INDUSTRY AGGLOMERATION AND TRADE IN MEXICO

by

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ABSTRACT

The thesis is a study of industry localization, the geographic concentration of firms in specific or related activities. The study centers on two principal issues: the process through which industry agglomerations form, and the relationship between the trade regime and the pattern of geographic concentration. We consider the particular case of the Mexican garment industry. Evidence is drawn from extensive firm-level interviews, as well as published and unpublished government sources.

Part one studies the formation of industry agglomerations. The industry follows a process of geographic concentration we term dispersed agglomeration. The industry begins concentrated in a single marketing center. Over time, production activities separate from the marketing center and relocate to periphery regions, but not until wages in the center far exceed those in the periphery. Under dispersed agglomeration, the location decision involves investment issues that are similar to an innovation process. A pioneer firm is the first to relocate, and undertakes the investments that are necessary to open a location to production. Other potential entrants wait and free ride off pioneer investments in later periods. The pioneer remains willing to open a periphery location due to temporary monopsony power enjoyed in the new location. Econometric analysis of industry location in Mexico offers positive support for the theory.

Part two studies how economic integration affects the pattern of geographic concentration. The particular case we consider is the integration of the Mexican garment industry into a North American Free Trade Area. Integration reshapes the pattern of vertical specialization between countries and the location of production within each country. Marketing externalities lead to the geographic concentration of distribution activities. Under the closed economy, Mexico City was the country's garment marketing center. New York and Los Angeles function as garment marketing centers in the U.S. With free trade, small country producers provide assembly services for firms in the large country marketing center. Mexican garment producers, who previously served the domestic

market, are shifting to off-shore garment assembly for U.S. firms. In the small country, production relocates to regions near the large country market; in the large country, integration favors marketing centers with better access to small country producers. Garment production in Mexico is relocating from central Mexico to the Mexico-U.S. border region; in the U.S., the Los Angeles marketing center has been the principal beneficiary of the opening of the Mexican economy.

Thesis supervisors: Michael Piore, Paul Krugman
Titles: Professor of Economics, Professor of Economics

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CHAPTER ONE: INTRODUCTION

The thesis is a study of industry localization, the geographic concentration of firms in specific or related activities. The study centers on two principal issues: the process through which industry agglomerations form, and the relationship between the trade regime and the pattern of geographic concentration. We consider the particular case of the Mexican garment industry. Evidence is drawn from extensive firm-level interviews, as well as published and unpublished government sources.

A first motivation for the thesis is current policy concerns about the transition from government to free market regulation of economy activity. Radical reform in Eastern Europe has attracted much attention, but these changes follow a decade of economic opening in developing countries. A common feature of recent regime shifts is the speed with which the transition is carried out. In Chile, Mexico, and Poland, change came virtually overnight. Trade barriers, or even whole planning structures, were dismantled in one fell swoop. The shock approach is based on the idea that a rapid transition minimizes disruptions to economic activity. Underlying this approach is optimism about how long it takes individuals and firms to adjust the arrangements through which they organize production and trade. The pattern of industry agglomeration represents one such set of arrangements. The

arrangements that develop under a closed regime are likely to be very different from those that eventually emerge in an open regime. We expect a transition to alter the organization of industry, but we know little about how economies actually adjust. A study of how firms in an industry absorb the shock of a rapid transition can provide insight into how regime shifts affect the organization of economic activity.

A broader motivation for the thesis is renewed academic interest in the subject of industry localization.[1] Recent attention is due in part to an apparent increase in the phenomenon of geographic concentration. A large case study literature documents localization in a diverse cross-section of regions and industries, ranging from the Sassuolo tile industry in Central Italy to the micro-electronics industry in Silicon Valley. The subject is by no means new to economics. The classic treatment of localization is Marshall's discussion of nineteenth century industrial districts; his original observations are the starting point for the current literature.[2] Marshall attributes localization to external economies of scale in the supply of industry-specific inputs. His collection of external economies includes the creation of a pool of workers with specific skills, knowledge spillovers

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[1] The recent literature is largely unrelated to earlier work on location theory. See Enright (1990) and Beckman and Thisse (1986) for surveys of the early literature.

[2] For more complete discussions of Marshall, see Becattini (1990) and Krugman (1990).

between firms, and the growth of subsidiary industries that provide specialized inputs.[3] Marshall's principal arguments provide a useful framework to discuss the recent literature.[4]

A first reason firms localize is to gain access to a pool of workers that have specific abilities, or what Marshall terms the creation of a "constant market for skill."[5] Firms benefit as they have access to a pool of trained workers; workers benefit as they have access to a variety of employers that value their skills. Rotemberg and Saloner (1990) incorporate this concept of external effects into a model of interregional specialization. In their story, workers will only invest in acquiring industry-specific human capital if they know a number of firms will locate in their area. Real world localized industries entail a variety of arrangements that promote the acquisition of specific skills. Piore and Sabel (1983) emphasize the importance of the family in preserving and transferring skill in Italian industrial districts. Enright (1990) and Porter (1990) suggest that pools of highly skilled labor have contributed to the development of numerous industry agglomerations, such as the film industry in Hollywood, the advertising and financial

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[3] A subordinate theme is that localization is tied to community structures, such as the family, craft guilds, or the church, which support the growth of local industry.

[4] This format follows Krugman (1990).

[5] Marshall (1920: 271).

services industries in New York, and the microelectronics industries in Silicon Valley and along Route 128 in Massachusetts.

A second reason firms localize is to benefit from spillovers of industry-specific knowledge. In this case, the accumulation of knowledge by one firm contributes to a local stock of knowledge from which all members of an agglomeration benefit. For Marshall, knowledge was transferred through the interchange of ideas between localized firms. Modern conceptions of knowledge spillovers vary widely. Jacobs (1984) identifies knowledge spillovers as a key ingredient in the economic function of cities. Piore (1990) suggests that knowledge sharing is commonplace in Italian industrial districts, and is part of a "peculiar combination of competition and co-operation" between localized firms.[6] Relationships between firms are typically embedded in local community institutions, such as the family, labor union, or local political party. Glaeser, Kallal, Scheinkman and Schleifer (1990) instead suggest firms acquire knowledge through "spying, imitation and rapid inter-firm movement of highly skilled labor."[7]

A third reason firms localize is the growth of subsidiary trades that provide intermediate inputs, especially where these inputs are specialized or involve large fixed costs.

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[6] Piore (1990: 54).

[7] Glaeser, Kallal, Scheinkman and Schleifer (1990: 2).

Krugman (1990) provides a model of localization in which the agglomeration of end users allows intermediate good producers to expand production and reduce average costs. Porter (1990) observes that industry agglomerations generally include a number of related industries. Enright (1990) describes how agglomerations attract specialized buyers and suppliers. As an example, he cites the Sassuolo ceramic tile industry, which has spawned a local tile equipment industry.

Marshallian external economies help explain why industry agglomerations exist. A number of questions remain about the dynamics of geographic concentration. A first set of questions relate to how agglomerations come into existence. With positive externalities, firms clearly benefit from localization. The literature models the location decision as a simultaneous-move process, or one in which firms and workers take actions in a well-ordered sequence.[8] In reality, location decisions are rarely so well-coordinated. Do firms move in bunches or does a first mover initiate agglomeration? Is there indeed a natural sequence of moves? How do the actions of first movers shape the actions of subsequent movers?

A second set of questions relate to how agglomerations adjust to changes in market conditions. An agglomeration, by definition, is a collection of independent firms where decision-making is decentralized. Dramatic changes in market

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[8] See, for instance, Rotemberg and Saloner (1990).

conditions often require firms to retrain workers, choose new technologies, or redesign the product they produce. All of these are actions that may have spillover effects on nearby firms. Do firms attempt to coordinate actions or does rampant individualism prevail? If firms do coordinate actions, what are the mechanisms that allow them to do so? When nations or regions with established industry agglomerations integrate, external economies imply it is efficient for a single agglomeration, or at most a limited number of agglomerations, to serve the entire market. With integration, which agglomeration becomes the new industry center? Do agglomerations in integrating regions also integrate activities in any way?

The Study

The thesis studies geographic concentration in the Mexican garment industry. Mexico provides a unique opportunity to analyze both how industry agglomerations form and how industries adjust to the transition from a closed to an open trade regime. Between 1940 and 1985, Mexico developed behind prohibitive trade barriers that were part of a conscious strategy of import substitution industrialization. A pattern of geographic concentration emerged in which Mexico City functioned as the country's principal industrial center. In 1980, the capital was home to nearly half of the country's manufacturing labor force. The development of all other

regions in the country was in some way tied to the center. In 1985, Mexico decided to join the General Agreement on Trade and Tariffs, or GATT, formally declaring an end to import substitution. In the following three years, the government eliminated, or at least drastically reduced, all barriers to trade. President Carlos Salinas, who came to power in 1988, has broadened the scope of trade liberalization to include a free trade agreement with the United States.

The most feasible way to study agglomeration is to focus on a single industry. There is of course a loss of generality with this approach, but it allows a more detailed analysis of how firms in an industry are organized. The structural features of the garment industry make it logical choice. There is a basic locational tension in garments between production and marketing: production pushes firm to disperse whereas marketing draws firms to agglomerate. In marketing, access to information about frequently changing consumer tastes necessitates proximity to concentrated areas of consumer demand. In production, the predominance of low-skill work and the amount of labor required compel firms to locate the activity in low-wage areas. Translating marketing knowledge into product designs requires a cadre of skilled design workers. Opening new locations to production requires initial investments in training design workers, even though these workers comprise a minority of the production work force.

In an open economy, the labor-intensive nature of garment production gives Mexico a presumed comparative advantage in the activity, at least in relation to the U.S. The precise role Mexico would play in a North American garment market remains unclear. Mexico has no clear advantage in design or marketing. In marketing, wages are less a factor than market size. The relatively small size of the Mexican economy puts Mexican firms at a disadvantage, especially in relation to the large U.S. market. In design, the knowledge and skills acquired under a closed economy may not be directly transferable to production for foreign markets. This may limit Mexico's participation, at least initially, to low-skill activities in production.

The thesis utilizes three sources of data: firm-level interviews, the Mexico Industrial Census, and unpublished government figures. The information necessary to study an industry is rarely available from official sources. The principal source of industry data in Mexico, as in most countries, is the Industrial Census. The Census provides a snapshot of the establishments in an industry at a given point in time. While useful, this snapshot lacks depth in that it provides no information on vertical or horizontal relationships between establishments. Given the lack of panel data on individual establishments, the Census also provides no way to relate snapshots taken at different points in time. Many of the reasons for which firms agglomerate are not

captured in the data that census takers collect. Consider Marshall's three basic localization economies. If we want to study firm-specific training, the exchange of information between firms, or the transactions that link the firms in an industry, it is necessary to go inside firms themselves. Until more sophisticated survey data become available, the obvious approach for this task is firm-level interviews.

There are various problems with firm-level interviews as an empirical tool. Each requires careful consideration, but none are insurmountable. Interviews are only as objective and complete as the imperfect eye of the researcher. This a valid concern in principal, but not given the alternatives. There is no reason to believe the researcher's eye is any more imperfect than that of the census taker. The importance of personal contacts in arranging interviews implies subjects are not drawn from a random sample. An obvious solution is to use Census data to verify empirical regularities suggested by interviews and follow these regularities back in time. A more practical concern is that interviews consume a great deal of time. Their ultimate justification is that they remain the only means of obtaining certain kinds of data. If we take strategic interaction between firms seriously -- and the bulk of current research in industrial organization suggests that we do -- we inevitably confront situations where we cannot econometrically distinguish between competing explanations. Our only recourse in this instance is to actually confront the

subjects we study.

Outline of Thesis Chapters

The body of the thesis contains five chapters. The chapters form an integrated whole, but each can also stand alone. The self-contained format of the thesis requires some repetition of material. This is unavoidable as each chapter, with the exception of Chapter Six, relies on the same body of interview data. Chapter Two presents the interview data in systematic fashion. Chapters Three and Four study how industry agglomerations form. Chapter Five studies the relationship between the pattern of geographic concentration and the trade regime. Chapter Six, the only purely theoretical chapter, presents a model of industry localization that is an extension of the discussion in previous chapters. A brief review of each chapter is presented below.

Chapter Two provides regional histories of industry agglomeration in Mexico. The histories are based on extensive firm-level interviews with manufacturers, subcontractors, and traders in the Mexican garment industry. The story of how agglomerations form is equivalent to the story of how regions become linked through trade or of how industrialization spreads across regions. Each version revolves around pioneer firms who expand or create opportunities for trade. The descriptive material contained in the chapter forms the empirical foundation for the dissertation. Subsequent

chapters use the interview data as a base from which to develop and test hypotheses about industry agglomeration. Regional histories of garment manufacturing in Mexico are interrelated. The chapter follows the industry from its inception to the recent opening to trade.

Chapter Three studies the formation of industry agglomerations. The industry follows a process of geographic concentration we term dispersed agglomeration. The industry begins concentrated in a single marketing center. Over time, production activities separate from the marketing center and relocate to periphery regions, but not until marketing center wages far exceed those in the periphery. Under dispersed agglomeration, the location decision involves investment issues that are similar to an innovation process. A pioneer firm is the first to relocate; it undertakes the investments that are necessary to open a location to production. Other potential entrants wait and free ride off pioneer investments in later periods. The pioneer's incentive to open a location is temporary monopsony power enjoyed in the periphery.

Chapter Four tests the empirical implications of the theory of dispersed agglomeration developed in Chapter Three. The theory predicts that industry location is determined by the interaction of wage differentials and industry-specific agglomeration economies. Agglomeration in a previous period expands the local skill base and enhances the productivity of local workers. The probability a location will be occupied is

a function of the difference between local production costs and those in an alternative location. The chapter uses a probit model to test for agglomeration effects in the location decision of Mexican garment firms. The Mexico Industrial Census provides state-level observations on sixteen six-digit garment industries. The results provide positive support for the theory. Agglomeration, by reducing unit labor requirements, raises the probability a location will be occupied in the future. The chapter then uses estimation results to predict the probability a location will be occupied for given wage differentials and levels of agglomeration.

Chapter Five studies how economic integration affects the pattern of geographic concentration. The particular case we consider is the integration of the Mexican garment industry into a North American Free Trade Area. Integration reshapes the pattern of vertical specialization between countries and the location of production within each country. Marketing externalities lead to the geographic concentration of distribution activities. Under the closed economy, Mexico City was the country's garment marketing center. The U.S. has garment marketing centers in New York and Los Angeles. With free trade, small country producers provide assembly services for firms in the large country marketing center. Mexican garment producers, who previously served the domestic market, are shifting to off-shore garment assembly for firms in U.S. marketing centers. In the small country, production relocates

to regions near large country markets; in the large country, integration favors marketing centers with better access to small country producers. Garment production in Mexico is relocating from central Mexico to the Mexico-U.S. border. In the U.S., the Los Angeles marketing center has been the principal beneficiary of the opening of the Mexican economy.

Chapter Six studies industry localization in the later stages of industrialization. Previous chapters focus on situations where skilled labor and industry-specific knowledge are spread unevenly across regions. When a large pool of skilled labor has accumulated in periphery regions, there may still be reasons for firms to localize. This chapter offers a formal model of industry location in which firms agglomerate in order to reduce bargaining costs associated with spatially dispersed production. Agglomeration represents an alternative to vertical integration. Industry location is the result of a three-stage game between traders and producers. Traders make costly ex-ante investments; producers have specific skills and offer production services to traders. Through agglomeration, traders increase competition among producers for the services they provide. The creation of a thick market reduces the potential for hold-up and increases traders' ex-ante incentives to invest.

CHAPTER TWO: REGIONAL HISTORIES OF INDUSTRY AGGLOMERATION IN MEXICO

This chapter presents a series of regional histories on the geographic concentration of firms in one industry. In the industry we consider, the story of how agglomerations form is equivalent to the story of how regions become linked through trade or of how industrialization spreads across space. Each version revolves around a single actor, the pioneer firm, who expands or creates opportunities for trade. The discovery of these opportunities, however accidental, confers upon the pioneer the role of innovator: by expanding markets, the pioneer enhances the productive potential of existing resources in the economy. The public good aspect of this innovation is extreme. Once realized, a trading opportunity in principle becomes available to all. What is striking about the instances this chapter describes is the length of time pioneer firms control access to the markets they have created.

The histories are based on 95 interviews with manufacturers, subcontractors, and traders in the Mexican garment industry I conducted between September, 1990 and May, 1991. Table 2.1 following the text describes interview methods and the sample of firms. The descriptive material capsulized in this chapter forms the empirical foundation for the dissertation. Subsequent chapters use the interview data as a base from which to develop and test hypotheses about

industry agglomeration. The chapter follows the industry from its inception to the recent opening to trade.

1. The Rise of the Mexico City Marketing Center

Until the 1920s, most garment production in Mexico was on a made-to-order basis. Housewives and neighborhood tailors used factory-made fabric to produce custom garments for family members or local patrons. It was not until the Mexican Revolution (1911-1917) that industrial garment production in Mexico became feasible. Rural dwellers fleeing violence in the countryside swelled the ranks of the capital and other major cities. The sudden urban agglomeration created the first mass consumer markets for garments in Mexico.[9] The individuals that initiated the production of ready-to-wear garments were primarily Lebanese and Jewish immigrants who had come to Mexico during the first three decades of this century. Many had been textile and garment merchants in their countries of origin. They left marketing centers in the Middle East and Eastern Europe to escape war, persecution, and economic

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[9] Mass markets in textiles existed as early as the mid 1800s in Mexico; mass consumer markets in garments did not appear until nearly two centuries later. See Walton (1977). One explanation is that search costs delay the industrialization of production until markets have reached some minimum size. For differentiated products, like garments, the minimum market size is larger. While individual fabrics can be used to make a wide variety of garments, even basic garments are differentiated by size.

instability.[10]

The first immigrant-traders arrived around the turn of the century. They continued their trade as textile merchants, distributing fabrics from textile factories to housewives and tailors. Commerce generated the financial capital they would later use to launch industrial enterprises.[11] The Mexican Revolution provided the immigrant-traders an unexpected advantage in textile commerce. Between 1911 and 1921, control over many rural areas was contested by a variety of armed groups. The immigrant-traders, by virtue of their obvious foreign origin, were able to appear neutral. The ability to travel throughout the countryside and distribute fabric to travelling armies and rural villages allowed them to consolidate their control over textile distribution channels. After the Revolution, established links with upstream textile suppliers made it easy for the immigrant-traders to backward integrate into garment manufacturing. They made the capital the hub of garment commerce and production, clustering their shops in downtown Mexico City.[12]

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[10] See Glade (1983) on Levantines in Latin America.

[11] Many immigrant-traders arrived with some amount of capital, as Mexican immigration law required at the time. See Alonso (1983).

[12] The centralization of commerce in the capital has historic roots. The Aztecs established a network of open-air markets in the Valley of Mexico. The Spanish later controlled interregional trade in the colony by requiring all goods to pass through the capital. See Walton (1976).

The newly established manufacturer-traders began by subcontracting production to outside shops. Only later, as markets expanded and became more secure, did they establish their own factories. As is the case with garment manufacturing around the world, production subcontracting has remained central to the industry. The manufacturer-trader buys fabric, secures purchase orders for the final garment, and oversees the design phase of production. Design is where the skill-intensive tasks of garment production take place. Design workers convert sketches of garments into workable patterns, grade these patterns according to different garment sizes, and use the graded patterns to cut the fabric into ready-to-assembly pieces in a manner that minimizes fabric wastage. The manufacturer-trader delivers ready-to-assembly pieces to subcontractors, whose sole task is to stitch the garment together. The basic production unit in assembly is a single worker and a single sewing machine. Assembly accounts for 70 to 80 percent of garment employment. The machinists who assemble garments achieve acceptable levels of productivity after three to four months on the job. Only assembly of the final garment is subcontracted to outside shops.[13]

Ethnic ties provided immigrant-traders with access to

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[13] These are the natural divisions along which the industry tends to separate when it is broken up. On garment production, see Ghadar and Davidson (1987), Hoffman and Rush (1988), Morawetz (1981), and Waldinger (1986).

finance.[14] While garment manufacturing requires only modest amounts of fixed capital, it requires relatively large infusions of working capital.[15] Many potential Mexican-born industrialists lacked the means to obtain credit. The immigrant-trader, on the other hand, not only had an established credit record with textile suppliers, but also had the advantage of being able to deal with relatives or other members of his ethnic group. New manufacturers rely on relatives to help them establish a reputation for credit-worthiness. They place their first fabric orders with the suppliers of an uncle or a cousin. Over time, they accumulate reputational capital with these suppliers, which allows them to make purchases which are not guaranteed by others and thus expand production. A reputation with one supplier enables a manufacturer to makes purchases from other suppliers. This arrangement provides suppliers with access to information about the background and business history of a manufacturer. A potential manufacturer who lacks working capital or contacts with established manufacturers who can vouch for him is poorly situated to enter manufacturing. An alternative is to begin

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[14] The predominance of immigrant-entrepreneurs was not unique to the garment industry. Haber (1989) observes that foreign-born merchant-financiers were ubiquitous in Mexico's early industrial growth. He attributes their success to commercial contacts and access to startup capital.

[15] In 1980, for instance, the ratio of fixed to working capital in garments was 4.5-to-1, compared to a ratio of 0.5-to-1 in all manufacturing industries (Censo Industrial, 1980).

as a subcontractor for an established manufacturer-trader and accumulate contacts and capital over time.

Second and third generation ethnic Jews and Lebanese have remained in the garment industry. They play an important role, if not a dominant one, in wholesale garment commerce. The directory of the Mexico City delegation of the National Garment Industry Chamber, to which all garment firms must belong by law, provides evidence on the ethnic composition of the industry. In 1989, 38.6 percent of registered garment establishments in the capital were owned by ethnic Arabs and Jews.[16] Among these shops were the largest traders and manufacturers in the industry.

2. Relocation, Regional Integration, and the Pioneer Firm

Over time, the Mexico City garment district ceased to be an ideal locale for both marketing and production activities. Rapid urban growth drove up land rents in the downtown area and new industries began to provide more attractive employment options for the urban workforce. By the 1960s, wage differentials between Mexico City and provincial regions had become as large as two-to-one (see Chapter Three). This created a dilemma for garment firms. In their capacity as traders, the garment district was a source of information about new fashions and styles and provided ready access to

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[16] Ethnic origin was inferred from maternal and paternal surnames.

upstream textile suppliers and downstream garment retailers. It was not just information that concerned garment firms, but the time required to obtain it. Garment styles and fashions often have exceedingly short life spans. This is compounded by the fact that new products require fixed investments in creating new designs and patterns. Recouping front-end investments places a premium on identifying new fashion trends as soon as they appear.

In their capacity as producers, the only advantage of locating in the Mexico City garment district was that it minimized the need to transport ready-to-assemble fabric pieces from design shops to assembly workers. The labor-intensive nature of production made firms especially sensitive to rising wages in the capital. Wage considerations eventually outweighed transport cost considerations. The solution was to separate production activities from marketing. The activities that left the capital first were low fashion items, such as production of socks and men's shirts and pants, where long product cycles made presence in a marketing center less important. Medium fashion items, such as sweaters and children's outerwear, moved out later. Only recently have firms in the capital begun to relinquish control over high fashion items, such as women's outerwear.

Manufacturer-traders followed two distinct relocation strategies. The initial response of many manufacturer-traders was to continue the existing pattern of subcontracting, but at

a greater distance. They kept their design and marketing operations in the garment district and relocated assembly to subcontracting shops located in shantytowns and rural communities surrounding the capital. Other manufacturer-traders pursued a more radical approach. They relocated both design and assembly facilities to provincial regions far from Mexico City. This move initiated the creation of new production centers and greatly expanded the geographic scope of trade in the industry. In their new locations, the manufacturer-traders continued to channel much of their production through the Mexico City marketing center. Over time, they expanded production for regional markets. Some production centers have become regional distribution centers.

2.1 Satellite Communities of Subcontractors

Traders seeking to relocate assembly chose communities where local residents had few alternative employment options. Shantytowns adjoining Mexico City and rural communities in states neighboring the capital were logical candidates. Each type of community possessed a relatively immobile low-wage labor force. In shantytowns, traders subcontracted to homeworkers. The typical homeworker is a housewife whose responsibilities in the home preclude her from taking a job in town. In rural communities, traders subcontracted to family-run shops. Local agriculture was not sufficient to absorb the ever expanding labor force; alternative employment was located

far away in the capital. Many rural communities experienced a steady out-migration of residents to Mexico City, but few were ever totally abandoned.[17] Migrants working in the capital often sent a portion of their earnings home to support family members. It was the individuals that remained in the rural communities that manufacturer-traders sought out as subcontractors. The traders often represented a community's first involvement in industrial production for a broad market.

Many satellite communities of subcontractors developed around Mexico City.[18] Examples include Nezahuacóyotl (women's and children's outerwear), Chinconcuac (sweaters), and Almoloya del Río (pants) in the state of Mexico; San Martín Texmelucán (shirts) in the state of Puebla; and Tlaxcala and surrounding communities (sweaters, women's outerwear) in the state of Tlaxcala. This section describes two satellite communities in detail, one located in a rural community and the other in a shantytown.

Almoloya del Río, Mexico: Almoloya del Río is a small town of 10,000 inhabitants that lies forty miles to the west of Mexico City. The community is a center for pants subcontracting. A trader from Mexico City established the town's first subcontracting shop twenty years ago, creating the first industrial link between Almoloya and the capital. Prior to

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[17] Muñoz, de Oliveira and Stern (1979).

[18] See Alonso (1991) on subcontracting in Mexico City.

that time, most residents had been farmers, wood cutters, or somehow involved in local agriculture.[19] The first shop, and several that soon followed, served as a training ground for local residents. After gaining experience on the job, workers in the original shops became subcontractors. Typically, they made this transition by travelling to the capital to purchase second-hand sewing machines and make contacts with other traders in the garment district. The proliferation of subcontractors attracted other capital traders to Almoloya.

The current generation of Almoloya residents has grown up around garment production. Most shops are located in the home, thus minimizing rent, and rely exclusively on family labor except during the Fall (pre-Christmas) production cycle when they may hire two or three outside workers. Children begin work as early as the age of six doing simple tasks such as collecting fabric scraps and cleaning the workshop. By the age of fourteen or fifteen, they have left school and become full-time workers in the family shop. The town's largest shop employs only twenty-five workers, and most employ no more than five workers. Given the small size of individual shops, traders often divide orders between five or six subcontractors. Approximately eighty percent of the families in the community are involved in the garment industry. An

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[19] Indeed, as late as the 1970s communities in the mountains above Almoloya continued to use firewood as currency for many transactions.

association of local garment producers has 176 members, which accounts for less than half of the local area producers.

