Industrial and Corporate Change, Volume 19, Number 6, pp. 1769–1800
doi:10.1093/icc/dtq049
Advance Access published September 25, 2010

The institutional determinants of agglomeration: a study in the global semiconductor industry

Xavier Martin*, Robert M. Salomon and Zheying Wu†**

We hypothesize that several characteristics of a country's institutional environment encourage firms to agglomerate. To test our hypotheses, we examine the collocation pattern of 931 plant investments made by 266 firms across 29 countries in the global semiconductor industry from 1975 to 2004. The results show that the decision to agglomerate is strongly dependent on a country's institutional context. Specifically, firms prefer to agglomerate when investing within countries with collectivist cultures, and those characterized by political and economic uncertainty. We assess the robustness of the results across multiple indicators of these institutional conditions.

1. Introduction

Choices about where to locate facilities represent an integral, yet often overlooked, facet of firm strategy (Porter, 2000). Specifically, whether firms agglomerate (i.e. locate in a geographic cluster of similar firms) not only impacts national, regional, and industrial outcomes, but also through its impact on operating costs and revenues, has lasting effects on firm performance (Breschi and Malerba, 2001).

Although scholars from various disciplines recognize the importance of such collocation decisions, research examining their antecedents has focused largely

*Xavier Martin, CentER and CIR, School of Economics and Management, Tilburg University, P.O. Box 90153, 5000 LE, Tilburg, The Netherlands. e-mail: x.martin@uvt.nl

**Robert Salomon, Stern School of Business, New York University, 44 W. 4th St., KMC 7-59, New York, NY 10012, USA. e-mail: rsalomon@stern.nyu.edu

†Zheying Wu, CentER, School of Economics and Management, Tilburg University, P.O. Box 90153, 5000 LE, Tilburg, The Netherlands. e-mail: z.wu1@uvt.nl

on natural endowments, competition, and knowledge spillovers (Marshall, 1920; Hotelling, 1929; Weber, 1929). We know less about how firm clustering varies across institutional contexts. To fill this gap, we examine institutional (cultural, political and economic) determinants of agglomeration. We theorize that a firm's incentives to agglomerate vary across countries, depending upon their institutional contexts.

To test these assertions, we examine the agglomeration patterns of 931 semiconductor plant investments made by 266 firms across 29 countries from 1975 to 2004. The dependent variable of interest is the decision of whether to locate a manufacturing facility within an existing agglomeration. Consistent with our theory, findings show that agglomeration patterns vary across countries. Firms are more likely to agglomerate when investing (domestically or abroad) within collectivist countries, and within those countries characterized by political and economic uncertainty. We compare and discuss results across several measures of each institutional factor.

2. Literature review

Because commitments to geographical locations are long-lasting and often irreversible, they can have enduring implications for firm performance. For example, building an efficient-scale semiconductor fabrication plant generally requires an investment of greater than $1 billion (IC Knowledge, 2001). Recognizing this, scholars in different disciplines note that firms carefully select locations for their facilities. On the input side, economic geographers note that resource endowments and the availability of human capital make certain geographic locations attractive. For this reason, firms should favor sites that are rich with such input factors (Weber, 1929; Ghosh and Rushton, 1987). Work in industrial organization, by contrast, maintains that firms should maximize their proximity to customers, yet keep their distance from competitors to avoid head-to-head competition (Hotelling, 1929).

Extending this latter insight, research in the strategic management literature has centered on whether similar firms should locate proximally to one another within an agglomeration [see Shaver and Flyer (2000) for a review]. They point out that agglomerating can have both positive and negative consequences for firms. On the one hand, an agglomeration of firms can generate beneficial externalities [see Caniëls and Romijn (2003) for a review]. For example, Marshall (1920) argued that the clustering of similar firms creates a pool of specialized labor that can be shared among members. Additionally, firms in the agglomeration benefit from specialized suppliers that increase the overall competitiveness of the industry (Porter, 2000). Moreover, locating close to similar firms affords firms the opportunity to share knowledge or absorb knowledge through competitive spillovers (Marshall, 1920). Firms can learn from their competitors' experiences, and competition among local

firms may improve performance (Shaver and Flyer, 2000, Chung and Song, 2004). Such positive externalities motivate firms to agglomerate.

On the other hand, agglomerating has some drawbacks. As the number of firms requiring similar resources in an agglomeration increases, competition for similar inputs and markets can become intense, especially if firms produce homogenous goods (Fischer and Harrington, 1996). Such competition can lead to increased human resource costs and land rents, and may result in entrenchment and increased firm failures (Hannan and Carroll, 1992; Porter, 1998; Schmutzler, 1999; Hoen, 2001). Therefore, firms that are similar to their competitors may strategically avoid collocating (Baum and Haveman, 1997).

The aforementioned literature supports a contingent view of agglomeration. That is, agglomerating is better for some firms than for others. Moreover, agglomerating may be better in certain contexts than in others. However, one important antecedent of agglomeration remains relatively understudied: the impact of a country's institutional context. By institutional context we refer to North's (1991: p. 97) conceptualization of institutions as "humanly devised constraints that structure political, economic, and social interaction . . . [and that] provide the incentive structure of an economy . . .." Accordingly, we focus on a country's cultural, political, and economic institutions, which normalize firm activities and shape the environment in which firms operate (Scott, 1995). These forces thereby impact agglomeration (Whitford and Potter, 2007). In the next section we hypothesize how national culture and political and economic uncertainty are likely to affect agglomeration.

3. Hypotheses

3.1 Cultural factors

One of the most important factors in the institutional environment in which firms operate is national culture. Culture normalizes the behavior of organizational actors within societies (North, 1991; Scott, 1995; Hofstede, 2001). As a product of the societies from which they are born, firms are inherently imprinted with societal norms, and these norms influence behavior.

Prior literature has investigated the impact of national culture on firms' decisions and activities. For example, national culture has been shown to affect managerial goals, management processes, organizational values, and organizational action (Hofstede, 1985, 1994; Hofstede, *et al.*, 2002). We likewise expect culture to have an impact on firm behavior with respect to agglomeration. Although national culture has multiple dimensions (Hofstede, 2001), we focus on the continua of individualism/collectivism and uncertainty avoidance as the cultural factors most likely to influence agglomeration. Hofstede (2001) described three other cultural dimensions

(i.e. masculinity, power distance, and long-term orientation), but we believe they are less relevant to explaining a firm's likelihood to join an agglomeration.[1]

Individualism refers to the extent to which decisions are made independent of larger group interests and norms, while collectivism encompasses the willingness to cooperate, an emphasis on relationships, and subordination to larger group goals (Morris *et al.*, 1994; Hofstede, 2001). Individualist cultures place greater value on, and are more accommodating of, individual decisions that vary from group norms. Collectivist cultures, by contrast, place a greater emphasis on the adoption of group norms and on within-group cooperation (Triandis, 1995).

With respect to agglomeration, research on national culture implies that the positive externalities associated with agglomeration are enhanced in a collectivist culture while the negative consequences of agglomeration are diminished. Although agglomerations are generally characterized by intense competition (Krugman, 1991; Sorensen and Audia, 2000), the severity of competition is likely to vary across cultures. Specifically, collectivist cultures put a greater emphasis on relationships, harmony, and within-group cooperation (Chen *et al.,* 2002). Therefore, in a collectivist country, firms within an agglomeration should be more willing to share knowledge. Thus, an agglomeration in a collectivist environment generates more spillovers and transmits the spillovers more efficiently than an agglomeration in an individualist environment. Moreover, collectivism suppresses free riding, mitigates opportunistic behavior, and induces individuals to sacrifice for the good of the group (Earley, 1989; Chen *et al.*, 2002). Collectivism thereby reduces transaction costs and competition among firms within the agglomeration. Consequently, firms have more to gain and less to lose from agglomerating in a country characterized by a collectivist culture.

