sophisticated counterparts:

HYPOTHESIS 4B. *Less technologically sophisticated firms are more likely to enter countries with high technological sophistication and high political hazards than are more technologically sophisticated firms, ceteris paribus.*

3. Empirical Estimation

3.1. Data Sources and Sample

Our primary data come from Strategic Marketing Associates (SMA), a market research firm that tracks existing and future semiconductor manufacturing facilities, including information on location and firm country of origin; years of production and type; technological sophistication, capacity, and size; products manufactured; and other data. SMA publishes these data yearly in its International Fabs of Disk (IFOD) database. Historical measures of several of the variables above, as well as other variables related to plant location decisions, are derived using a version of this database for every year in the sample. We join the SMA firm-level data with country-level data on the economic, political, and demographic characteristics of potential host-country markets from the World Bank's *World Development Indicators* on CD-ROM (World Bank 2001) and the political constraints dataset (Henisz 2000b).[3]

Although the sample consists of hundreds of public and private semiconductor entities, only semiconductor firms that establish commercial production facilities in host countries outside the home country are the relevant population for the empirical examination. In particular, entities such as universities that have production facilities solely for research and teaching purposes, research labs that possess production facilities for consulting purposes, and so on are eliminated from our sample. Of the remaining 388 semiconductor firms in the sample, 44 made a total of 69 overseas investments in new manufacturing plants in 13 countries during the 1994–2002 period.

Due to data limitations, analysis is restricted to this eight-year period, but we employ metrics of experience based on the full history of surviving fabs.

3.2. Empirical Specification

We create a foreign investment production function similar to a patent production function that has been applied to patent data (Hall and Ziedonis 2001, Hausman et al. 1984). This production function relates the number of foreign investments by a semiconductor firm in a given country-year to its past experience, technological capabilities, and other firm-level characteristics, as well as the potential host country's level of political hazards, technological environment, competitive environment, and other country-level characteristics.

We utilize several econometric methods in our empirical estimation. Because the data represent the number of foreign investments undertaken by a semiconductor firm in a particular country in a given year, we take a count model approach. Because a likelihood ratio test indicates overdispersion in our sample, we employ a negative binomial model that adjusts standard errors for within-group clustering as our primary econometric approach. The expected number of investments events by a given semiconductor firm x in country i in year t is an exponential function of these characteristics:

$$E(IE_{xit} \mid W_{xit}) = \exp(W_{xit}\beta). \tag{1}$$

We also employ a zero-inflated negative binomial and discrete time hazard rate models (Allison 1984) and compare the results to the count model estimation as tests for robustness.[4] For each of these econometric models, we create a separate observation record for each semiconductor manufacturing concern that was exposed to the hazard of undertaking an investment event across all countries in the sample and across time. The sample therefore includes multiple observations across time for the same firm-country pair. These estimation approaches all address the problem of right censoring and allow for time-varying explanatory variables. We cluster the standard errors by either country of location or investing firm, depending on the specification.

3.3. Dependent Variables

We define a *foreign investment* as the construction of a new fab. Greenfield construction in the semiconductor industry represents a significant capital expenditure commitment in both equipment and infrastructure development. For the negative binomial and zero-inflated negative binomial specification, the dependent variable represents a count of foreign investments by semiconductor firm x in country i at time t. For the discrete time logit specification, the above count variable is transformed into a binary indicator variable that takes the value 1 if the count for that firm-country-year triplet is greater than 0, and 0 otherwise.

Table 1 Summary Statistics by Location of Foreign Investsment, 1994–2002

Country	Count	Mean political hazards	Mean technological environment
United States	16	0.148	0.631
Taiwan, China	8	0.260	0.725
Japan	7	0.238	0.678
Singapore	7	0.466	0.705
Germany	7	0.157	0.582
England/Scotland/Wales	7	0.261	0.513
China	5	1.000	0.312
Italy	3	0.230	0.578
France	3	0.273	0.592
Ireland	3	0.240	0.730
Netherlands	1	0.259	0.533
Malaysia	1	0.245	0.283
Israel	1	0.222	0.769

There are 69 firm-country-year triplets in which a semiconductor firm undertakes a foreign investment. Table 1 provides a distribution of the number of foreign investments, the mean level of political hazards, and the mean level of technological sophistication by location of foreign investment from 1994 to 2002.

3.4. Independent Variables

Firm Experience. We define firm experience as the cumulative years of experience that a firm has operating fabs within a given host country, in other foreign countries (internationally), and in the firm's home (origin) country. Experience variables are logged because the incremental value of an additional year of experience is greater for lower levels of experience than for higher levels of experience (Epple et al. 1991). Prior to logging the experience variables, we add one year to the sums described above to avoid the indeterminacy of logging zero experience.

Firm Technological Environment. Technology generations in semiconductor manufacturing are normally defined by manufacturing process linewidth or process geometry (Hayes et al. 1996). This measure represents the minimum size of the smallest circuit feature that can be produced reliably. Smaller linewidths are desired because the smaller the circuitry, the greater the storage capacity (for memory products) and the faster the integrated circuit (IC) operates (for logic products), ceteris paribus. In addition, smaller process linewidths increase the number of ICs that can be placed on a given wafer, ceteris paribus, increasing the overall revenue per wafer.