The growth of garment subcontracting in Almoloya gave residents the idea to establish a garment market in town to provide local shops a place to sell goods they had manufactured themselves. Mexico City traders were not interested in helping local producers expand the market for their goods. Some traders even threatened subcontractors with termination if they sought work from other traders. At first, local producers manned their own stalls; over time, local merchants began to appear who specialized in garment commerce. Ninety local producers and sixty-five local merchants now participate in the market. Each has an assigned stall, and all are prohibited from selling goods that are not produced locally. The Almoloya market attracts low income consumers and small-scale retailers who serve remote rural communities. These are individuals who previously travelled to the capital to make retail or wholesale purchases.

Nezahuacóyotl, Mexico: Nezahuacóyotl is a sprawling marginal neighborhood that adjoins Mexico City. Urban squatters established the community in the late 1960s on the salt flats of the Texcoco lake bed. The community now has three million residents. In 1970, manufacturers of women's and children's outerwear from Mexico City began to subcontract assembly to shops in the community. Local production remains concentrated

in these products. Most shops are run by women who work out of their homes; most operate clandestinely in that they fail to pay taxes or comply with government labor standards. Producing in the home allows subcontractors to conceal their shops from government inspectors. They pick up and deliver orders from traders in the garment district on a weekly or biweekly basis. Homeworkers generally exhibit a low attachment to the labor force. Many do not work on a consistent basis throughout the year. A common practice is for the homeworker to subcontract during peak production cycles in the Fall and Spring, when demand for subcontractors is high, but participate in other activities during the rest of the year. Homeworkers' frequent movements in and out of the labor force contribute to rapid turnover in subcontracting relationships between traders and subcontractors. Subcontractors rotate between traders as often as every two or three months. Traders suggest that for this reason they are constantly in search of new subcontractors.

A survey by Alonso (1991) estimates that in 1976 Nezahuacóyotl was home to 1,500 garment shops, which employed a total of 5,000 women. Three-fourths of these shops were clandestine.[20] The average number of sewing machines per shop was 1.2. Only a quarter of the shops hired workers from

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[20] Clandestinity implies much of the industry is hidden from view. The 1980 Mexico Industrial Census, for instance, only identifies 101 establishments that employed 504 workers.

outside the home; none employed more than five workers. In the 1980s, production in Nezahuacóyotl declined as Mexico City traders moved assembly to smaller and more isolated communities in neighboring states.

2.2 New Production Centers

Firms initially did not have to travel far from Mexico City to find a low-wage labor force. The spectacular growth of the capital quickly changed this. As Mexico City enveloped surrounding communities, local populations gained access to more attractive employment alternatives and became less willing to put up with the low pay of garment work. The growth of Nezahuacóyotl, for instance, attracted furniture producers, metal workers, and food processing plants.[21] At the same time that satellite communities of subcontractors were springing up around the capital -- and in some cases well before -- a few Mexico City garment traders embarked on a more ambitious relocation strategy. These pioneer firms relocated the entire production apparatus -- design and assembly facilities -- to regions far removed from the capital. Several pioneers initiated industrial development in their new locations. Pioneers brought with them access to marketing

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[21] A more recent blow to the Mexico City garment industry was a major earthquake in 1985 that devastated much of the capital. The downtown area, where the garment district is located, was the hardest hit. Dozens of factories were destroyed and hundreds of garment workers killed.

channels in the Mexico City garment district. Opening a location to production required training local workers in all aspects of garment design and production. The most promising employees often became business partners of the pioneer. The marketing contacts and training the pioneers brought opened the way for local residents to become subcontractors, or even launch independent enterprises. This section describes the formation and growth of five regional production centers.

Monterrey, Nuevo León: Monterrey, a city of two million people, is the principal garment manufacturing and distribution center for northeast Mexico. The city has been a major industrial center since the turn of the century. Throughout its history, Monterrey has maintained an unusual degree of political and economic autonomy from the capital. Its independence is rooted in its geographical isolation from the rest of the country and its relative proximity to the U.S., with which it has always maintained relatively close commercial and financial ties. Under the closed economy, Monterrey was the only city to develop an industrial base that rivaled that of the capital. Just before 1900, a few large firms initiated production in the beer and steel industries. These firms later expanded into glass, cement, and chemicals and still control most industrial activity in the region.[22]

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[22] On Monterrey's economic development, see Saragoza (1988), Vellinga (1979), and Walton (1977).

The pioneers of the Monterrey garment industry were two Arab immigrants who came to the region in the 1930s. They established a pattern of specialization that shaped the local industry's development for four decades. The first pioneer, a Mr. Marcos, was an Arab textile merchant who moved to Monterrey from Mexico City in search of trading opportunities with Texas. He began by exporting shirts that were assembled by local seamstresses. The Texas market collapsed with the Great Depression and Marcos shifted to production for local consumers in Monterrey, which at the time was emerging as an industrial center. The continued expansion of the local beer, steel, and glass industries created sufficient demand for Marcos to launch his own factory, Camisas Palma, which remains one of Monterrey's largest garment establishments.

The second arrival, a Mr. Canavati, was a Palestinian shirt manufacturer who came to Mexico in 1900. He worked a variety of odd jobs in the capital, while searching for an opportunity to return to shirt manufacturing. He came to Monterrey in the 1930s after hearing of Marcos' success. Canavati began producing at home with a few sewing machines. Within three years demand had exceeded his capacity and he established a small factory. This venture went bankrupt during World War II. After the War he established the shirt factory Manchester, which remains one of Monterrey's largest garment establishments. The two pioneers made Monterrey a center for shirt production. Along with Mexico City, the

region dominated shirt production in Mexico until the 1980s.

In the 1960s, two other Arab immigrants, a Mr. Kalifa and a Mr. Zablah, moved to Monterrey to launch garment manufacturing enterprises. Each had experience in Mexico City garment commerce. Kalifa was a brother-in-law of Canavati. Together, they launched Portefino, Monterrey's first large pants factory. The venture coincided with the dramatic rise in the popularity of jeans in Mexico. Portefino later split into two firms along family lines, but the venture served as the point of entry for Kalifa into the Monterrey garment industry. Kalifa's sons used Portefino as a base from which they established six other garment firms, each a separate enterprise controlled by a different sibling.

There have been numerous intermarriages among the second and third generations of the pioneer families.[23] Today, the four pioneer families account for a total of thirty-five local garment manufacturing firms. Of the nine local garment factories that employ more than 250 workers, the four pioneer families founded all but two. The existing pioneer firms and their off-shoots are run by members of the third generation, who are now in their twenties and thirties. The third generation has shown a greater interest in establishing their

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[23] There have been at least four inter-marriages. In the second generation there is the Marcos Canavati family, and in the third generation there are the Zablah Marcos, Marcos Murra, and Zablah Murra families (in Spanish, the first surname is the paternal and the second surname is the maternal).

own ventures, perhaps because opportunities for advancement are limited in the original enterprises. Most begin as subcontractors for parents, uncles, or cousins. Others have become fabric distributors and count relatives as their principal clients. The tendency to transact with relatives in no way means that firms are run cooperatively. In-laws, cousins, and even brothers often compete directly with one another in final product markets. At the same time, they share information with one another about new business opportunities. One cousin may supply another with fabric at the same time they compete as pants producers.

Guadalajara, Jalisco: Guadalajara, a city of four million people, is the principal garment manufacturing and distribution center for northwest and west-central Mexico. Under Spanish colonial rule, Guadalajara emerged as a local marketing center for agricultural products. Like Mexico City, it experienced its first rapid growth during the Mexican Revolution as rural inhabitants sought refuge in the city from bloodshed in the countryside. Unlike Monterrey, Guadalajara has traditionally maintained close ties to the capital. Local political elites tend to take their orders from Mexico City bosses and most large local industrial enterprises are subsidiaries of industrial groups based in the capital.[24]

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[24] On Guadalajara, see Arias (1985), de la Peña and Escobar (1986), and Walton (1977).

Also unlike Monterrey, Guadalajara's industry is dominated by small and medium firms in light industry.[25]

The pioneers of the Guadalajara garment industry were Lebanese textile merchants who came to the region just after the turn of the century. Guadalajara served as an overflow destination for immigrant-traders from the capital. The city's role as a regional distribution center made it a natural destination for the immigrant-traders. Similar to the experience of traders in the capital, the urban growth that resulted from the Revolution created a large consumer market for ready-to-wear garments. Local immigrant-traders used this opportunity to expand from textile commerce into garment production.[26] The first immigrant-traders to produce garments began with knitwear, and in particular socks. By 1935 there were twenty small knitwear establishments in Guadalajara, by one estimate half of which were owned by Lebanese immigrants.[27] High and medium fashion garments, such as women's outerwear, were from the outset dominated by Mexico City producers. The Guadalajara garment industry remained concentrated in knitwear until the 1970s.

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[25] Walton (1977) attributes the diffuse ownership structure to the pattern of land tenure around Guadalajara, which historically was among the least concentrated in all of Mexico. Historic patterns of land tenure around Monterrey, as in much of northern Mexico, were highly unequal.

[26] Lailson (1988).

[27] Ibid.

Unlike Monterrey, the influence of Guadalajara's pioneer was short-lived. Many of the pioneer firms were out of business by 1950, replaced by new entrants.[28] Also in contrast to the experience of Monterrey, most Guadalajara garment producers have remained small and medium-size enterprises. Few firms employ more than forty or fifty workers. There are few remaining ethnic networks in the Guadalajara industry, but firms associate with each other in the industry through informal grupos, or groups. Grupos consist of ten to fifteen enterprises that are based on family or neighborhood ties. They share information on new fabrics, fashion trends, and commercial opportunities with large buyers. Less frequently, firms share production orders; rarely do they launch joint ventures. There are five or six widely recognized grupos in the Guadalajara garment industry. Two grupos have alternated leadership of the Guadalajara delegation of the National Garment Industry Chamber over the last ten years. Local firms are required by law to pay dues to the chamber. The local chamber organizes commercial activities, which include a regional trade fair and a wholesale commercial plaza. These activities allow firms to make contacts with regional and national garment traders. The dominant grupo at any point in time appears to enjoy

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[28] Ibid.

privileged access to these benefits.[29]

Aguascalientes, Aguascalientes: Aguascalientes, a city of 500,000 people and the capital of a centrally located state of the same name, is the principal manufacturing center for children's outerwear in Mexico. Until the 1970s, Aguascalientes was a cattle town. A dwindling ground water supply was causing cattle production to slowly die out, and many residents were migrating to other regions in search of work. In the last two decades, the region has undergone a dramatic industrial transformation. The growth of the local garment industry has played a key role in this transition.

Aguascalientes is unique among garment production centers in Mexico for it has a history that predates industrial garment manufacturing. The region is home to a traditional form of embroidery that first became popular in the early 1800s. Local artisans produced embroidered goods and sold them in open-air markets. Artisan production grew up around the San Marcos trade fair, an annual agricultural event that was the largest of its kind in north-central Mexico. It was not until the 1960s that local garment producers shifted from handicraft to industrial production. At this time, several firms began to mechanize embroidery by replacing workers with

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[29] As the activities of the chamber mostly pertain to trade liberalization, we postpone discussion of the chamber until the next section.

specialized equipment. One firm in particular, Bordados Maty, was a pioneer in converting embroidery into a large-scale industrial activity. Other firms followed Maty's lead and the region became a center for mass-produced embroidered linens.

In the late 1970s, the market for embroidered linens suddenly declined. Local garment firms looked to Maty for guidance. Many of the founders of the area's garment establishments had started as workers in Maty's shops. Maty had financed a number of these firms with loans of equipment or cash. Maty choose to switch from embroidered linens to children's outerwear. Most other firms in the area followed suit, with many directly imitating styles and designs. Maty nearly went bankrupt during the turbulent early 1980s, as a series of devaluations greatly increased the peso value of foreign bank loans it had at the time. The firm never regained its earlier preeminence, but its actions established a new pattern of regional specialization. By 1985, children's outerwear accounted for over half of employment in the local garment industry and Aguascalientes had surpassed Mexico City in the production of children's clothes.

A close working relationship among local firms has played an important role in the recent growth of the Aguascalientes garment industry. Coordination among firms has smoothed the transition into children's outerwear. Most activities have been coordinated by the local delegation of the National Garment Industry Chamber, which is the most active chapter in

the country. The chamber has established a commercial plaza where eighty manufacturers have retail outlets, a credit union, and, more recently, an export trading company which organizes groups of firms to produce large orders for U.S. buyers. The commercial plaza was created in 1974 to give local firms a place to sell mass-produced linens. To successfully move from handicrafts into production for a mass market, firms needed access to wholesale buyers from Guadalajara and Mexico City. A commercial plaza, they thought, would allow buyers to visit a number of firms at once. With the move into children's outerwear, firms doubled the size of the commercial plaza. The industry chamber has also worked with the local public university to create a program in fashion design. Chamber members train students in technical tasks, such as pattern-making and grading. Chamber members attribute the spirit of cooperation in their delegation to the fact that current members are children or grandchildren of artisans. They have known their fellow members since childhood and share a respect for the role of the garment industry in the region.

The growth of the local garment industry has launched an industrial boom in Aguascalientes. Since 1985, Nissan, Xerox, Texas Instruments, and Moto Diesel have built assembly plants in the city, converting the region into one of largest assembly platforms in interior Mexico. Foreign firms have chosen Aguascalientes in part due to a large labor force

accustomed to assembly work from experience in the garment industry.[30] Indeed, many garment manufacturers complain they have lost workers to foreign assembly plants and fear a regional labor shortage in the near future. A second factor that has lured foreign firms to the region is the relative lack of labor conflict. The leaders of the state's principal business organizations, which includes the local delegation of the garment industry chamber, meet on a regular basis with the governor and the state's principal labor federation to negotiate potential conflicts. There has been only one strike in the last dozen years. This contrasts with more volatile labor relations in the capital and certain border states.

Tehuacán, Puebla: Tehuacán is a city of 200,000 people located four hours driving distance south of Mexico City. Until the 1970s, most residents of Tehuacán were involved in one of two activities: poultry production or bottling of mineral water from nearby springs. Two garment industry pioneers have transformed the regional economy. A thriving local garment industry now specializes in the assembly of jeans and men's shirts and dress pants.

The first garment industry pioneer was a Lebanese immigrant who came to Tehuacán in 1962. The immigrant had spent several decades in the Mexico City garment district and

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[30] "De Rancho a Imán Industrial," Expansión, 7-24-85, pp. 90-98.

was looking for a new location where he could produce men's pants. His principal client was the Haddad family, three Lebanese brothers who ran a textile and garment wholesale business in Mexico City. The Haddads produced all their garments through subcontractors. When the immigrant went bankrupt, the three brothers bought his business and moved to Tehuacán. They continued to manufacture under their own label until 1979 when they switched to assembly of jeans and dress pants for Mexico City traders, many of whom had been their business associates in the capital. In the switch to assembly, the brothers ceded control of purchasing fabric and designing the garment to client firms; they retained control over converting designs into workable patterns, cutting fabric for production, and assembling the final product.

The brothers have added five additional garment factories, which together now employ 1,600 workers. The Haddads run a tight-knit family enterprise, in which the brothers or their sons make all management decisions. All enterprises are jointly owned, but in each shop a single family member has primary responsibility for day-to-day operations. The Haddads have expanded their operation in part by attracting workers from Oaxaca, a poor state located just to the south of Tehuacán. This has required busing in workers from their homes in rural communities. Labor turnover among rural workers is high, as many workers maintain a primary attachment to agriculture. They take garment assembly work

during low periods of agricultural production and return to the fields for planting and harvest. Even after five or six years of garment labor, workers may still be active in agriculture, if not directly for themselves then for a relative.

Tehuacán's second pioneer was Alfonso Fernández, a Spanish immigrant who came to Tehuacán in the early 1970s to subcontract for several Mexico City traders. Fernández also specialized in men's pants and jeans. Shortly after his arrival, he saw opportunities for expansion. He invited a fellow Spanish immigrant from the nearby city of Puebla to co-invest in a pants factory. This venture lead to two subsequent joint ventures, also with Spanish immigrants from Puebla. After these initial ventures, Fernández began to finance startups by employees he thought showed considerable promise. He has financed four such startups. The employees he has chosen were production supervisors or design workers. Whereas the Spanish partners had sufficient capital to enter directly into a joint venture, the employee-partners have had to borrow funds from Fernández to finance their investments. In each arrangement, Fernández is the majority owner and leaves day-to-day decisions to the other partner. Fernández' local business empire now includes twelve factories that employ 2,000 workers.

Fernández' three most recent ventures are located in rural areas surrounding Tehuacán. Workers are increasingly

not from town but from rural communities nearby and in Oaxaca. A rural factory location provides better access to the relevant labor force. Fernández has followed a careful strategy of penetrating particular communities to find the most suitable workers. Garment assembly is generally a rural worker's first involvement in an activity other than agriculture. The first worker from a given community serves as a vehicle for bringing other rural workers into the industry. After testing the waters, a worker may be followed by a sibling or a neighbor. Fernández' production supervisors suggest that good workers -- workers who return to the factory month after month -- are more likely to draw other good workers.

The pioneers' activities have expanded opportunities for local individuals in Tehuacán. A number of former employees of the two pioneer firms have launched their own enterprises and now subcontract independently for traders in the capital. The new subcontractors generally know little about the distribution end of the business. Mexico City traders deliver fabric and garment designs and subcontractors return a final product. The traders closely guard information about the final destination of their products. They often attach garment labels themselves to prevent subcontractors from discovering the brand of clothing they are producing.

Irapuato, Guanajuato: Irapuato is a city of 500,000 people in

the centrally located state of Guanajuato. The city is a crossroads for the major rail and truck lines that connect Monterrey, Guadalajara, and Mexico City. Garment firms in the city specialize in the assembly of jeans. Irapuato is not yet a major garment production center, but the development of the local industry exhibits many of the same characteristics as the agglomerations described above, suggesting it is in an earlier stage of the same trajectory.

In the 1940s, two Lebanese immigrants, a Mr. Nazar and a Mr. Tome, founded Irapuato's first garment factories. These shops were among the first industrial enterprises in the region. Nazar had been a manufacturer in Mexico City. He moved the contents of his shop to Irapuato after hearing about the success of other Lebanese immigrants in the nearby state of Michoacán. The local garment industry remained small until the 1960s, when the dramatic rise in the popularity of blue jeans provided new opportunities for the pioneer firms. Nazar closed shop in the early 1970s, but left a lasting imprint on the industry. A number of his former employees used their training and experience to start their own enterprises. Tome's operations have survived. Beginning in the 1960s, he expanded his enterprise by financing the startups of several former employees. The first such venture took place in 1962. Tome entered into a joint venture with Fernando Barba, then a production supervisor who had worked his way up from the shop floor. Tome and Barba have since established several new

shops and in the second generation are linked by marriage.

Tome and Barba rely on subcontractors for most of their production. Many of their subcontractors are located in rural communities surrounding Irapuato. The residents of these communities, and in particular the young women, have few employment alternatives. Rarely do rural subcontracting shops meet fiscal obligations. Local area residents are grateful that the women of the community do not have to travel or move to larger towns to find work. They view client firms like Tome and Barba as conserving the fabric of the community, and often protect subcontracting shops from detection by government officials.

3. The Liberalization of Trade

In 1985, Mexico initiated a process of trade liberalization. Within two years, most trade barriers had been eliminated, or at least drastically reduced. The impact of the opening to trade on the organization of the garment industry has been dramatic. Under the closed economy, the industry was organized around the Mexico City marketing center and served the domestic market. With trade liberalization, both the reference market and the competitive landscape have changed. For all intents and purposes, trade liberalization for Mexico implies integration into the North American economy. The reference market for producers is becoming that of the U.S. Access to markets means producers must develop

contacts with traders in U.S. marketing centers. Mexico City traders face direct competition for control over design and marketing activities from the larger and more sophisticated garment districts of Los Angeles and New York.

This section describes how different agglomerations of firms in the Mexican garment industry are responding to trade liberalization. The effect of trade liberalization upon different regions varies greatly, depending on the function they served under the closed economy.

3.1 The Mexico City Marketing Center

For the Mexico City industry, the opening to trade has meant chaos. Centralized garment distribution networks have provided ready channels for imports. Many traders have shut down their factories and subcontracting operations to become importers.[31] In some cases, relatives in New York, Los Angeles, and Panama assist traders by directing them to foreign buyers and ensuring orders arrive intact and on time. There is a general consensus among retailers that immediately following trade liberalization, importers brought in a poor quality goods.[32] Importers lacked experience in foreign markets and were easy prey for foreign distributors. Limited

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[31] Expansión, April 17, 1991, pp. 72-73.

[32] See "La Industria del Vestido Contraataca," Expansión, 4-11-90, pp. 21-33. R. Benítez, "Estrictos Requisitos de Calidad Cubrirá la Ropa de Importación, El Financiero, 10-22-90, p. 18.

variety in the Mexican market had made them more focused on price than quality. Buyers were not prepared to deal with the variety of goods they faced in foreign markets, and lacked the specialized knowledge necessary to distinguish between different fabric qualities, patterns, and styles. The personalized nature of transactions between retailers and manufacturers in Mexico had also left buyers unprepared to deal with the international garment market. Few importers knew how to ensure proper shipment of goods by adding clauses to letters of credit. Foreign distributors took advantage of novice Mexican buyers. In order to get price discounts, exporters required buyers to purchase orders that were too large for the Mexican market; others sent shipments late; and still others sent damaged goods or wrong sizes. Importers have learned from experience by observing foreign traders and by attending foreign trade and fashion shows.

The producers that remained in the capital during the 1960s and 1970s were mostly those involved in women's outerwear. The importance of fashion makes proximity to a marketing center essential in this market segment. Women's outerwear producers find themselves at a disadvantage in the newly open economy. At the high end of the market, they cannot compete with designs from Paris, Milan, or New York. At the low end of the market, they are undersold by simple products from China. In mid-range markets, they are under greater pressure from competitors in other regions of Mexico.

Satellite communities of subcontractors have felt ripple effects from the troubles of Mexico City manufacturer-traders. Subcontractors rely on traders in the capital to market the goods they assemble. Traders exiting the industry, whether they shut down to become importers or due to increased competition, leave their subcontractors without work. The commercial isolation of satellite communities limits their access to alternative markets.

There have been several industry-wide attempts to respond to the opening to trade. All have been coordinated by the national office of the National Garment Industry Chamber. The National Garment Industry Chamber collects an annual membership fee that is a percentage of each member's sales. There is a national office in Mexico City and local chapters in Monterrey, Guadalajara, Aguascalientes, Tehuacán, Mérida, and Irapuato. Of the 14,000 garment firms in the country, 7,000 belong to the chamber, 3,000 of which are located in Mexico City. The original idea behind industry chambers was to create institutionalized communication channels between business and government.[33] In practice, the principal functions of the national office of the garment chamber have been to communicate relevant information about government decrees to members and to lobby the executive branch on behalf of individual members or groups of members. This role has underscored the importance of good relations between the

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[33] See Story (1986).

chamber and the PRI, the ruling party. Good standing with the PRI appears to be necessary for ascendancy in chamber leadership. Local delegations of the chamber, on the other hand, tend to be more focused on local industry concerns.

The national office of the garment chamber has coordinated two activities to help Mexico City firms adjust to the opening to trade. The idea for the first came from a World Bank-funded study by the Boston Consulting Group, which concluded that Mexican firms needed to export in order to survive. Two problems, according to the study, were impeding the industry from breaking into export markets: firms produced in quantities that were too small for foreign buyers, and firms lacked the ability to make foreign contacts.[34] To remedy this problem, the study recommended creating intermediaries that could group together small firms to produce large orders for foreign buyers. The idea was to replicate a strategy the Italian firm Benetton had followed to great success. The national office, with the financial backing of several government ministries, followed up on this recommendation by creating the Fashion and Design Center. The center was outfitted with German computer-aided-design equipment and computerized cutting equipment at the cost of US$1.5 million.[35] The new technology was intended to eliminate a perceived bottleneck between the design and

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[34] Boston Consulting Group (1988).

[35] Expansión, 4/11/90, p. 27.

assembly stages of production.

Neither the Boston Consulting Group or the national office of the industry chamber consulted the small firms that were the intended beneficiaries of the program, most of which still utilize cardboard patterns in design and simple electrical cutting tools. The center has been in operation for two years. Its client base consists exclusively of medium and large firms; none are exporting. Few small firms have considered using the center's services. The fee structure for computerized cutting favors large batches, and use of the facilities requires fifty percent payment upfront. Firms lack the working capital to make large upfront payments and do not have the technical know-how to utilize the new equipment.

A second activity of the national office has been to lobby the Ministry of Trade and Industrial Promotion to impose tougher restrictions on imported clothing. Local manufacturers of T-shirts and underwear have accused Asian knitwear producers of dumping garments on the Mexican market. In the name of defending Mexican consumers, they proposed import restrictions which would require imported garments to carry a label which provided information on fabric composition, country of origin, name and address of exporter, name and address of importer, and date and location of entry into Mexico. In October, 1990, the import restriction was imposed by presidential decree.[36]

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[36] El Financiero, 4/10/90, p. 36.

There is a widespread belief that President Salinas plans to do away with obligatory membership in industrial chambers. This has caused concern in the national office of the garment chamber. The chamber's leadership believes that there are few services the chamber could provide that would be of interest to large firms, and has decided to focus on the needs of small and medium-size members. To prepare itself for the change, the national office is for the first time surveying members in Mexico City about the services they would be willing to pay for. Members overwhelmingly request two services: contacts with foreign buyers, and worker training programs, including basic programs for seamstresses and intensive courses for skilled workers, such as graders, markers, and designers.

3.2 Production Centers in Outlying Regions

In outlying regions, the opening to trade is viewed much differently. Firms are gaining access to superior designs and far larger markets than were ever available through the Mexico City garment district. Agglomerations of producer firms are de-linking themselves from Mexico City and trying to develop contacts with traders from U.S. marketing centers in Los Angeles and New York. In some cases, provincial firms are trying to use these new opportunities to capture activities that under the closed economy were the exclusive domain of Mexico City firms. This section reviews the experience in four of the regional production centers discussed above.

Monterrey: The Monterrey garment industry is shifting from shirt production into women's outerwear. The owners of new ventures include descendants of the pioneer families, as well as new entrants into the industry. The local industry includes a boutique line of expensive items and an economical line of fashion-oriented items for the popular market. In contrast to the original pioneer enterprises, most firms in the new market segment are small. There are only four women's outerwear manufacturers with more than 100 workers; the rest have between ten and fifteen workers per shop. The growth of the local women's outerwear industry has come at the expense of manufacturers in Mexico City. Numerous industry observers suggest that Monterrey firms are surpassing the capital in design and in quality. The proximity of the U.S. makes Monterrey a testing ground for new fashions. Producers can check which items are doing well in the U.S. market by taking a two-hour trip to visit shopping malls in Laredo, Texas. Consumers are reportedly now more aware of fashion trends and quality standards in the U.S.

The new Monterrey garment firms are forming grupos, similar to those that exist in Guadalajara. New producers of women's outerwear, especially those in high fashion segments, often share information about designs, fabrics, and sewing techniques with a select group of colleagues. The grupos are generally an extension of some existing set of relationships, such as the extended family or long-time acquaintances. These

grupos do not yet actively participate in a more structured organization like the garment industry chamber.