From an institutional perspective, firms can obtain greater legitimacy by joining an agglomeration in countries characterized by collectivism. Because an agglomeration is a manifestation of group preference, joining an existing agglomeration should be regarded by society at large as rational, efficient, and legitimate (Meyer and Rowan, 1977). Agglomerating thereby reflects "cultural expectations" through a process of collective isomorphism (DiMaggio and Powell, 1983). To prevent a loss of legitimacy and to enhance chances for survival, firms in a collectivist culture are more likely to adopt societally accepted norms and imitate the location behavior of firms that resemble them. Otherwise stated, because collectivist cultures value conformity with group norms over independent behavior (Morris *et al.*, 1994), firms face greater environmental pressures to conform, and agglomerating represents the most legitimate choice in these countries. Individualist cultures, by contrast, more readily support independent behavior. In such cultures, deviation from group norms

[1]In results not reported, we explored models including masculinity, power distance, and long-term orientation. Consistent with our priors, we found no relationship between these cultural factors and agglomeration.

is more socially acceptable. Therefore, choosing a location far away from existing agglomerations is more likely to be viewed as socially legitimate.

For these reasons, we expect firms operating in countries characterized by collectivist cultures to be more likely to agglomerate than in countries characterized by individualist cultures.

> *H1: All else equal, firms will be more likely to locate in an economic agglomeration when investing within a country characterized by a more collectivist, versus individualist, culture.*

In addition to individualism/collectivism, we believe that uncertainty avoidance represents an important cultural determinant of agglomeration. Uncertainty avoidance captures societal attitudes toward risk, ambiguity, and unpredictability (Hofstede, 2001). Economic actors in high uncertainty-avoidance cultures often adhere to norms or fixed patterns of behavior to reduce uncertainty.

By their nature, location decisions involve uncertainty. Firms often put substantial sums of money at risk and make long-term commitments to specific locales. In so doing, they take on whatever uncertainty is associated with the resources available within the specific environment. One way in which firms can mitigate their exposure is by agglomerating. This entails lower uncertainty because specialized inputs are more readily available within an agglomeration even if they may be more expensive (Marshall 1920). Furthermore, information about future inputs such as labor, suppliers, raw materials, and infrastructure may be more predictable within an agglomeration. Therefore, for firms in high uncertainty-avoiding cultures, the certainty of input availability within the agglomeration has higher value.

For these reasons, we expect firms investing in high uncertainty-avoidance cultures to be more likely to agglomerate. We therefore hypothesize,

> *H2: All else equal, firms will be more likely to locate in an economic agglomeration when investing within a country characterized by a more uncertainty-avoidant culture.*

Besides cultural factors, a country's political and economic environment also has an impact on firm strategy. Specifically, firms may agglomerate as a strategic response to political and economic uncertainty.

3.2 Political factors

Although volatile political conditions discourage investment in general (Williamson, 1979; Henisz and Macher, 2004), firms can develop strategies to operate in politically volatile settings (Delios and Henisz, 2000; Henisz and Delios, 2001). Agglomerating represents one such strategy. This is, in part, because because agglomerations generate spillovers of firms' private knowledge of the political environment (Mariotti and Piscitello, 1995). A firm may therefore agglomerate to gain privileged access to

information on policy developments, and to better understand and adapt to the political environment.

A firm may also choose to agglomerate to increase the power of its industry group *vis-à-vis* local and even national policymakers. A powerful interest group's collective action affords more opportunities to influence policy in its favor (Olson, 1965; Laffont and Tirole, 1991). Although industry trade associations mainly lobby on behalf of the whole industry (Porter, 2000), networks established within an agglomeration allow these firms to influence both local and national policies. Furthermore, closely connected groups can coordinate collective action more efficiently than loosely connected ones (Olson, 1965). Because geographic proximity enables firms to interact with each other more routinely, firms within an agglomeration may have more power to impact policymakers. As a result, in an uncertain political environment, a firm may agglomerate in order to better mobilize action when necessary.

In summary, in an environment characterized by uncertain political conditions, agglomerating benefits firms by facilitating shared access to policy information. Moreover, as an interest group, the firms in an agglomeration are in a better position to influence policy in their favor. We therefore predict,

> *H3: All else equal, firms will be more likely to locate in an economic agglomeration when investing within a country where the political environment is more uncertain.*

3.3 Economic factors

Another consideration for plant location is a country's economic institutions. When product-market prices are unpredictable, whether due to a lack of market openness, distortions brought about by regulatory intervention, or inefficient government, the quality of the information that can be gleaned from the market decreases (Hayek, 1945). In such cases, information shared among firms within an agglomeration is likely to be richer and more reliable than information available elsewhere (Burt, 1992; Uzzi, 1997). This externality is especially important when firms face greater levels of economic uncertainty, as shared information among agglomeration members can substitute for unreliable market information.

Economic uncertainty may also result from inefficient capital markets. When capital markets are incomplete and financial information is less transparent, it is more difficult for firms to raise capital. In such situations, lending institutions generally rely on social and environmental cues (Uzzi and Lancaster, 2003). For example, with limited resources and information, banks generally restrict loans to firms about which they have privileged information or with which they share ties—including those from the same geographic area (Gerlach, 1992; Lamoreaux, 1994). In countries with weak external capital markets, firms may obtain financing on better terms by signaling their quality. One observable and persuasive signal is whether the firm is associated with other reputable corporations (Stuart *et al.*, 1999). A firm may signal

its association with or similarity to other reputable corporations by agglomerating. Because the agglomeration includes many similar and related firms, potential lenders can recognize the common traits of these firms and better infer information about each. In addition, uncertainty encourages herding in lending and financing decisions among neighboring financial institutions (Devenow and Welch, 1996; Drehmann *et al.*, 2005). Firms that agglomerate are more likely to benefit from such herding, as they create more chances for the local financial institutions to initiate and maintain a financing bandwagon.

Integrating the above arguments, we contend that in uncertain economic environments, firms can benefit by agglomerating. This strategy may enable firms to obtain market information from competitors, signal their quality to external capital markets, and better attract financial resources. Thus,

> *H4: All else equal, firms will be more likely to locate in an economic agglomeration when investing within a country where the economic environment is more uncertain.*

4. Research design

4.1 Sample

We are interested in the impact of a country's institutional characteristics on agglomeration. Therefore, an industry with investments in diverse national markets is most appropriate for this study. We chose to study the global semiconductor industry, which presents two advantages for our purposes. First, semiconductor plants are dispersed worldwide and the industry is global in scope. This offers ample variance in institutional and locational patterns. Second, it is a high-profile industry in which plant investments can be reliably documented.

The International Fabs on Disk database, our main source, includes information on 1229 semiconductor plant investments from 1960 to 2004. It identifies the city and country in which the plant is located, the corporate parent, the year of establishment, the type of product manufactured, and the technology used in the plant. These data help us identify a firm's location and capture important firm-specific characteristics. Due to missing data from this and supplemental sources (discussed below), our final sample includes 931 plants from 266 parent firms across 29 countries from 1975 to 2004.

4.2 Dependent variable

Our dependent variable captures whether a firm elects to agglomerate when making a new plant investment. Consistent with prevailing literature, we define an agglomeration as a geographic location (city) with at least five neighboring semiconductor plants that are located within a 60-mile radius and that are separated by an area of

Figure 1 (**a**) Semiconductor plants in the United States (all plants in 1980). (**b**) Semiconductor plants in the United States (agglomerations in 1980).

distinct, empty geographic space (Baum and Haveman, 1997; Almeida and Kogut, 1999; Alcacer and Zhao, 2006).[2] The 60-mile cutoff is based on Getis (1969). Because we have information on the exact year in which each semiconductor plant was built, the agglomeration measure is time-varying, allowing for agglomerations to change as firms build more plants. This allows a more precise definition of the construct than previously employed in the literature (e.g. Head *et al.*, 1995; Shaver and Flyer, 2000).