The state of the art in semiconductor manufacturing varies, however, according to the types of products manufactured. For instance, leading-edge memory (e.g., DRAM) and leading-edge logic (e.g., microprocessors) have smaller linewidths than other products, such

as advanced logic (e.g., ASICs) or discrete devices. We therefore introduce a scaling procedure for the technological sophistication of a manufacturing facility according to the major product families manufactured. Available market research information defines the leading edge in process linewidth for several major product families over our sample period.[5] Using this information, we calculate the technological sophistication of a manufacturing facility in a given year as the leading-edge process linewidth divided by the manufacturing facility's process linewidth, where the numerator and denominator are adjusted according to the most sophisticated product manufactured by the manufacturing facility using the product listing provided by SMA. Finally, we calculate the technological sophistication of a semiconductor firm in a given year as the average technological sophistication of the most recent five (to eliminate archaic or so-called legacy fabs) fabs that the firm has established. This scaling results in a measure that ranges from 0.02 (technologically lagging) to 1 (technologically leading), with many of the technological leaders in the industry, including integrated manufacturers such as Intel, Samsung, and Texas Instruments, and contract manufacturers such as TSMC and WSMC scoring near the maximum.

Firm Size. To separate the effects of experience of theoretical interest from any spurious relationship with firm size, we include a logged measure of the total production capacity of each semiconductor firm in our specification.

Country Institutional Environment. Our time-varying measure of the political hazards in a host country, the political hazards index (POLHAZ) is taken from Henisz (2000b). This variable measures the extent to which a change in the preferences of any one actor can lead to a change in government policy. First, it uses existing political science databases to identify the number of independent branches of government (executive, lower and upper legislative chambers, judiciary, and subfederal political institutions) with veto power over policy change in a given year. The preferences of each of these branches and the status quo policy are then assumed to be independently and identically drawn from a uniform, unidimensional policy space. This assumption allows for the derivation of a quantitative measure of political hazards using a simple spatial model of political interaction. This initial measure is then modified to take into account the extent of alignment across branches of government using panel data on the party composition of the executive and legislative branches for each country. Such alignment increases the feasibility of policy change. The measure is then further modified to capture the extent of preference heterogeneity within each legislative branch that increased (decreased) the decision costs of overturning policy for legislatures aligned

(opposed) to the executive. The main results of the derivation (available in Henisz 2000a) are that (1) each additional veto point (a branch of government that is both constitutionally effective and controlled by a party different from other branches) provides a negative but diminishing effect on the total level of hazards; and (2) homogeneity (heterogeneity) of party preferences within an opposed (aligned) branch of government is negatively correlated with the level of hazards. Possible scores for the final measure of political hazards for a given country in a given year ranged from 0 (minimal hazards) to 1 (extremely hazardous).

Country Technological Environment. The technological environment of a given country in a given year is measured using the average technological sophistication of the last five fabs (to eliminate archaic or so-called legacy fabs) opened within the country by either foreign or domestic firms.

Country Competitive Environment. Because the prior investment decisions of multiple populations of firms can provide information to investing firms, we introduce three different measures of a host country's competitive environment. The first represents the natural log of the number of years of host-country fab operating experience by domestic semiconductor firms in each sample year. The second and third measures represent the same calculation for other foreign semiconductor firms who are from home countries other than the focal firm's home country, and other foreign semiconductor firms who are from the same country as the focal firm.

Other Country Controls. We include two time-varying measures to proxy for the market potential of a particular host country. These measures are one-year-lagged measures of gross domestic product per capita and current population that are computed annually for the 1993–2001 period, and entered as logged variables in the empirical specification. We also control for mimetic effects that can lead foreign investors to follow the herd and invest in the hot country of the moment (Bastos and Greve 2003). Specifically, we include a count of foreign-owned fabs opened within a host country over the past five years. The inclusion of this variable also helps ensure that our measure of the country-level technological environment, which is based on the technological sophistication of fabs opened within the past five years by both domestic and foreign producers, is not merely picking up unobserved country-level characteristics that make a country more attractive as evidenced by a large number of new foreign investments.

Interactions. We mean-center the constituent variables in all of our interaction terms to address collinearity and to facilitate the interpretation of the results by linking individual coefficient estimates to specific hypotheses.

Indicator Variables. We include both host- and home-country indicator variables in all specifications. Our

primary estimating sample consists of those countries into which at least one semiconductor firm entered over the sample period and from which at least one semiconductor firm undertook a foreign investment over the sample period. Defining the sample in this manner allows us to employ both host-country indicator variables that capture all time-invariant dimensions of market or cultural attractiveness of the host-country and home-country indicator variables that in turn capture country-level differences in the propensity to invest abroad, including those that result from explicit government policies. In our robustness analysis, we also consider a broader sample that includes all countries with a semiconductor manufacturing facility, even if no foreign investment has occurred in that country or if no outward investment has originated in that country. We also control for unobserved time-varying factors that influence firms' entries and investment decisions for all countries in the same manner by introducing annual time-indicator variables. Finally, in some of the econometric models, we also control for unobserved heterogeneity among the population of investing firms by introducing firm-level indicator variables.