Guadalajara: The Guadalajara industry is also shifting into women's fashions. The local delegation of the National Garment Industry Chamber is playing a key role in this transition. The delegation's principal activity is Exhimoda, a twice yearly trade fair ongoing since 1980. Exhimoda attracts buyers from Mexico, the U.S., and Canada, and has become the largest garment industry event in Latin America. The trade fair helps local firms adjust to the opening to trade. Firms that have lost big clients, like department and supermarket chains, to imports have used the trade fair to develop a new client base, especially among retailers in smaller cities who have less access to foreign goods.

The local industry chamber is consciously promoting regional specialization in women's outerwear. With the decline of the women's outerwear industry in the capital, leaders of the local chamber hope to convert Guadalajara into the new center for women's fashion in Mexico. An agglomeration of manufacturers, they maintain, is more likely to attract the attention of buyers, both domestic and foreign. It also allows them to jointly provide certain public goods. The local chamber reinvests profits from the trade fair in numerous projects. These include an industrial park, a wholesale commercial center with space for 130 garment

manufacturers to display their products, and a design center which allows members to share computer-aided-design equipment.

Aguascalientes: In response to trade liberalization, firms in Aguascalientes have formed an export trading company. The trading company was created in 1986, just after the government announced Mexico was joining GATT. The initiative began as the brainchild of two local manufacturers, but the leadership of the local garment industry chamber convinced them to make it a region-wide activity. The trading company has forty members and organizes groups of five or six firms to produce orders for U.S. buyers. Member firms range from shops with as few as twenty machines to as many as 650. Most of the contracts are through foreign brokers and are for off-shore assembly, not manufacturing. One of the motivations behind the trading company is to help firms make contacts with foreign buyers that are interested in long-term joint ventures. The trading company is currently negotiating projects with two large U.S. retailers.

Many firms that participate in the trade company initially had trouble coordinating manufacturing, which is primarily for the domestic market, and assembly, which is primarily for the U.S. market, in the same plant. Assembly does not require many of the fixed costs that are necessary in manufacturing, such as maintaining personnel to design garments, create patterns, purchase fabrics, and handle sales.

To streamline operations, groups of member firms have established separate assembly plants in the form of joint ventures. So far the trading company has only been able to obtain part-time subcontracting work from U.S. clients. As a result, capacity utilization in the assembly plants remains low. Firms have had to expand the range of products they produce in order to appeal to a broader scope of clients which has created further difficulties in managing assembly.

Tehuacán: Since 1985 the local garment industry in Tehuacán has expanded rapidly, doubling employment from 5,000 jobs to over 10,000 jobs. With the opening to trade, the local industry is becoming an off-shore assembly center for shirts and pants. The sole business class hotel in the city reports that U.S. buyers are visiting Tehuacán at the rate of two or three per month. Tehuacán's two pioneer firms are leading the transition. The contacts they develop with foreign buyers create opportunities for other local firms. Mr. Fernández has five shops dedicated to off-shore garment assembly. The Haddad brothers began to export in 1986, and three of their six plants are dedicated to export production. They began with off-shore garment assembly of jeans for Bugle Boy and Levis-Strauss. After three years, they graduated to private label manufacturing. They purchase the fabric and assemble the garment, and the client firm distributes the final product and provides assistance in quality control.

4. Concluding Remarks

The descriptive analysis of this chapter sets the stage for the theoretical and empirical analysis of following chapters. It raises a basic set of questions about industrialization, geographic concentration, and trade. Knowledge about markets and production do not flow smoothly across space. Localized knowledge tends to contain productive activities within an industrial center. This is especially true where the commercial relationship between regions is limited. Firms do not leave an established agglomeration and open new locations to production until the gains from trade are considerable. The pioneer firms that link regions by trade stand much to gain. They emerge as central figures in the industrialization of undeveloped regions.

As industrial activities disperse across regions, the pattern of geographic concentration that emerges is dictated by the reference market. When the reference market changes, such as through trade liberalization, the existing pattern of industry agglomeration is no longer relevant. Adjustment requires dramatic changes in the organization of the industry. Knowledge in existing industrial centers may be useless for the new reference market, in which case firms must develop a new set of trading relationships. The following chapters provide a careful study of these issues.

2.1 INTERVIEW METHODS AND THE SAMPLE OF FIRMS

Interview data come from 95 firm-level interviews conducted between September, 1990, and May, 1991. Interviews were arranged through five organizations: the National Garment Industry Chamber (78 interviews), Dynamic Consultants to Micro-Enterprises (6 interviews), the September 19th Garment Workers Union (5 interviews), the National Autonomous University of Mexico (2 interviews), and the Authentic Labor Front (2 interviews). Interviews followed a general questionnaire (available on request from the author), but maintained an open-ended format.

The following is a breakdown of the total number of interviews by region and activity:

Mexico City (52)	Number		Number
Garment Industry Chamber:	5	Unions:	4
Fashion and Design Center:	2	Women's Outerwear:	8
Men's Outerwear:	9	Knitwear:	5
General Subcontracting:	3	Retailers/Traders:	11
Other:	5		

Monterrey, Nuevo Léon (13)		Guadalajara, Jalisco (10)	
Women's Outerwear:	6	Women's Outerwear	6
Pants:	2	Other	4
Shirts:	2		
Other	3		

Aguascalientes, Ags (9)		Tehuacán, Puebla (7)	
Children's Outerwear:	5	Pants:	4
Linens:	2	Shirts:	3
Other:	2		

Nezahuacóyotl, Mex (2)		Almoloya del Río, Mex (2)	
Subcontracting:	2	Subcontracting:	2

CHAPTER THREE:

GEOGRAPHY AND TRADE IN MEXICO:

AGGLOMERATION, DISPERSION, AND THE PIONEER FIRM

The Mexican garment industry exhibits a pattern of geographic concentration that is characterized by a number of distinct stages. The industry begins concentrated in a single marketing center. Over time, production activities separate from the marketing center and relocate to periphery regions. A pioneer firm relocates first, and undertakes investments in training workers that are necessary to open a new location to production. The pioneer emerges as the dominant firm in its new location, and instigates the formation of a new production center by financing the startups of former employees. We term this process dispersed agglomeration.

Dispersed agglomeration derives from a basic tension between marketing and production. In marketing, access to information about frequently changing consumer tastes necessitates proximity to concentrated areas of demand. In production, the predominance of low-skill work compels firms to locate the activity in low-wage areas. Translating marketing knowledge into product designs requires a cadre of skilled workers. Opening a new location to production requires initial investments in training design workers, even though these workers comprise a minority of the work force. Marketing knowledge gives firms from the center a first-mover

advantage in relocating production to the periphery. Training costs imply firms delay relocation until wage differentials between the center and the periphery are substantial. A firm's incentive to become a pioneer is temporary monopsony power in the periphery as the sole intermediary through which local agents can transact with the marketing center. Other marketing center firms allow the pioneer to move first, as they benefit by free riding off pioneer investments in later periods.

This chapter develops a theoretical framework to explain the process of dispersed agglomeration we observe in the Mexican garment industry. We focus on the development of the industry in a closed economy; Chapter Five extends this framework to an open economy. The chapter has three sections. Section one presents a series of generalizations about geographic concentration in the Mexican garment industry. Section two offers a theoretical framework to explain dispersed agglomeration. And section three provides concluding remarks.

1. Agglomeration, Dispersion, and the Pioneer Firm

This section presents a series of generalizations about how industry agglomerations form and how they develop over time. The generalizations build on the interview material presented in the last chapter by incorporating data the from the Mexico Industrial Census. Census data make it possible to

verify empirical regularities suggested by interviews, and follow these regularities back in time.

1.1 Industrialization and Geographic Concentration

The agents that pioneer industrialization are individuals with previous experience in marketing. Production and trade begin concentrated in a single marketing center. Industry pioneers divide production into a series of vertical stages, in which they retain control over skill- and knowledge-intensive tasks and subcontract low-skill tasks.

The previous chapter describes the rapid assimilation of immigrant-traders into the Mexican garment industry. The pattern of geographic concentration that resulted is evident in Table 3.1, which provides employment levels for the garment industry, for all manufacturing industries, and the share of employment in each activity located in the Federal District, the federal entity that contains Mexico City. In 1965, the first year for which data comparable to later years is available, 58.7 percent of garment manufacturing employment was located in the Federal District. Garment jobs remained concentrated in the capital until the mid 1970s. Marketing activities were also highly concentrated in the capital. In 1980, 69.8 percent of wholesale trade in garment, textile, and leather goods was conducted in the Federal District.[37]

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[37] Unfortunately, data on commercial activities is only available for 1980.

3.1 THE SHARE OF NATIONAL EMPLOYMENT IN MEXICO CITY, 1965-88

LEVELS/Shares (levels in 000s)	1965	1970	1975	1980	1985	1988
NAT'L GARMENT EMPLOYMENT	75.9	98.5	102.4	144.0	146.8	173.3
Federal District Share	0.587	0.554	0.508	0.447	0.332	0.292
NAT'L MANUFACT. EMPLOYMENT	1,410	1,581	1,708	2,701	3,269	2,473
Federal District Share	0.339	0.311	0.289	0.311	0.230	0.192

As discussed in the last chapter, the immigrant-traders divided garment manufacturing into four vertical stages: fabric purchase, garment design, garment assembly, and marketing. They retained control over fabric purchase, design, and marketing, and divided assembly between their own shops and a large number of small subcontractors. The Mexico Industrial Census offers further evidence of the vertical organization of the industry. Table 3.2 provides a size distribution of garment industry establishments and of manufacturing establishments in general. The 1980 Census lists 12,199 garment establishments that employed 144,346 workers. At one extreme are a small number of large manufacturer-traders. The 250 establishments with 100 or more workers accounted for 43.0 percent of total garment employment. At the other extreme are a large number of very small subcontracting establishments. Of the 12,199 establishments, 7,047 did not employ remunerated labor; the

average shop employed 1.5 workers. Another 2,186 establishments employed between one and five workers.[38]

3.2a SIZE DISTRIBUTION OF MANUFACTURING ESTABLISHMENTS, 1980

ESTABLISHMENT TYPE		NUMBER OF ESTAB.	NUMBER OF WORKERS	SHARE OF TOTAL ESTAB.	SHARE OF TOTAL WORKERS
Total		131,625	2,701,137	--	--
w/ Paid Labor		65,244	2,587,260	0.496	0.957
w/o Paid Labor		66,381	113,877	0.504	0.042
Workers per Estab.	1 to 5	36,266	98,141	0.276	0.036
	6 to 25	16,727	201,735	0.127	0.075
	26 to 100	7,880	395,931	0.060	0.146
	101 +	4,371	1,891,453	0.033	0.700

3.2b SIZE DISTRIBUTION OF GARMENT ESTABLISHMENTS, 1980

ESTABLISHMENT TYPE		NUMBER OF ESTAB.	NUMBER OF WORKERS	SHARE OF TOTAL ESTAB.	SHARE OF TOTAL WORKERS
Total		12,199	144,346	--	--
w/ Paid Labor		5,152	133,831	0.422	0.927
w/o Paid Labor		7,047	10,515	0.578	0.073
Workers per Estab.	1 to 5	2,186	6,188	0.179	0.043
	6 to 25	1,842	22,468	0.151	0.156
	26 to 100	874	43,185	0.072	0.299
	101 +	250	61,990	0.021	0.430

[38] The Census reports that shops with five workers or less accounted for 11.6 percent of garment employment. This is likely a gross underestimate. As discussed in Chapter Two, many small shops are clandestine; they actively avoid government officials, including census takers. An interview I had with a Mexico City subcontractor illustrates this point. After an hour-long interview, during which it became clear I was a foreigner, the subcontractor still believed I was a government inspector and was expecting me to ask for a bribe.

1.2 Vertical Separation and the Dispersion of Production

Over time, the industry disperses: production activities move to outlying regions, while marketing activities remain concentrated in the initial agglomeration. Relocation preserves the pattern of localization: the production of individual goods moves to specific regions, as agglomerations of specialized producer firms are formed. Industry dispersion coincides with the persistence of wage differentials between the center and periphery regions. Wage differentials lessen as relocation proceeds.

Beginning in the 1960s, the share of garment employment located in Mexico City began to fall, as new production centers developed in outlying regions. Initially, this was due to faster job growth in outlying states, but by the 1980s, Mexico City was experiencing a net outflow of garment jobs. Table 3.1 shows that the Federal District's share of garment employment declined from 55.4 percent in 1970, to 44.7 percent in 1980, and to 29.3 percent in 1988.

The exodus of garment jobs from Mexico City coincided with the persistence of wage differentials between the capital and outlying states. Table 3.3 shows the ratio of average nominal state wages to average nominal national wages in the garment industry from 1965 to 1988 for selected states. The table shows figures for states where garment production ultimately relocated; similar wage differentials existed

3.3 RATIO OF AVERAGE NOMINAL STATE WAGE TO AVERAGE FEDERAL DISTRICT WAGE FOR THE GARMENT INDUSTRY, 1965-88

STATE	1965	1970	1975	1980	1985	1988
Aguascalientes	0.518	0.539	0.727	0.750	0.837	0.712
Guanajuato	0.425	0.572	0.463	0.535	0.572	0.630
Jalisco	0.606	0.553	0.693	0.693	0.715	0.716
Nuevo León	1.020	0.981	0.965	0.893	0.949	0.802
Puebla	0.456	0.580	0.595	0.483	0.572	0.612
Tlaxcala	0.083	0.339	0.459	0.569	0.763	0.560

between the capital and all other states. In the decade before garment jobs began to leave the capital, average nominal garment wages in the Federal District were higher than all other states, except the state of Mexico, which borders Mexico City, and Nuevo León, which by that time was already an industrialized state. In 1965, the differentials between the Federal District and the states of Aguascalientes, Guanajuato, Jalisco, and Puebla were approximately two-to-one.

A similar pattern of regional wage differentials exists for manufacturing activities in general (see Table 3.5 following the text). These wage differentials were one feature of a broader process of geographic concentration in Mexico. This pattern is evident in Table 3.1. In 1965, 33.4 percent of Mexico's manufacturing labor force was located in

the Federal District.

The exodus of garment jobs from Mexico City preserved the localized nature of production. This pattern is clearly reflected in Table 3.4, which shows employment levels in six-digit industries for selected states.[39] Between 1970 and

3.4 STATE SHARES OF NATIONAL GARMENT EMPLOYMENT BY SIX-DIGIT INDUSTRY, 1970-85

EMPLOYMNT IN ACTIVITY/ State Share of Total	1970	1975	1980	1985
CHILDREN'S OUTERWEAR	--	4,503	10,782	9,103
Federal District	--	0.649	0.470	0.307
Aguascalientes	--	0.041	0.196	0.444
WOMEN'S UNDERWEAR	9,902	8,945	14,530	10,373
Federal District	0.675	0.508	0.464	0.469
Mexico (state)	0.104	0.126	0.140	0.381
INDUSTRIAL UNIFORMS	--	3,651	6,036	5,717
Federal District	--	0.673	0.570	0.339
Aguascalientes	--	0.001	0.035	0.230
SWEATERS	3,808	4,582	5,416	5,121
Federal District	0.793	0.618	0.583	0.323
Guanajuato	0.038	0.018	0.130	0.154
Mexico (state)	0.029	0.133	0.106	0.161
Tlaxcala	0.003	0.003	0.008	0.110
SHIRTS	10,589	10,218	12,492	9,990
Federal District	0.386	0.384	0.341	0.410
Nuevo León	0.350	0.245	0.247	0.204
Puebla	0.033	0.068	0.089	0.117
WOMEN'S OUTERWEAR	--	16,173	27,704	17,482
Federal District	--	0.750	0.615	0.413
Jalisco	--	0.020	0.065	0.120
Nuevo León	--	0.018	0.020	0.078

1985, production of individual garments relocated from Mexico

[39] The garment industry consists of two four-digit industries: clothing and knitwear.

City to new production centers in outlying states. The figures are at the state level, but in each case production is concentrated in one or two municipalities. Children's outerwear and industrial uniforms have relocated to Aguascalientes, Aguascalientes; women's underwear has relocated to Naucálpan, Mexico; sweaters have relocated to three communities in the states of Guanajuato, Mexico, and Tlaxcala; men's shirts have moved to Tehuacán, Puebla; and women's outerwear continues to move to Guadalajara, Jalisco, and Monterrey, Nuevo León.[40] Other six-digit garment industries (socks, leather apparel, and accessories) are also localized. It is also clear in Table 3.4 that garments have left Mexico City in a particular order. Low fashion garments (underwear and men's shirts) were the first to move, followed by medium fashion garments (sweaters, children's outerwear, and uniforms), and only recently by high fashion garments (women's outerwear). High fashion garments have remained in the capital despite persistent regional wage differentials.

From Table 3.3, it is clear that, as the relocation of garment production has proceeded, wage differentials have fallen between the Federal District and the states where new production centers are located. Wage differentials between the Federal District and outlying states have not been

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[40] In shirts and women's outerwear much of the shift has occurred since 1985, and is not fully evident in Table 3.4. In Tehuacán, for instance, interview data suggest garment employment more than doubled between 1985 and 1990.

eliminated, but have in all cases been substantially reduced.

1.3 The Formation of Industry Agglomerations

New agglomerations are formed by a single pioneer trader from the marketing center. To open a new location to production, the pioneer invests in training local workers. The pioneer initially represents a periphery location's sole access to downstream markets. The pioneer emerges as a dominant firm in his new location and expands production by financing local startups. Local firms ultimately develop independent links with the marketing center.

As Chapter Two illustrates, new garment production centers were initiated by a single trader from the Mexico City garment district. To move design and assembly operations to outlying regions, a pioneer must make two types of initial investments. The first is to train workers in design, pattern-making, and fabric cutting -- activities in which workers require two to three years before they achieve standard levels of productivity. The second is to organize machinists and subcontractors for assembly work. Interview material suggest that pioneers initially hire workers with little or no previous experience in industry. This was true both in urban shantytowns, such as Nezahuacóyotl, and rural areas, such as Tehuacán and Irapuato.

Initially, all individuals in the local garment industry work for the pioneer in some capacity, either as machinists,

subcontractors, or in the skill positions. All local contact with garment retailers and with textile suppliers is through the pioneer. Over time, a new production center grows up around the pioneer, with firms specializing in the activity the pioneer has brought to the periphery. This transformation occurs along one of two paths: through startups by former employees of the pioneer, or through the formation of an ethnic enclave of producers. In both instances, the pioneer supplies venture capital.

The Adopted-Son Strategy: Along this path, the pioneer finances new ventures by adopting former employees into his business empire. The pioneer chooses skilled employees, such as production supervisors or design workers, as his business partners. The pioneer employs a careful screening process in selecting long-term partners. Where the partner is not a family member, the pioneer and partner often become linked by marriage. The pioneer firm in Tehuacán, for instance, has equity investments in a dozen local firms. Similar patterns exist in Aguascalientes, Tehuacán, and Irapuato.

The Ethnic-Enclave Strategy: Along this path, the pioneer invites a relative or associate to move to the region and participate in a joint venture. Word of a pioneer's success spreads within the ethnic community, attracting other entrants. Where entrants come to the region uninvited, they

soon develop ties with the pioneer. The second and third generations of pioneer families fortify family and ethnic ties in the industry, rather than diversify into other activities. They reinvest in family firms, marry within the enclave, and steer business towards in-laws or members of the extended family. An enclave of four families in Monterrey, for instance, owns seven of the ten largest local garment firms and accounts for a total of thirty-five local garment shops. A similar pattern exists in Tehuacán.

Over time, local firms develop independent access to distribution channels. The emerging production center attracts other traders from the marketing center. Local firms capture some marketing activities from the capital, such as wholesale distribution of specific products, but do not fully replace the initial marketing center. This process takes a decade or more. While agglomerations ultimately shed the dominant firm-satellite firm structure, the speed with which this transition occurs varies considerably across locations. In Aguascalientes and Guadalajara, pioneer firms faded quickly into the background; but in Monterrey, Tehuacán, Irapuato, pioneer firms dominated local production for several decades after their arrival.

2. Theory

Section one describes a process of geographic

concentration we term dispersed agglomeration. This section develops a theoretical framework to explain this process. Dispersed agglomeration involves four stages:

1. An initial agglomeration of industry activities.
2. The vertical separation of the industry through the geographic dispersion of production.
3. The relocation of production by pioneer firms.
4. Pioneer financing of industry expansion.

This is not the only pattern one can imagine, nor is it the only one we observe. An exception to this pattern in the study is Aguascalientes, where an agglomeration of garment producers has developed around a local population of artisans whose skills predate industrial production. Marshall (1920) suggests industry agglomerations generally form in regions with a history of artisanship. As we discuss below, it is the lack of such a history that creates a role for a pioneer.

2.1 The Dynamics of Dispersed Agglomeration

Interview material suggest dispersed agglomeration results from the interaction of three factors: (1) knowledge spillovers between firms in marketing activities, (2) a separable production process that requires workers with specific skills, and (3) regional variation in wages, due to some exogenous process. This section explains how these factors give rise to the four distinct stages of dispersed agglomeration. Figure 3.1 provides a graphic illustration.

1. Initial Agglomeration: Knowledge spillovers in

marketing lead firms to agglomerate. Frequent changes in the style of garment consumers demand imply firms must remain abreast of constantly shifting tastes. Firms gain access to information about market conditions by locating near other firms. This occurs indirectly through spying and imitation and directly through open communication between firms. All else equal, firm locate marketing and production together.

Knowledge spillovers are a widely cited characteristic of the garment industry. Lichtenberg (1960), Steed (1981), and Waldinger (1986) describe similar external economies in the New York and Hong Kong garment industries. In low income countries like Mexico style changes are less important than in industrialized countries, but communication costs between locations are higher, due to poor telephone service and inefficient transportation systems.

2. Vertical Separation and Industry Dispersion: Wage differentials between the center and periphery cause the industry to separate. Firms move production, the labor-intensive activity, to low-wage regions, and leave marketing concentrated in the initial agglomeration. Production involves two activities: assembly and design. Marketing knowledge gives traders a first-mover advantage, and it is they that open periphery locations to production.

3. Relocation and the Pioneer Innovation: In a given periphery location, a single trader assumes the role of pioneer. The pioneer makes front-end investments in training

a cadre of design workers and organizing machinists for assembly. Initial training costs imply firms delay relocation until wage differentials become sufficiently large.

The pioneering activities we identify correspond with Leibenstein's (1968) notion of entrepreneurship in developing countries. He suggests the entrepreneur's main function is to create channels for input supply and expand channels for the distribution of output. What sets apart pioneering activities as a distinct form of entrepreneurship is the integration of regions by trade.

An obvious question is, why do periphery workers not invest in acquiring skills themselves? Training in design is general to garment manufacturing and not specific to individual firms. Human capital theory suggests workers should be willing to absorb the costs of general on-the-job training in the form of below market wages during the training period.[41] It is rational for them to do so as training increases their productivity, and hence their expected compensation, in future periods. If design workers paid for their own training, marketing center firms would be willing to relocate production as soon as wage differentials emerged between the center and periphery. In this event, there would be no role for a pioneer and no delay in the spread of industrial production across regions.

A role does exist for a pioneer because periphery workers

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[41] See Becker (1964) and Mincer (1974).

do not perceive design skills to be general in nature. Prior to the pioneer's arrival, periphery workers remain dedicated to local agriculture and have scant contact with any broader industrial economy. To willingly cover the costs of their training, periphery workers must understand how such training affects their future compensation. Nothing in their previous experience allows them to make this sort of calculation; they are unable to internalize the impact training has on their future productivity. If a pioneer wants skilled workers, he is obliged to provide the training himself.

This argument is analogous to Becker's (1964) distinction between general and firm-specific on-the-job training. From the point of view of the firm, design training is general to garment manufacturing. From the point of view of the worker, however, design training is firm-specific. Workers are unwilling to bear the costs of firm-specific training, as this training is of no value to them in the market as they perceive it. During the training period, the pioneer must at least pay workers their alternative wage. The pioneer is willing to cover training costs, as long as he is confident he can inhibit turnover and delay entry by competitors for sufficiently long to recoup his training investments.

A broader interpretation of the pioneer is that of an agent who brings industrial work habits to the periphery. Endowing workers with general industrial skills is a task common to early industrial entrepreneurs. One such example is

that of Josiah Wedgwood, the founder of the British pottery industry.[42] Wedgwood developed a durable form a pottery that could be mass produced, but lacked industrial workers to man his shops. He had to train workers not only in the tasks specific to pottery, but also in the work habits that are essential to industrial production. A similar task faces pioneer firms in the Mexican garment industry: the pioneer must lure workers out of the fields and into the factory before he can identify a cadre of capable workers to train in design activities.

Our view of how agglomerations are formed contrasts with Rotemberg and Saloner's (1990) model of regional specialization discussed in Chapter One. They suggest agglomerations are formed through a sequence of related actions by workers and firms. Firms move to a given location in bunches in order to give workers an incentive to invest in acquiring industry-specific human capital. If a single firm moved by itself, workers, fearful of a solitary firm's monopsony power, would not acquire necessary skills. This framework may be appropriate for some developed country contexts, but does not capture the flavor of the transition Chapter Two describes. Pioneers initiate a fundamental transformation in the organization of economic activity in the periphery. It is only a select group of workers, those in design, that require industry-specific skills. The bulk of

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[42] Langton (1984).

workers are in assembly, who require not so much training as organization; they must be convinced to leave their agricultural activities and join the assembly line. A role for a pioneer exists precisely because workers do not foresee the future stream of benefits industrial work holds for them.

The above discussion begs a second question: why do traders avoid competition over the right to open a given location? Other marketing center traders -- a pioneer's potential competitors -- benefit by delaying entry and free riding off pioneer activities in later periods. Pioneer investments in training create a non-appropriable asset in the periphery. Property rights on skills are by definition vested in workers. A firm considering whether to join a pioneer in the periphery prefers to wait until the pioneer has trained a cadre of design workers and organized workers for assembly. Later entrants can free ride off pioneer investments in training. The incentive for the pioneer to move first is that he enjoys temporary monopsony power in the periphery. The pioneer is the only firm in a given periphery location with knowledge about downstream markets. This makes him the sole intermediary through which local agents can transact with the marketing center. The pioneer also has, at least initially, knowledge about the local labor market that other marketing center traders lack. He knows the abilities of different individuals, and how much training each has received; he may also command some degree of loyalty on the part of periphery

workers. Local knowledge initially inhibits entry by other marketing center traders.

In dispersed agglomeration, the location decision involves investment issues that are similar to an innovation process. At any point in time, the pattern of localization appears Marshallian: firms agglomerate to obtain information about demand conditions and to gain access to skilled design workers. Across time periods, industry location resembles a Schumpeterian (1942) innovation process: short-term rents justify investments in developing a new technology -- which in this case is opening a new location to production -- even though innovating firms know they may be surpassed by later entrants. This type of innovation process has so far only been linked to the development of new products or new production processes, such as the patent race literature surveyed in Tirole (1987) and the Aghion and Howitt (1990) model of growth through creative destruction.