As an example, Figures 1 and 2 illustrate how we identified agglomerations in the United States. In 1980 there were 101 plants and 4 distinct agglomerations in the United States. In contrast, in 2000, there were 237 semiconductor plants and seven agglomerations. To precisely identify agglomerations across the globe, we similarly

[2]We tested robustness with alternative definitions of an agglomeration as including 10 or 15 plants; the results were slightly weaker in statistical significance with the 15-plant cutoff but otherwise similar.

Figure 2 (**a**) Semiconductor plants in the United States (all plants in 2000). (**b**) Semiconductor plants in the United States (agglomerations in 2000).

plotted all semiconductor plants and repeated these procedures country by country, for each year of data available. We did this by using the exact latitude and longitude coordinates of the city in which the plant is located, obtained from the Getty Thesaurus of Geographic Names. The mappings and the identification of the clusters were obtained using ArcView software.

Once each agglomeration was identified, we determined whether each new plant was located within an agglomeration. Using the great-circle distance formula, we calculated the distance in miles from the focal semiconductor plant to the latitude/longitude centroid of the nearest agglomeration.[3] We define *AGGLOMERATE* as 1 if a plant is located within 60 miles of the nearest agglomeration, 0 otherwise.

[3]In contrast to Euclidean distance, which calculates the distance between two points on a plane, the great-circle formula calculates the shortest distance between two points on the surface of a sphere.

4.3 Independent variables

4.3.1 Collectivist/individualist national culture

To test Hypothesis 1, we adopt Hofstede's (2001) individualism/collectivism scale. This focuses on the relationship between an individual and referent others. In individualist cultures, individual interests supersede those of the group. In contrast, in collectivist cultures, individuals subjugate their own interests to those of the group. In the measure defined by Hofstede (2001), 0 represents an extreme collectivist society and 100 represents an extreme individualist society. Because a higher value of this scale represents stronger individualism, we expect the coefficient of this variable to be negative implying that firms are less likely to locate in an agglomeration. We label this variable INDIVIDUALISM.[4] As described in the Additional Analyses section, we examine two alternative indicators of individualism/collectivism to further test hypothesis 1.

4.3.2 Uncertainty-avoidance national culture

To test hypothesis 2, we use Hofstede's (2001) uncertainty-avoidance scale. This measures responses to unpredictable and uncertain situations. The scale varies from 0 to 100. Higher values represent more uncertainty-avoiding cultures. A positive coefficient for *UNCERTAINTY AVOIDANCE* would be consistent with our hypothesis.

4.3.3 Political uncertainty

To operationalize political uncertainty, we chose the political constraints (POLCON) index (Henisz, 2002). This measure reflects the level of latent political volatility within a country. With greater political checks and balances in place, policies are less likely to change arbitrarily. In such cases, the political environment will be more predictable. We label this measure *POLCON INDEX*. The index lies on a continuum from 0 to 1, where 0 represents extreme volatility (in which few, if any, checks and balances exist and leaders may make changes arbitrarily) and 1 represents lesser volatility (where many safeguards are in place). The index has been used widely to measure political uncertainty (e.g. Henisz and Delios, 2001; Henisz and Macher, 2004). Results consistent with hypothesis 3 would produce a negative coefficient. As discussed in the Additional Analyses section below, we examine several other indicators of political uncertainty to establish the robustness of our results.

[4]Because some agglomerations are not composed entirely of domestic firms, the national culture indexes of individualism/collectivism and uncertainty avoidance may not precisely reflect the original cultural norms of all the firms in the agglomeration—though it accurately reflects the broader national culture in which each plant operates, which forms the basis of our hypotheses. We also ran models limiting the sample to domestic firms. The results were similar to those presented here.

4.3.4. Economic uncertainty

We capture economic uncertainty in the form of volatility in real GDP growth. Macroeconomists point out that economic change stems from both short-run volatility and long-term growth. Economies grow steadily in the long run because of technological improvements and growth in the labor and capital supply. However, economies may fluctuate substantially in the near term due to unanticipated external shocks (Froyen, 1999). Given that we control separately for the stable growth pattern (see below), an appropriate measure of economic uncertainty lies in the volatility of a country's real GDP growth rate (Ramey and Ramey, 1995; Blanchard and Simon, 2001; Stock and Watson, 2002). Furthermore, volatility in GDP growth contains both a predictable and an unpredictable component (Servén, 1998). We are interested in capturing the impact of violent and unpredictable swings in economic conditions on the behavior of firms. Following Servén (1998), we therefore use a GARCH approach to impute the volatility of real GDP growth rates.[5] We label this variable *GDP VOLATILITY*. A positive coefficient would be consistent with hypothesis 4.

4.4 Control variables

We control for several other plant-, firm-, agglomeration-, and country- specific variables that could influence the dependent variable. First, we control for technological superiority of the focal plant by including a measure of relative feature size. Feature size, expressed in microns, measures the width of the conducting channels on a semiconductor chip. The narrower the feature size, the greater the capacity of the device, as more circuits fit on one chip. In this industry, firms compete on the basis of their ability to produce semiconductors with ever-thinner features (Malerba, 1985; Eisenhardt and Schoonhoven, 1996; Martin and Salomon, 2003). As Shaver and Flyer (2000) note, firms with superior technology may locate away from the agglomeration to avoid information leakage. To capture technological superiority, we measure the focal plant's feature size relative to other plants (see Henisz and Macher, 2004; Salomon and Martin, 2008). Specifically, we define RELATIVE FEATURE SIZE as the ratio of the focal plant's feature size to the average feature size of all plants previously built in the nearest agglomeration, or in the same country if that country

[5]We adopt a GARCH (1,1) approach developed by Bollerslev (1986) to estimate the volatility of real GDP growth. The estimation procedure takes the following functional form:

$$y_{it} = \alpha_0 + \alpha_1 t + \beta_1 y_{it-1} + \varepsilon_{\mathrm{it}}; \quad t = 1, \ldots, T;$$
$$\sigma^2_{it} = \gamma_{i0} + \gamma_{i1}\varepsilon^2_{it-1} + \delta_i \sigma^2_{it-1};$$

where y_{it} denotes real GDP growth for country i at time t, and $\sigma^2{}_{it}$ refers to the variance of the error term (ε_{it}) conditional on information up to time t. The fitted value of $\sigma^2{}_{it}$ measures the volatility of real GDP growth and forms the basis for our measure of economic uncertainty.

has no agglomeration. For the first plant in a given country, the measure receives the value of 1. If firms with superior technology avoid collocating (Shaver and Flyer, 2000), the smaller the relative feature size of its products, the less likely the firm will agglomerate.

If the purpose of a particular plant is to explore new technologies, as in R&D facilities and pilot plants, a firm may have the incentive to locate its plant within an agglomeration to benefit from information spillovers and to access a preexisting specialized labor pool (Almeida and Kogut, 1999). Moreover, locating within an agglomeration may help firms access (directly or via other member firms) knowledge from supporting institutions such as universities or government labs (Aharonson *et al.*, 2007). The variable *R&D FACILITY* controls for whether the focal plant is a specialized R&D/pilot facility (1) or a manufacturing facility (0).

We control for the size of the plant, measured as its monthly wafer fabrication capacity (expressed in millions). It could be that larger plants have a greater impact on the agglomeration than smaller plants, and therefore, differing incentives to locate there. We label this measure *PLANT CAPACITY*.