3.5. Empirical Results

Table 2 presents summary and correlation statistics and Tables 3 and 4 present the results of the empirical analysis. Table 3 provides the results of the primary count model specification incrementally adding the independent variables of theoretical interest. The first model includes our country- and firm-level control variables, as well as the full set of indicator variables. Model 2 adds the firm-level measures of experience and technological sophistication, and the country-level measures of the institutional, technological, and competitive environments. Model 3 adds the interactions between own-firm and the two measures of other-foreign-firm experience. Model 4 adds the interactions among and between firm-level technological capabilities, country-level technological sophistication, and country-level political hazards. As each of these models improves the fit on its predecessor, we focus our attention on Model 4.

We first note that larger firms (as measured by their total production capacity) are more likely to go abroad and countries with more recent entries are more likely to attract subsequent investment. Neither the focal firm's experience in its home country nor the host-country experience of firms resident in that country had a robust influence on the predicted count of entries. The inclusion of both host-country indicator variables and the count of recent entries in the host country effectively captures the attractiveness of that country, while the remaining within-country changes in population or income per capita are actually negatively associated with the likelihood of entry.

To facilitate discussion of the economic as well as statistical significance of our results with respect to the variables of theoretical variables of interest, we discuss the support for our individual hypotheses in two groups. We first examine the independent and joint effects of own- and other-firm experience, and then examine the independent and joint effects of firm-level technological capabilities, the country-level institutional environments, and country-level technological capabilities.

Own- and Other-Firm Experience. We argue that firms with more direct experience in the prospective host country (Hypothesis 1a) are more likely to make foreign investments because of their ability to overcome the liabilities associated with foreign ownership. We find strong support for this hypothesis ($p < 0.001$). By contrast, we find no support for greater international experience (Hypothesis 1b). These results suggest that country-specific knowledge is highly contextual and not readily transferable abroad, at least in the semiconductor industry.

We argue that countries in which other foreign firms (Hypothesis 2c) or other firms from the same home country (Hypothesis 2d) have greater experience in operating fabs and are more likely to attract subsequent investment due to various processes of imitation of similar firms by the focal investor. Although we find strong support for both of these hypotheses ($p < 0.01$ and $p < 0.001$), the effect of a given increase in other-foreign-firm experience is surprisingly more than twice as great as the effect of other-firm experience from the same home country. We discuss this counterintuitive finding below. We further suggest that the effects of own-firm and other-firm experience are not additive—i.e., that the positive effect of own- (other-) firm experience would be declining in other- (own-) firm experience (Hypotheses 3a and 3b). We find support ($p < 0.01$) for a substitution between own-firm and other-foreign-firm experience (Hypothesis 3a), but not own-firm and other-firm from the same home-country experience (Hypothesis 3b).

An examination of the economic significance of these results demonstrates that the effect of own-firm experience in a potential host country on the count of entries when holding all other variables constant at their mean levels, though statistically significant, is small in magnitude. Specifically, a one standard deviation increase (seven months) from the mean level of own-firm experience (five months) increases the predicted count of entries in that country by 17% of the mean of the dependent variable. For some firms, however, the effect is substantial: A change from 5 months of experience to 10 years of operating experience increases the predicted count of entries by 807% of the mean of the dependent variable.

Holding all other variables constant at their means, the effect of increasing the quantity of other-foreign-firm

Table 2   Summary and Correlation Statistics

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Mean	0.001	9.767	2.817	0.067	0.889	0.392	17.178	9.190	0.933	3.637	0.329	0.439	3.155	0.704
Standard deviation	0.038	2.692	1.608	0.492	1.558	0.274	1.603	1.330	1.389	1.911	0.252	0.263	2.754	1.467
Minimum	0.000	0.000	0.000	0.000	0.000	0.020	14.670	5.830	0.000	0.000	0.100	0.020	0.000	0.000
Maximum	2.000	14.583	6.600	6.600	6.332	1.000	20.960	10.750	4.883	8.035	1.000	1.000	8.277	7.536
(1) Foreign investment	1.000													
(2) Firm total production capacity	**0.039**	1.000												
(3) Firm home-country experience	**0.029**	**0.518**	1.000											
(4) Firm host-country experience	**0.191**	**0.151**	**0.137**	1.000										
(5) Firm international experience	**0.062**	**0.473**	**0.294**	**0.281**	1.000									
(6) Firm technological capabilities	**0.041**	**0.348**	**0.267**	**0.077**	**0.283**	1.000								
(7) Population	**0.022**	−0.012	−0.022	**0.085**	−0.015	−0.003	1.000							
(8) GDP per capita	**0.017**	−0.020	−0.034	**0.097**	−0.031	−0.022	**−0.303**	1.000						
(9) Country five-year prior investment	**0.048**	−0.033	−0.053	**0.135**	−0.035	0.006	**0.330**	**0.210**	1.000					
(10) Domestic firms host-country experience	**0.035**	−0.022	−0.027	**0.127**	−0.019	−0.031	**0.414**	**0.092**	**0.444**	1.000				
(11) Country political hazards	−0.003	0.004	0.012	−0.051	0.010	0.017	0.022	**−0.416**	−0.063	0.044	1.000			
(12) Country technological environment	**0.026**	−0.021	−0.049	**0.079**	−0.034	0.026	−0.014	**0.592**	**0.374**	**0.224**	**−0.282**	1.000		
(13) Foreign firms (different home country) host-country experience	**0.038**	−0.045	−0.078	**0.157**	−0.063	−0.032	**0.225**	**0.591**	**0.538**	**0.358**	**−0.168**	**0.542**	1.000	
(14) Foreign firms (same home country) host-country experience	**0.050**	−0.007	0.028	**0.146**	−0.023	0.000	**0.126**	**0.280**	**0.295**	**0.204**	**−0.145**	**0.286**	**0.376**	1.000

Note. **Bold** indicates pair-wise significance at 0.05 level.