4. Entry Pre-Emption and Rent-Sharing: Training design personnel and organizing assembly workers ultimately reduces relocation costs for other traders. The pioneer is aware of this externality. To pre-empt entry, the pioneer expands his operations through partnerships with former employees or other potential entrants. He chooses business partners from the ranks of his most skilled employees. These are the individuals whose training best equips them to launch their own enterprises. Converting them into partners is a form of

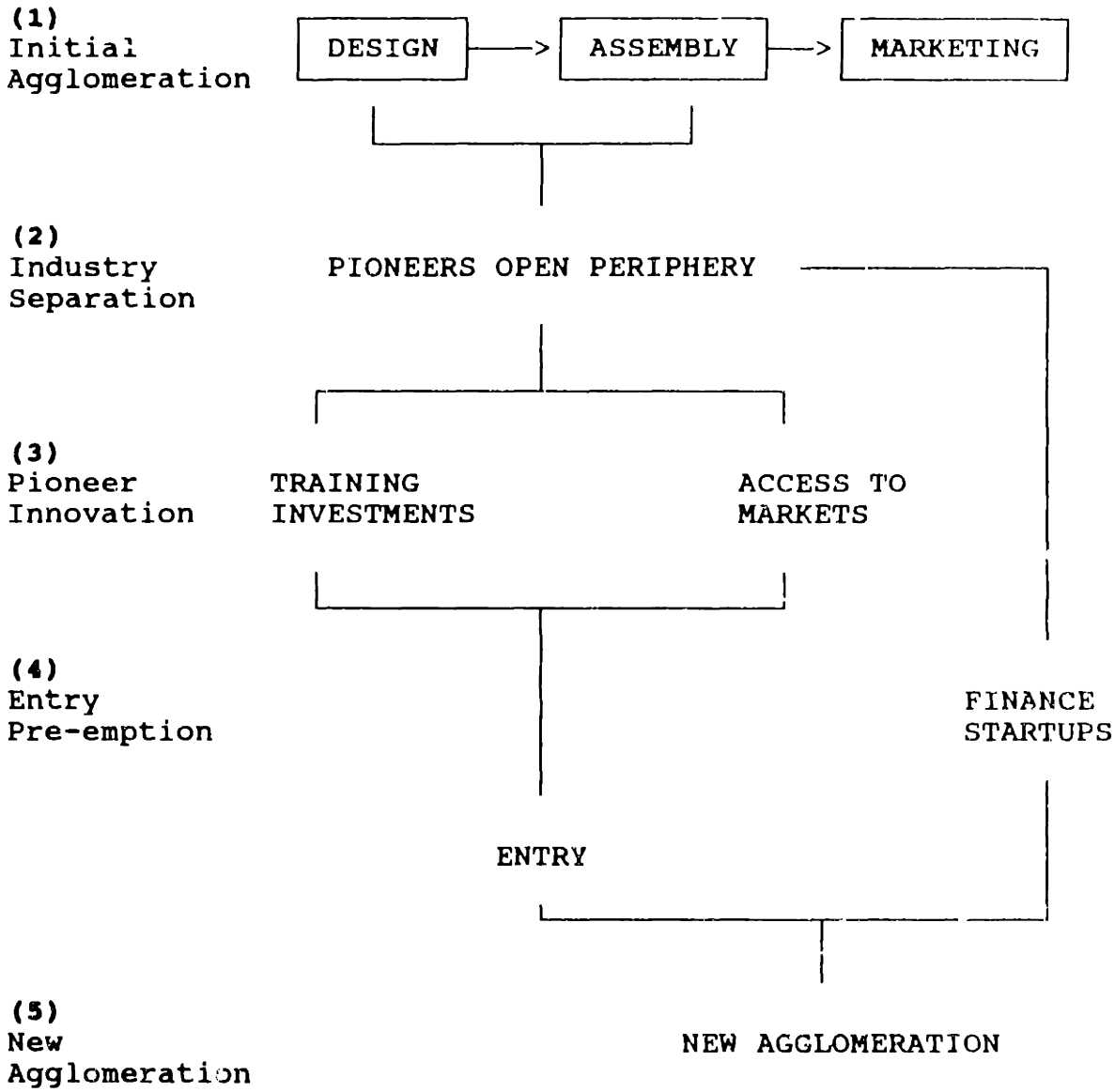
rent-sharing that keeps them from becoming direct competitors. Expanding capacity in the periphery also deters other marketing center firms from relocating to the pioneer's periphery location, but at the cost of bidding up periphery wages. That is, to prevent other marketing center traders from joining him in the periphery, the pioneer must expand his operations until the incentive for them to do so -- a wage differential between the periphery and the marketing center -- is eliminated, or at least substantially reduced. Ultimately, some entry is inevitable, both by periphery workers who have acquired sufficient knowledge to develop direct contacts with the marketing center and by other marketing center traders.

Rent-sharing accounts for a common form of family-based entrepreneurship that is widely cited in the literature, but never fully explained. In this arrangement, a family-owned business group incorporates employees who are often not family members to run new enterprises in return for an ownership stake in the business. Business ties with employee-partners are cemented through direct ties to the family, such as marriage. Piore and Sabel (1984) refer to this type of arrangement as a federated enterprise. A first example is employment practices in Japanese zaibatsu, as described by Hirschmeir and Yui (1981). The zaibatsu were confederations of firms in complementary activities, such as trading, insurance, and mining, that were owned and controlled by a single family. The zaibatsu came into being after the Meiji

Restoration (1868) and reached their apex of economic power in the 1920s and 1930s. Zaibatsu expanded into new lines of economic activity by endowing sons or promising managers from within the enterprise with sufficient capital. Where business partners were not family members, they were treated as adopted sons and often married into the family.

A second example is the systéme Motte, a strategy of family-based enterprise development in the nineteenth century French textile industry described by Landes (1976). At marriage, sons and daughters of textile families received sufficient capital from their parents to establish their own firms. Parents directed children into lines of activity which complemented the family's existing operations, and would often pair their children with a capable technician from their own shops. Over time, fathers, sons, uncles and cousins formed an interconnected web of complementary enterprises. In the zaibatsu and the systéme Motte, children and former employees represent potential competitors whose entry threatens the competitive position of the incumbent family firm. Offering them an ownership stake comes at the cost of shared rents, but ensures that junior members, who have acquired industry-specific skills and knowledge from the incumbant family firm, do not become direct competitors.

FIGURE 3.1
DISPERSED AGGLOMERATION AND INDUSTRY LOCATION



2.2 A Model of Regional Industrialization and Trade

The basic ideas of the last section can be captured formally in a simple model of industry location. We model the location decision as a two-period non-cooperative game between traders, the agents that link regions by trade.[43] The model has three elements:

1. N traders Cournot compete in a single market. There are two periods; in each, traders first choose where to produce and then choose how much to produce. All moves are simultaneous. Demand is given by

$$P = P(Q), \quad P' < 0, \quad P'' \leq 0 \qquad (1)$$

where Q is total industry output.

2. There are three production locations: a Marketing Center and two identical periphery locations. In the center, traders face zero fixed costs and constant marginal costs W. In the periphery, fixed costs are positive and traders Cournot compete for labor services. Marginal costs in periphery location i are

$$MC^i = C(Q^i), \quad C' > 0, \quad C'' \geq 0. \qquad (2)$$

where Q^i is total output produced in location i.

3. Fixed costs in the periphery take the following form: If the location was unoccupied in a previous period, fixed costs equal F for all traders choosing the location that period. In the next period, fixed costs in that location are zero.

The fixed costs are those required in training a cadre of skilled design workers and of organizing assembly workers. Traders do not face fixed costs in the Marketing Center. A history of production in the Marketing Center provides traders

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[43] Dudey (1990) and Eaton and Lypsey (1979) also offer location models based on strategic interaction.

with access to the skilled personnel they need. In periphery locations, there are no skilled workers. Once a trader opens a periphery location, the design facilities he creates are free for all to use. There is a lag in this externality, as traders can only free ride in the period after investments are made, and not within periods. The model involves the unrealistic assumption that training is a one time investment and sufficient for any level of production. The model can be easily complicated by adding additional periods, additional locations, or making fixed costs a function of past output, without altering the basic results. The formation of the marketing center is consciously left in the background to focus on the location of related industry activities.

Under a plausible set of conditions, the following pair of strategies is a Nash equilibrium:

1. One trader chooses a pioneer strategy: he opens a periphery location in period one and remains there in period two.

2. All other traders follow a free ride strategy: they allow the pioneer to enjoy monopsony power in period one and free ride off his investments in period two.

We term this equilibrium the pioneer localization path. We begin in the second period and work backwards. Period two competition depends on location investment decisions made in period one. Before making period one investments, traders look forward to determine how these decisions impact their long-run profit stream.

Period Two Quantity and Location Decisions: Period two competition depends on which of the three possible period one outcomes obtains: both locations are open, one location is open, and neither location is open.

First, consider the case where both periphery locations are opened in period one. In this event, traders can costlessly source production to any location they choose. Equilibrium requires that marginal costs in the periphery are bid up to Marketing Center levels. We assume the level of output at which periphery marginal costs are bid up to W is small relative to total industry output, but not relative to the output of an individual trader. Consider the quantity choice for trader i. If both locations are open, there is no investment decision to be made, and the second period problem reduces to a one-shot Cournot quantity game.

Call the periphery sites Location A and Location B. Let Q be the total output of the N traders, which consists of three components: Q^{mc}, total output in the marketing center; Q^a, total output in periphery location A; and Q^b, total output in periphery location B:

$$Q = Q^{mc} + Q^a + Q^b \qquad (3)$$

Trader i must decide how much output to source to each location. In the Marketing Center, trader i faces zero fixed costs and wage W. Naturally, no trader would choose to source production to a periphery location past the point where marginal costs exceed W. In other words, trader i will choose

q^a such that,

$$W \geq C^a(Q^a) + C^{a\prime}(Q^a)*q^a \qquad (4)$$

given Q^a. Define π^* to be Cournot profits for trader i when all traders face marginal production costs equal to W. If both periphery locations are open, all traders earn symmetric profits π^*. This is shown in an appendix. Entry equates periphery and Marketing Center marginal costs, and traders earn the same level of profits they would have earned had all traders remained in the Marketing Center.

Next, consider the case where Location A is opened in period one, but Location B is not. For Location A, the above logic applies: traders will source production to the open location until marginal costs are bid up to W. Will any trader be willing to open Location B? If no trader opens Location B, all traders earn symmetric profits π^*. Since Location B remained closed during period one, any trader who wishes to occupy Location B in period two must incur fixed costs F. A period two locational Nash equilibrium requires that no additional trader, taking other traders' actions as given, wishes to invest in opening Location B.

Consider the problem of the trader who is deciding whether to become the first pioneer. As a pioneer, he maximizes

$$\max_{q^a} [P(Q) - C^a(q^a)]*q^a \qquad (5)$$

given the output choices of other traders when they face

marginal production costs W. The first order condition for (5) is

$$P(Q) + P'(Q)*q^a - C^a(q^a) - C^{a\prime}(q^a)*q^a = 0 \qquad (6)$$

where we apply the assumption that the pioneer trader's optimal choice of q^a does not bid periphery marginal costs up to W. Since the pioneer's marginal production costs are less than W, he is able to capture market share from the other traders, and earns higher profits that he did in the marketing center. Let π^p be the Cournot profits a first pioneer trader earns in a periphery location when the N-1 other traders face marginal costs W. A trader will be willing to open Location B in period two as long as,

$$\pi^p - F \geq \pi^* \qquad (7)$$

Expression (7) is a necessary condition for any periphery location to be occupied. Whether (7) holds depends on the relationship between F, W, and periphery marginal costs. Suppose W is rising exogenously over time. At some point, W reaches a level where (7) binds and the location process gets under way.

How many traders will choose to occupy Location B in period two? Define π^{**} to be the profits the N-1 traders in the Marketing Center earn when a monopsonist trader occupies Location B. As the Marketing Center traders have higher marginal costs than the pioneer, they earn lower profits than they do in the absence of a pioneer:

$$\pi^* > \pi^{**} \qquad (8)$$

Define π^{pp} to be profits a duopsonist trader earns in Location B when the N-2 other traders face marginal costs W. No second trader will be willing to open Location B in period two if

$$\pi^{**} > \pi^{pp} - F \qquad (9)$$

This will certainly be true if (7) binds and the presence of two traders in a periphery location is sufficient to bid periphery marginal costs up to W. Assume for the moment that (9) holds. The next section explains why we expect this to be the case.

Finally, consider the case where neither location is opened in period one. In this case, a period two locational Nash equilibrium requires that no additional trader, taking the actions of other traders as given, wishes to open a periphery location. If no trader opens a location, all traders earn symmetric profits π^{*}. By (7), it follows that at least one location, say Location A, will be opened. Will Location B also be opened? Let π^{f} be the profits a monopsonist trader earns in Location B, given there is a monopsonist trader in Location A and N-2 traders in the Marketing Center. Location B will remain unopened if,

$$\pi^{**} > \pi^{f} - F \qquad (10)$$

Since periphery marginal production costs are less for a second monopsonist than for a duopsonist,

$$\pi^{f} > \pi^{pp} \qquad (11)$$

or that (9) holds as long as (10) holds.

The Period One Location Decision: In period one, traders make investment decisions before they make quantity decisions. In deciding whether to open a periphery location, they look ahead to period two in order to determine the total profit stream associated with different actions, taking the actions of other traders as given. If both locations are opened in period one, all traders earn symmetric profits $\pi^{\bullet}$ in period two, as entry bids marginal costs up to W in all locations. If only one location is opened in period one, our assumptions imply in period two that one trader earns $\pi^{P} - F$ and N-1 traders earn $\pi^{\bullet\bullet}$. These profit outcomes also obtain in period two if neither location is opened in period one.

Consider the effect of an exogenously rising Marketing Center wage. When W reaches the level where

$$\pi^{\bullet} = \pi^{P} - F \qquad (11)$$

a single trader just becomes willing to open a periphery location. The potential pioneer trader knows that if he opens a periphery location, say Location A, in period one, it will be worth it for some other trader to open Location B in period two. Taking the actions of the other traders in period one as given, and using his perfect foresight about period two, the potential pioneer trader will open Location A if

$$\pi^{P} - F + \pi^{\bullet\bullet} \geq \pi^{\bullet} + \pi^{\bullet\bullet} \qquad (12)$$

which is guaranteed by (11). The left-hand side of the inequality in (12) shows total pioneer profits, which are the sum of first period monopsony profits, fixed costs, and second

period profits when one location is opened in period one, given the N-1 other traders remain in the Marketing Center in period one. The right-hand side represents total profits in the alternative case, in which the trader remains in the Marketing Center during period one and period two. (This implicitly assumes the pioneer ignores the possibility that he is the trader that opens Location B in period two.)

For the pioneer localization path to be an equilibrium, it must be true that, given one trader chooses to be a pioneer in period one, no other trader finds it profitable to simultaneously open Location B or occupy Location A with the pioneer. That is, no trader can want to be a second pioneer monopsonist or a pioneer duopsonist. This will be the case if

$$\pi^{f} - F + \pi^{\bullet} < \pi^{\bullet\bullet} + \pi^{\bullet\bullet} \qquad (13)$$

The left-hand side of the inequality in (13) shows the sum of period one monopsony profits for a second pioneer, fixed costs, and period two profits when both locations are opened in period one, given that in period one a first pioneer opens Location A and the N-2 other traders remain in the Marketing Center. The right-hand side represents the profits a trader earns by remaining in the Marketing Center during period one and period two. (Again, this implicitly assumes the second pioneer ignores the possibility that he opens Location B in period two.) For (13) to hold, (10) must also hold, so our assumptions are consistent.

Combining (12) and (13) yields the following sufficient

condition for the pioneer localization path to be a Nash equilibrium:

$$\pi^p - \pi^* > \pi^f + \pi^* - 2\pi^{**} \quad (14)$$

which rearranges to yield

$$\pi^p - \pi^f > 2[\pi^* - \pi^{**}] \quad (15)$$

The expression in (15) says the loss in profits for the first pioneer monopsonist when a second pioneer opens another periphery location must be greater than twice the loss in profits the representative trader in the Marketing Center endures when a single trader leaves the Marketing Center to become a monopsonist.

Is (15) a plausible condition? An appendix decomposes (15) into market shares, price-marginal cost ratios, and industry revenue to demonstrate the condition is plausible. There is also a clear intuition for (15). When a pioneer leaves the Marketing Center to open a periphery location, he captures market share from the remaining traders. The loss in market share is split among N-1 agents, so the loss in profit an individual trader faces is small relative to the gain in profit for the first pioneer. When a second pioneer opens the other periphery location, he captures market share from the first pioneer and the N-2 traders that remain in the Marketing Center. It is the first pioneer that suffers the greatest relative loss in profits as he now faces a competitor with the same degree of monopsony power. This effect will be most significant when N is large and the capacity of periphery

locations is small relative to industry output.

As long as (15) holds, the pioneer localization path is a Nash equilibrium. Which trader becomes the pioneer and which free ride is indeterminate, as is the order in which the periphery locations are opened. What is determinate is how periphery locations are opened to production. All traders are equally capable of becoming pioneers. Who moves first is determined not by innate characteristics but instead by some random process through which traders gain access to information about conditions in the periphery.

3. Concluding Remarks

An essential feature of industrialization in the creation or expansion of markets. This chapter provides a detailed analysis of the relationship between industrialization, geographic concentration, and regional trade. We identify a dynamic process of industry location we term dispersed agglomeration. Dispersed agglomeration resembles a process of technological change. The innovation, in this case, is opening a new location to production. One firm develops a new technology, while other firms wait, knowing they can free ride in future periods. Agglomeration implies the development of periphery regions is tied to the region where industry first begins. Wage differentials allow periphery regions to pull production out of the center, but not until these differentials have reach impressive levels. When firms from

the center do relocate to the periphery, they bring only activities where external economies are weak, implying regional disparities in industrial composition persist.

The initial pattern of concentration also determines who leads the process of industrialization. It is agents from the center that bring industry to the periphery. The knowledge they accumulate in the center gives them a first-mover advantage over potential entrants in the periphery. These agents remain dominant actors in periphery industry for a considerable period of time. Where history capriciously bestows certain agents with the opportunity to link regions by trade, they stand to capture, at least for a while, the lion-share of gains from trade.

3.5 RATIO OF AVERAGE STATE WAGE TO AVERAGE NATIONAL WAGE FOR SELECTED STATES AND ACTIVITIES, 1965-88

STATE/ activity	1965	1970	1975	1980	1985	1988
FEDERAL DISTRICT						
Manufact.	1.167	1.130	1.087	0.949	1.092	1.100
Knitwear	1.041	1.005	1.083	1.089	1.128	1.088
Clothing	1.212	1.172	1.132	1.201	1.146	1.185
MEXICO (STATE)						
Manufact.	1.224	1.262	1.200	1.217	1.293	1.215
Knitwear	1.378	1.220	1.106	1.269	1.216	1.182
Clothing	1.160	0.999	0.983	1.088	1.269	1.132
AGUASCALIENTES						
Manufact.	0.480	0.517	0.538	0.538	0.637	0.725
Knitwear	0.919	0.573	0.630	0.563	0.537	0.835
Clothing	0.628	0.632	0.823	0.900	0.960	0.844
NUEVO LEON						
Manufact.	1.305	1.270	1.180	1.201	1.191	1.176
Knitwear	0.662	1.038	0.973	1.149	0.748	0.841
Clothing	1.237	1.150	1.093	1.073	1.088	0.951
JALISCO						
Manufact.	0.840	0.881	0.870	0.855	0.613	0.737
Knitwear	0.747	0.857	0.815	0.773	1.108	0.875
Clothing	0.734	0.684	0.784	0.832	0.819	0.848
PUEBLA						
Manufact.	0.813	0.923	0.977	0.914	0.906	0.960
Knitwear	0.466	0.625	0.799	0.875	0.932	0.899
Clothing	0.553	0.679	0.674	0.580	0.743	0.725
GUANAJUATO						
Manufact.	0.586	0.569	0.595	0.707	0.736	0.661
Knitwear	0.536	0.235	0.392	0.291	0.435	0.388
Clothing	0.516	0.670	0.524	0.642	0.655	0.747
TLAXCALA						
Manufact.	0.658	0.491	0.551	0.656	0.863	0.810
Knitwear	0.012	0.377	0.178	0.156	1.255	1.013
Clothing	0.100	0.397	0.519	0.684	0.875	0.663

Source: Censo Industrial, 1981.

APPENDIX

A. Cournot Competition With Two Open Periphery Locations:

Consider the optimization problem for trader i. He chooses how to divide production between the Marketing Center, Location A, and Location B, given the decisions of other traders. For trader i, let q_i be total output, q^{mc}_i be output sourced to the Marketing Center, q^a_i output sourced to Location A, and q^b_i output sourced to Location B, where,

$$q_i = q^{mc}_i + q^a_i + q^b_i.$$

Trader i's period two optimization problem is

$$\max_{\{q_i,\ q^a,\ q^b\}} \quad P(Q)*q_i - W*[q_i - q^a_i - q^b_i] - C^a(Q^a)*q^a_i - C^b(Q^b)*q^b_i$$

where Q is total industry output, and Q^j is industry output sourced to location j. The first order conditions are

$$P(Q) + P'(Q)*q_i - W = 0 \qquad (a.1)$$

$$W - C^a(Q^a) - C^{a\prime}(Q^a)*q^a_i = 0 \qquad (a.2)$$

$$W - C^b(Q^b) - C^{b\prime}(Q^b)*q^b_i = 0 \qquad (a.3)$$

First order conditions for the N-1 other traders are symmetric. Given these 3*(N-1) first order conditions, trader i solves for q_i, q^a_i, and q^b_i. Conditions (a.2) and (a.3) show that each trader sources output to Locations A and B up to the point where periphery marginal production costs equal W, given the output sourced to the location by other traders. For (a.2) and (a.3) to hold, each trader must source the same level of output to each location. Given the symmetry of the problem, all traders choose the same level of output in equilibrium. Denote symmetric Nash equilibrium output levels $\{q^*, q^{a*}, q^{b*}\}$.

Since periphery marginal production costs are bid up to W, profits are the same as the case where the N traders remain in the Marketing Center. Let π^* be symmetric Cournot profits for trader i, which can be written as

$$\pi^* = P(Q^*)*q^* - W*[q^* - q^{a*} - q^{b*}] - C^a(Q^{a*})*q^{a*} - C^b(Q^{b*})*q^{b*}$$

where, $Q^* = N*q^*$, $Q^{a*} = N*q^{a*}$, and $Q^{b*} = N*q^{b*}$.

B. A Sufficient Condition for Pioneer Localization:

The text derives the following sufficient condition for the pioneer localization path to be a Nash equilibrium:

$$\pi^p - \pi^f > 2[\pi^* - \pi^{**}] \qquad \text{(b.1)}$$

It can be shown that (b.1) is plausible, by decomposing the expression into its components parts. Rewrite profits as

$\pi^p = [P(Q^p) - C^a(q^p)]*q^p$ (1st pioneer profits)

$\pi^f = [P(Q^f) - C^a(q^f)]*q^f$ (2nd pioneer profits)

$\pi^* = [P(Q^*) - W]*q^*$ (symmetric Marketing Center profits)

$\pi^{**} = [P(Q^p) - W]*q^{**}$ (Marketing Center profits w/ a single pioneer)

Profits can be written in terms of three components:

$\alpha_i = q_i/Q$ firm i's market share

$L_i = [P - C_i]/P$ firm i's price-cost ratio

$R = P(Q)*Q$ industry revenue

In terms of α_i, L_i, and R, condition (b.1) is

$$L^p\alpha^pR^p - L^f\alpha^fR^f > 2[L^*\alpha^*R^* - L^{**}\alpha^{**}R^p] \qquad \text{(b.2)}$$

First, consider α. It is clear that

$$\alpha^p > \alpha^f > \alpha^* > \alpha^{**} \qquad \text{(b.3)}$$

as this ordering represents decreasing relative monopsony power. It also appears likely that,

$$\alpha^p/\alpha^f > \alpha^*/\alpha^{**} \qquad \text{(b.4)}$$

To see this, note that the fall in market share in going from being the only monopsonist (α^p) to being one of two monopsonists (α^f) is large. α^* and α^{**} can be rewritten as

$$\alpha^* = N^{-1}$$

$$\alpha^{**} = \frac{1 - \alpha^p}{N-1}$$

$$\frac{\alpha^{*}}{\alpha^{**}} = \frac{1}{1-\alpha^{p}} \frac{N-1}{N} \qquad (b.5)$$

For large N, α^{*}/α^{**} approaches one, while α^{p}/α^{f} is likely to be much larger than one.

Second, consider industry revenue, R. Industry output increases with the number of monopsonist firms, as the lower costs of these firms lead them to expand production. Revenue will rise if demand is elastic, which we expect to be the case under Cournot oligopoly, as it is under monopoly. In this case,

$$R^{f} > R^{p} > R^{*} \qquad (b.6)$$

If industry revenue rises at a decreasing rate for each firm that moves to a periphery location, it will be true that,

$$R^{f}/R^{p} < R^{p}/R^{*} \qquad (b.7)$$

If (b.4) and (b.7) hold, (b.1) is plausible.

CHAPTER FOUR:

AN EMPIRICAL ANALYSIS OF AGGLOMERATION EFFECTS IN INDUSTRY LOCATION

This chapter tests the empirical implications of the theory of geographic concentration developed in Chapter Three. The theory predicts that industry location will be determined by the interaction of wage differentials and industry-specific agglomeration economies. The industry we consider involves two distinct activities: marketing and production. In the absence of regional wage differentials, both activities agglomerate in a single location, from which firms serve a national market. Over time, wage differentials emerge between the marketing center and periphery regions. Firms respond by relocating production to the periphery. To open a new location to production, firms must train a cadre of design workers who translate marketing knowledge into designs for a broader production work force. Training costs imply firms delay relocation. Training by first movers reduces setup costs for later entrants. The availability of skilled labor implies that, all else equal, relocating firms prefer "occupied" locations to "unoccupied" locations.

This chapter tests for agglomeration effects in the location decision of Mexican garment firms. The Mexico Industrial Census provides state-level observations on sixteen six-digit garment industries. Using a probit model, we

estimate the probability a location will be occupied as a function of the difference between local marginal production costs and those in Mexico City. Theory suggests agglomeration in a previous period makes a location more attractive in future periods by enhancing the productivity of local workers. The results show positive support for this theory. Agglomeration, by reducing unit labor requirements, raises the probability a location will be occupied in the future.