Because joint ventures have multiple parents with potentially competing interests, there may be some systematic differences in their location patterns. We measure the *JOINT VENTURE* status of the focal plant by whether it has two or more substantive corporate parents (1) or is wholly owned (0).

Foreign investments may differ from domestic investments with respect to agglomeration (Shaver, 1998). A control measure, *FDI*, receives the value of 1 if a foreign firm owns the focal plant, and 0 otherwise.

To reduce transaction costs and increase coordination, firms may locate their manufacturing facilities adjacent to their headquarters, whether within an agglomeration or not. We define the measure *HEADQUARTERS* as a dichotomous variable that equals 1 if the focal plant is in the same city in which the firm's headquarters reside, and 0 otherwise.

Sorenson and Audia (2000) and Chung and Song (2004) point out that firms with little experience have an incentive to agglomerate. Moreover, a firm's prior experience in a particular country will likely affect where it chooses to locate subsequent investments in that country. We therefore define *FIRM EXPERIENCE* as a count of plant investments made by a firm in a given country, prior to the focal plant.

Although inexperienced firms may be more likely to locate within an agglomeration, firms may have a preference to agglomerate if they have previously built plants in a specific agglomeration. We therefore define *NUMBER OF OWN PLANTS* as a tally of the plants built by the parent firm in the agglomeration nearest to the focal plant.

Competition from rivals within the agglomeration can discourage firms from locating there. We control for the number of plants previously built within the nearest agglomeration that produce products similar to those of the focal plant (*NUMBER OF DIRECT RIVALS*). We also control for the number of semiconductor

plants within the agglomeration that manufacture products dissimilar to those of the focal plant and are thus potential complementors or indirect rivals (*NUMBER OF INDIRECT RIVALS*).[6] We separate these two categories to recognize that the presence of product-market rivals can create different pressures than noncompeting industry participants, although both may affect where firms locate facilities (Martin *et al.,* 1998).

Some agglomerations are established based on favorable terms or incentives provided by local or regional governments (e.g. favorable tax rates, investment subsidies, industrial science parks). To control for this, *SPONSORED SITE* takes the value 1 if the location in question is a government-sponsored science park or if the firm received favorable treatment for choosing the particular location, and 0 otherwise.

We also use two macro-level country controls: GDP and GDP per capita. GDP correlates with the size of the national market (i.e. larger economies support more semiconductor investment) and with physical landmass.[7] Our measure of GDP captures the gross domestic product of the country in which the focal plant is built in a given year, expressed in billions of purchasing-power parity US dollars.

We also control for *GDP PER CAPITA*, expressed in thousands of purchasing power parity US dollars. Economic geographers have pointed out that firms are likely to build plants in countries with advanced infrastructures and skilled labor (McCann and Shefer, 2003; Holl, 2004). As a measure of income per person, GDP per capita is a correlate of infrastructure and labor quality.[8]

[6]International Fabs on Disk (IFOD) publishes detailed data on the product being manufactured in each facility. We use this information as the basis for our direct and indirect rival measures. Following Henisz & Macher (2004), we assign fabs based on the following distinct product segments: Memory, Logic, ASIC, Analog, Discrete, GAAS, and Miscellaneous (other). We then count the number of facilities in each segment. Those plants located in the (nearest) agglomeration and from the same product segment are considered direct rivals. Those within the (nearest) agglomeration and from a different product segment are considered indirect rivals.

[7]As an alternative to GDP, we tested the actual measure of landmass in square miles. The results did not change. However, because GDP and country size are highly correlated ($\rho = 0.78$), we decided against including both measures in the same specification. Also, country landmass hardly varies from year to year within our sample, so we could not include this control amidst non time-varying institution variables.

[8]We tested direct measures of the quality of a country's infrastructure (e.g. airports and seaports per square mile, number of highway miles per capita) and the availability of skilled labor (e.g. gross ratio of tertiary education levels, engineering graduates per capita, the number of universities within an agglomeration). Results were similar to those presented. However, because the indicators were highly correlated with each other, models including them together failed to converge. Moreover, the indicators varied very little over time and were highly correlated with both GDP and GDP per capita.

4.5 Statistical method

In addition to the control variables mentioned above, we use statistical means to address potential unobserved firm effects that may affect location decisions. Each parent company, for reasons not fully observable, may have a different propensity to agglomerate. If a firm has several plants, the error term may not be independent within firm observations. Fixed- or random-effects models may be used to correct for this (Greene, 2000). However, in our data, many parent firms exhibit no variance in the dependent variable—including, necessarily, firms with a single plant. Given this, and that we have few observations per firm on average, a random-effects model is preferred (Kennedy, 1998). Accordingly, and given that the dependent variable is binary, we employ a random-effects logit model. The random-effects specification is common when studying agglomeration (e.g. Head *et al.*, 1995; Shaver and Flyer, 2000).

5. Results

Descriptive statistics are in Table 1. About half of the sample plants are located within an agglomeration, and correlations are generally as expected. The substantial correlations between individualism, GDP and GDP per capita, and between POLCON and uncertainty avoidance, may raise some multicollinearity concerns; however, no independent variable had a variance inflation contribution greater than 10, which is the generally accepted range for individual variables (Kennedy, 1998), and no model exceeded the conventional threshold of 30 (Belsley *et al.*, 1980). Thus, we conclude that multicollinearity does not adversely impact the reported findings.

Multivariate regression results are in Table 2. In addition to random firm effects, we include fixed-time dummies to control for a time trend in agglomeration. Although not presented, the time dummies are significant as a set ($P<0.05$) and suggest that firms were more likely to agglomerate over time. Likewise, the random firm effects are significant as a set ($P<0.01$). This suggests lasting and systematic differences among firms in their propensities to agglomerate.

Column 1 presents a base model of control variables. Consistent with Shaver and Flyer (2000), the positive and significant effect of relative feature size indicates that plants with superior technology are less likely to agglomerate. Shaver and Flyer (2000) relied on firm size as a proxy for superiority and conjectured that technological superiority explains why large firms locate farther away. We corroborate their finding with a direct, and precise, measure of technological superiority.

Both joint-venture and R&D plants are more likely to be located within an agglomeration, perhaps reflective of the learning objective of these types of investments or their need for specialized labor. The positive and significant coefficient for number