Table 3   Foreign Investment Results

	(1) Coef (s.e.)	(2) Coef (s.e.)	(3) Coef (s.e.)	(4) Coef (s.e.)	(5) Coef (s.e.)	(6) Coef (s.e.)
Firm-level variables						
Firm total production capacity	1.297*** (0.166)	0.740** (0.271)	0.710*** (0.210)	0.702*** (0.210)	0.916 (0.592)	0.573*** (0.135)
Firm home-country experience	−0.302** (0.096)	−0.361 (0.187)	−0.271 (0.153)	−0.271 (0.156)	−0.326 (0.711)	−0.284* (0.127)
Firm host-country experience (Hypothesis 1a > 0)		0.777*** (0.162)	1.894*** (0.264)	1.857*** (0.329)	2.033*** (0.274)	1.758*** (0.219)
Firm international experience (Hypothesis 1b > 0)		0.098 (0.113)	0.091 (0.102)	0.085 (0.107)	0.366 (0.254)	0.146* (0.072)
Firm technological capabilities (Hypothesis 1c > 0)		3.265*** (0.741)	3.261*** (0.640)	2.892*** (0.502)	3.321* (1.549)	3.327*** (0.425)
Country-level variables						
Population	−0.098 (0.405)	−0.282 (0.380)	−0.481 (0.296)	−1.029** (0.328)	−0.550 (0.396)	−0.193 (0.140)
GDP per capita	0.529 (0.277)	−0.856 (0.544)	−2.319*** (0.648)	−2.802*** (0.796)	−1.857*** (0.523)	−1.896*** (0.376)
Country five-year prior investment	0.836*** (0.246)	0.585*** (0.169)	0.557** (0.203)	0.572** (0.199)	0.693*** (0.169)	0.472** (0.180)
Domestic firms host-country experience	0.393 (0.349)	−0.005 (0.277)	−0.061 (0.301)	0.122 (0.303)	−0.056 (0.406)	−0.123 (0.075)
Country political hazards (Hypothesis 2a < 0)		0.272 (0.467)	0.388 (0.630)	−4.087* (2.072)	−2.524* (1.186)	−1.831* (0.934)
Country technological environment (Hypothesis 2b > 0)		2.828* (1.435)	2.174 (1.678)	1.370 (1.671)	2.013 (2.039)	2.369* (1.220)
Foreign firms (different home country) host-country experience (Hypothesis 2c > 0)		0.675 (0.349)	1.382*** (0.404)	1.356** (0.448)	0.791 (0.413)	0.866*** (0.205)
Foreign firms (same home country) host-country experience (Hypothesis 2d > 0)		0.293*** (0.082)	0.582** (0.190)	0.551*** (0.165)	0.446*** (0.130)	0.384*** (0.106)
Firm- and country-level trade-offs and contingencies						
Firm host-country experience × foreign firms (different home country) host-country experience (Hypothesis 3a < 0)			−0.259*** (0.068)	−0.249** (0.078)	−0.291*** (0.064)	−0.272*** (0.054)
Firm host-country experience × foreign firms (same home country) host-country experience (Hypothesis 3b < 0)			−0.061 (0.047)	−0.059 (0.040)	−0.003 (0.048)	−0.040 (0.029)
Firm technological capabilities × country political hazards (Hypothesis 4a < 0)				−2.685** (0.857)	−5.517** (2.022)	−2.004* (0.811)
Country technological environment × country political hazards				19.667*** (4.436)	18.947*** (2.848)	15.178*** (3.036)
Firm technological capabilities × country technological environment				3.059 (2.150)	2.595 (2.919)	3.057 (1.770)
Firm technological capabilities × country technological environment × country political hazards (Hypothesis 4b < 0)				−13.643* (6.008)	−15.464* (6.144)	−17.413*** (4.238)
Constant	−28.160*** (8.331)	−9.847 (9.488)	4.126 (8.533)	18.712 (10.492)	1.118 (8.641)	−0.039 (5.365)
Specification	nbml	nbml	nbml	nbml	nbml	nbml
Year fixed effects	yes	yes	yes	yes	yes	yes
Host-country fixed effects	yes	yes	yes	yes	yes	no
Origin-country fixed effects	yes	yes	yes	yes	yes	no
Firm fixed effects	no	no	no	no	yes	no
Pseudo-log likelihood	−321.65	−268.95	−252.53	−248.17	−192.06	−261.79
N	42,502	42,502	42,502	42,502	7,378	50,888

Notes. Standard errors (s.e.) are robust and adjusted for clustering by host country.
    *, **, *** correspond to *p*-values of <0.05, <0.01, and <0.001, respectively.