Two strands of the empirical literature on industry location address agglomeration effects. A first strand studies agglomeration economies using aggregate data on a cross-section of industries. Nakamura (1985) and Henderson (1986) use a production function approach to test for agglomeration economies, in which agglomeration has the effect of Hicks-neutral technical change. Both use data on two-digit industries located in large urban areas (Nakamura with data from Japan, Henderson with data from the U.S. and Brazil); both distinguish between general urbanization economies and industry-specific localization economies; and both find strong support for positive localization economies in a variety of industries.[44] A second strand of the literature uses firm-level data to study the general determinants of firm location, where agglomeration is one factor among many. Carlton (1983, 1979) uses firm-level data on three four-digit U.S. industries

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[44] Nakamura finds evidence of significant localization economies in the garment industry, but Henderson does not.

to examine the location decision of new firms and the location of branch plants by existing firms.[45] Firms choose from a variety of locational alternatives. Using a multinomial logit model, he finds agglomeration at the four-digit level raises the probability a location will be chosen.[46]

The present work makes several contributions. (1) Data from firm-level interviews suggest specific functional forms for production technology and the nature of agglomeration effects. The aggregate approach of Nakamura and Henderson assumes all industries use a general production technology that varies only in terms of the magnitude of certain parameters. (2) The Mexico Industrial Census provides data at the six-digit level on all establishments in a single two-digit industry. This allows us to makes use of the information implicit in the fact that some locations remain unoccupied.

The chapter has five sections. Section one provides an empirically tractable model of industry location. Section two describes the data. Section three presents estimation

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[45] The industries are Fabricated Plastics (SIC 3079), Communication Transmitting Equipment (SIC 3662), and Electronic Components (SIC 3679).

[46] Related work studies a variety of issues. On new plant location see Bartik (1989), Schenner, Huber, and Cook (1987)); on firm migration see Nakosteen and Zimmer (1987); and on intra-urban locational choice see Erickson and Wasylenko (1980), McGuire (1985). There is also a vast literature on the impact of tax rates on firm location; see Bartik (1990) and Papke (1989) for recent work.

results. Section four uses the results to predict the probability a location will be occupied for given wage differentials and levels of agglomeration. And section five offers concluding remarks.

1. An Empirical Model of Industry Location

Chapter Three discusses agglomeration in the initial stages of industrialization. Data limitations require we study the industry during the period 1980 to 1985. By this point in time, most pioneering activity had taken place in the industry and garment manufacturing had become widespread in Mexico. Pioneers in some regions had been in place for several decades. We are limited to an empirical analysis of industry location in the aftermath of pioneering activities. There are a host of interesting questions the Census data do not allow us to address: What causes some pioneers to succeed and others to fail? Are there noticeable differences in industry development between the adopted-son and ethnic-enclave paths? What distinguishes an outlying region's ability to capture distribution activities?

It is likely the nature of competition between firms in the industry has evolved with industrialization. We make the simplifying assumption that the post-pioneer phase of industry development is characterized by perfect competition. Under perfect competition, the location decision can be studied from the point of view of the representative firm. Firms choose

location to minimize total costs. In garment manufacturing, the basic production unit is a single worker, a single sewing machine, and a given amount of fabric. A natural assumption is that production technology is Leontief. Marginal production costs for industry j in location i are

$$C_{ij} = a_{Lj}w_i + a_{Kj}r_{ij} + a_{Fj}f_{ij} \qquad (1.1)$$

where w_i is the wage in location i, r_{ij} is the rental cost of capital for industry j in location i, f_{ij} is the cost of fabric for industry j in location i, and the a's are unit factor requirements.

Labor markets are regional in nature, but markets for machinery and fabric appear to be national in scope. In Mexico, virtually all industrial sewing machines are imported and fabric comes from a few concentrated textile production centers. Both inputs are distributed through the Mexico City marketing center. Unit capital and fabric costs can be expressed as the sum of a base price and unit transport costs:

$$r_{ij} = r_{bj} + r*z_i*d_i$$

$$f_{ij} = f_{bj} + f*z_i*d_i \qquad (1.2)$$

where r_{bj} and f_{bj} are base input prices in industry j, z_i is transport costs per unit distance to location i, d_i is the distance from the marketing center to location i, and r and f are input-specific scale factors that do not vary across industries. As data are available at the state level, we refer to locations as states.

Interview data discussed in Chapter Three suggest

agglomeration expands the local skill base in design activities.[47] This has the effect of making existing assembly-line workers more productive. In terms of the model, agglomeration reduces unit labor requirements. Interview data also suggest agglomeration effects operate with a lag. It takes some time before training provided by one firm has an effect on the local skill base. This can be captured by making unit labor requirements in one period a function of agglomeration in the previous period. An appropriate measure of agglomeration is the number of six-digit establishments in a given location. There are two reasons for this choice: training occurs at the firm level and design skills are specific to individual products.

Define E_{ijt-1} to be the number of industry j establishments in state i at time t-1. We write unit labor requirements for state-industry ij at time t as a decreasing linear function of E_{ijt-1}:

$$a_{Lij} = \alpha_{Lj}(1-\alpha_{Ej}*E_{ijt-1}) \qquad (1.3)$$

Incorporating (1.2) and (1.3) into (1.1), marginal production costs at time t for state-industry ij are

$$C_{ijt} = \alpha_{Lj}(1-\alpha_{Ej}*E_{ijt-1})w_{it} + a_{Kj}(r_{bjt} + r*z_{it}*d_i) + a_{Fj}(f_{bjt} + f*z_{it}*d_i) \qquad (1.4)$$

A serious issue for estimation is the potential

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[47] From Chapter Two, design includes three activities: converting garment sketches into workable patterns; grading patterns according to different garment sizes; and using graded patterns to cut fabric into ready-to-assemble pieces.

endogeneity of wages. The wage may be related to past industry agglomeration. Local labor demand is a function of current industry agglomeration, and current agglomeration is associated with past agglomeration. The state wage will be independent of local garment production where the local garment labor force is small relative to the local manufacturing labor force. As this is the case for most states during the time period under study, it is reasonable to assume from the firm's perspective that w_{it} and E_{ijt-1} are exogenous at time t.

The second component of costs is the expense of transporting final goods to market. Firms in one state can potentially export to consumers in any other state. With 32 states, there are 496 distinct trading routes. The existing organization of the industry implies the actual trading system in the Mexican garment industry is much simpler. Chapters Two and Three make clear that the garment district in Mexico City functions as the country's garment marketing center; in 1980, 69.8 percent of wholesale trade in garments and textiles took place in the Federal District.[48] A reasonable simplifying assumption is that all states trade through the capital. In this case, total transport costs for industry j are

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[48] The Federal District is the federal entity that contains Mexico City. We use Federal District activity levels to approximate those in the capital. This is an imperfect measure given that the capital has spread into the neighboring state of Mexico.

$$\sum_{i=1}^{N} (z_i * d_i) * M_{ij} \qquad (1.5)$$

where $z_i * d_i$ are unit transport costs from state i to Mexico City and M_{ij} is net shipments from Mexico City to state i for industry j (all variables are for time t, unless otherwise noted; denote Mexico City by i=1). Assume per distance unit transport costs are equal for all industries in a given state.

The stylized decision framework of this model can be described in the following manner. Each period, firms observe the realization of state manufacturing wages as the result of some exogenous process. From the wage, they calculate marginal production costs in each location, based on their knowledge of how many firms located in each state during the previous period. Firms then choose to serve a given market from the location where production costs, inclusive of transport costs, are lowest.

Let D_{ij} be demand for product j in state i, and Q_{ij} be output of j in i. Total costs for industry j are

$$\sum_{i=1}^{N} C_{ij} * Q_{ij} + \sum_{i=1}^{N} (z_i * d_i) * (D_{ij} - Q_{ij}) \qquad (1.6)$$

where $D_{ij} - Q_{ij}$ replaces M_{ij}. Industry output is subject to two constraints. Output in state-industry ij must be non-negative and total industry supply must satisfy total industry demand:

$$Q_i \geq 0, \qquad i = 1, \ldots, N$$

$$\sum_{I=1}^{N} (Q_i - D_i) \geq 0, \qquad (1.7)$$

Minimizing (1.6) with respect to Q_{ij} subject to (1.7) yields the following Kuhn-Tucker conditions:

$$\begin{aligned} C_{1j} + \mu_{1j} - \delta_j &\leq 0, && \text{c.s. } Q_{1j} \\ C_{ij} - z_i * d_i + \mu_{ij} - \delta_j &\leq 0 \quad i=2,\ldots,N, && \text{c.s. } Q_{ij} \end{aligned} \qquad (1.8)$$

where μ_{ij} is the multiplier on Q_{ij}, δ_j is the multiplier on excess demand, and c.s. stands for complementary slackness. With no excess demand, δ_j is positive and has the obvious interpretation as the market price. There will be a corresponding set of Kuhn-Tucker conditions for each industry.

For industry j, the solution to (1.8) involves a production plan in which the market in each state is served from the location that has the lowest marginal costs, inclusive of transport costs. In principle, it is possible to serve the entire country from a single location (indeed, the Mexico City production center served most of Mexico for several decades). State-industry ij will have zero production if there is some other state k where

$$C_{ij} - z_i * d_i > C_{kj} + z_k * d_k \qquad (1.9)$$

That is, state-industry ij will have zero production if it is cheaper to serve consumers in state i from an alternative location. If the alternative location is not Mexico City,

this would involve transport from state k to Mexico City, at unit transport cost z_k*d_k, and transport from Mexico City to state i, at unit transport cost z_i*d_i.

We make the following crucial assumption: the relevant alternative location for all state-industries is Mexico City. In this case, state-industry ij will be occupied only if

$$C_{ij} - z_i*d_i \leq C_{lj} \qquad (1.10)$$

That is, a state-industry will have positive production if it is cheaper to satisfy state demand locally than from Mexico City.[49] Interview data presented in Chapters Two and Three suggest this assumption is reasonable. Provincial locations are opened to production by firms from the Mexico City garment district. Commercial contacts with the Mexico City marketing center are necessary for a firm to initiate garment production, making marketing center firms the natural first-movers. The progressive geographic decentralization of the industry is likely to change this pattern, but the centrality of the Mexico City marketing center is a valid working assumption for the period of time period under study.

The decision to open a state to production is amenable to discrete choice analysis. Define the dummy variable y_{ij}:

$$y_{ij} = 1 \qquad \text{if } Q_{ij} > 0$$

$$y_{ij} = 0 \qquad \text{otherwise} \qquad (2.1)$$

Redefine marginal production costs as

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[49] Technically, Mexico City is the relevant alternative location if there is no state l where $C_{lj} + z_l*d_l < C_{lj}$.

$$C_{ij} = \alpha_{Lj}(1-\alpha_{Ej}*E_{ijt-1})w_i + a_{Kj}(r_{bj} + r*z_i*d_i) + a_{Fj}(f_{bj} + f*z_i*d_i) + \epsilon_i \quad (2.2)$$

where ϵ_i represents unobserved factors that affect marginal costs in state i. Assume ϵ_i is normally distributed with mean zero and variance σ^2. The probability a location will be open to production is

$$\text{Prob}(Q_{ij} > 0) = \text{Prob}(C_{1j} \geq C_{ij} - z_i*d_i) \quad (2.3)$$

In this framework, the decision is whether to locate in state i or remain in Mexico City. For each state, J industries make this decision and each decision involves a realization of ϵ_i. There is no necessary reason why the process that generates ϵ is the same across states. This fact presents potential problems for estimation.

For industry j, the difference in marginal production costs between Mexico City and state i is

$$\begin{aligned} C_{1i} - [C_{ij} - z_i*d_i] &= [\alpha_{Lj}(1-\alpha_{Ej}*E_{1jt-1})w_1 + a_{Kj}*r_{bj} + a_{Fj}*f_{bj} + \epsilon_1] \\ &\quad - [\alpha_{Lj}(1-\alpha_{Ej}*E_{ijt-1})w_i + a_{Kj}(r_{bj} + r*z_i*d_i) \\ &\quad + a_{Fj}(f_{bj} + f*z_i*d_i) + \epsilon_i - z_i*d_i] \\ &= \alpha_{Lj}(w_1 - w_i) - \alpha_{Ej}(E_{1jt-1}*w_1 - E_{ijt-1}*w_i) \\ &\quad + z_i*d_i(1 - a_{Kj}*r - a_{Fj}*f) + \epsilon_1 - \epsilon_i \end{aligned} \quad (2.4)$$

The expression for transport costs has several interpretations. Transport costs represent the additional cost of transporting inputs from the marketing center to outlying regions. An equivalent interpretation is that these

costs represent the per unit costs of opening a location to production. Note that the cumulative expression for transport costs has an ambiguous sign: as distance from the marketing center increases, the unit costs of shipping goods from the marketing center rise, but so do the unit costs of non-labor inputs for local producers.

For expositional ease, redefine the marginal cost differential according to observed and unobserved factors

$$C_{1j} - (C_{ij} - z_i * d_i) = (X_{1j} - X_{ij})\beta + \epsilon_1 - \epsilon_i \qquad (2.5)$$

where $(X_{1j} - X_{ij})$ is a 1x3 vector of factor price differences and β is a 3x1 vector of parameters. The probability a state has positive production becomes

$$\text{Prob}(Q_{ij} > 0) = \text{Prob}[\epsilon_i - \epsilon_1 \leq (X_{1j} - X_{ij})\beta] \qquad (2.6)$$

In terms of the standard normal cumulative distribution function, (2.6) is

$$Prob(Q_{ij} > 0) = \Phi[(X_{1j} - X_{ij})\beta/\sigma)] \qquad (2.7)$$

The coefficients can be estimated using maximum likelihood. The resulting coefficient estimates are of β/σ and not β alone.

2. The Data

The data come from the 1980 and 1985 Mexico Industrial Census. The Census aggregates over establishments at the state and six-digit industry level. There are 32 states in Mexico. The garment industry consists of two four-digit

industries and sixteen six-digit industries:

Four-Digit Industry	Six-Digit Industry
Knitwear	Socks and Hosiery
	Sweaters
	Knitted Underwear
	Knitted Fabric
	Knitted Outerwear
Clothing	Men's Outerwear
	Women's Outerwear
	Shirts
	Industrial Uniforms
	Leather Clothing
	Children's Outerwear
	Other Outerwear
	Women's Intimate Apparel
	Underwear
	Sombreros, Hats
	Accessories

The Census provides observations on a number of variables, including the number of establishments, number of workers, total operating costs, total revenue, total remuneration, value of total output, raw material in stock, and value of fixed capital. There is no direct data on unit factor costs.

Census data always present problems for empirical research; these problems are acute in developing countries. One concern is that the Census aggregates over both firms and municipalities. Interview data suggest firms are heterogeneous. Aggregating over establishments ignores inter-firm differences. Industry agglomerations are located in municipalities, not states. Aggregating over municipalities bunches agglomerations together. This is fortunately not a serious problem in most states. In Aguascalientes and Nuevo León, for instance, virtually all manufacturing is located in

each state's largest city, making state-level data essentially equivalent to municipality-level data. In other states, the effects of aggregation across municipalities is ameliorated by the fact that different industries are agglomerated in different municipalities. In Puebla, for instance, shirt production is concentrated in Tehuacán, while knitwear production is concentrated in the city of Puebla.

A more fundamental problem is with the collection of Census data. A significant share of garment industry employment -- some industry observers say as much as half -- takes place in clandestine establishments. Clandestine shops do not meet fiscal obligations or comply with labor regulations, and go out of their way to avoid detection by government officials, including census takers. As a result, Census data may be drawn disproportionately from larger establishments. Once a census taker locates an establishment there is no guarantee he will obtain an accurate account of its contents. The range of accounting practices in the industry is considerable. Some managers have graduate business degrees and maintain computerized accounts of their operations. Many small shopowners, in contrast, do not even keep records of their transactions. They know what orders are currently in the pipeline, but can only hazard a guess at the annual value of their activities. In the absence of prior knowledge about how detection of clandestine firms varies across states or industries we are powerless to correct for

these potentially serious errors in data collection.

3. Estimation

The expression in (2.7) can be estimated as a probit model using maximum likelihood. The likelihood function is

$$L(\beta,\sigma) = \prod_{j=1}^{J} \Phi[(X_{1j}-X_{ij})\frac{\beta}{\sigma}]^{y_{ij}}(1-\Phi[(X_{1j}-X_{ij})\frac{\beta}{\sigma}])^{1-y_{ij}} \qquad (3.1)$$

The unit of analysis is the decision and not the decision-maker. The decision to be studied is whether a state will be open to production. The technically correct approach is to consider each of the 31 states separately and estimate a separate probit model for each. This limits the number of observations to 16 per state. A more serious problem is that observations for a number of states are either all "successes" (j's where $Q_{ij} > 0$) or all "failures" (j's where $Q_{ij} = 0$). One solution is to group states and estimate the location decision in a single probit. This approach has theoretical appeal on two counts: the location decision for each state is the same -- produce in state i or produce in Mexico City; and technological parameters should not vary across states (or should not vary in a way for which we cannot systematically account). Grouping states increases the number of observations to 496, a substantial gain. Grouped estimation is unwarranted if σ varies across states. ϵ includes

unobserved factors that affect marginal costs. All relevant economic information should be contained in the wage and agglomeration variables, leaving no obvious functional form for σ.[50]

A sensible solution is to proceed as follows.[51] First, estimate (2.7) on grouped data. The likelihood function is

$$L(\beta,\sigma)=\prod_{j=1}^{J}\prod_{i=1}^{N}\Phi\left[(X_{1j}-X_{ij})\frac{\beta}{\sigma}\right]^{y_{ij}}\left(1-\Phi\left[(X_{1j}-X_{ij})\frac{\beta}{\sigma}\right]\right)^{1-y_{ij}} \tag{3.2}$$

Second, estimate (2.7) separately for each state. This will be possible only for states where there are both successes and failures. β is a vector of technological parameters that we expect does not vary across states. The estimated coefficients are of β/σ and not β alone. A σ that is constant across states implies both the estimated coefficients and their ratios should be the same for each state. An informal test of a constant σ is to compare the coefficient estimates and their ratios from the individual state probits with those from the grouped probit.

The dependent variable is $\mathbf{OPEN}_{ij}$, which is defined as follows:

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[50] Dealing with non-constant variance in ϵ is not as simple as in OLS, where one can often postulate a relationship between σ and right-hand-side variables.

[51] Bruno Boccara provided key advice on estimation, including suggesting this approach.

$OPEN_{ij} = 1$ if $Q_{ij} > 0$ in 1985

$OPEN_{ij} = 0$ otherwise (3.2)

OPEN takes a value of one if state-industry ij had output greater than zero in 1985 and zero otherwise. The explanatory variables are the difference between marginal production costs in Mexico City and marginal production costs less transport costs in state i. From (2.3), $Prob(OPEN_{ij} = 1)$ is equal to the probability that the difference in total marginal cost between Mexico City and state i for industry j is greater than zero. From (2.4), the cost difference is

$$C_{1i} - [C_{ij} - z_i*d_i] = \alpha_{Lj}(w_1 - w_i) - \alpha_{Ej}(E_{ijt-1}*w_1 - E_{ijt-1}*w_i) + z_i*d_i(1 - a_{Kj}*r - a_{Ej}*f) + \epsilon_1 - \epsilon_i \quad (3.3)$$

The wage variable is $\mathbf{WGE}_i$, average annual remuneration in 1985 per manufacturing worker in state i. The measure of agglomeration is $\mathbf{EST}_{ijt-1}$, the number of establishments in state-industry ij in 1980. The measure of transport costs is $\mathbf{BUSHRS}_i$, distance in hours of bus travel from the capital of state i to Mexico City; this is a more accurate measure of transport costs than miles since the quality of roads vary greatly across states. Table 4.1 lists variable means.

The estimated model is

$$Prob(Q_{ij} > 0) = Prob(\beta_0 + \beta_1(WGE_1 - WGE_i) + \beta_2(WGE1*EST_{ijt-1} - WGE_i*EST_{ijt-1}) + \beta_3 BUSHRS_i \geq u_{ij}) \quad (3.4)$$

where the error term is

$$u_{ij} = \epsilon_{ij} - \epsilon_{ij} \qquad (3.5)$$

Consistent with (3.3), we expect β_1 to be positive, β_2 to be negative, and β_3 to be either positive or negative.

Technological parameters may vary across industries. We control for industry effects at the four-digit level with the variable **IND**, which takes a value of one if the activity is in the knitwear industry and zero is the activity is in the clothing industry. It is likely other factors that affect marginal costs, such as transportation and communication facilities, vary across regions. We control for regional effects with a second set of dummy variables distinguishes between five regions in Mexico:

Region	States
BRD (Border):	Baja California, Coahuila, Chihuahua, Nuevo León, Sonora, Tamaulipas.
CEN (Center):	Guanajuato, Hidalgo, México, Querétero, Puebla, Tlaxcala, Veracruz.
NOW (Northwest):	Baja California Sur, Nayarít, Sinaloa.
NCEN (North-Central):	Aguascalientes, Durango, Jalisco, San Luís Potosí, Zacatecas.
SOU (South):	Campeche, Colima, Chiapas, Guerrero, Michoacán, Morelos, Oaxaca, Quintana Roo, Tabasco, Yucatán.

A widely used measure of goodness of fit is ρ^2:

$$\rho^2 = 1 - LL(\beta_{MLE})/LL_0 \qquad (3.6)$$

where $LL(\beta_{MLE})$ is the log-likelihood of the unconstrained regression and LL_0 is the log-likelihood of the regression where all coefficients are constrained to be zero.[52] A related measure is ρ^2 corrected for degrees of freedom, or

$$\bar{\rho}^2 = 1 - (LL(\beta_{MLE}) - k)/LL_0 \qquad (3.7)$$

where k is the number of estimated coefficients.

Table 4.2 gives probit estimates for grouped data. Column (1) shows estimates of unit labor requirements and transport costs, without agglomeration effects. Column (2) includes $BUSHRS_i^2$, bus hours squared, to test for nonlinear transport costs. The coefficient on $BUSHRS_i^2$ is significant and the variable is included in subsequent estimation. Column (3) includes the agglomeration effects variable, $WGE_i*EST_{ijt-1} - WGE_i*EST_{ijt-1}$. The coefficient estimate for agglomeration effects has the wrong sign, and is not significant. Column (4) adds right-hand-side variables interacted with IND, to test whether technology parameters vary across four-digit industries. We reject the null hypothesis that technology is constant across four-digit industries at a 5% level of significance; allowing technology to vary across industries improves the goodness of fit moderately. Column (5) includes regional dummies, which improve the goodness of fit substantially.

The results on agglomeration effects are disappointing.

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[52] See Amemiya (1981) for a discussion of goodness of fit in discrete choice models.

One problem with the estimation reported in Table 4.2 is that the coefficient on agglomeration effects is constrained to be the same for Mexico City as it is for outlying states. This is consistent with the model, but it may be inconsistent with reality. The impact of past agglomeration is likely to be markedly different in the marketing center, where the industry has a long history, than it is in outlying regions, where garment production is a relatively new activity. We estimate a second probit model in which the coefficient on agglomeration effects is allowed to be different for outlying states. This model is

$$\begin{aligned} \text{Prob}(Q_{ij} > 0) = \text{Prob}(&\gamma_0 + \gamma_1(WGE_1 - WGE_i) + \gamma_2 WGE1*EST_{1jt-1} \\ &+ \gamma_3 WGE_i*EST_{ijt-1} + \gamma_4 BUSHRS_i + \gamma_5 BUSHRS_i^2 \geq u_{ij}) \end{aligned} \tag{3.7}$$

Consistent with (3.3), we expect to be γ_1 and γ_3 to be positive, γ_2 to be negative, and γ_4 and γ_5 again to be either positive or negative.

Table 4.3 shows results for the unconstrained probit. The change is striking. We reject the null hypothesis that $\gamma_2 = -\gamma_3$ at any level of significance. Agglomeration effects enter with the correct sign and are highly significant. These results are unaffected by allowing technology to vary across industries or by introducing regional dummies. What is most impressive is that the unconstrained model dramatically improves the goodness of fit. Comparing constrained and unconstrained estimation with industry and regional effects --

column (5) in Table 4.2 and column (3) in Table 4. 3 -- ρ^2 rises from .184 to .384.

Questions remain about using grouped data. Tables 4.4 and 4.5 provide probit estimates for individual states. Bus hours and the wage differential are excluded from the estimation, as both are constant across industries in a given state. Table 4.4 shows probit estimates where agglomeration effects are constrained to be constant across locations. The coefficient on agglomeration effects has the correct sign in 13 of 26 states, but is significant in none. The table includes the ratio of the estimated coefficient on agglomeration effects to the coefficient on the constant term. Both the coefficient estimates and their ratios vary widely across states, suggesting that grouping states is unwarranted.

Table 4.5 provides probit estimates for individual states where the coefficient on agglomeration effects in outlying states is allowed to be different from Mexico City. Again, the unconstrained results are positive. The coefficient on agglomeration effects in outlying states has the correct in every case. The coefficient on agglomeration effects in Mexico City has the correct sign in 13 of 20 states. The table also reports the ratio of the coefficients on agglomeration effects. Again, both the coefficient estimates and their ratios vary widely across states, raising further questions about using grouped data for estimation.

4. Prediction

It is interesting to know not just whether agglomeration effects matter, but how much they matter. A useful feature of the probit model is that it allows straightforward prediction of the probabilities that a particular event occurs for given values of the explanatory variables. To generate interesting results, we need to use parameter estimates from the grouped model. The results of the last section suggest there may be problems with grouped results. We must qualify our results in this section, but it is still interesting to know what estimation implies in broad terms for industry location.

This section uses grouped estimation results to address two questions: what is the effect of marginal changes in explanatory variables on the probability firms occupy a location; and, for given values of the explanatory variables, what is the predicted probability firms occupy a location. Table 4.6 reports the effects of marginal changes in the explanatory variables on the probability that a location is occupied. The effect of a change in X_{ij} on $Prob(Q_{ij} > 0)$ is

$$\frac{\delta Prob(Q_{ij} > 0)}{\delta X_{ij}} = \frac{\delta \Phi [(X_{ij}-X_{ij}) \frac{\beta}{\sigma}]}{\delta X_{ij}} = \phi [(X_{ij}-X_{ij}) \frac{\beta}{\sigma}] * \frac{\delta (X_{ij}-X_{ij}) \frac{\beta}{\sigma}}{\delta X_{ij}} \tag{4.1}$$

where $\phi()$ is the density function of the standard normal. The estimated coefficients are those from column (2) in Table

4.3.[53] The corresponding probit model is

$$\begin{aligned}\text{Prob}(Q_{ij} > 0) = \text{Prob}(&\gamma_0 + \gamma_1(WGE_l - WGE_i) + \gamma_2 WGE1*EST_{ljt-1} \\ &+ \gamma_3 WGE_i*EST_{ijt-1} + \gamma_4 BUSHRS_i + \gamma_5 BUSHRS_i^2 \\ &+ IND*[\gamma_6(WGE_l - WGE_i) + \gamma_7 WGE1*EST_{ljt-1} \\ &+ \gamma_8 WGE_i*EST_{ijt-1} + \gamma_9 BUSHRS_i] \geq u_{ij})\end{aligned} \tag{4.2}$$

As the value of $\phi()$ varies with the value of $(X_{li} - X_{ij})\beta/\sigma$, so does the effect of a marginal change. A natural criterion for selecting values of right-hand-side variables is the predicted probability associated with their cumulative total. Table 4.6 shows marginal effects, given probabilities that range from .1 to .9. The magnitude of marginal effects varies widely across variables. This is due to the fact that the underlying variables take on different magnitudes.[54] The effects of small change in wages, for instance, appear to be substantial, but not when it is taken into account that wages take on a value that is near one.