Table 1 Descriptive statistics and product moment correlations

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.
1. Agglomeration	1.00																	
2. Relative feature size	−0.03	1.00																
3. R&D facility	0.04	−0.08	1.00															
4. Plant capacity	0.03	−0.03	−0.42	1.00														
5. Joint venture	0.18	−0.06	−0.13	0.15	1.00													
6. FDI	−0.08	0.01	−0.15	0.16	0.37	1.00												
7. Headquarters	0.19	0.05	0.18	−0.17	−0.11	−0.37	1.00											
8. Firm experience	0.20	−0.18	−0.06	0.09	0.11	0.19	−0.29	1.00										
9. No. of own plants	0.35	−0.12	−0.09	0.11	−0.04	−0.15	0.01	0.46	1.00									
10. No. of direct rivals	0.23	−0.14	−0.02	0.10	0.04	−0.04	0.10	0.01	0.02	1.00								
11. No. of indirect rivals	−0.06	−0.09	0.06	−0.03	−0.08	−0.05	0.15	−0.09	−0.08	0.25	1.00							
12. Sponsored site	0.02	0.04	0.11	−0.01	0.11	0.04	0.16	−0.19	−0.22	0.16	0.25	1.00						
13. GDP	0.00	−0.09	0.18	−0.25	−0.17	−0.18	0.00	0.07	−0.08	−0.06	0.30	0.13	1.00					
14. GDP per capita	0.09	−0.14	0.11	−0.11	−0.16	−0.08	−0.13	0.26	0.08	0.11	0.24	−0.04	0.67	1.00				
15. Individualism	−0.27	0.00	0.21	−0.26	−0.31	−0.03	−0.11	−0.05	−0.19	−0.21	0.20	0.08	0.75	0.63	1.00			
16. Uncertainty avoidance	0.05	0.07	−0.05	0.07	−0.14	−0.22	−0.03	0.16	0.22	0.02	−0.10	−0.40	−0.35	−0.12	−0.39	1.00		
17. POLCON index	−0.07	0.02	0.06	−0.05	−0.31	−0.21	−0.08	0.16	0.14	0.05	0.04	−0.28	0.05	0.36	0.19	0.67	1.00	
18. GDP volatility	0.08	0.01	−0.05	0.00	0.05	−0.04	0.02	0.02	0.04	−0.04	−0.05	−0.04	−0.12	−0.12	−0.14	0.26	0.02	1.00
Mean	0.45	0.67	0.25	15.85	0.15	0.19	0.42	6.48	13.20	3.74	9.46	0.57	3.33	20.56	58.94	64.70	0.42	0.00
Standard error	0.50	0.69	0.43	11.06	0.36	0.39	0.49	8.60	13.33	5.69	10.70	0.50	2.58	6.71	27.58	24.19	0.14	0.00
Minimum	0	0.07	0	0.06	0	0	0	0	0	0	0	0	0.04	1.21	17	8	0	0.00
Maximum	1	7.23	1	80	1	1	1	44	65	40	50	1	10.83	37.93	91	95	0.71	0.07

Table 2 Logit regression results for full sample

DV: Agglomerate = 1	1.	2.	3.	4.	5.	6.
Constant	−4.14***	−3.85***	−4.33***	−3.46***	−4.82***	−3.68***
	(−4.28)	(−4.15)	(−4.02)	(−3.50)	(−4.88)	(−3.33)
Relative feature size	0.52***	0.48***	0.51***	0.55***	0.50***	0.54***
	(2.51)	(2.46)	(2.46)	(2.62)	(2.39)	(2.62)
R&D facility	0.83***	0.88***	0.82***	0.87***	0.90***	0.98***
	(2.66)	(2.90)	(2.64)	(2.76)	(2.87)	(3.13)
Plant capacity	0.01	0.01	0.01	0.01	0.02	0.01
	(1.10)	(0.72)	(1.10)	(1.15)	(1.27)	(0.91)
Joint venture	2.11***	1.40***	2.11***	1.90***	2.05***	1.29***
	(5.32)	(3.55)	(5.34)	(4.73)	(5.14)	(3.20)
FDI	0.02	0.36	0.05	−0.12	0.29	0.26
	(0.04)	(0.91)	(0.14)	(−0.32)	(0.74)	(0.64)
Headquarters	1.64***	1.50***	1.64***	1.64***	1.72***	1.56***
	(4.91)	(4.74)	(4.92)	(4.89)	(5.12)	(4.80)
Firm experience	0.06**	0.05**	0.06**	0.06**	0.06***	0.05**
	(2.13)	(1.81)	(2.14)	(2.04)	(2.36)	(2.06)
No. of own plants	0.57***	0.54***	0.57***	0.59***	0.58***	0.55***
	(7.08)	(6.75)	(7.06)	(7.14)	(7.15)	(6.72)
No. of direct rival plants	0.14***	0.10***	0.14***	0.14***	0.14***	0.11***
	(4.37)	(3.34)	(4.37)	(4.45)	(4.53)	(3.56)
No. of indirect rival plants	−0.07***	−0.06***	−0.07***	−0.07***	−0.07***	−0.06***
	(−5.23)	(−4.70)	(−5.23)	(−5.20)	(−5.12)	(−4.55)
Sponsored site	0.80***	0.57**	0.82***	0.68***	0.88***	0.48**
	(2.86)	(2.10)	(2.89)	(2.41)	(3.08)	(1.67)
GDP	0.05	0.38***	0.06	−0.01	0.12**	0.29***
	(0.76)	(4.20)	(0.85)	(−0.18)	(1.66)	(2.76)
GDP per capita	0.07***	0.17***	0.07***	0.11***	0.06**	0.22***
	(2.47)	(5.06)	(2.42)	(3.29)	(2.23)	(5.09)
Individualism		−0.07***				−0.07***
		(−6.08)				(−5.09)
Uncertainty avoidance			0.00			−0.01
			(0.40)			(−0.55)
POLCON Index				−3.40***		−2.54*
				(−2.81)		(−1.40)
GDP volatility					760.02***	252.20*
					(3.06)	(1.40)
n	931	931	931	931	931	931
Log likelihood$_{(d.f.)}$	−427.27$_{(19)}$	−406.14$_{(20)}$	−427.19$_{(20)}$	−422.98$_{(20)}$	−419.03$_{(20)}$	−398.19$_{(23)}$

t–statistics are in parentheses.

*$P<0.1$; **$P<0.05$; ***$P<0.01$ (one–tailed tests).

of direct rivals, coupled with the negative and significant coefficient on the number of indirect rivals, implies that firms prefer to collocate with plants that manufacture similar products. Conversely, they avoid agglomerations comprised of dissimilar firms. At first glance these findings might seem surprising, as we might expect firms to avoid locating near competitors due to increased competition and the increased likelihood of outward knowledge spillovers, while seeking collocation with firms that make complementary products. However, taken together, the results imply that there are greater benefits to locating closer to similar firms than dissimilar firms, and agglomerations tend toward specialization by product. Not surprisingly, government-sponsored science parks and special incentives attract firms to agglomerations.

Counter to expectations, experienced firms are more likely to agglomerate. Firms are more likely to agglomerate when building plants in the same city as the corporate headquarters. Firms are also more likely to agglomerate if they have more plants within a nearby agglomeration. Taken together, these results indicate that firms prefer to collocate with themselves, likely in an effort to increase coordination across facilities and to reduce knowledge transfer costs (Martin and Salomon, 2003).

Finally, with respect to macro-level variables, GDP per capita is positive and significant, indicating that firms are more likely to agglomerate in wealthier nations. The effect of absolute GDP is mixed.

Columns 2 through 6 introduce the hypothesized variables. In columns 2 and 3, we add indicators of culture. Consistent with hypothesis 1, we find a negative and significant relationship between individualism and agglomeration—that is, the likelihood of agglomeration increases with collectivism. Hypothesis 2, by contrast, does not receive support. The effect of uncertainty avoidance on agglomeration does not statistically differ from zero. In column 4, consistent with hypothesis 3, firms are more likely to agglomerate in countries characterized by greater political uncertainty (lower POLCON index). Column 5 adds the economic uncertainty measure meant to test hypothesis 4. We find that GDP volatility has a positive and significant impact on agglomeration—that is, firms are more likely to agglomerate in economically volatile environments. Results for the full specification appear in column 6. They are consistent in direction and significance with those in other columns, lending further support to the findings.