Table 4   Foreign Investment Results (Alternative Specifications)

	(1) Coef (s.e.)	(2) Coef (s.e.)	(3) Coef (s.e.)	(4) Coef (s.e.)	(5) Coef (s.e.)	(6) Coef (s.e.)
Firm-level variables						
Firm total production capacity	0.702*** (0.210)	0.916 (0.598)	0.629*** (0.146)	0.761*** (0.233)	1.014 (0.657)	0.613*** (0.158)
Firm home-country experience	−0.271 (0.156)	−0.326 (0.717)	−0.304* (0.136)	−0.304 (0.175)	−0.389 (0.764)	−0.312* (0.143)
Firm host-country experience (Hypothesis 1a > 0)	1.857*** (0.329)	2.033*** (0.273)	1.812*** (0.220)	2.035*** (0.381)	2.325*** (0.275)	1.877*** (0.248)
Firm international experience (Hypothesis 1b > 0)	0.085 (0.107)	0.366 (0.255)	0.154* (0.077)	0.084 (0.113)	0.444 (0.304)	0.150* (0.075)
Firm technological capabilities (Hypothesis 1c > 0)	2.892*** (0.502)	3.321* (1.548)	3.417*** (0.425)	3.054*** (0.556)	4.291* (1.890)	3.477*** (0.478)
Country-level variables						
Population	−1.028** (0.328)	−0.550 (0.394)	−0.236 (0.136)	−1.107*** (0.347)	−0.581 (0.468)	−0.222 (0.161)
GDP per capita	−2.801*** (0.797)	−1.858*** (0.517)	−2.004*** (0.364)	−3.142*** (0.891)	−2.084*** (0.587)	−2.056*** (0.425)
Country five-year prior investment	0.572** (0.199)	0.693*** (0.171)	0.479** (0.172)	0.578** (0.207)	0.750*** (0.208)	0.493** (0.190)
Domestic firms host-country experience	0.122 (0.303)	−0.056 (0.405)	−0.121 (0.077)	0.105 (0.337)	−0.097 (0.471)	−0.123 (0.081)
Country political hazards (Hypothesis 2a < 0)	−4.087* (2.073)	−2.525* (1.183)	−1.818 (0.964)	−4.272* (2.165)	−2.405 (1.415)	−1.979* (1.014)
Country technological environment (Hypothesis 2b > 0)	1.370 (1.672)	2.013 (2.038)	2.450 (1.269)	1.505 (1.785)	2.567 (2.261)	2.508* (1.294)
Foreign firms (different home country) host-country experience (Hypothesis 2c > 0)	1.356** (0.448)	0.791 (0.412)	0.908*** (0.215)	1.514** (0.514)	0.840 (0.503)	0.926*** (0.225)
Foreign firms (same home country) host-country experience (Hypothesis 2d > 0)	0.551*** (0.165)	0.446*** (0.130)	0.389*** (0.112)	0.580** (0.183)	0.507*** (0.154)	0.397*** (0.111)
Firm- and country-level trade-offs and contingencies						
Firm host-country experience × foreign firms (different home country) host-country experience (Hypothesis 3a < 0)	−0.249** (0.078)	−0.291*** (0.063)	−0.274*** (0.055)	−0.277** (0.089)	−0.339*** (0.068)	−0.291*** (0.059)
Firm host-country experience × foreign firms (same home country) host-country experience (Hypothesis 3b < 0)	−0.059 (0.040)	−0.003 (0.048)	−0.039 (0.030)	−0.059 (0.047)	0.007 (0.059)	−0.038 (0.030)
Firm technological capabilities × country political hazards (Hypothesis 4a < 0)	−2.685** (0.858)	−5.517** (2.022)	−2.387* (1.185)	−2.894** (0.948)	−6.472** (2.395)	−2.122* (0.859)
Country technological environment × country political hazards	19.667*** (4.438)	18.947*** (2.823)	14.380*** (3.836)	21.808*** (4.997)	22.841*** (3.040)	16.260*** (3.256)
Firm technological capabilities × country technological environment	3.059 (2.151)	2.595 (2.917)	2.896 (1.826)	3.586 (2.308)	2.608 (2.970)	3.441 (1.843)
Firm technological capabilities × country technological environment × country political hazards (Hypothesis 4b < 0)	−13.639* (6.012)	−15.464* (6.205)	−15.611* (6.350)	−14.381* (6.611)	−18.062** (6.858)	−18.022*** (4.596)
Constant	18.707 (10.493)	1.119 (8.669)	0.909 (5.146)	21.603 (11.323)	0.550 (9.448)	0.974 (5.976)
Specification	zinb	zinb	zinb	logit	logit	logit
Year fixed effects	yes	yes	yes	yes	yes	yes
Host-country fixed effects	yes	yes	no	yes	yes	no
Origin-country fixed effects	yes	yes	no	yes	yes	no
Firm fixed effects	no	yes	no	no	yes	no
Pseudo-log likelihood	−248.17	−192.06	−261.13	−242.60	−181.86	−257.48
N	42,502	7,378	50,888	42,502	7,378	50,888