Table 4.6 contains three findings of interest:

1. A small increase in the number of establishments occupying a location in the previous period raises the

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[53] Column (2) does not include regional dummies. The coefficient estimates are for the clothing industry; calculations with coefficient estimates for the knitwear industry yield similar effects.

[54] The fact that marginal effects are largest for a probability of 0.5 is an implicit feature of the form of the cumulative normal distribution function.

probability the state will be occupied in the next period by as much as 8.7 percent. This suggests there is a herd effect in relocation: once a location has been open to production, other producers follow quickly. Marketing center firms do not wait until a sizable agglomeration of producers has emerged before relocating production. This is not inconsistent with the theory of the last section. It only takes a single industry pioneer to open the way for other firms to follow.

2. A small decrease in the number of industry establishments located in Mexico City increases the probability a state will be open to production by at most .076 percent. This suggests there is no herd effect in departure. Once firms have begun to leave an industry agglomeration in Mexico City, it does not appear that other firms rush to move.

3. A small increase in distance (where the distance variable is comparable in magnitude to the agglomeration variable) at most reduces the probability a state will be occupied by 1.18 percent. It appears that distance from the marketing center does not play a large role in determining whether a location will be occupied.

The results in Table 4.6 are intriguing, but the varying magnitude of the explanatory variables somewhat clouds our ability to interpret their marginal effects. A clearer picture emerges from examining the predicted probability a location will be occupied. Table 4.7 reports the predicted probability a state will be occupied for different values of

the explanatory variables. To isolate agglomeration effects, we vary EST_{ijt-1}, the number of establishments in state-industry ij in 1980, and leave other explanatory variables fixed. The table reports predicted probabilities as the number of establishments in a state increases as a fraction of the number of establishments in Mexico City from 0 to .2 at .05 increments. The coefficient estimates are again those from column (2) in Table 4.3. The predicted probabilities are calculated according to expression (4.2). We first calculate the sum of the explanatory variables times the estimated coefficients and then obtain probabilities from tables for the cumulative distribution function of the standard normal.

Table (a) gives the predicted probability a location will be occupied, where explanatory variables take their mean values. The mean ratio of the state wage to the Mexico City wage is .78. When no establishments occupied a location in the previous period, the probability a location will be occupied in the following period is .21. With three establishments -- or five percent the mean number of establishments in Mexico City -- the predicated probability rises to .47; with seven establishments, the predicted probability is .75; and with ten establishments predicted probability is .92. The critical mass of establishments necessary to virtually ensure a location will continue to be occupied is approximately ten. The presence of a few firms may be insufficient evidence that a location is a viable

production site, but the threshold level of agglomeration necessary to attract firms remains relatively low.

Table (b) gives the predicted probability a state will be occupied, where the state wage is one-half the Mexico City wage, and other variables take their mean values. Even with a substantial wage differential, if a location was unoccupied in the previous period the probability of being occupied in the following period is only .31. Hence, low wages are not sufficient to attract firms to a location. Again, the threshold level of agglomeration is low. With three establishments the probability a location will be occupied is .49, and with seven establishments the probability is .68.

Table (c) gives the predicted probability a state will be occupied where bus hours equals its means plus one standard deviation, or 14.2 plus 14.05; other variables take their mean values. It is instructive to compare these results with those in Table (a). Where a location was unoccupied in the previous period, the increase in distance lowers the predicted probability by only .05, from .21 to .16. The effect with more establishments is approximately the same. Hence, distance does not seem to be an important factor.

5. Concluding Remarks

Probit estimation with unconstrained agglomeration effects offers positive support for the theory of geographic concentration developed in Chapter Three. Agglomeration in a

previous period reduces unit labor requirements and raises the probability a location will be occupied in the future. The coefficient estimates for individual states vary considerably, raising questions about estimation with grouped data. More importantly perhaps, the unconstrained results for individual states point in the same direction as the results for grouped data. Prediction with probit estimates paints a clear picture of how cost differentials and agglomeration effects interact to determine industry location. Agglomeration has a large impact on the future prospects of a location. Where a location was unoccupied in a previous period, even large wage differentials are insufficient to attract firms. The threshold level of agglomeration necessary to attract firms remains relatively low. The presence of ten firms is sufficient to virtually ensure a location will be occupied in the future at the mean wage differential. In other words, wage differentials matter, but only once a critical mass of firms has become established in a location. Transport costs play a small role in industry location. Substantial increases in distance have only a marginal affect on the probability a location will be occupied in the future.

4.1 VARIABLE MEANS

Variable	Year	Mean	Std. Deviation
OPEN	1985	.403	.491
WGE_1	1985	1.139	--
WGE	1985	.899	.264
$WGE_1 - WGE_i$	1985	.240	.264
EST_{1jt-1}	1980	131.750	159.351
EST_{ijt-1}	1980	6.762	29.515
$WGE_1 * EST_{1jt-1}$	--	150.073	181.512
$WGE_i * EST_{ijt-1}$	--	6.668	36.465
$WGE_1 * EST_1 - WGE_i * EST_{ijt-1}$	--	143.405	180.075
EMP_{1j}	1985	2799.188	2259.334
EMP_{ij}	1985	177.238	458.276
$BUSHRS_i$	--	14.217	14.031
$BUSHRS_i^2$	--	398.587	848.309

No. of Obs. = 496

Subscript $_1$ denotes the Federal District (Mexico City).

4.2 PROBIT RESULTS FOR GROUPED DATA

Variable	(1)	(2)	(3)	(4)	(5)
	(asymptotic t-statistics in parentheses)				
CONSTANT	.0226	.2689	.2215	.1693	13.0450
	(0.25)	(2.33)	(1.81)	(1.32)	(2.29)
WGE_l-WGE_i	.3585	.5586	.5565	.6291	1.9344
	(1.52)	(2.30)	(2.29)	(2.21)	(4.56)
WGE_l*EST_{ljt-1} - WGE_i*EST_{ijt-1}			.00037	.00027	.00032
			(1.16)	(0.82)	(0.93)
$BUSHRS_i$	-.0265	-.0690	-.0697	-.0645	-.0858
	(-4.99)	(-5.15)	(-5.18)	(-4.56)	(-4.16)
$BUSHRS_i^2$		.00079	.00080	.00079	.00098
		(3.55)	(3.58)	(3.45)	(3.09)
IND* (WGE_l - WGE_i)				-.2308	-.2381
				(-0.46)	(-0.43)
IND* (WGE_l*EST_{ljt-1} - WGE_i*EST_{ijt-1})				.00308	.00368
				(1.84)	(2.09)
IND*$BUSHRS_i$				-.0209	-.0237
				(-1.82)	(-1.90)
ρ^2	.0443	.0621	.0641	.0734	.1513
ϱ^2	.0502	.0711	.0761	.0943	.1842
LL	-319.65	-313.68	-313.02	-309.91	-283.85
LL_0	-334.45				
Regional Dummies	no	no	no	no	yes
Obs No.	496	496	496	496	496

4.3 UNCONSTRAINED PROBIT RESULTS FOR GROUPED DATA

Variable	(1)	(2)	(3)
	(asymptotic t-statistics in parentheses)		
CONSTANT	-.4534 (-3.03)	-.5857 (-3.68)	10.1998 (1.56)
$WGE_1 - WGE_i$	.7843 (2.80)	.9917 (2.94)	2.1800 (4.28)
$WGE_1 * EST_{1jt-1}$	-.00138 (-2.98)	-.00167 (-3.36)	-.00144 (-2.83)
$WGE_i * EST_{ijt-1}$	.2212 (8.40)	.2423 (8.02)	.2214 (7.28)
$BUSHRS_i$	-.0334 (-2.17)	-.0296 (-1.81)	-.0616 (-2.73)
$BUSHRS_i^2$	.00039 (1.55)	.00041 (1.58)	.00077 (2.23)
IND* $(WGE_1 - WGE_i)$		-.5118 (-0.91)	-.5051 (-0.83)
$IND*WGE_1*EST_{1jt-1}$		.0062 (3.17)	.0066 (3.22)
$IND*WGE_i*EST_{ijt-1}$		-.0735 (-1.17)	-.0720 (-1.19)
$IND*BUSHRS_i$		-.0209 (-1.72)	-.0231 (-1.75)
ρ^2	.2954	.3118	.3453
$\bar{\rho}^2$	.3103	.3387	.3842
LL	-235.66	-230.18	-218.96
LL_0	-334.45		
Regional Dummies	no	no	yes
Obs No.	496	496	496

4.4 CONSTRAINED PROBIT RESULTS FOR INDIVIDUAL STATES

State	$WGE_1*EST_{1jt-1} - WGE_i*EST_{ijt-1}$ (asymptotic t-statistics in parentheses)	CONSTANT	β_2/β_0
Grouped Data	.00034 (1.05)	-.02277	-.01476
Aguascalientes	-.00053 (-0.29)	.23390	-.00225
Baja California	.00308 (1.03)	-.40686	-.00756
Baja California Sur	-.00012 (-0.04)	-1.5159	.00008
Campeche	n.s.		
Coahuila	.01018 (1.67)	-1.0918	-.00933
Colima	n.s.		
Chiapas	-.00026 (-0.08)	-1.4962	.00018
Chihuahua	.00339 (1.09)	-.61134	-.00555
Durango	.00095 (0.50)	-1.0430	-.00092
Guanajuato	.00450 (0.77)	.29662	.01518
Guerrero	-.00093 (-0.41)	-.54944	.00169
Hidalgo	.00203 (0.75)	.06012	.03373
Jalisco	n.f.		
Mexico	n.f.		
Michoacán	.00618 (0.96)	.06799	.09087
Morelos	-.00013 (-0.07)	-.65487	.00020

4.4 CONTINUED

State	$WGE_1*EST_{1jt-1} - WGE_i*EST_{ijt-1}$	CONSTANT	β_2/β_0
Nayarít	-.00023 (-0.09)	-1.1172	.00020
Nuevo León	.00689 (1.12)	-.17775	-.03877
Oaxaca	-.00242 (-0.81)	-.00886	.27356
Puebla	.01267 (0.83)	.30939	.04097
Querétero	.00414 (1.09)	-.52182	-.00793
Quintana Roo	-.00012 (-0.04)	-1.5163	.00008
San Luís Potosí	-.00157 (-0.74)	.22036	-.00710
Sinaloa	-.00443 (-0.74)	-.42013	.01053
Sonora	.00007 (0.04)	-.68487	-.00010
Tabasco	n.s.		
Tamaulipas	-.00043 (-0.20)	-.61265	.00070
Tlaxcala	.00501 (1.17)	-.61078	-.00820
Veracruz	-.00093 (-0.46)	-.02789	.03317
Yucatán	.01021 (1.58)	-.86224	-.01184
Zacatecas	-.00114 (-0.47)	-.52009	.00220

Obs. per state = 16
n.f. = no failures
n.s. = no successes

4.5 UNCONSTRAINED PROBIT RESULTS FOR INDIVIDUAL STATES

State	WGE_1*EST_{1jt-1}	WGE_i*EST_{ijt-1}	γ_2/γ_3
	(asymptotic t-statistics in parentheses)		
Grouped Data	-.00138 (2.80)	.22116 (8.40)	-.00622
Aguascalientes	-.00381 (-1.24)	.24105 (1.26)	-.01581
Baja California	.00170 (0.40)	.26357 (0.70)	.00647
Baja California Sur	**		
Campeche	n.s.		
Coahuila	.00706 (0.95)	.23026 (1.34)	.03067
Colima	n.s.		
Chiapas	**		
Chihuahua	.00037 (0.10)	.14400 (0.87)	.00255
Durango	-.00049 (-0.19)	.14194 (1.24)	-.00343
Guanajuato	.00138 (0.07)	.28359 (1.12)	.00488
Guerrero	-.01013 (-0.58)	.72141 (1.22)	-.01405
Hidalgo	.00006 (0.02)	.07676 (1.04)	.00078
Jalisco	n.f.		
Mexico	n.f.		
Michoacán	**		
Morelos	-.00394 (-1.03)	.45368 (1.16)	-.00869

4.5 CONTINUED

State	$WGE_l * EST_{ljt-1}$	$WGE_i * EST_{ijt-1}$	γ_3/γ_4
Nayarít	**		
Nuevo León	.00076 (0.09)	.09112 (0.98)	.00828
Oaxaca	-.00578 (-1.66)	.60784 (1.61)	-.00952
Puebla	.01363 (0.67)	.09212 (0.71)	.14795
Querétero	**		
Quintana Roo	**		
San Luís Potosí	-.00180 (-0.81)	.06472 (0.48)	-.02779
Sinaloa	-.02296 (-1.01)	3.9556 (0.53)	-.00580
Sonora	-.00027 (-0.09)	.74763 (2.14)	-.00036
Tabasco	n.s.		
Tamaulipas	-.00159 (-0.54)	.24160 (0.64)	-.00657
Tlaxcala	-.00163 (-0.26)	.20591 (1.47)	-.00791
Veracruz	-.00170 (-0.72)	.05250 (0.91)	-.03238
Yucatán	**		
Zacatecas	-.00114 (-0.46)	.00525 (0.03)	-.21705

Obs. per state = 16
n.f. = no failures
n.s. = no successes
** = variable dropped due to collinearity or perfect prediction

4.6 EFFECTS OF MARGINAL CHANGES IN EXPLANATORY VARIABLES ON THE PROBABILITY A STATE IS OPEN TO PRODUCTION

$P_i^{\bullet}$	$Z_{ij}^{\bullet\bullet}$	WGE_1	WGE_i	EST_{1jt-1}	EST_{ijt-1}	$BUSHRS_i$
.1	-1.180	.1743	.1242	-.00038	.0433	-.0059
.2	-.840	.2458	.1752	-.00054	.0611	-.0083
.3	-.525	.3047	.2172	-.00066	.0757	-.0103
.4	-.255	.3386	.2413	-.00074	.0841	-.0114
.5	.000	.3498	.2493	-.00076	.0869	-.0118
.6	.255	.3386	.2413	-.00074	.0841	-.0114
.7	.525	.3047	.2172	-.00066	.0757	-.0103
.8	.840	.2458	.1752	-.00054	.0611	-.0083
.9	1.180	.1743	.1242	-.00038	.0433	-.0059

$^{\bullet}$ $P_i = \text{Prob}(Q_{ij} > 0)$.

$^{\bullet\bullet}$ $Z_{ij} = (X_{1j} - X_{ij})\beta/\sigma$.

The probit model is that in expression (4.2). The following lists the effect on $\text{Prob}(Q_{ij} > 0)$ of a marginal change in each variable:

$$\phi(Z_{ij}) * \delta Z_{ij}/\delta WGE_1 = \phi(Z_{ij}) * [\gamma_1 + \gamma_2 EST_{1jt-1}] \quad \text{(a)}$$

$$\phi(Z_{ij}) * \delta Z_{ij}/\delta WGE_i = \phi(Z_{ij}) * [-\gamma_1 + \gamma_3 EST_{ijt-1}] \quad \text{(b)}$$

$$\phi(Z_{ij}) * \delta Z_{ij}/\delta EST_1 = \phi(Z_{ij}) * \gamma_2 WGE_{1j} \quad \text{(c)}$$

$$\phi(Z_{ij}) * \delta Z_{ij}/\delta EST_i = \phi(Z_{ij}) * \gamma_3 WGE_{ij} \quad \text{(d)}$$

where estimated coefficients are from Table 4.2. For (a)-(d), marginal effects are calculated using mean values of the variables EST and WGE.

4.7 PREDICTED PROBABILITY A STATE IS OPEN TO PRODUCTION

Table (a)

mean values for WGE_l, WGE_i, EST_{ljt-1}, $BUSHRS_i$

WGE_l	WGE_i	EST_{ljt-1}	$BUSHRS_i$	EST_{ijt-1}	Z_{ij}^{*}	P_i^{**}
1.14	.9	69	14.2	0	-.816	.21
1.14	.9	69	14.2	3	-.070	.47
1.14	.9	69	14.2	7	.677	.75
1.14	.9	69	14.2	10	1.424	.92
1.14	.9	69	14.2	14	2.170	.98

Table (b)

$WGE_i = 0.5*WGE_l$
mean values for WGE_l, EST_{ljt-1}, $BUSHRS_i$

WGE_l	WGE_i	EST_{ljt-1}	$BUSHRS_i$	EST_{ijt-1}	Z_{ij}^{*}	P_i^{**}
1.14	.57	69	14.2	0	-.490	.31
1.14	.57	69	14.2	3	-.017	.49
1.14	.57	69	14.2	7	.456	.68
1.14	.57	69	14.2	10	.929	.82
1.14	.57	69	14.2	14	1.402	.92

Table (c)

$BUSHRS_i$ = mean + std. dev.
mean values for WGE_l, WGE_i, EST_{ijt-1}

WGE_l	WGE_i	EST_{ljt-1}	$BUSHRS_i$	EST_{ijt-1}	Z_{ij}^{*}	P_i^{**}
1.14	.9	69	28.25	0	-.987	.16
1.14	.9	69	28.25	3	-.241	.41
1.14	.9	69	28.25	7	.506	.70
1.14	.9	69	28.25	10	1.253	.89
1.14	.9	69	28.25	14	1.999	.98

* $Z_{ij} = (X_{lj} - X_{ij})\beta/\sigma$.

** $P_i = \text{Prob}(Q_{ij} > 0)$.

CHAPTER FIVE:

INDUSTRY LOCALIZATION, VERTICAL SPECIALIZATION AND MEXICO-U.S. FREE TRADE

The creation of a North American Free Trade Area (NAFTA) would integrate two regions with unprecedented differences in their levels of economic development. It is the magnitude of the differences between Mexico and the U.S. and Canada that have heightened expectations about the potential gains from free trade. The relatively small size and poor state of the Mexican economy has lead many to believe the effects of integration would be felt most strongly south of the Rio Grande. Proponents of a NAFTA cite two familiar sources of gains from trade for Mexico. The first is efficiency gains from specializing in goods that are intensive in their use of Mexico's relatively abundant factor, labor. The second is positive scale effects Mexico would achieve by producing a smaller range of goods in larger, more efficient quantities.

In Mexico, there has been much discussion of a third effect: the conversion of Mexico into an off-shore assembly plant, or maquiladora, for the U.S. economy.[55] When Mexican

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[55] See R. R. Cavazos, "Maquiladoras e Integración Industrial," El Financiero, 1-31-90, p. 50. J.L. Gaona, "No se han integrado las maquiladoras con la industria nacional," El Economista, 9-18-90, p. 17. "¿Nos Invadirá la maquila?" El Exportador Mexicano, 6-13-90, p. 1.

industrialists look north, they see an industrial complex in which firms have access to skilled labor, specialized buyers and suppliers, and new technologies on a scale that gives them a huge cost advantage. They fear integration will relegate Mexican producers to low value-added activities like assembly where proximity to an industrial complex is less a factor. Mexican industrialists have in mind a model of trade where agglomeration economies are significant, but vary across production activities. Skill- and knowledge-intensive activities, where external economies are strongest, concentrate near large markets, leaving less developed areas with low-skill activities, where external economies are weak. In this scenario, North American integration deindustrializes Mexico.

This chapter extends the discussion in Chapter Three to consider the relationship between agglomeration and economic integration. We continue to focus on the garment industry. Recent Mexican trade policy provides a natural experiment of sorts. Between 1985 and 1987, Mexico dramatically eliminated most barriers to trade, bringing an end to four decades of import substitution industrialization. The opening of the Mexican economy has initiated a process of integration with the U.S. Important trade barriers remain, but the recent experience makes it possible to examine emerging patterns of industry organization and location between the two countries.

The discussion in earlier chapters illustrates how under

a closed economy, agglomeration economies give rise to the geographic concentration of garment production and distribution. This chapter argues that due to agglomeration economies economic integration will redefine the pattern of vertical specialization between Mexico and the U.S., and the location of production within each country. With free trade, a pattern of vertical specialization emerges in which small country producers provide assembly services for firms in the large country marketing center. Mexican garment producers, who previously served the domestic market, are shifting to off-shore garment assembly for firms in the U.S. U.S. firms, given their ties to the New York and Los Angeles marketing centers, provide Mexican producers with access to markets. Integration also leads to a relocation of activities within each country: in the small country, production shifts to regions near the large country market; in the large country, integration favors marketing centers with better access to small country producers. Garment production in Mexico is relocating from central Mexico to the Mexico-U.S. border region. In the U.S., the Los Angeles marketing center has been the principal beneficiary of the opening of the Mexican economy.

The chapter has three sections. Section one uses the Mexico Industrial Census and unpublished Mexican government trade figures to build on interview material presented in Chapter Two. We outline the organization of production and

trade in the Mexican garment industry before and after trade liberalization. Section two develops a theoretical framework to explain the relationship between industry location, vertical organization and trade policy, and uses this framework to discuss the integration of the Mexican garment industry into a North American Free Trade Area. Section three provides concluding remarks.

1. Industry Localization and Trade in Mexico

This section describes the impact of the opening to trade on the Mexican garment industry. Under a closed economy, the industry divides into two distinct segments, one oriented towards the domestic market and the other oriented towards foreign markets. The distinguishing feature of the domestic industry is the geographic concentration of production and distribution. Parallel to the domestic industry is an enclave of off-shore assembly plants that provide subcontracting services for firms in foreign marketing centers. These plants locate in border regions, and have virtually no linkages with the domestic economy, outside of hiring labor. With trade liberalization, the domestic industry becomes more vertically specialized, and production relocates to regions with easy access to foreign markets.

1.1 Industry Localization in a Closed Economy

Chapters Two and Three discuss at length the organization

and development of the domestic garment industry under the closed economy. Salient characteristics include the initial concentration of production and marketing activities in Mexico City and the subsequent relocation of production to specialized agglomerations of producer firms located in outlying regions. This basic pattern is clearly illustrated in Table 3.1, which we reprint below as Table 5.1. The table shows Mexican employment in garments and general manufacturing from 1965 to 1988 and the share located in the Federal District. The industry began concentrated in Mexico City. Over time, wage differentials emerged between the capital and outlying states. In response, firms established new

5.1 THE SHARE OF NATIONAL EMPLOYMENT IN MEXICO CITY, 1965-88

LEVELS/Shares (levels in 000s)	1965	1970	1975	1980	1985	1988
TOTAL GARMENT EMPLOYMENT	75.9	98.5	102.4	144.0	146.8	173.3
Federal District Share	0.587	0.554	0.508	0.447	0.332	0.292
TOTAL MANUFACT. EMPLOYMENT	1,410	1,581	1,708	2,701	3,269	2,473
Federal District Share	0.339	0.311	0.289	0.311	0.230	0.192

production centers outside Mexico City. Distribution activities, however, remained highly concentrated in the capital.

In the last two decades, an enclave of off-shore assembly plants has developed alongside the domestic industry. The

plants are owned and operated by domestic agents, but rely on foreign firms for input supply, product designs, and access to foreign markets. Garment maquiladoras first began to appear in the late 1960s, but did not proliferate until the 1980s. Between 1980 and 1988, the share of national garment employment in maquiladoras increased from 12.9 percent to 20.0 percent. The expansion of the maquiladora enclave was, until recently, concentrated along the Mexico-U.S. border.

The maquila arrangement closely resembles subcontracting in the domestic garment industry. U.S. firms, in a manner similar to domestic manufacturers, undertake marketing and design activities, and subcontract assembly to maquiladoras. Maquiladoras have virtually no backward or forward linkages with the domestic industry. Raw materials are supplied by the foreign client firm. Between 1981 and 1988, domestic inputs accounted for an average of 0.25 percent of total inputs consumed by garment maquiladoras located along the border and 2.36 percent of total inputs consumed by garment maquiladoras located in interior Mexico.[56] Foreign firms distribute assembled garments through their own marketing channels and export virtually all output. The U.S. firms that engage in off-shore assembly are primarily national retail chains, such as Sears and J.C. Penney, or firms with their own well-established national or regional labels, such as Haggar, Levi

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[56] Estadísticas de la Industria Maquiladora de Exportación, 1978-1988. Aguascalientes: INEGI, 1989.

Strauss, and Warnaco.[57] Maquiladora production is concentrated in four products: men's pants (primarily jeans), men's shirts, bras, and underwear.[58]

Table 5.2 provides the share of national employment in garments and general manufacturing that was located in the five border states between 1965 to 1988.[59] The border region's share of national garment employment increased from

5.2 EMPLOYMENT IN THE MEXICO-U.S. BORDER REGION, 1965-88

LEVELS/Shares (levels in 000s)	1965	1970	1975	1980	1985	1988
TOTAL GARMENT EMPLOYMENT	75.9	98.5	102.4	144.0	146.8	173.3
Border Share	0.044	0.069	0.101	0.096	0.112	0.164
TOTAL MANUFACT. EMPLOYMENT	1,410	1,581	1,708	2,701	3,269	2,473
Border Share	0.114	0.113	0.123	0.120	0.159	0.201

4.4 percent in 1965 to 16.4 percent in 1988. This expansion coincided with an overall shift in manufacturing employment towards the border. The border region's share of national manufacturing jobs increased from 11.4 percent in 1980 to 20.1

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[57] Waldinger (1986: 78).

[58] Waldinger (1986) suggests that delivery lags and quality control impede the use of off-shore assembly for high quality, small-batch garments, such as women's outerwear.

[59] The five border states are Baja California Norte, Sonora, Chihuahua, Coahuila, and Tamaulipas.

percent in 1988.

Policies in both the U.S. and Mexico have encouraged the development of maquiladoras. In 1965, the Mexican government initiated an official program to promote the expansion of an off-shore assembly industry.[60] The government waived foreign ownership limitations for maquiladoras and exempted the plants from taxes and import duties. This basic package of incentives, with minor changes, has remained largely intact. To be eligible for tax breaks, maquiladoras must export their production. A presidential decree in 1987 lowered the export requirement from 100 percent to 80 percent, and a second decree in 1990 lowered the requirement further to 50 percent.[61] In the U.S., item 807 of the U.S. tariff schedule allows firms to engage in the off-shore assembly of U.S. manufactured components and only pay import duties on the value-added abroad.[62] In this arrangement, a firm exports components from the U.S., assembles the components abroad, and imports the final product. If firms were to use Mexican textiles, they would have to pay duties on the value of the entire garment.[63]

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[60] On maquiladoras, see Fernández-Kelly (1983), Gibson and Corona (1985), Grunwald and Flamm (1985), and Sklair (1989).

