

THE GEOGRAPHIC COMPONENT OF PRODUCTION TECHNOLOGY

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ABSTRACT

In today's global economy manufacturing companies are continuously re-evaluating their location. In many instances companies decide to relocate some or all of their manufacturing activities to so called low labor cost countries. However, the perception that this is cost effective is not always correct. In many instances the costs of producing in low labor cost countries are highly under estimated. In some instances the costs of the production alone, i.e. excluding logistics cost, are already higher than producing in so called high labor cost countries. Previous research suggests that some of the reasons for these higher costs are related to the particular geographic environment. This study is focused on increasing our understanding of the relationship between geographically determined factors and production technology. Understanding the relationship between geographical factors and production factors allows insight into production location and companies may learn to avoid wrongly moving production away from the developed, high labor cost, countries. For governments; knowledge on geographically determined factors places governments in a better position to selectively nurture specific industries based on their geography-production technology relationship.

Keywords: Production technology, location, operations strategy, international operations

1. INTRODUCTION

A major concern to developed countries, e.g. the United States, is the continued trend of businesses outsourcing some of their activities to other countries. The concern is that jobs are leaving and this does not only refer to blue-collar jobs but also relates to white-collar jobs (Engardio et al., 2003). The general perception is that these activities are transferred to low labor cost countries because due to the wage differences it is less costly to produce in those countries. However, this perception of lower cost is not always correct. Baranson (1967: 83), Van Hasselt et al. (1977) and the U.S. International Trade Committee (1998: 5-12) illustrate that moving manufacturing to low labor cost countries may lead to an increase in production cost instead of decrease.

The reason why production costs are perceived to be lower can be found in economic (trade) theories. Theories such as absolute advantage, comparative advantage and the abundance

of input factors mostly explain international trade and movement of production by assuming that this movement occurs because of rational reasons, i.e. cost is the explaining factor (Dunning, 1991; Harris, 1992). However, this may not be a justified assumption, since, not all international production takes place primarily because of economic considerations Ferdows (1997). Also, Markides and Berg (1988) argued that it is not always beneficial for companies to move manufacturing offshore, and the mere fact that a lot of companies are doing it doesn't make it smart.

Knowing that total manufacturing cost may in certain cases actually be higher in low labor cost countries poses the question in which situations is it better for a company to retain production in the United States? And, in which situations is it better to outsource its production? Are there situations in which it is better for companies from low labor cost countries to move production to the United States? If production is retained in the United States, are there specific geographic locations within the United States that are more or less suitable for a particular type of production? What can (local) governments do to increase the attractiveness of their location so that companies become more internationally competitive?

We are addressing these issues by studying the geographic elements that contribute to the performance of a production technology. Understanding the linkage of geographic elements with the performance of production technology contributes to our understanding in three ways. It contributes to a better understanding of international technology or the initiating of new businesses overseas, which is required since Benito (1997) showed that more than half of a given stock of foreign direct investment was divested within a period of ten years. It aids the company location decision by potentially leading to the identification of performance factors that may not previously have been considered. It also aids regional development offices in their efforts for economic development, including attracting certain types of businesses. The purpose of this paper is to discuss the current literature to 1) identify gaps and 2) to help develop the methodology for an empirical study.

2. LITERATURE REVIEW

There are several sources of literature that contribute to the understanding of geographical elements that may help, or hinder, the performance of a production technology, i.e. a production plant. There is a wide range of publications that look at the location of companies, i.e. where do companies locate and why, which is relevant because it provides factors that influence the location decision. Since these decisions involve (expected) performance as well as geographic elements, it is essential for our purpose. Also, there is literature that has studied the influence of geographical factors on performance. Some of these focused on the performance of companies, others on the performance of regions and the importance of clusters. Figure 1 provides an overview of the different perspectives from the literature.