Notes. Standard errors (s.e.) are robust and adjusted for clustering by host country in Models 1, 3, 4, and 6 and by firm in Models 2 and 5.
  *, **, *** correspond to *p*-values of <0.05, <0.01, and <0.001, respectively.
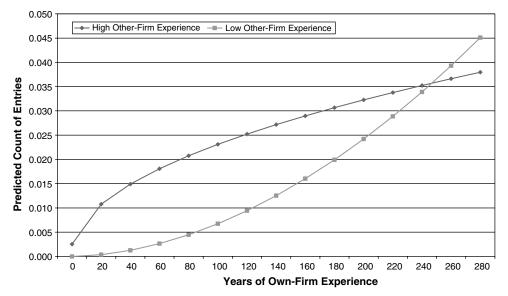
Figure 1   The Substitutability of Own- and Other-Firm Experience

experience in a country by one standard deviation from its mean level increases the predicted count of entries by 465% of the mean of the dependent variable. The effect is also highly nonlinear, however: An increase of 1.5 standard deviations from the mean of other-foreign-firm operating experience increases the impact to 3,071% of the mean of the dependent variable. The effects are still statistically significant but far smaller when we consider entry by other firms from the same home country ranging from 14% to 480% of the mean of the dependent variable.

Firms with extensive operating experience in a potential host country are less sensitive to the signals provided by the operation of other foreign firms. When we compare the effect of increasing own-firm experience for firms contemplating entry into countries with low versus high other-foreign-firm experience (see Figure 1), we see that in the latter case predicted rates of entry are higher when firms have little experience of their own but that they increase at a diminishing rate with own-firm experience. By contrast, in the case where other-foreign-firm experience in a potential host country is low, entry rates are initially lower but increase rapidly in own-firm experience, and eventually surpass the level in countries in which other foreign firms have greater operating experience.

Firm- and Country-Level Technological Sophistication and Country-Level Political Hazards. We argue that more technologically advanced firms have higher propensities for foreign direct investment, ceteris paribus (Hypothesis 1c), due to their differential ability to exploit their existing technological base and their desire to augment that base. We find strong support for that hypothesis ($p < 0.001$). We also argue that country-level political hazards should deter foreign direct investment (Hypothesis 2a) due to the deleterious effects

of uncertain policy environments on multibillion-dollar fixed investments with relatively long time horizons. Once we control for the differential sensitivity to political hazards of technologically sophisticated versus unsophisticated firms (Hypothesis 4a) and the differential effect of a country's technological and institutional environment on technologically sophisticated versus unsophisticated firms (Hypothesis 4b) in Model 4, we find support for the negative effect of political hazards ($p < 0.05$). We also find support for our hypothesis ($p < 0.01$) that more technologically advanced firms are particularly sensitive to the negative effect of political hazards (Hypothesis 4a). Furthermore, as argued in Hypothesis 4b, less technologically advanced firms do appear ($p < 0.05$) to make trade-offs between the advantages of country-level technological sophistication (Hypothesis 2b) and the deterring effect of political hazards (Hypothesis 2a).

Holding all other variables constant at their mean levels, increasing a firm's level of technological sophistication by one standard deviation from the mean level increases the predicted count of investments in overseas fabs in a given country by 12% of the mean level of the dependent variable. Increasing a country's level of political hazards one standard deviation from the mean level reduces the predicted count of new investments by 6.4% of the mean of the dependent variable. These effects are relatively small in economic magnitude but increase substantially when we allow both variables to deviate from their mean levels, as suggested by Hypothesis 4a. For example, the effect of increasing firm-level technological sophistication by one standard deviation from its mean level ranges from an increase of 41% of the mean of the dependent variable when political hazards are at their minimum, to 0.23% of the mean of the dependent variable when political hazards are at their maximum.
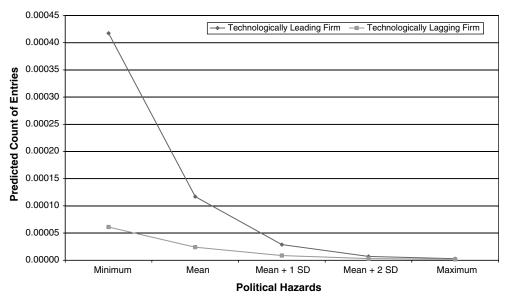
Figure 2 **Technologically Leading Firms Are More Sensitive to Political Hazards**

Similarly, increasing country-level political hazards by one standard deviation reduces the predicted count of investment by only 1.83% of the mean of the dependent variable for technologically lagging firms but by 44% for technologically leading firms. Figure 2 displays this conditionality graphically, demonstrating that technologically sophisticated firms display a far greater sensitivity to the deleterious effect of political hazards.