[61] Ehrenthal and Newman (1988: 197).

[62] MIT Commission (1990: 19).

[63] In 1987, the U.S. weighted-average tariff on fabrics was 11.5 percent (MIT Commission (1990: 17)). Until recently, firms using Mexican textiles to manufacture garments for

1.2 Industry Localization in an Open Economy

In 1985, President Miguel de la Madrid announced that Mexico was joining GATT. Over the next two years, he initiated a series of reforms that would eliminate, or at least drastically reduce, most trade barriers in the space of three years. The rapid opening to trade came as a virtual shock to garment and other manufacturing industries. While de la Madrid gave clear indications that he was serious about dismantling the regulatory apparatus of import substitution, relatively few firms began to prepare themselves for the opening to trade. This was due perhaps to the fact that previous administrations had threatened trade reform but never followed through.

A first set of barriers were import tariffs, which had been in place since the late 1940s. For garments, the production-weighted average tariff fell from 49.8 percent in June, 1985, to 39.9 percent in June, 1987, and to the new maximum allowed tariff of 20 percent in December, 1987. In general, quantity restrictions on imports were a more significant trade barrier than tariffs. Import licenses gave the government discretion over which goods could be imported.

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export also had to pay the 15 percent Mexican value added tax (a presidential decree in 1989 allows exporting firms to recoup taxes incurred in production). For domestic sourcing of textile inputs to be cost-effective, Mexican fabrics would on average have had to cost 26.5 percent less than U.S. textiles.

It was virtually impossible to import many goods, especially where it appeared a domestically-produced substitute was available. Trade reform completely eliminated quantity restrictions. For garments, the coverage of import licenses as a percent of domestic production was reduced from 100.0 percent in June, 1985, to 88.8 percent in December, 1985, and finally to zero in May, 1988.[64]

This section details the impact of trade liberalization on trade, employment, and industry organization in garment manufacturing. Before doing so, we briefly describe the international context in which Mexican garment producers now find themselves.

1.2.1 World Garment Trade

Mexico enters the world garment trade perched tenuously above low-wage countries producing low-quality, high-volume products, such as China, Malaysia and the Philippines, and below high-wage countries producing technology- or design-intensive products, such as Italy, Germany, and Japan.[65] Mexico shares this middle ground with the enormously successful countries of East Asia. Hong Kong, Korea, and Taiwan have dominated world trade in garments over the last

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[64] For textiles, the coverage of import licenses was reduced from 88.4 percent in June, 1985, to 3.4 percent in December, 1985, and to 1.9 percent in May, 1988.

[65] See Mody and Wheeler (1987) for recent trends in world garment trade.

two decades. In 1980, the three countries accounted for 59.8 percent of U.S. garment imports; in 1987, this figure was 46.7 percent.[66]

Underlying Asian garment industries are a set of production and marketing arrangements that link manufacturers to foreign markets and allow firms to rapidly respond to the ever changing demands of Western consumers. Two arrangements, in particular, appear to have been fundamental in the rapid growth of Asian garment manufacturing: the local export trader and the network of subcontractors. These arrangements are particularly common of the Hong Kong and Taiwan garment industries.

Local export traders function as intermediaries, dividing production for large volume orders from foreign buyers among myriad small shops. Pre-existing commercial linkages have provided a basis for local garment traders to emerge. In Hong Kong, for instance, the first garment manufacturers were businessmen that had emigrated from Shanghai. Steed (1981) observes that their access to foreign markets came through Hong Kong's British-owned merchant houses. The agglomeration of garment manufacturers that formed around this link later attracted a large number of foreign buyers.[67] Traders produce garments through networks of subcontractors, where individual

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[66] Herzenberg (1990).

[67] Steed (1981: 293). Levy (1988) describes a similar process in the Taiwanese footwear industry.

subcontractors work for specific traders. Steed (1981: 293) describes the Hong Kong garment industry in the following way:

> The competitive position of the Hong Kong manufacturers was enhanced by both their free access to foreign fibres and fabrics ... and their flexibility arising from the evolving process of local sub-contracting. As the industry grew, with employment increasing more than threefold during the 1960s, so did the range of specialist suppliers and sub-contractors. The leading manufacturers could accept and fulfill orders beyond their own production capacity knowing that they could find suitable sub-contractors.

Over time, traders have moved across the Pacific and now operate out of Los Angeles and New York. With rising wages in Taipei and Hong Kong, traders are organizing agglomerations of subcontractors in neighboring countries. Industry observers suggest off-shore traders account for most garment exports from mainland China.

1.2.2 Trade Liberalization in Mexico

Tariff barriers gave domestic producers a captive national market and import restrictions limited access to the inputs they would have needed to compete in foreign markets. In the textile industry, firms lagged behind foreign producers in the variety of fabric designs and colors they offered, in the quality of dyeing processes, and in the delivery time of production orders. Few garment manufacturers were able to obtain import permits and the rest suffered the same problems of poor fabric quality and late delivery.

Since the opening to trade, the domestic garment industry has stagnated. Table 5.3 provides quarterly employment

indices for general manufacturing, the domestic garment industry, and the off-shore garment assembly industry. Between January, 1987 and January, 1990, employment in the domestic garment increased by 0.16 percent, compared to a 2.7 percent increase for manufacturing as a whole.

5.3 QUARTERLY INDEX OF EMPLOYMENT, 1987-90

Quarter	All Manufact.	Off-Shore Garment Assembly	Domestic Garment Industry
87.01	100.00	100.00	100.00
87.02	101.65	--	102.20
87.03	102.26	--	99.09
87.04	102.88	--	101.03
88.01	101.34	104.39	98.85
88.02	102.78	114.54	100.21
88.03	102.06	117.78	97.99
88.04	102.06	117.78	99.06
89.01	101.34	113.76	95.38
89.02	104.22	122.25	97.79
89.03	104.53	136.27	101.16
89.04	104.32	136.54	102.23
90.01	102.26	138.93	100.16
90.02	--	--	99.07
90.03	--	--	95.79

Source: Unpublished data, Banco de Mexico.

The stagnation of the domestic industry is due in part to increased competition from imports. The dramatic rise in garment imports is evident in Table 5.4, which provides garment imports and exports for the domestic and off-shore assembly industries. Garments imports increased from US$ 29.5 million in 1987 to US$ 214.8 million in 1989, and totaled US$

183.0 million in the first eight months of 1990. In terms of domestic consumption, the import share rose from 5.3 percent in 1988, to 11.5 percent in 1989, and to 15.0 percent in 1990.

5.4 MEXICO INTERNATIONAL TRADE IN GARMENTS, 1982-90

(in millions of 1985 $US)

	Domestic Industry Imports (I)	Domestic Industry Exports (II)	Maquila Value Added (III)	Maquila Gross Exports* (IV)	Total Net Exports (II+III-I)
1982	161.723	20.697	67.338	196.128	-73.688
1983	9.282	13.571	50.909	217.521	55.198
1984	17.766	21.874	71.168	259.822	75.287
1985	33.546	16.695	71.878	238.131	55.027
1986	28.735	19.191	82.971	266.538	73.427
1987	29.485	52.630	100.868	299.954	124.013
1988	119.828	85.215	120.922	322.192	80.758
1989	224.990	68.263	160.325	496.281	3.598
1990**	188.221	41.093	113.651	351.804	-35.431

* (IV) reports total exports, including imported inputs. (III) reports total exports less imported inputs.

** January through August. Sources: Secofi, unpublished data. INEGI, Industria Maquiladora de Exportación.

The point of entry for garment imports is the Mexico City garment district. As discussed in Chapter Two, interview data suggest many traders in the garment district have closed down their production activities to become importers.[68] In making the transition from domestic trading to importing, firms have

[68] See also Expansión, April 17, 1991, pp. 72-73.

had to adopt a new set of commercial practices. Transactions in the closed economy were conducted largely on a personalized basis. International exchanges are based on formal contracts, generally embodied in a letter of credit which defers payment until certain conditions are met. Traders have learned from painful experience that in the absence of formal contracts they are unlikely to see their orders filled.[69]

A second reason the domestic garment industry has stagnated is that few producers have succeeded in penetrating export markets. This is evident in Table 5.4. Non-maquiladora garment exports rose from US$ 52.7 million in 1987 to US$ 85.2 million in 1988 and decreased to US$ 68.3 million in 1989. For the first eight months of 1990, non-maquiladora garment exports totaled US$ 41.1 million, or 9.7 percent less than the same period in 1989. These trade figures exaggerate even the minimal export success of the domestic garment industry. A substantial share of non-maquiladora garment exports is due to a few large firms. The Ministry of Trade and Industrial Promotion provides a special classification for firms which export more than US$ 3 million a year. Of the 170 domestic garment firms currently listed as exporters, only eight had exports in excess of US$ 3 million in 1989. A lower

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[69] It might have been possible to reduce the costs of adjusting to international buying practices through the provision of basic information about contractual devices, such as letters of credit. In general, there appear to be learning costs that are an unavoidable feature of adjustment.

bound for the total exports in 1989 of these eight firms is US$ 24 million, or 27.1 percent of 1989 non-maquiladora exports. Many of these large firms are either subsidiaries of multinationals, former subsidiaries of multinationals, or firms which hold licenses for the domestic production of foreign labels.

The U.S. continues to be Mexico's principal trading partner. Table 5.5 reports Mexico-U.S. non-maquiladora trade in garments. Between 1985 and 1989, Mexican garment imports from the U.S. increased from US$ 29.9 million to US$ 131.9 million; the share of Mexican garment imports from the U.S. fell from 89.1 percent in 1985 to 52.9 percent in 1990.

5.5 MEXICO-U.S. NON-MAQUILADORA GARMENT TRADE, 1982-90

(in millions 1985 $US, trade share in parentheses)

	Exports		Imports	
	Level	Share	Level	Share
1982	14.121	(0.682)	74.802	(0.463)
1983	9.317	(0.687)	6.618	(0.713)
1984	18.196	(0.832)	15.780	(0.888)
1985	15.257	(0.914)	29.881	(0.891)
1986	15.107	(0.787)	25.139	(0.875)
1987	44.142	(0.839)	26.744	(0.907)
1988	37.749	(0.853)	52.384	(0.754)
1989	54.512	(0.799)	131.866	(0.614)
1990 **	27.273	(0.663)	96.817	(0.529)

** January through August. Source: Secofi.

Industry observers suggest a large share of Mexican garment imports from the U.S. are manufactured in Asia and merely

distributed by U.S. traders in New York and Los Angeles. Hong Kong has been the most active new country in the Mexican garment market; the country's share of Mexican garment imports increased from 1.3 percent in 1988 to 22.4 percent in 1990.

The U.S. maintains quotas on Mexican garment exports under the Multi-Fiber Arrangement (MFA). Recent Mexico-U.S. bilateral textile trade agreements have made quotas more flexible. The current agreement, which was signed in 1988 and revised in 1990, allows Mexico to obtain quota increases for most goods on request. Quotas appear to be binding only for a few select products. For the period 1988 to 1990, average quota utilization rates were over 60 percent in only four products categories out of 61: overalls (112.9%), pants (102.1%), pajamas (88.6%), and shirts and blouses (80.9%).[70] Far from limiting Mexico's role in the U.S. market, quotas likely guarantee Mexico a share of U.S. garment imports it would cede to Asia in their absence.

In contrast to the anemic performance of the domestic industry, the maquiladora industry is booming. Between January, 1987 and January, 1990, employment in the garment maquiladora industry increased by 39.5 percent. The reason for this employment growth is clearly evident in Table 5.4. Maquiladora exports have increased dramatically since the opening to trade, rising from US$ 300.0 million in 1987, to

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[70] Quota utilization rates for 61 product categories are available on request from the author.

US$ 322.0 million in 1988, and reaching US$ 496.3 million in 1989. In 1989, value added in maquiladora exports alone -- total exports less the value of imported inputs -- was 2.4 times non-maquiladora garment exports. Virtually all Mexican maquiladora exports are destined for the U.S. market. Greater flexibility in U.S. garment quotas has made this export growth possible.

Most of the recent job growth in off-shore assembly has taken place not along the border but in interior Mexico. This is evident in Table 5.6, which provides total employment in garment maquiladoras, and the division of employment between border states and interior states. The share of maquiladora

5.6 EMPLOYMENT IN THE GARMENT OFF-SHORE ASSEMBLY INDUSTRY, 1981-90

YEAR	TOTAL	BORDER Level	(%)	INTERIOR Level	(%)
1981	18,059	14,278	(79.1)	3,781	(20.9)
1982	15,002	11,891	(79.3)	3,111	(20.7)
1983	16,212	12,885	(79.5)	3,327	(20.5)
1984	19,888	15,161	(76.2)	4,727	(23.8)
1985	21,473	15,089	(70.3)	6,384	(29.7)
1986	25,311	16,883	(66.7)	8,428	(33.3)
1987	30,273	19,399	(64.1)	10,874	(35.9)
1988	34,707	20,289	(58.5)	14,418	(41.5)
1989	42,400	--		--	
1990	42,828	--		--	

Source: INEGI, La Industria Maquiladora de Exportación.

employment in interior states increased from 20.9 percent in

1981 to 41.5 percent in 1988. Interview data suggest the shift is the result of domestic producers converting to off-shore assembly. An example from Chapter Two is the Tehuacán garment industry, where firms are switching in dramatic fashion from subcontracting for Mexico City traders to off-shore assembly for U.S. client firms.

Not all domestic producers are converting to off-shore assembly. Chapter Two describes how producers in a few agglomerations have coordinated efforts to adjust to the opening to trade. These attempts are still in their formative stages, and are limited to specific regions, but they reveal the extent to which adjustment strategies vary across regions. A common feature of coordinated adjustment is the creation of new distribution channels that give firms direct access to foreign markets. Firms in the state of Aguascalientes have created an export trading company that serves as a vehicle for forming joint ventures with U.S. garment manufacturers. The trading company is jointly owned and managed by local firms. Firms in Guadalajara have organized a trade fair to help local area firms replace clients lost to imports. Profits from the trade fair are being used to create a design center that provides technical assistance to local firms. The intention is to convert Guadalajara into the new center for women's fashion in Mexico. Firms in Monterrey have taken advantage of the decline of the Mexico City garment industry in the aftermath of trade liberalization to move into women's

outerwear. Proximity to the border has given firms access to new designs and fashions. Coordination among firms is less extensive than in Aguascalientes and Guadalajara, but the active exchange of information still appears to play a role in how firms learn about new business opportunities.

2. Industry Location, Vertical Organization and Trade

This section develops a theoretical framework that relates industry location, vertical organization, and trade. Chapter Three studies the dynamics of geographic concentration in an industry that is characterized by variation in the strength of external economies across activities. Below, we extend this framework to a general equilibrium context. The industry we consider involves two activities: marketing, which exhibits external economies, and assembly, which exhibits constant returns to scale. There are two countries, which each contain a number of regions; one country is significantly larger in terms of it labor force than the other country. Agents also consume a region-specific resource, land. Agglomeration creates congestion costs by driving up the regional price of land. Under autarky, external economies lead regions to vertically specialize. The agglomeration of marketing activities drives up wages and land prices in a particular region. Assembly, the constant returns activity, moves to the unagglomerated region, where wages and housing prices are lower. With trade, countries vertically

specialize. The large country captures the strong external economy activity and the small country provides assembly services for large country firms.

2.1 A Model of Agglomeration and Vertical Specialization

Consider two countries, Home and Foreign. Home consists of two regions, North and South. For simplicity, assume Foreign consists of a single region. In each country there are two types of households: landowners, who own one unit of housing, and laborers, who own one unit of labor. Labor is mobile across regions, housing is fixed. There is no international factor mobility. Tastes and technology are identical in each country. Home's labor force, L, is smaller than Foreign's labor force, L^*.

There are two consumption goods, housing, T, and garments, Y. Preferences are Cobb-Douglas: each country spends a share α of its income on housing and a share $1-\alpha$ on garments. Landowners and laborers supply their endowments inelastically; landowners receive all rental income and laborers receive all wage income. As the supply of housing is fixed in each region, an inflow of labor bids up the regional housing price. Labor is the only factor used in garment production. Garments are produced in two stages: assembly yields an intermediate good, Z, that requires marketing services to become a final product. The production of Z is given by

$$Z = L_z \qquad (1)$$

Marketing combines Z with an additional labor input. Total garment production is given by

$$Y = L_y^{\phi} Z^{1-\phi} Y^{(\sigma-1)/\sigma}, \qquad 0.5 < \phi < 1, \quad \sigma > 1 \qquad (2)$$

where L_y is labor used is marketing, Z is assembled garments, and the final term captures external economies.[71] External economies are region-specific: the regional marginal product of L_y depends only on the region-wide output of Y. As there are no external economies in assembly, the marginal product of L_z does not depend on where Z is produced.

The external economies we have in mind are a widely cited characteristic of the garment industry.[72] External effects in marketing are due to frequent changes in the style of garment consumers demand. Style changes imply firms must remain abreast of constantly shifting tastes. Firms gather information about market conditions by locating near other firms. This occurs indirectly through spying and imitation and directly through the exchange of information between firms. Rapid style changes also make it impractical to standardize many assembly operations, and assembly remains highly labor-intensive. Separating assembly from marketing allows firms to keep production a footloose activity.

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[71] This approach follows Ethier (1982) and Helpman and Krugman (1985).

[72] Lichtenberg (1960) and Waldinger (1986) describe similar external economies in the New York garment district.

Autarky: Consider autarky in Foreign. Foreign contains T^* landowners and L^* laborers. A landowner's income is P^*_t, the price of housing, and a laborer's income in w^*, the wage. Equating demand with supply for housing and garments yields

$$T^* = \frac{\alpha P^*_t T^*}{P^*_t} + \frac{\alpha w^* L^*}{P^*_t}$$

$$Y^* = \frac{(1-\alpha) P^*_t T^*}{P^*_y} + \frac{(1-\alpha) w^* L^*}{P^*_y} \qquad (3)$$

Marketing clearing in housing defines the wage in terms of the housing price,

$$\frac{(1-\alpha) T^*}{\alpha L^*} = \frac{w^*}{P^*_t} \qquad (4)$$

Using the fact that $Z=L_z$ and that zero profits imply $w=P_z$, we subsume L_z into production of Y. Profit maximization in garment production implies

$$\frac{w^*}{P^*_y} = \phi L_y^{\phi-1} L_z^{1-\phi} Y^{(\sigma-1)/\sigma}$$

$$\frac{w^*}{P^*_y} = (1-\phi) L_y^{\phi} L_z^{-\phi} Y^{(\sigma-1)/\sigma} \qquad (5)$$

Combining (5) with the full employment condition, $L_z+L_y=L^*$, makes it possible to solve for L_y and L_z in terms of L^*:

$$L_z = (1-\phi) L^*$$

$$L_y = \phi L^* \qquad (6)$$

This yields the following wage relative to the price of garments:

$$\frac{w^*}{P^*_y} = \phi^{\phi\sigma} (1-\phi)^{\sigma(1-\phi)} (L^*)^{\sigma-1} \qquad (7)$$

The wage in terms of the garment price, or the price of P_z relative to P_y, is an increasing function of the labor force,

due to increasing returns. Hence, larger countries are relatively more efficient in marketing. The relative price of housing to garments is

$$\frac{P^*_t}{P^*_y} = \frac{\alpha\phi^{\phi\sigma}(1-\phi)^{\sigma(1-\phi)}L^{\sigma}}{T(1-\alpha)} \qquad (8)$$

which is also increasing in L, as increases in the population bid up the price of housing.

The autarky equilibrium in Home is complicated by the fact there are two regions. Location-specific external economies make it efficient to concentrate production of Y in a single location. Each region has its own housing stock; as labor is mobile across regions, agglomeration in one region bids up the housing price relative to the other region. There are three possible configurations of production: (1) regional autarky, where each region produces its own Z and Y, (2) agglomeration of Y in a single region, with Z production divided between the two regions, and (3) regional specialization, where one region specializes in Z and the other in Y. We show that regional specialization is the unique equilibrium.

Suppose for the moment that North specializes in Z and South specializes in Y. There are three markets for consumption goods: the North housing market, the South housing market, and the economy-wide garment market. Income depends on the region in which households are located. Assume there are an equal number of landowners, T, in North and

South. Let superscript n denote North and superscript s denote South. Specialization implies $L^n=L_z$ and $L^s=L_y$, where $L^s+L^n=L$. Equating supply and demand for housing and garments yields

$$T^n = T = \frac{\alpha P^n_t T}{P^n_t} + \frac{\alpha w^n L_z}{P^n_t}$$

$$T^s = T = \frac{\alpha P^s_t T}{P^s_t} + \frac{\alpha w^s L_y}{P^s_t}$$

$$Y = \frac{(1-\alpha) P^n_t T}{P_y} + \frac{(1-\alpha) P^s_t T}{P_y} + \frac{(1-\alpha) w^n L_z}{P_y} + \frac{(1-\alpha) w^s L_y}{P_y} \qquad (9)$$

Market clearing in housing defines the regional relative wage:

$$\frac{w^s}{w^n} = \frac{L_z}{L_y}\frac{P^s_t}{P^n_t} \qquad (10)$$

As in (5), profit maximization in garment production implies

$$\frac{w^s}{P_y} = \phi L_y^{\phi-1} L_z^{\phi} Y^{(\sigma-1)/\sigma}$$

$$\frac{w^n}{P_y} = (1-\phi) L_y^{\phi} L_z^{\phi-1} Y^{(\sigma-1)/\sigma} \qquad (11)$$

which yields the following relative wage:

$$\frac{w^s}{w^n} = \frac{\phi}{1-\phi}\frac{L_z}{L_y} \qquad (12)$$

Given labor is mobile, equilibrium requires that workers in each region enjoy the same level of utility. From (9), consumption per laborer, C, for goods Y and T in South and North are

$$C^s_y = \frac{\alpha w^s}{P_y} \qquad C^n_y = \frac{\alpha w^n}{P_y}$$

$$C^s_t = \frac{(1-\alpha) w^s}{P^s_t} \qquad C^n_t = \frac{(1-\alpha) w^n}{P^n_t} \qquad (13)$$

which yields the following labor market equilibrium condition:

$$\left[\frac{\alpha w^s}{P_y}\right]^{\alpha}\left[\frac{(1-\alpha)w^s}{P^s_t}\right]^{1-\alpha} = \left[\frac{\alpha w^n}{P_y}\right]^{\alpha}\left[\frac{(1-\alpha)w^n}{P^n_t}\right]^{1-\alpha} \qquad (14)$$

(14) reduces to

$$\frac{w^s}{w^n} = \left[\frac{P^s_t}{P^n_t}\right]^{\alpha} \qquad (15)$$

Combining (10), (11), and (12) with the full employment condition gives the geographic distribution of the labor force

$$L_y = \frac{L}{1+\mu}$$

$$L_z = \frac{\mu L}{1+\mu} \qquad \text{where } \mu = \left[\frac{\phi}{1-\phi}\right]^{\sigma-1} \qquad (16)$$

We can now solve for the regional relative wage and for regional wages and housing prices in terms of P_y,

$$\frac{w^s}{w^n} = \left[\frac{\phi}{1-\phi}\right]^{\alpha}$$

$$\frac{P^s_t}{P^n_t} = \frac{\phi}{1-\phi}$$

$$\frac{w^s}{P_y} = \phi\mu^{\sigma(1-\phi)}L^{\sigma-1}(1+\mu)^{1-\sigma}$$

$$\frac{w^n}{P_y} = (1-\phi)\mu^{\sigma(1-\phi)-1}L^{\sigma-1}(1+\mu)^{1-\sigma} \qquad (17)$$

Given $\phi > 1-\phi$, $w^s > w^n$ and $P^s_t > P^n_t$. Agglomeration in the South drives up housing prices and wages, pushing assembly into the North.

Why is regional specialization is the unique equilibrium? External economies in marketing imply <u>all</u> Y producers prefer to be in the region with the largest share of Y production. Agglomeration of Y in one region pushes production of Z into the other region, as no Z producer can bid workers away from

Y production in the Y production center. With constant returns in Z, the marginal product of labor in Z is the same in any region. Since the value marginal product of labor in Y exceeds that in Z, producers of Z are only able to attract workers by moving to the unagglomerated region, where housing prices are lower.

Trade: Consider the result of trade between Home and Foreign. The fact that Foreign has a larger labor force than Home implies Foreign is more efficient in the production of Y. To see this, compare w^*/P^*_y and w_n/P_y, the relative price of Z and Y in each country:

$$\frac{w^*}{P^*_y} = \phi^{\phi\sigma}(1-\phi)^{\sigma(1-\phi)}(L^*)^{\sigma-1}$$

$$\frac{w^n}{P_y} = (1-\phi)\mu^{\sigma(1-\phi)-1}L^{\sigma-1}(1+\mu)^{1-\sigma} \qquad (18)$$

Foreign is more efficient in marketing if $w^*/P^*_y > w_n/P_y$. From (18), this will be the case if

$$\frac{L^*}{L} > \frac{\phi^{[\alpha\sigma(1-\phi)-\alpha+1-\sigma]/(\sigma-1)}(1-\phi)^{[\alpha\sigma\phi-\sigma+1]/(\sigma-1)}}{\phi^{\alpha-1} + (1-\phi)^{\alpha-1}} \qquad (19)$$

A little algebra reveals (19) is true even for equal sized countries if $\sigma-1 > \alpha\sigma\phi$. (19) will certainly hold if L^* is considerably larger than L, as is assumed to be the case. The relative price of Z to Y is lower in Home than in Foreign, leading Home to export Z and import Y. With increasing returns in Y, Foreign captures all marketing activities and Home specializes in assembly.

A natural question is whether it is possible to recreate the integrated economy equilibrium through trade. Given external economies, this will depend on how labor is divided between Home and Foreign. If Foreign's share of the labor force is sufficient to provide the same level of marketing services as in the integrated economy, factor price equalization obtains and trade reproduces the integrated economy. The minimum share of the labor force in Foreign for the integrated economy equilibrium to obtain is given by the single region solution in (6). As long as,

$$L^* > \phi(L^* + L), \quad \text{or}$$

$$L^* > \frac{L\phi}{1-\phi} \tag{20}$$

the integrated economy equilibrium obtains. If L^* exceeds the level in (20), Foreign produces all Y and some Z, and wages are equalized. If (20) exact binds, Foreign specializes in Y and Home specializes in Z, and wages are just equalized between the two countries.

Trade has a dramatic effect on both the location and organization of production. Trade creates a pattern of vertical specialization in which the small country specializes in assembly and the large country specializes in marketing. Trade also lead to a relocation of production in the small country. Labor that used to engage in marketing in South converts to assembly. Under autarky, $L^* > L^n$ causing housing prices in South to exceed those in North. Now that both

regions produce Z, equilibrium requires the wage paid to L_z be the same in each region. For this to be true, trade must lead to a migration of labor from South to North. Trade deindustrializes the South and expands industry in the North.