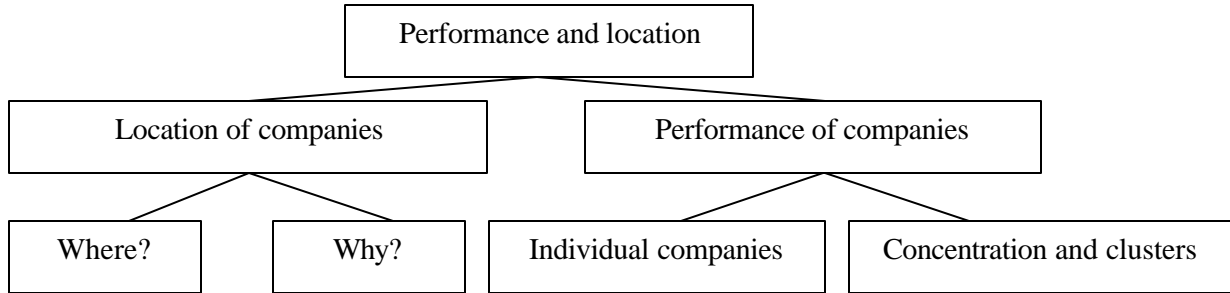


Figure 1. Overview of perspectives found in the literature

These different strands of literature should, at least theoretically, show consistent results, i.e. locational factors. Figure 2 shows their relationship. A company examines locational factors when considering a new location. These important locational factors are probably related to an estimated performance. For example, being close to customers saves on transportation costs which ultimately affect a company’s performance. Furthermore, even subjective factors should be considered as stated by Zimmer in (Browning, 1980: ix) “...the primacy of the so-called “subjective” factors in a real estate decision becomes clearer – factors like the quality of schools, parks, police and fire protection, recreational facilities, and other resources available in a new community. Such factors, difficult to measure, aren’t supposed to affect the bottom line, but every manager knows they do.” After the company is located in the new location, the ‘real’ performance takes place and (geographic) factors that influence the performance can be identified. Ideally, the factors identified at this stage should also have been included in the factors that the company considered when it made its location decision. Based on the performance of a group of companies, certain regional factors may be identified that for example aid the development of clusters or concentrations which may lead to economic agglomeration effects. For example, Ellison and Glaeser (1997: 891) identified physical spillovers, intellectual spillovers and natural advantages as agglomerative forces. These factors, if they appear, affect individual business performance and hence should be part of the initial location decision.

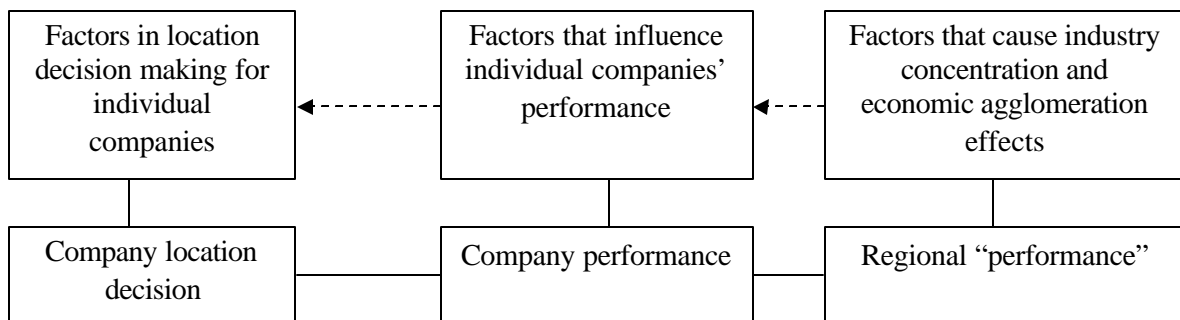


Figure 2. Overview of theoretical linkages

This paper is focused on the first block in figure 2, i.e. it is aimed at understanding the business location decision. The studies that look at why firms locate where they do can be divided into two groups according to Blair and Premus (1987) and Martin, McHugh and Johnson (1993); a group that has studied location decisions primarily by asking companies how they make their decisions, e.g. through surveys on factors, and a group that has studied location decisions

primarily through econometric studies on the actual location of companies. In this paper, another approach is followed. We will distinguish between the decision making process (section 3) and the locational factors that are being considered in this process (section 4) because this allows a better in-depth insight into how and why the location decisions are made.

3. LOCATION DECISION PROCESS

Several studies have emphasized the process of the location decision. Roughly speaking, the process can be very different in different situations. Mazzarol and Choo (2003) studied factors in the location decision making process, in particular the purchase or leasing of operational facilities. They state that depending on the size of the organization, the buying behavior may involve a multi-phase, multi-person, multi-departmental and multi-objective process. Factors that influence the decision makers' buying behavior are risk and the role of the participants. The roles can be "user", "buyer", "influencer", "decider" and "gatekeepers" (Mazzarol and Choo, 2003).

Decker and Crompton (1993) identified the process by which business location decisions are made in footloose industries (including manufacturing) in contrast with traditional manufacturing industries. Decker and Crompton (1993: 69) define footloose as "The footloose companies are those that have relatively few constraints when making location decisions"¹. They focus on footloose companies because these companies, precisely because they are footloose, can be targeted by communities to attract them. Decker and Crompton (1993) developed a location decision making model based on the literature, unstructured in-depth telephone interviews and a survey of company executives, company relocation consultants and economic development personnel. These telephone interviews and survey were conducted in the State of Texas. Their model contains four phases, see figure 3.