The results can be assessed in terms of the economic magnitudes of the hypothesized effects. Marginal effects indicate that a one-point increase from the mean of the individualism score decreases the likelihood of agglomeration by 2%. Similarly, an increase of 0.1 unit in POLCON makes a firm 8.5% less likely to agglomerate. Finally, an increase of 0.001 unit from the mean GDP volatility increases the likelihood of agglomeration by 18.9%. By comparison, only a few of the control variables have stronger unit or standardized effects in terms of economic magnitude, and those (e.g. joint venture, number of own firm plants in a nearby agglomeration,

and firm headquarters located in a nearby agglomeration) all reflect well-understood factors in deciding to agglomerate.[9]

6. Additional analyses

We perform a series of additional tests to assess our predictions with alternative measures and to compare these measures as they pertain to our research question. First, we assess alternative measures of the individualism/collectivism dimension. Several scholars have criticized Hofstede's sample frame of IBM employees (Triandis, 1982; Lytle *et al.*, 1995). Alternative proxies of culture have since validated or extended Hofstede's work, which was first published in 1980. The Schwartz (1994) measures are the most prominent among these. Using a sample of schoolteachers and college students from 67 nations, Schwartz (1994) validated two orthogonal constructs related to individualism/collectivism, labeled autonomy and conservatism.[10] Autonomy refers to cultures in which individuals are encouraged to think independently and to pursue individual goals. Conservative cultures value group connections, social relationships, shared goals, social order, and traditions. Given their conceptual complementarity to Hofstede's scale, these measures provide a useful robustness test. The correlations between the Schwartz and Hofstede measures ($\rho = 0.61$) suggest conceptual consistency (Schwartz, 1994, 2004). If the theory underlying hypothesis 1 is correct, a strongly autonomous national culture should encourage firms to disperse rather than to agglomerate, while a strongly conservative culture should encourage agglomeration. Therefore, in Table 3, we re-estimate the individualism/collectivism results from column 2 in Table 3 using Schwartz's (1994) autonomy and conservatism measures instead of the single Hofstede scale.[11]

Column 1 introduces the effect of conservatism. Because greater values represent a more conservative culture, the positive and significant coefficient confirms our prior results. Column 2 introduces the measure of autonomy. The coefficient is negative and significant, as expected. Since the Schwartz (1994) and Hofstede (2001) measures are the most proven measures related to individualism/collectivism (Koen, 2005), the results provide very consistent support for this effect on agglomeration. Unfortunately, no similar measure is available to verify the result pertaining to uncertainty avoidance (Koen, 2005).

[9] Although not shown here, marginal effects tables are available from the authors upon request.

[10] Conservatism was relabeled *embeddedness* in Schwartz (2004).

[11] Hofstede (2001) provides data for 29 of the countries in our sample. By contrast, Schwartz's (1994) data are only available for 18 countries. The sample therefore decreases from $n = 931$ to $n = 835$. The results reported above do not change when we use the Hofstede (2001) measures on the smaller sample.

Table 3 Logit regression results for Schwartz measures

DV: Agglomerate = 1	1.	2.
Constant	−17.43***	6.48**
	(−4.86)	(2.19)
Relative feature size	0.71***	0.71***
	(3.09)	(3.07)
R&D facility	1.03***	1.02***
	(3.05)	(3.01)
Plant capacity	0.01	0.02
	(1.07)	(1.19)
Joint Venture	1.70***	1.66***
	(4.04)	(3.94)
FDI	0.37	0.33
	(0.91)	(0.81)
Headquarters	1.66***	1.71***
	(4.73)	(4.84)
Firm experience	0.07***	0.07***
	(2.63)	(2.48)
No. of own plants	0.56***	0.55***
	(6.42)	(6.38)
No. of direct rivals	0.11***	0.12***
	(3.34)	(3.43)
No. of indirect rivals	−0.06***	−0.06***
	(−4.30)	(−4.46)
Sponsored site	0.31	0.35
	(1.02)	(1.16)
GDP	0.00	0.00
	(0.15)	(−0.48)
GDP per capita	0.09***	0.10***
	(2.89)	(3.03)
Conservatism	3.29***	
	(4.00)	
Autonomy		−1.39***
		(−3.69)
n	835	835
Log likelihood$_{(d.f.)}$	−385.41$_{(20)}$	−386.29$_{(20)}$

t–statistics are in parentheses.

*$P<0.1$; **$P<0.05$; ***$P<0.01$ (one–tailed tests).

Second, we re-estimate models using alternative proxies for political (and to some extent economic) uncertainty from three sources. The first of these is the CHECKS index from the Database of Political Institutions. The CHECKS index counts the number of veto players in a political system, adjusting for political cohesiveness (Beck *et al.*, 2001; Keefer and Stasavage, 2003). As such, it captures the overall level of political volatility within a country. The results are in column 1 of Table 4. As with POLCON, the findings for the CHECKS index indicate that firms are more likely to agglomerate in more politically volatile countries.

The second source of alternative measures comes from La Porta *et al.* (1998) (hereafter LLSV). LLSV argued that features of a country's legal system impact political and economic stability, and thereby corporate governance. We focus on three specific measures from LLSV that are germane to our context: efficiency of the judicial system, rule of law, and corruption.[12] If the intuition underlying hypotheses 3 and 4 regarding political and economic uncertainty is correct, we should expect firms to agglomerate in countries in which the judicial system is inefficient, in those without a longstanding tradition in rule of law, and in those that exhibit greater levels of corruption.[13]

Given the high correlations among the three dimensions (0.67, 0.85, and 0.79, respectively) described by LLSV, we introduce these variables separately in columns 2–4 of Table 4. Consistent with our theory, firms are more likely to agglomerate when the legal system is less efficient and more prone to corruption. The effect for the rule of law measure is directionally correct, but statistically insignificant.

A third set of measures of political uncertainty that we assess is from Kaufmann *et al.* (2006), who measured six features of institutions: participation in government by the people (voice and accountability), the likelihood that a government could be overthrown (political stability), the quality of government services (government effectiveness), the efficiency of government policy (regulatory quality), the effectiveness of the legal system (rule of law), and the degree of corruption (control of corruption). If political and economic uncertainty impacts agglomeration as Hypotheses 3 and 4 suggest, we would expect firms to be less likely to agglomerate

[12]Although LLSV measure 23 features of a country's legal system, many of them relate to corporate governance rather than political and economic institutions. For example, constructs include creditor rights, mandatory dividend, proxy by mail, etc. Efficiency of the judicial system, rule of law, and corruption are the three constructs most closely related to macro-level political and economic uncertainty.

[13]We lose two observations (one country) when using the CHECKS data. The LLSV data cover fewer countries (23), so that sample size decreases from $n = 931$ to $n = 889$. Again, the results from Table 2 do not change when we run these models on the smaller samples from Table 4.

Table 4 Logit regression results for Beck *et al.* (CHECKS) and La Porta *et al.* (LLSV) measures

	Panel 4a: CHECKS	Panel 4b: LLSV		
DV: Agglomerate = 1	1.	2.	3.	4.
Constant	−4.03***	−5.11***	−5.56***	−1.51
	(−4.10)	(−3.20)	(−2.90)	(−0.90)
Relative feature size	0.55***	0.50***	0.51***	0.52***
	(2.67)	(2.34)	(2.40)	(2.58)
R&D facility	0.87**	0.78***	0.82***	0.84***
	(2.76)	(2.44)	(2.59)	(2.70)
Plant capacity	0.01	0.01	0.01	0.01
	(1.02)	(0.95)	(1.00)	(0.84)
Joint venture	2.01***	2.00***	2.05***	1.88***
	(4.97)	(4.81)	(4.94)	(4.59)
FDI	0.07	−0.05	−0.09	0.12
	(0.09)	(−0.12)	(−0.23)	(0.31)
Headquarters	1.69***	1.84***	1.81***	1.73***
	(5.04)	(5.31)	(5.23)	(5.22)
Firm experience	0.06**	0.05**	0.06**	0.04*
	(2.29)	(1.82)	(1.91)	(1.54)
No. of own plants	0.58***	0.56***	0.57***	0.52***
	(7.17)	(6.82)	(6.94)	(6.50)
No. of direct rivals	0.13***	0.14***	0.14***	0.13***
	(4.24)	(4.29)	(4.58)	(3.96)
No. of indirect rivals	−0.07***	−0.07***	−0.06***	−0.06***
	(−5.24)	(−4.82)	(−4.76)	(−4.56)
Sponsored site	0.83***	0.64**	0.67***	0.53**
	(2.93)	(2.26)	(2.34)	(1.89)
GDP	0.00	−0.02**	−0.01*	−0.03***
	(0.67)	(−1.66)	(−1.35)	(−2.76)
GDP per capita	0.09***	0.25***	0.21***	0.38***
	(3.08)	(3.57)	(3.18)	(4.91)
CHECKS Index	−0.20**			
	(−2.15)			
LLSV legal efficiency		−0.30*		
		(−1.48)		
LLSV rule of law			−0.15	
			(−0.58)	
LLSV corruption				−1.09***
				(−4.22)
n	929	889	889	889
Log likelihood$_{(d.f.)}$	−422.57$_{(20)}$	−399.47$_{(20)}$	−400.41$_{(20)}$	−391.22$_{(20)}$

t–statistics are in parentheses.