While holding all other variables constant at their mean level we do not find consistent support for the effect of the country-level technological environment (Hypothesis 2b), but do find evidence ($p < 0.05$) that firm-level technological sophistication alters the perceived trade-off between the technological sophistication of a potential host country and its level of political hazards (Hypothesis 4b). More technologically advanced firms are more likely to invest abroad in countries with low political hazards and high technological capabilities. By contrast, less technologically advanced firms are more likely to invest abroad in countries with high political hazards and high technological capabilities or low political hazards and low technological capabilities. Given the difficulty in summarizing the results from a three-way interaction term, we create a two-panel plot on a logarithmic scale to facilitate a comparison across the two schedules that shows the predicted count of entries for technologically lagging (Figure 3a) and technologically leading (Figure 3b) firms assessing potential host countries with various levels of technological sophistication and political hazards. First, note that both lagging and leading firms are willing to make trade-offs between country-level technological sophistication and country-level political hazards. On both graphs, the schedule plotting the predicted count of entries for technologically advanced countries is not declining in political hazards as is the case when technological sophistication is held

at its mean level (see Figure 2).[6] Technologically lagging firms, however, are more willing to invest in politically hazardous but technologically advanced countries. By far the highest predicted count of entry observed for technologically lagging firms occurs where political hazards are at their maximum and country-level technological sophistication is high. By contrast, technologically leading firms appear to exhibit a slight preference for countries with low political hazards and low technological sophistication, perhaps seeking to avoid potential spillovers of knowledge to their competitors (Shaver and Flyer 2000).

3.6. Robustness
Models 5 and 6 of Table 3 and all of the models in Table 4 present alternative empirical specifications that are described in turn. Model 5 of Table 3 addresses concerns of unobserved firm-level heterogeneity by adding firm-level indicator variables to the specifications of Model 4. This requires us to limit our analysis to a reduced sample of firms that undertake multiple overseas investments. Model 6 of Table 3 addresses concerns that restricting the samples to include only countries (Models 1–4) and firms (Model 5) with multiple investments might be biasing the results. In response to this concern, we broaden the sample to include all firms that operate a fab and all countries that contain a fab regardless whether the firm made an overseas investment or whether the country received such an investment. Table 4 addresses concerns regarding the use of a negative binomial specification by replicating the results of Models 4–6 of Table 3 using zero-inflated negative binomial and logit specifications. The coefficient estimates and standard errors are relatively stable across these various specifications leading to few substantive changes in the support for the hypotheses described above. The only
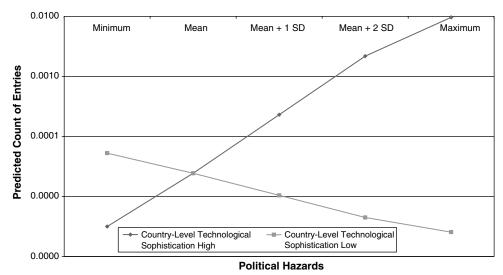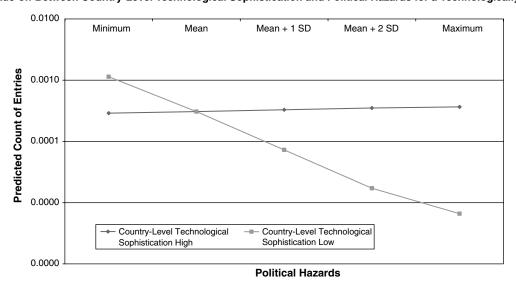
Figure 3a   Trade-off Between Country-Level Technological Sophistication and Political Hazards for a Technologically Lagging Firm

Figure 3b   Trade-off Between Country-Level Technological Sophistication and Political Hazards for a Technologically Leading Firm

exceptions of note are that firm-level control for size (total production capacity) is no longer significant once we include firm fixed effects (Model 5 of Table 3), the magnitude of the coefficient estimate for political hazards (Hypothesis 2a) declines in several of these specifications and becomes statistically insignificant in the zero-inflated binomial specification using the full sample of countries and firms (Model 3 of Table 4) and the logit specification employing firm fixed effects (Model 5 of Table 4). By contrast, when we expand the sample to include all countries and firms and use a negative binomial specification (Model 6 of Table 3), we do find support for the attractiveness of the country-level technological environment (Hypothesis 2b).

3.7.   Discussion

The empirical results provide support for the roles of firm-level experience and technological capabilities, and

country-level institutional, technological, and competitive environments on foreign investment decisions. The most interesting findings, however, link these environments. We demonstrate that own-firm and other-firm experience in a country are partial substitutes for each other. When considering whether to enter a potential host country, multinational firms with less experience in that country place greater weight on the actions of peer firms (those where they share a common foreign status), whereas more experienced firms rely on their own internal operating experience to assess potential foreign investment opportunities. We also show that technologically advanced and lagging firms assess the trade-offs between country-level technological sophistication and country-level political hazards in a fundamentally different manner. Holding the country-level technological environment constant, technologically advanced firms are highly sensitive to political hazards. Once we allow

the country-level technological environment to vary as well, technologically sophisticated firms are less willing to make trade-offs between these two country-level attributes, whereas technologically lagging firms trade off one attribute against the other. Overall, the results support the argument that firm- and country-level factors operate in complex and intricate patterns to influence firms' foreign investment decisions.