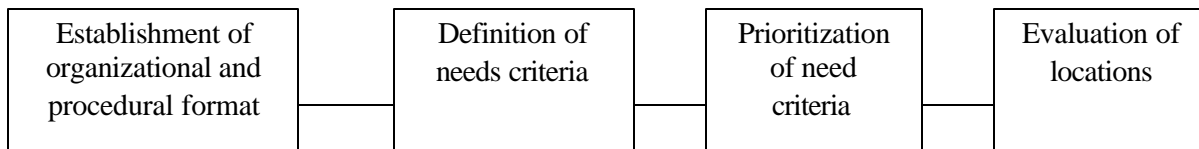


Figure 3. Location decision process, adapted from (Decker and Crompton, 1993)

First, the establishment of an organizational and procedural format. In this phase, the role of relocation consultants and the process by which the final decision will be made is determined. Second, the definition of needs criteria for the type of business. In this phase Decker and Crompton distinguish four types of footloose industries, i.e. headquarters, high technology, research and development and services. These four types of industries have different requirements. Third, the prioritization of need criteria. The most frequently adopted approach to prioritizing the multitude of need items which may be considered in a location decision is to designate certain of them as "must" conditions and others as "wants", i.e. desirables. Fourth, the evaluation of locations and the recommendation of the best location. Company executives and relocation consultants are likely to possess an "awareness set" of locations. This set appears t

¹ Premus (1982) provides additional insight into this definition. He describes high technology companies as footloose in that access to raw materials, access to markets and transportation are not major locational determinants. Nor are factors such as water resources, energy supplies, and climate important determinants of the location of high technology companies (Premus, 1982: 16).

meet “musts” and primary “wants” satisfactory. In most cases, not all the locations included in this initial awareness set will be good options for the company once they are subjected to detailed scrutiny. The locations which emerge after the initial screening are termed “evoked set”. Typically between two and six locations receive in-depth consideration. The length of the overall process varied from one month to almost 4.5 years from the time a decision was made to move until the final selection of a location was made (Decker and Crompton, 1993). They found that economic development personal had several misconceptions about the location decision process and that the most important sources of information were personal sources and colleagues rather than for example economic development organizations. Similarly, Blair and Premus (1987: 83) note: “The effectiveness of specific subsidies or locational incentives has not been shown to be a particularly significant variable although incentives have been included in some measures of fiscal climate. The lack of strong econometric and survey evidence contrasts with the opinions of many policymakers that some development incentives are essential for a successful job creation effort. Perhaps the varieties of incentives are too complex to be captured by the econometric models or perhaps they are so widely offered that they cancel out”.

Blair and Premus (1987) describe a similar process as Decker and Crompton (1993). However, they add another important distinction in the decision making process. Blair and Premus (1987) state that the location decision is made sequentially for large, multi-plant companies. The first stage is rather broad, i.e. seeking a general region in which to locate. A subsequent stage has a more micro-focus, i.e. the selection of a specific community and site. This means that different factors are involved in the different phases of the decision making process. For the broad, i.e. state or region, choice, factors such as labor, state tax variables, climate, proximity to markets, and other features that may have significant interregional variation but are similar almost everywhere within a region are considered. Later, micro-factors such as land costs, access to major roads, and schools are considered. This has important methodological consequences because it means that a distinction has to be made between intraregional locational factors and interregional locational factors. Premus (1982: 18) makes similar observations.

4. LOCATION DETERMINANTS

In this section, several studies will be discussed to highlight important findings in the literature. For each study, the underlying methodology will be highlighted so that an understanding can be reached about the validity of the results and in which situations they apply.

Browning (1980) provides information about locational factors for different types of companies. This information was collected through a survey which, among other things, combined the type of company with 14 locational factors. Respondents had to rate the importance of these factors on a scale from 1 to 4. The respondents included companies that were relocating, acquiring or building new or additional facilities. Browning (1980) did not provide information on the current location of these businesses or which new locations they were considering. Also, no distinction was made between relocating or expanding decisions. Browning (1980: 58) showed that the factors being considered for the location decision differ for manufacturing plants, distribution centers, regional divisional offices, R&D facilities and corporate headquarters. Table 1 provides an overview of the five most important factors for each type, out of a potential 14 factors.