*$P<0.1$; **$P<0.05$; ***$P<0.01$ (one–tailed tests).

when the government and its policies are more accountable, stable and efficient; the legal system is more effective; and corruption is lower.[14]

Because the six variables are highly correlated (between 0.61 and 0.93), we introduce them separately in Table 5. Except for political stability and rule of law, each has a negative and significant coefficient. Since greater values represent less uncertainty, the results imply that firms tend to agglomerate when the political and economic environment is less stable and efficient. This is consistent with our theory.

Taken together, the results presented in Tables 4 and 5 corroborate the finding from Table 2 whereby political and economic uncertainty encourages firms to agglomerate. Only 3 of 12 variables examined are not supported: political stability and rule of law (Kauffman *et al.*, 2006), and rule of law (LLSV). Although the rule of law measures are not significant, they are directionally consistent with the underlying theory. Overall, then, the additional analyses broadly indicate that firms change their agglomeration behavior across institutional contexts as assessed via multiple measures.

7. Sensitivity and robustness

To assess the sensitivity and robustness of the results, we tested several variants of the models presented herein.[15] First, because the sample is comprised of both domestic and foreign firms (81% and 19% of the sample, respectively), we assessed whether foreign firms were impacted differently than domestic firms by the institutional context of the country in which firms made their plant investments. It could be, in particular, that the political interests of foreign firms differ substantively from the political interests of domestic firms, thereby impacting differentially their propensity to agglomerate. To test this possibility, we examined models with interactions between the institutional variables and the FDI ownership variable. We also ran results separately for the sub-samples of domestic and foreign firms. With both approaches, the results suggest that the institutional context affects foreign and domestic firms similarly.

Second, above we define agglomerations based on a cutoff of 60 miles. We tested the sensitivity of the results to alternative agglomeration cutoffs at 10, 40, 100, and

[14]The Kaufmann et al. (2006) measures are available from 1996 to 2005. To preserve data fidelity, we truncated our sample to match those years. In table 6, we therefore report results for the subsample of observations from 1996 to 2004 ($n = 266$). Although not reported, we also extrapolated these measures from 1995 to 1970 to run models on the full range of our sample. The results were robust.

[15]All results discussed in this section are available from the authors upon request.

Table 5 Logit regression results for Kauffman *et al.* (WB) measures (1996–2004)

DV: Agglomerate = 1	1.	2.	3.	4.	5.	6.
Constant	−4.97***	−1.36*	−2.14**	−2.29***	−2.15**	−2.83***
	(−2.88)	(−1.47)	(−2.25)	(−2.32)	(−2.05)	(−2.64)
Relative feature size	0.62*	0.37	0.42	0.43*	0.40	0.40
	(1.53)	(1.14)	(1.26)	(1.32)	(1.22)	(1.21)
R&D facility	0.85*	0.50	0.61	0.66	0.56	0.60
	(1.45)	(0.96)	(1.17)	(1.28)	(1.08)	(1.15)
Plant capacity	−0.01	−0.01	−0.00	−0.00	−0.01	−0.01
	(−0.51)	(−0.48)	(−0.13)	(0.00)	(−0.54)	(−0.40)
Joint venture	2.21***	2.21***	2.24***	2.23***	2.17***	2.16***
	(3.73)	(4.29)	(4.47)	(4.41)	(4.20)	(4.19)
FDI	−0.79*	−0.59	−0.42	−0.46	−0.58	−0.39
	(−1.40)	(−1.23)	(−0.87)	(−0.94)	(−1.20)	(−0.79)
Headquarters	0.58	0.63*	0.56	0.58*	0.61*	0.54
	(1.11)	(1.38)	(1.22)	(1.29)	(1.34)	(1.18)
Firm experience	0.00	0.01	0.00	0.00	0.01	0.00
	(−0.11)	(0.31)	(0.09)	(0.09)	(0.39)	(0.20)
No. of own plants	0.67***	0.59***	0.57***	0.56***	0.57***	0.55***
	(4.12)	(4.34)	(4.32)	(4.27)	(4.29)	(4.10)
No. of direct rivals	0.15***	0.14***	0.15***	0.14***	0.14***	0.14***
	(3.66)	(3.83)	(4.00)	(4.00)	(3.83)	(3.74)
No. of indirect rivals	−0.03**	−0.04***	−0.04***	−0.04***	−0.04***	−0.04***
	(−1.97)	(−2.76)	(−2.56)	(−2.56)	(−2.69)	(−2.61)
Sponsored site	0.10	0.63*	0.60*	0.62*	0.46	0.52*
	(0.22)	(1.57)	(1.50)	(1.56)	(1.15)	(1.30)
GDP	−0.03***	−0.00	−0.01**	−0.01*	−0.01*	−0.01**
	(−2.35)	(−0.50)	(−1.91)	(−1.58)	(−1.49)	(−1.84)
GDP per capita	0.15***	0.00	0.12***	0.11**	0.10*	0.15***
	(2.80)	(0.00)	(2.46)	(2.13)	(1.49)	(2.60)
WB voice and accountability	−2.82***					
	(−2.99)					
WB political stableness		0.67				
		(1.06)				
WB government effectiveness			−1.17**			
			(−2.31)			
WB regulatory quality				−1.25**		
				(−1.87)		
WB rule of law					−0.81	
					(−1.17)	
WB control of corruption						−1.26***
						(−2.46)
n	266	266	266	266	266	266
Log likelihood$_{(d.f.)}$	−109.41$_{(15)}$	−118.15$_{(15)}$	−115.87$_{(15)}$	−118.15$_{(15)}$	−118.02$_{(15)}$	−115.44$_{(15)}$

t–statistics are in parentheses.

*$P<0.1$; **$P<0.05$; ***$P<0.01$ (one–tailed tests).

150 miles. We also explored models in which we varied the definition of an agglomeration based on the size of the country by applying cutoffs of 10, 60, and 100 miles for countries with land masses of less than 100,000 km^2, 100,000 to 1 million km^2, and greater than 1 million km^2, respectively. The results across specifications were largely similar to those presented herein.

Third, in this study we rely on retrospective data from the International Fabs on Disk database. While this data source is authoritative in its historical and geographic coverage, there remains a possibility that data for older plans are not as reliable as data for more recent plants, especially with respect to the technologies being used at the plants. Because semiconductor plants are highly customized to the products they are meant to produce, it is relatively rare for a plant to be retrofitted to make semiconductors of a different feature size (Malerba, 1985). Each plant generally uses a single generation of technology for the duration of its useful life. Nevertheless, we undertook several steps to verify that the results are not an artifact of noisy data. We first examined the average feature size (line-width of the conducting channel on the wafer) reported in the IFOD data over time. We found that the average feature size decreases predictably over time. This is consistent with priors in that older plants have larger feature sizes—i.e. more dated technology. Second, we examined the sensitivity of our results by limiting our sample to recent plants. We first truncated the data from the years 1998 to 2004, a period for which we have access to each year's worth of updated data (including all new plant investments). The results were consistent with those that we present in the manuscript, and stronger in economic magnitude. We likewise corroborated the results while truncating the sample at 1980 and 1990.We therefore conclude that whatever bias might occur due to inaccurate data is likely to be negligible.