Despite these promising results, the paper has some potential limitations. One concern is the generalizability of the empirical setting. The semiconductor industry is somewhat unusual, characterized by rapid technological advancement, significant capital and R&D investment, learning economies, and long gestation lags between when capital investments are made and the actual production of saleable product. While other (especially high-technology) industries face some of these characteristics, relatively few other industries face all of these characteristics, or to the same degree, as semiconductors. We also admittedly cannot fully control for some of the informal most-favored-firm agreements that are sometimes associated with investment in the semiconductor industry in some countries. Among other things, the resemblance between this industry and traditional infrastructure industries in terms of the effect of the institutional and technological environments on investment patterns could, therefore be different. A final potential limitation relates to the emphasis placed on the foreign investment location decision, rather than other international strategic decisions of interest.

Additional research is also called for to explore the origins of some of our surprising findings. In contrast to evidence of market seeking found in extant work on foreign direct investment, we observe that holding all other variables constant, the location of semiconductor fabs is more likely in smaller countries with lower per capita incomes. These results could point to the relative importance of local factor costs, as opposed to local market size in determining the attractiveness of a potential host country in this globally integrated product market or to the willingness of relatively small and underdeveloped countries to provide informal investment incentives to attract large-scale investments with substantial spillovers. A second result warranting additional study was evidence that investing firms, although strongly influenced by the prior operating experience of other foreign firms, are not responsive to other foreign firms from the same home country. Once again, these results could derive from a highly integrated global market that leads to an investing firm perceiving its competitors to be defined not by nationality, but by product niche or other characteristics that are highly diffused across home-country markets.

4. Conclusion

Most researchers would agree that a multitude of firm- and country-level factors influence foreign investment

decisions. They would also concur, however, that microlevel datasets that include sufficient variation in those phenomena to identify trade-offs and contingencies among these factors are difficult to obtain. Firm-level variation in capabilities is often poorly proxied by the accounting information available in 10-K financial reports. Datasets that capture firm-level variation better are rarely able to extend their data coverage to the population of competing firms or able to extend coverage across national boundaries. Because factors at each of these levels are likely to interact with each other to determine the attractiveness of a given national environment for a given firm, research in strategic management has been limited in its ability to develop a more complete understanding of international plant location and investment decisions. Although we do not claim to completely solve these problems, the firm-level measures of experience and technological capabilities and country-level measures of the institutional, technological, and competitive environments that we employ in the empirical analysis all offer substantial promise. The specification that we employ is also quite rich in considering how these factors interact to influence foreign investment decisions.

Literature that posits that firm-level capabilities provide the basis for competitive advantage often has difficulty in identifying the nature of these capabilities and in demonstrating the competitive effects of these capabilities in isolation from unobserved firm-level heterogeneity. By examining market entry and investment in an international setting, we demonstrate not only that technological capabilities shape investment decisions, but also that these capabilities vary in their effect across different potential markets in a manner consistent with theoretical predictions. If one is concerned that measures of firm-level technological capabilities are simply proxying for unobserved differences in the cost of capital, managerial expertise, or other similar factors, one also needs to offer alternate theoretical explanations for why these factors would be positively associated with entry in technologically advanced countries with low political hazards, whereas countries low in these unobserved factors would be more likely to trade off these two country-level features.

By leveraging variation both within the population of investing firms and across the set of potential markets, we highlight the importance of and connections between firm-level constructs of experience and technological capabilities and country-level constructs such as the institutional, technological, and competitive environments. We find evidence not only that firm-level capabilities influence investment strategies, but also that this influence is contingent on country-level factors, and vice versa.

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Endnotes

[1]The entirely domestic policy favored by Japanese semiconductor firms was challenged in the 1990s by the domestic recession, a significant downturn in semiconductor sales, and the rise of formidable competitors in South Korea and Taiwan, which has led to notable increases by Japanese firms in fabrication capacity in Asia and the Pacific region, mostly through joint ventures and technology licensing agreements with local semiconductor firms. These Japanese firms subsequently added to their Asian manufacturing base and expanded to Europe and the Americas. NEC represents a notable exception because for years it has located a significant portion of its fabrication capacity outside Japan.

[2]Intel views China as an investment for the future and has developed a semiconductor assembly and test facility in Shanghai, but does not currently manufacture semiconductor components in the country. TSMC, Taiwan's leading semiconductor manufacturing concern, is contemplating entering mainland China, but any manufacturing facility in place will produce less-sophisticated products compared with the more cutting-edge products it manufactures in Taiwan (Boudreau 2002).

[3]See http://www-management.wharton.upenn.edu/henisz/ for additional information on the political constraints dataset.

[4]While techniques for incorporating panel error structures such as generated by our observations of the same firm-country pair across multiple years into count or binary choice models are relatively nascent, our results are qualitatively unchanged when we use a population averaged random effect logit estimator in which we specify either an ar(1) error structure or, more generally, any heteroskedastic panel error structure.

[5]The major product families that we control for include (1) advanced memory (DRAM, SRAM, Flash, etc.); (2) advanced logic (microprocessors, microcontrollers); (3) other logic (ASICs, etc.); (4) analog/mixed signal; (5) discrete devices; (6) (GaAS); and (7) other. If a semiconductor manufacturing facility manufactures more than one product family, we classify it according to the most technologically advanced product.

[6]The coefficient estimate on the interaction between political hazards and country-level technological, for which we did not propose a hypothesis, is positive and highly significant.

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