These types of distinctions are also made elsewhere for example by Jarboe (1986) who distinguishes high-technology from manufacturing. Jarboe (1986) interviewed 46 high technology firms in the Ann Arbor, Michigan, USA area to determine the why companies had

originally located in the Ann Arbor area and what they liked and disliked about the area. The interviews were open-ended, with top management. The firms represented several different high technology industries although it must be noted that Jarboe did not define high technology but relied on staff of the Michigan Technology Council's judgment as to what constitutes "high technology" (Jarboe, 1986: 119). The firms were generally small, rapidly growing, new companies with a large percentage of their personnel devoted to research and development activities. Almost 80% of the firms were founded by people with roots in the Ann Arbor area and almost 70% of the firms did not look at sites outside of the area when they decided upon their current location. Jarboe (1987: 124) notes that small, newly created firms are generally limited in their site selection process to nearby locations.

Table 1. Locational factors adapted from (Browning, 1980)

Rank	Manufacturing plant	Distribution center	Regional divisional office	R&D facilities	Corporate headquarters
1	Availability of labor	Highway facilities	Air transport facilities	Availability of executive/professional talent	Air transport facilities
2	Availability of fuel/energy	Accessibility to established markets	Highway facilities	Air transport facilities	Highway facilities
3	Highway facilities	Accessibility to new markets	Availability of executive/professional talent	Highway facilities	Availability of executive/professional talent
4	Accessibility to established markets	Availability of labor	Accessibility to established markets	Availability of labor	Availability of energy/fuel
5	Availability of raw materials	Availability of energy/fuel	Accessibility to new markets	Availability of energy/fuel	Availability of labor

Premus (1982) also studied the location decision of high technology companies. He defined high technology companies by Standard Industrial Classification code based on labor-intensity, science-based, or R&D inputs. Premus (1982) surveyed high technology companies through a questionnaire which addressed factors that influence the location decision as well as where the companies were located and about their expansion plans. Premus (1982) distinguishes between regional factors and within regional factors. Table 2 provides an overview. The rating is based on the percentage of respondents that rated the factor significant or very significant (as opposed to somewhat significant or no significance). With regard to availability of workers for within region location, a ranking occurred within this category: technical (96.1%), skilled (88.1%), professional (87.3%), and unskilled (52.4%).

Table 2. Locational factors for high technology companies adapted from (Premus, 1982)

Rank	Regional location choice	Within region location choice
1	Labor skills/availability	Availability of workers
2	Labor costs	State and/or local government tax structure
3	Tax climate within region	Community attitudes towards business
4	Academic institutions	Cost of property and construction
5	Cost of living	Good transportation for people
6	Transportation	Ample area for expansion
7	Access to markets	Proximity to good schools
8	Regional regulatory practices	Proximity to recreational and cultural opportunities
9	Energy costs/availability	Good transportation facilities for materials & products
10	Cultural amenities	Proximity to customers
11	Climate	Availability of energy supplies
12	Access to raw materials	Proximity to raw materials & component supplies
13	-	Water supply
14	-	Adequate waste treatment facilities

Mazzarol and Choo (2003) found that there were significant differences in factors based on firm size for location-factor influencers of proximity to customers, freight terminals and the owner or manager's home. Smaller firms placed significantly more importance on proximity to customers and the manager's home. By contrast, larger firms placed significantly greater importance on proximity to freight terminals. Mazzarol and Choo (2003: 191), using Decker and Crompton's (1993) definition, state that large firms tend to be footloose. It must be noted that they focused on one geographical location and did not distinguish between different types of industries.

Anderson and Johnston (1992) connect company factors with regional performance factors, see figure 2. They demonstrate a practical methodology for identifying industries that should be attracted to a state for its existing markets and/or available supplies. Essentially, Anderson and Johnston (1992) use an input-output table, i.e. a matrix that shows how much one local industry contributes to another local industry by forward or backward linkages, and by making specific choices on the importance of the linkages they illustrate why certain industries should be attracted to a state due to the benefits of locating near suppliers and/or customers.

5. CONCLUSIONS

Based on the above literature discussion, it is evident that it is not possible to rely on a simple relationship between the location decision process and the geographic performance, which has implications for methodological choices. The discussion focused on geographical performance indirectly by looking at factors that are being considered by companies in their location decision.

The literature on the decision making process showed that this process is by no means standardized. It is at the very least dependent on the size of the company and the number of people involved. It is also important to realize that early on, the process may be about selection a state or region while later on it may be about selection a precise location. This involves different factors. In manufacturing oriented companies, the main locational factors seem to be labor availability and access to raw materials and markets.

However, it was illustrated that the factors being considered in the location decision vary depending on the methodology which was applied and no two studies reveal identical findings due to the potpourri of approaches (Blair and Premus, 1987: 72).