Finally, although tolerance statistics indicate that multicollinearity is not a concern for the overall model, there remains a substantial correlation between FDI and joint ventures. This correlation is not altogether surprising, as many scholars find a positive relationship between foreign investment and joint ventures, as firms investing abroad will often engage a partner to reduce the liability of foreignness (e.g. Martin and Salomon, 2003). Nevertheless, it is possible that the relationship between FDI and agglomeration is being masked by the underlying covariance between FDI and joint venture. To explore this possibility, we ran results including the joint venture variable while excluding the FDI variable, and vice versa. Although the joint-venture variable was positive and significant irrespective of the specification, we found a weakly positive and significant effect for FDI when we excluded the joint-venture variable. Therefore, to the extent that the FDI result is being masked by the joint-venture status of the plants, that is, because the FDI effect is driven by the fact that many such plants are joint ventures. Nevertheless, regardless of the specification (excluding joint venture or FDI), the results on the institutional variables of interest do not change.

8. Discussion and conclusion

This study focused on the impact of the cultural, political, and economic institutional environment on the agglomeration pattern of firms across countries. In general, we find evidence consistent with our hypotheses, as country-specific institutional heterogeneity significantly impacted agglomeration. Specifically, we find that firms are more likely to agglomerate in countries characterized by collectivist cultures and political/economic uncertainty.

The findings from this study hold several important implications for research and practice. First, this work represents the first cross-country comparative study of its kind, and the first to demonstrate that agglomeration patterns vary systematically across countries. Work of this kind is sorely needed to advance our understanding of collocation, agglomeration, and clusters. Our findings also show which dimensions of the institutional context matter to firm agglomeration. A collectivist national culture encourages agglomeration while one of individualism discourages it. Likewise, our results indicate that agglomeration decisions are made as strategic responses to political and economic uncertainty. Thus, firms are proactive in adapting to these dimensions of the institutional environment. Taken together, these results indicate that the institutional environment is an important determinant of agglomeration, and one that deserves more attention in its cultural, political, and economic dimensions alike.

Second, we also show that technology, firm, and market characteristics are important determinants of agglomeration. We demonstrate that relative technological standing impacts agglomeration. We highlight potential tradeoffs that firms make with respect to competition with rivals versus coordination with their own facilities. We show that firms balance learning via R&D-oriented facilities with the potential for outward technological spillovers to rivals. We also highlight the influence of external parties on agglomeration—in the context of joint ventures, and in seeking sites sponsored by host governments. We do this while controlling for market and infrastructure characteristics that economic geographers suggest are important determinants of location decisions.

Finally, while most empirical studies of agglomeration use data from a single economy, we use cross-country panel data. Moreover, we use a time-varying measure of agglomeration. We are therefore afforded richer insight into the antecedents of agglomeration than heretofore existed in the literature.

Several caveats apply to the findings. First, although our results document associations between the institutional characteristics of countries and agglomeration patterns, the causation cannot be inferred to run only from institutional context to agglomeration. In developing our arguments we treated institutional characteristics as primarily exogenous; however, institutional environments are subject to change over time, and with industrial development (North, 1981; Künneke, 2008). For example, increasing globalization and the associated movement of capital, goods,

services, and people can lead to changes in the cultural, political, and economic environments of countries (Ingelhart and Baker, 2000; Zweynert, 2009). While the decision to agglomerate or not within a given country does not generate such transnational flows *per se*, it may facilitate spillovers such that the abovementioned influences are stronger in some instances. In that general sense, and given the importance of transmission mechanisms in cultural change (Bowles, 1998), we can therefore not rule out the possibility that agglomeration contributes to macro-institutional change. That said, we follow a well-established tradition in the literature that treats institutions as exogenous (at least to the individual firm in the short run) and demonstrates how institutional characteristics impact various economic outcomes such as market growth, industrial development, and national/regional competitiveness (e.g. Zysman, 1994; Porter, 1998; Guiso, Sapienza and Zingales, 2006). Moreover, the slow-changing nature of institutions (see Ingelhart and Baker, 2000; Guillén, 2001; Hofstede, 2001) implies that our interpretation is cogent.

Second, and related to the abovementioned caveat, our measures of culture are not time varying. This is certainly a data limitation; however, as Hofstede (2001) and others point out, national cultures (even more than political and economic institutions) remain relatively stable over time. And just like firm adaptation varies across institutional factors (see also Cuypers and Martin, 2010), the extent to which each type of institution—and its business manifestations—is influenced by economic developments may vary. But again, institutional change occurs in an expectedly slow fashion (Koen, 2004). Nevertheless, research that compares and contrasts the effects of agglomeration on the evolution of various national institutions, over an adequately long timeframe, could complement the research presented here.

Third, our data are limited to the semiconductor industry. To the extent that agglomeration patterns are idiosyncratic to this industry, our results may not be as informative for other industries. Fourth, although we controlled for industrial parks and known special location incentives, we lacked information regarding unannounced agreements between local governments and individual firms. Firms might make location decisions because of such unobserved incentives as well as because of the institutional factors we study here. Finally, our empirics do not explain the creation of agglomerations (e.g. Krugman, 1991). Nevertheless, we extend the literature on agglomeration formation (e.g. Perez-Aleman, 2005) while highlighting the tension between forces that encourage and discourage firm agglomeration given local conditions.

Our results suggest several other research extensions. First, if we assume that location decisions are ultimately tied to performance, future research could link agglomeration, fit with the institutional environment, and performance. All else equal, we would expect firms that agglomerate in countries with more collectivist cultures and in countries characterized by economic and political uncertainty to

perform better. Second, as a comparative study of agglomeration across countries/institutional environments, the sample comprised largely of plant investments made by domestic firms. An interesting extension could isolate the smaller subsample of foreign investments to examine further determinants of their agglomeration decisions. In contrast to domestic firms, foreign entrants are from nations where the institutional environments often differ from those in the host country. The question then is whether foreign firms, in deciding whether to agglomerate, adapt to those forces in host country, or preserve patterns of behavior exhibited in their home country.

Our analyses demonstrate the importance of institutional conditions on agglomeration. We hope others will follow in exploring the interplay between institutions and location. Given the theoretical importance of these issues and the significance of our findings with a variety of institutional measures, further conceptual and empirical research in this area is well warranted.

Acknowledgments

Xavier Martin's research was funded by the CentER for Economic Research and the Center for Innovation Research at Tilburg University. Robert Salomon's research was funded by The Center for Japan-US Business and Economic Studies. Zheying Wu's research was funded by the Marshall School of Business at the University of Southern California and by the CentER for Economic Research at Tilburg University. We appreciate helpful comments from Paul Adler, Pino Audia, Daniel Beunza, Joel Brockner, Aaron Chatterji, Richard D'Aveni, Peer Fiss, Vijay Govindarajan, Robert Hanson, Connie Helfat, Sheena Iyengar, Mark Kennedy, Bruce Kogut, Kyle Mayer, Margie Peteraf, Nandini Rajagopalan, David Ridley, Scott Rockart, Myles Shaver, Stephen Tallman, Alva Taylor, Charles Williams, Bernard Yeung, Bennet Zelner, Feng Zhu, and seminar participants at Columbia, Dartmouth, Duke, NYU, and USC. All remaining errors are our own.

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