Interestingly, the factors identified in the literature do not include factors such as local working conditions and communication infrastructure. The latter were, for example, identified by Steenhuis and de Bruijn (2001) as factors that influence production performance. This indicates that location decisions may not include performance factors indicating that the dotted lines in figure 2 may not be present. More research on this is required. Also, Decker and Crompton (1993: 81-84) and Lopez and Henderson (1989) identify personal preferences as important. Furthermore, economic development personal typically overestimate their importance and influence (Decker and Crompton, 1993; Blair and Premus, 1987: 83).

Malecki (1985) introduced the industry element. He argues (Malecki, 1985: 347) that individual industries, narrowly defined, occur in very few places, despite apparent dispersion when aggregate sectors are examined. In other words, it appears that specific geographic factors have specific effects on individual, narrowly defined industries. Furthermore, he notes that "If a functional distinction within firms is not made, rather confusing survey results can occur, where both production labor costs and availability of technical talent may be found to be important, when they actually are important to contrasting activities in different locations" (Malecki, 1985: 349). Empirical research on the link between geographical factors and performance should therefore take into consideration company characteristics, such as size, orientation, industry, as well as personal preferences and other environmental elements, such as working conditions and infrastructure, to determine their impact on location decisions and performance.

6. REFERENCES

- Anderson, D. and Johnston, S.A. 1992. A linkage approach to industrial location. *Growth and Change* Summer, 23(3), 321-334.
- Baranson, J. 1967. *Manufacturing problems in India, The Cummins Diesel experience*, Syracuse University Press, Syracuse.
- Benito, G.R.G. 1997. Divestment of foreign production operations. *Applied Economics* 29(10), 1365-1377.
- Blair, J.P. and Premus, R. 1987. Major factors in industrial location: a review. *Economic Development Quarterly* 1(1), 72-85.
- Browning, J.E. 1980. *How to select a business site, The executive's location guide*, McGraw-Hill Company, New York.
- Decker, J.M., Crompton, J.L. 1993. Attracting footloose companies: an investigation of the business location decision process. *Journal of Professional Services Marketing* 9(1), 69-94.
- Dunning, J.H. 1991. *Explaining international production*, Harper Collins Academic, London.
- Ellison, G., Glaeser, E.L. 1997. Geographic concentration in U.S. manufacturing industries: a dartboard approach. *The Journal of Political Economy* 105(5), 889-927.
- Engardio, P., Bernstein, A., Kripalani, M. 2003. Is your job next? *Business Week*, February 3, 50-60.
- Ferdows, K. 1997. Making the most of foreign factories. *Harvard Business Review*, March-April 1997, 73-88.
- Harris, R.G. 1992. New theories of international trade and the pattern of global specialization, in Liemt, G. van (ed.) *Industry on the move, Causes and consequences of international relocation in the manufacturing industry*, International Labour Office, Geneva.
- Hasselt, R. van, Bruijn, E.J. de, Wirjomartono, S.H. 1977. An investigation into the appropriate application of modern methods of production and management in the engineering industry of Indonesia. *Annals of the CIRP* 25(1), 263-268.
- Jarboe, K.P. 1986. Location decisions of high technology firms: a case study. *Technovation* 4(2), 117-129.

- Lopez, R.A., Henderson, N.R. 1989. The determinants of location choices for food processing plants. *Agribusiness* 5(6), 619-632.
- Malecki, E.J. 1985. Industrial location and corporate organization in high technology industries. *Economic Geography* 61(4), 345-369.
- Markides, C.C., Berg, N. 1988. Manufacturing offshore is bad business. *Harvard Business Review* 66(5), 113-120.
- Martin, S.A. McHugh, R., Johnson, S.R. 1993. The influence of location on productivity: manufacturing technology in rural and urban areas. *Growth and Change* 24, 459-486.
- Mazzarol, T. Choo, S. 2003. A study of the factors influencing the operating location decisions of small firms. *Property Management* 21(2), 190-208.
- Premus, R. 1982. *Location of high technology firms and regional economic development* (staff study prepared for the Joint Economic Committee, U.S. Congress), U.S. Government Printing Office, Washington D.C.
- Steenhuis, H.J. and Bruijn, E.J. de 2001. Developing countries and the aircraft industry: match or mismatch? *Technology in Society* 23(4), 551-562.
- U.S. International Trade Commission, 1998. *The changing structure of the global large civil aircraft industry and market: implications for the competitiveness of the U.S. industry*. U.S. International Trade Commission, Washington D.C.