Transport Costs: Suppose there are transport costs between Home and Foreign and that the costs between South and Foreign exceed those between North and Foreign. The effect is to further deindustrialize the South. To see this, suppose transport costs are zero between North and Foreign, but positive between South and Foreign. Suppose further that transport costs take Samuelson's iceberg form: of each unit shipped, only a fraction ϵ actually arrives. Foreign firms now will only be willing to pay ϵ times the price for Z produced in South, compared to Z produced in North or in Foreign. Equilibrium requires

$$\frac{w^s}{w^n} = \epsilon \tag{21}$$

For workers in South to be willing to work for a lower wage they must be compensated with lower housing prices. From (15), the labor market equilibrium condition is,

$$\frac{w^s}{w^n} = \left[\frac{P^s_t}{P^n_t}\right]^{\alpha} \tag{22}$$

From (10), equilibrium in the regional housing markets implies

$$\frac{w^s}{w^n} = \frac{L^n}{L^s}\frac{P^s_t}{P^n_t} \tag{23}$$

Combining (21), (22), and (23) gives the distribution of labor

across regions:

$$\frac{L^s}{L^n} = \epsilon^{(1-\alpha)/\alpha} < 1 \qquad (24)$$

Trade in the presence of transport costs leads to a further flow of labor from South to North.

2.2 North American Economic Integration

The rudimentary model of the last section captures many of the essential features of the integration of the Mexican garment industry into the North American economy. Trade shifts assembly from the U.S. to Mexico, given lower wages south of the border. U.S. firms, given the larger size of the U.S. market, capture marketing activities from Mexico. The process of moving assembly to the small country takes a particular form. The agents that bring assembly work to Mexico are firms from U.S. marketing centers, as they have exclusive knowledge about the home market. The Mexico City marketing center is being eclipsed by marketing centers in Los Angeles and New York. The smaller size of the Mexican market implies that Mexico cannot support a marketing center that competes directly with those in the U.S.; traders in Mexico City consequently drop their relationships with producers in outlying agglomerations to become importers. The pattern of vertical specialization is determined by market size. The small country, in effect, becomes a periphery region of the large country.

Under the closed economy, border regions in Mexico played little role in domestic garment production. Integration turns the border into the natural assembly platform for marketing centers in the U.S. Most U.S. garment firms doing business in Mexico are from the Los Angeles marketing center; Los Angeles is also the main channel through which garments imports arrive in Mexico City. The small size of the Mexican market may not initially affect the balance between the New York and Los Angeles marketing centers, but over time it is likely Los Angeles will emerge as the principal marketing center in the U.S., at least for a certain range of products.

Are there alternative explanations for the growth of the garment maquiladora industry? Many observers attribute the expansion of maquiladoras to existing policies, such as item 807.[73] This view confuses in-bond production with off-shore assembly. Item 807 gives garment firms that engage in off-shore assembly an incentive to use U.S. fabric. It implies nothing, however, about who should control design and marketing activities. If contacts with U.S. marketing centers were unnecessary, Mexican firms would participate in all aspects of off-shore production -- including design and distribution -- not just assembly. They could just as easily take advantage of item 807, Mexican fiscal incentives, and low Mexican wages by establishing a plant in the U.S. to purchase U.S. fabric and a second plant in Mexican to assemble

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[73] See Fernández-Kelly (1983) and Sklair (1989).

garments. In reality, Mexico's role is limited to assembly. Mexican assembly plants depend on foreign clients to provide product designs and access to markets.

2.3 Is there Life after Maquila?

There are a variety of shortcomings to a maquiladora-oriented development path that reflect the fears of Mexican industrialists alluded to at the outset of this chapter. Maquiladoras often depend on a single client for access to U.S. markets. Assembly also represents the least profitable link of the value-added chain in garment manufacturing; value added by maquiladoras between 1981 and 1988 represented an average of 32.7 percent of the value of maquila exports. A more significant issue is that maquiladoras face highly cyclical demand for their labor. When U.S. garment manufacturers face a downturn in demand, it is maquiladoras they layoff first. Table 5.6 shows employment in garment maquiladoras fell by 16.9 percent during the 1981-1982 U.S. recession; Table 5.3 shows employment fell by 2.0 percent between June and September, 1990, during the beginning of the current recession, as compared to a 6.1 percent increase during the same period the year before.

Is Mexico doomed to the task of off-shore assembly in the North American market? The theoretical framework of the last section suggests the location of the marketing center is purely a function of market size. This implies off-shore

assembly represents Mexican producers only access to U.S. markets. Interview material suggest this characterization is too stark. There are gradations between the two extremes of pure assembly and integrated production and marketing. Indeed, Chapter Three clearly illustrates that in the development of the domestic industry producer agglomerations typically controlled design activities, and in some instances part of the wholesale distribution process. What distinguishes the experience of domestic producer agglomerations is that their participation in design and marketing was limited to specialized tasks. Specialization allowed them to coexist with a larger marketing center in Mexico City.

In the newly open economy, firms in Aguascalientes, Guadalajara, and Monterrey appear to be following a similar strategy of specialized vertical expansion. Firms have selected a particular high valued-added activity and are attempting to capture it from larger, more developed marketing centers. In Aguascalientes and Guadalajara, the activity is wholesale distribution; in Monterrey it is design of mid-range women's outerwear. Firms in Guadalajara are also trying to use their accumulated experience in distribution to establish a design center. A common feature of firm strategies in Aguascalientes and Guadalajara is the reliance on a regional trade association -- in both cases the local delegation of the National Garment Industry Chamber -- to coordinate activities.

Agglomerations of firms in Mexico may not be able to replicate the success of Asian manufacturing agglomerations, but their experiences suggest coordination is a necessary component in the transition from assembly to high value-added activities.

Is there a role for policy in specialized vertical expansion? There would appear to be a natural role for policy in coordinating actions to capture design and distribution activities from larger marketing centers. Indeed, the Aguascalientes export trading company and the Guadalajara trade fair would seem obvious candidates for replication in other regions. It is essential to point out that these initiatives were developed and implemented by firms themselves. The coordinating organizational body, the local industry chamber, is run by firms. As discussed in Chapter Two, the only government-sponsored initiative was the Fashion and Design Center in Mexico City. This effort, while similar in scheme and intent to those in Aguascalientes and Guadalajara, has failed because the project coordinators neglected to consult the target population of firms. There remains little doubt that a role for policy exists; but there remains a great deal of doubt about the ability of the designated government agencies to carry out the appropriate measures.

3. Concluding Remarks

It was the architect of Mexico's first attempt at

outward-oriented development, General Porfirio Díaz (1876-1910), who made the oft-repeated exclamation, "Poor Mexico! So far from God and so near to the United States." The remark, though nearly a century old, still resonates in Mexico as the country looks forward to a future of closer economic ties with the U.S. For Mexico, integration is a two-edged sword. Integration allows Mexican firms gain access to new markets and technologies on a scale that would have never been attainable under the old regime. The tradeoff for enhanced productivity is a loss of control over the production process. Access to U.S. markets requires Mexican firms to shift from fully-integrated manufacturing to a vertically specialized role as subcontractors for U.S. client firms. In garments, and other industries, this transition involves conversion to off-shore assembly. Given the large size of the U.S. economy, it is still likely the gains Mexican producers enjoy from having access to the U.S. market will swamp any losses from ceding external economy activities to the U.S.

There is a strong nationalist current in Mexico that equates off-shore assembly with a loss in sovereignty. This view overlooks the regional disparities that were an inherent feature of import substitution industrialization. Under the closed economy, Mexico City emerged as the country's principal industrial center. The process of geographic concentration in the capital peripheralized other regions in the country, including northern Mexico, which under Díaz had developed

strong commercial ties with the U.S. A North American Free Trade Area would transform the process of regional economic development in Mexico. Integration would convert the former center into a periphery region of the U.S., while granting the North access to substantially better markets and technology. To call this a loss in sovereignty is not a nationalist perspective but a regionalist perspective that favors the welfare of the center over the welfare of other regions.

CHAPTER SIX: A MODEL OF INDUSTRY LOCALIZATION AS A SOLUTION TO THE EMPLOYEE HOLD-UP PROBLEM

Chapters Three and Four study geographic concentration as it relates to the initial stages of industrialization. A key feature of this process is the diffusion of knowledge from the location where industry begins to outlying regions. In this context, firms leaving the initial agglomeration follow each other in order to gain access to skilled labor. In later stages of industrialization, there will be a large pool of skilled labor in outlying regions. Is there still a reason for firms to agglomerate?

This chapter argues that industry localization eliminates hold-up problems created by spatially dispersed production. We study an industry where production and trade are carried out by two types of agents: traders and producers. Traders make costly investments in expanding distribution channels; producers have specific skills and offer production services to traders. Once a trader undertakes investments and commits herself to a particular location, she faces the risk that producers may try to hold-up production and demand a larger share of any pre-negotiated distribution of the surplus. The risk of hold-up is greater in locations with fewer producers. Through agglomeration, traders increase competition among producers for the services they provide and reduce bargaining problems.

The similarity between this framework and the transaction-cost view of the firm is intentional. Using Williamson's (1985) language, agglomeration allows firms to avoid the creation of relationship-specific assets. Agglomeration can be seen as an alternative to vertical integration. Williamson suggests integration reduces bargaining costs created by bilateral monopoly. (Though why integration improves matters is not made explicit; see Grossman and Hart (1986) and Kreps (1990) for alternative views.) Integration, however, may bring with it unwanted concentration of ownership; for instance, integration may raise monitoring costs by replacing many owners with one. Agglomeration reduces bargaining problems without concentrating ownership.

The location process consists of a three-stage game between traders and producers. Section one outlines the nature of production and trade. Section two describes the timing of actions taken by traders and producers. Section three describes the bargaining process. Bargaining outcomes are given by Shapley Values. As this device is not well-known, we discuss it some detail. Section four derives the agglomeration equilibrium. Agglomeration represents an efficiency gain over geographically decentralized production. Traders benefit since they gain access to a larger pool of producers with whom to transact; producers benefit since they gain access to downstream markets. Section five provides

concluding remarks.

1. Production and Trade

Location outcomes are the result of a three-stage game between traders and producers.

Producers: There are N producers who distribute themselves across $K \leq N$ periphery locations. Each location is distinct; there is no communication between agents in different locations. Each producer has an identical production technology that is characterized by the following total cost function:

$$TC = c*q, \qquad (1)$$

where q is output, and c is unit cost. Cost is measured in terms of the single good. Producers lack access to downstream markets and rely on traders to market their output.

Traders: There are J traders, each of whom is based in a marketing center that is spatially separate from periphery locations. The commercial possibilities for a trader are given by a revenue function, R(), that is a function of e, the level of effort invested, and q, the level of output, where

$$R_e(e,q) > 0 \qquad R_{ee}(e,q) \leq 0$$

$$R_q(e,q) > 0 \qquad R_{qq}(e,q) \leq 0$$

$$R_{qe}(e,q,) \geq 0 \quad \text{for all } e,\ q \geq 0 \qquad (2)$$

Investment of effort allows traders to expand the scope of

their market, the concavity of R() in e implies traders are limited in their ability to do so. Effort is costly for traders. This cost is given by a function, f(e), where,

$$f_e(e) > 0$$
$$f_{ee}(e) \geq 0 \qquad (3)$$

An individual trader chooses e and q independent of the actions of other traders. This is somewhat disingenuous given R() is concave in q, implying that traders face a downward-sloping demand curve.[74]

Traders choose between producing for themselves and travelling to a periphery location to transact with producers. If a trader chooses to visit a periphery location, she forgoes the opportunity to produce for herself or visit other locations. If a trader chooses own production, she faces marginal production cost c^*, where

$$c^* > c \qquad (4)$$

implying there are gains from trade between traders and producers. Under own production, trader profits are

$$R(e,q) - f(e) - (c^*)q \qquad (5)$$

Profit maximization with respect to e and q leads to the following first order conditions:

$$R_e(e,q) = f_e(e)$$

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[74] An example of this type of situation is where traders have divided up sales regions between them in a pie-like fashion, and each trader is permitted to expand her market away from the center, but not permitted to encroach on the adjoining wedges allotted to her neighbors.

$$R_q(e,q) = c^* \qquad (6)$$

Given (2) and (3), there is a unique pair $\{e^*, q^*\}$ that solves (6). Define trader profits under own production to be π^*:

$$\pi^* = R(e^*,q^*) - f(e^*) - c^*q^* > 0 \qquad (7)$$

2. Timing

Location, production, and trade occur in three stages. All decisions are irreversible; contracts which specify a course of action <u>across</u> time periods are assumed impossible. In period one, traders non-cooperatively make location and investment decisions, incurring costs f(e). In period two, producers non-cooperatively make location decisions. In period three, production and trade take place, which amounts to choosing q and dividing up any surplus.

If a trader chooses own production, her choices on e and q are given by (6). If a trader instead visits a periphery location, she bargains with the producers and traders at that location over the distribution of the gains from trade. Bargaining occurs among the agents that share a location; there is no interaction between agents in different locations. Consider Location A, with n producers and J_A traders. Given period two decisions on e, the surplus in period three is

$$\sum_{j=1}^{J_A} [R(e_j^{**}, q_j) - cq_j], \qquad J_A: \{all\ j \in A\}, \qquad (8)$$

where e_j^{**} is trader j's period one investment choice. If within period contracts are possible, traders and producers can sign a period three contract specifying q and each agent's share of the total surplus. Naturally, traders and producers will choose q to maximize (8), given c and e_j^{**}. This yields the following set of first order conditions,

$$R_q(e_j^{**}, q_j) = c, \qquad \text{all j at A} \tag{9}$$

For trader j, (9) yields the following period one reaction function,

$$q_j = q(e_j, c), \tag{10}$$

which is assumed to be increasing and concave in e. Foreseeing the period three outcome, trader j incorporates (10) into her period one decision on e, in Stackelberg-like fashion.

3. The Bargaining Framework

Bargaining outcomes are given by Shapley Values. The Shapley Value essentially generalizes the Nash bargaining solution.[75] Consider a group of M agents. The Shapley Value of agent i is her expected marginal contribution to a coalition formed from M. In other words, an agent's Shapley Value is her average marginal contribution over all coalitions of agents that might form from M. Let V() represent the total surplus generated by a given coalition of agents from M.

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[75] See Hart (1987) and Hart and Moore (1988) for a discussion.

Consider a coalition S, to which agent i belongs. By definition, agent i's marginal contribution to S is

$$V(S) - V(S-\{i\}) \tag{11}$$

in which case agent i's Shapley Value is

$$\sum_{\{S \mid i \in S\}} p(s) * [V(S) - V(S-\{i\})], \tag{12}$$

where p(S) is the probability that the coalition S arises. The probability p(S) is derived straightforwardly. Arrange the M total agents on a line, and include in S agent i and all agents that precede her -- that is, all agents to her left. Assuming the M! possible orderings of agents are all equally likely, agent i's Shapley Value is

$$\sum_{\{S \mid i \in S\}} \left[\frac{(s-1)\,(M-s)\,!}{M!}\right] [V(S) - V(S-\{i\})] \tag{13}$$

where s equals the number of agents in coalition S.

In principle, agent i's marginal contribution to a coalition S, V(S) - V(S-{i}), can take a different value for every coalition. In the location game we consider, the setup is very simple. M corresponds to the number of traders and producers that share a given location. An agent's marginal contribution takes only one of two values. A trader has a positive marginal contribution in all coalitions in which she is joined by at least one producer. This is due to the fact that traders in periphery locations have foregone the

opportunity to produce for themselves and rely on producers for access to production facilities. As each trader has access to a unique set of distribution channels, a trader's marginal contribution, where it is positive, does not vary across coalitions. A producer has a positive marginal contribution in all coalitions in which he is the sole producer; given producers are identical, a producer only makes a non-trivial contribution to a coalition where he is the coalition's sole access to production facilities.

Consider Location A, where there are n producers and J_A traders. Trader i has a positive marginal contribution to a coalition in all orderings in which there is at least one producer to her left. By (11), the marginal contribution of trader i is

$$\{i \sum_{\in J_A}\} [R(e_j^{\bullet\bullet}, q_j) - cq_j] - \{i \sum_{\notin J_A}\} [R(e_j^{\bullet\bullet}, q_j) - cq_j], \; J_A: \{all \; i \in A\} \tag{14}$$

Given that a trader's marginal contribution to a coalition is independent of the presence of other traders, (14) reduces to

$$R(e_i^{\bullet\bullet}, q_i) - cq_i \tag{15}$$

Trader i's Shapley Value is the expression in (15) times the probability that trader i is in a coalition with at least one producer. It is easiest to calculate this probability indirectly as one minus the probability that trader i is in a coalition <u>without</u> a producer.

The following diagram lists the coalitions in which

trader i is preceded solely by traders:

Trader i's order in coalition:		Number of corresponding coalitions:
1st:	T_i, ...	$(n+J_A-1)!$
2nd:	T_k, T_i, ...	$(n+J_A-2)!*(J_A-1)$
3rd:	T_k, T_j, T_i, ...	$(n+J_A-3)!*[(J_A-1)!/((J_A-1)-2)!]$
.		
.		
.		
J_Ath:	T_k,.....,T_i,...	$(n+J_A-J_A))!*[(J_A-1)!/((J_A-1)-(J_A-1))!]$
		(where k,j do not equal i).

The probability trader i is in a coalition without a producer is calculated by summing down the right-hand side of the diagram and dividing this sum by the total number of coalitions, which is $(n+J_A)!$. One minus this probability is the probability that trader i has a marginal contribution equal to $R(e_i^{**},q_i) - cq_i$. Trader i's Shapley Value is then

$$[1 - \sum_{j=1}^{J_A} \frac{(n+J_A-j)!\,[\frac{(J_A-1)!}{((J_A-1)-(j-1))!}]}{(n+J_A)!}]*[Re_i^{**},q_i,) - cq_i] \qquad (16)$$

A little algebra reveals that the expression inside the brackets in (16) reduces to n/(n+1). This is left to an appendix. Written compactly, trader i's Shapley Value is

$$[n/(n+1)]*[R(e_i^{**},q_i) - cq_i] \qquad (17)$$

Hence, trader i's share of the surplus is independent of the number of other traders with whom she shares a given location.

The Shapley Value for any producer k at Location A can be calculated in a similar manner. A producer has a positive marginal contribution only in those coalitions in which he is the sole producer. Where producer k is the sole producer, he represents the coalition's only access to production facilities. Hence, his marginal contribution is equal to the total surplus generated by the coalition, which equals the expression in (15) times the number of traders in the coalition. With n producers and J_A traders, a producers Shapley Value is

$$\sum_{j=1}^{J_A} \left[\frac{(n+J_A-(j+1))!\left[\frac{J_A!}{(J_A-j)!}\right]}{(n+J_A)!}\right] * (j) * [R(e_i^{**}, q_i) - cq_i] \qquad (18)$$

Expression (18) is constructed in a manner similar to expression (16). The construction of (18) is left to an appendix.

4. The Agglomeration Equilibrium

Given lower marginal costs in outside locations, traders are naturally interested in transacting with producers in periphery locations. The bargaining process reduces traders' incentives to invest in effort, thereby dissipating the potential gains from trade. For a given trader, the arrival of an additional producer increases her bargaining power and she takes home a greater share of the surplus. She naturally

prefers locations with a larger concentration of producers. From (17), the arrival of an additional trader leaves her unaffected. These two factors are what lead traders to agglomerate.

We claim that the formation of a single agglomeration is a Nash equilibrium. Proof is by construction. We begin in the last period and work backwards.

Period Three: In period three, production and trade occur. This amounts to a choice on q and a division of the surplus. The choice on q is given by (9), which yields a period one reaction function for each trader. The reaction function is given by (10). The period three distribution of the surplus for an individual trader is given by (17), and for an individual producer by (18).

Period Two: In period two, producers make location decisions. Equilibrium requires that, given traders' period one decisions and the location decisions of other producers, no individual producer is better off by changing locations. It is not necessary that producer profits in occupied locations be equal, but it must be true that, given the distribution of traders and producers, no single producer can earn higher profits by leaving his current location and moving to a new one. If traders are agglomerated in a single location, no producers can do better than choosing the agglomerated

location.

Period One: For agglomeration to be a Nash equilibrium, it must be true that, given a situation where all traders choose a single location, no individual trader is better off by moving to a new location. In other words, the ith trader must not be able to attract a sufficient number of producers to earn higher profits than she would in the agglomerated location.

Consider a location with n producers and J traders -- that is, a situation where all traders have chosen the same location. In period one, each trader chooses a level of investment, e, which is given by (10), based on her expected share of the surplus. Combining (10) with (17) yields the following period one optimization problem for trader i:

$$\max_{\{e\}} [n/(n+1)]*[R(e, q(e,c)) - cq(e,c)] - f(e), \qquad (19)$$

where subscripts denoting individual traders are dropped for expositional ease. Maximization of (19), yields the following first and second order conditions,

$$[n/(n+1)]*[R_e(e,q(e,c)) + R_q(e,q(e,c))*q_e(e,c) - cq_e(e,c)] - f_e(e) = 0$$

$$[n/(n+1)]*[R_{ee}(e,q(e,c)) + R_{qq}(e,q(e,c))*q_e(e,c) + R_q(e,q(e,c))*q_{ee}(e,c) - c*q_{ee}(e,c)] - f_{ee}(e) \leq 0 \qquad (20)$$

As long as the second order condition holds, there is a unique Nash equilibrium $\{e^{**},q^{**}\}$, given n and c. Profits for an

individual trader become

$$[n/(n+1)]*[R(e^{\bullet\bullet},q^{\bullet\bullet}) - cq^{\bullet\bullet}] - f(e^{\bullet\bullet}) \qquad (21)$$

The profits given by (21) can be rewritten as

$$\pi^{i}(e(n),q(n),n,j) \qquad (22)$$

a function of the number of producer that occupy a location.

We can now show that no trader would be better off by moving to a location with fewer producers. Trader i knows that if all traders are agglomerated in a single location at the end of period one, then in period two all producers will choose the agglomerated location. This implies that n = N. If trader i moves to an unoccupied location, her profits can only decrease. To see this, consider the change in trader profits due to a change in n, the number of producers at a location. By the envelope theorem, the indirect effect of a change in n on e and q will be zero; $\delta\pi^{i}/\delta n$ is

$$\frac{\delta\pi^{i}(e(n),q(n),n,j)}{\delta n} = (n+1)^{-2}*[R(e^{\bullet\bullet},q^{\bullet\bullet}) - f(e^{\bullet\bullet}) - cq^{\bullet\bullet}] > 0 \qquad (23)$$

Trader profits are at a maximum where n = N. Even if trader i moves to a location where she is the sole trader, she will be unable to earn higher profits than she earns in the agglomerated location. As long as

$$\pi^{i}(e(N),q(N),N,J) > \pi^{\bullet} \qquad (24)$$

the formation of a single agglomeration is a Nash equilibrium.

5. Concluding Remarks

There is a clear economic intuition why agglomeration is an equilibrium outcome. The agglomeration of traders and producers represents an overall efficiency gain. In the agglomerated location, traders take home a larger share of the surplus they generate; this gives them a greater incentive to invest in developing new markets. A higher level of investment increases the total surplus. In a geographically decentralized outcome, traders bargain with a smaller group of producers, which gives producers greater bargaining power (but does not necessarily increase their total earnings, due to dampened investment incentives for traders). Producers cannot credibly commit in period one not to take advantage of whatever bargaining power they will have in period three. Hence, trader incentives to invest are reduced. Localization improves trader investment incentives by reducing the possibility of ex-post opportunistic behavior. In the agglomerated location, traders have access to a large pool of potential clients that value their services, and producers gain access to downstream markets.

APPENDIX

A.1 Trader i's Shapley Value

From (16), the probability a trader makes a positive marginal contribution to a coalition is given by

$$1 - \sum_{j=1}^{J_A} \frac{(n+J_A-j)!\left[\frac{(J_A-1)!}{((J_A-1)-(j-1))!}\right]}{(n+J_A)!}$$

We show the above expression reduces to n/(n+1), or that the summation expression reduces to 1/(n+1). Writing out the summation expression yields

$$\frac{\frac{n!(J-1)!}{0!} + \frac{(n+1)!(J-1)!}{1!} + \frac{(n+2)!(J-1)!}{2!} + \ldots + \frac{(n+J-1)!(J-1)!}{(J-1)!}}{(n+J)!}$$

Step one is to rewrite the numerator by carrying out the implied division. This yields

$$\frac{n!(J-1)! + (n+1)!(J-1)! + (n+2)!\prod_{j=3}^{J-1}(j) + (n+3)!\prod_{j=4}^{J-1}(j) + \ldots + (n+J-1)!}{(n+J)!}$$

Step two is to carry out the implied division of each expression in the numerator by the denominator. This yields

$$\frac{(J-1)! + (n+1)(J-1)! + (n+1)(n+2)\prod_{j=3}^{J-1} j + \ldots + (n+1)*\ldots*(n+J-1)}{(n+1)(n+2)\ldots(n+J)}$$

Step three is to add the first two terms in the numerator to obtain (n+2)(J-1)!. Since (n+2) enters every term in the numerator and the denominator it is dropped from the expression. Step four is to make use of the fact that

$$\prod_{j=k}^{J-1}(j) = k\prod_{j=k+1}^{J-1}(j)$$

This makes it possible to collect product terms in the numerator and progressively eliminate them from the expression, as in step three, until we arrive at 1/(n+1).

A.2 Producer k's Shapley Value

Producer k will have a positive marginal contribution to any coalition in which he is preceded exclusively by traders. In this case, he represents the coalition's only access to production facilities; his marginal contribution to the coalition is the total surplus generated by the coalition. The total surplus for a coalition with j traders is

$$[R(e_i^{**}, q_i) - cq_i]*j$$

Producer k's Shapley value equals the above expression times the probability that he is the sole producer in a coalition. This probability is the probability that producer k is preceded exclusively by traders. The diagram below lists such coalitions (where h, i, and j are not equal).

Producer k's order in coalition:		Number of corresponding coalitions:
2nd:	T_h, $\mathbf{P_k}$, ...	$(n+J_A-2)!*J_A$
3rd:	T_h, T_i, $\mathbf{P_k}$, ...	$(n+J_A-3)!*J_A!/(J_A-2)!$
4th:	T_h, T_i, T_j, $\mathbf{P_k}$, ...	$(n+J_A-4)!*J_A!/(J_A-2)!$
.		
.		
(J_A+1)th:	T_h,.....T_i, $\mathbf{P_k}$,...	$(n+J_A-(J_A+1))!*J_A!$

Summing down the right-hand-side and dividing by $(n+J_A)!$, the total number of coalitions, yields the probability that producer k has a positive marginal contribution to a coalition. Producer k's Shapley Value is, then,

$$\sum_{j=1}^{J_A} \left[\frac{(n+J_A-(j+1))!\left[\frac{J_A!}{(J_A-j)!}\right]}{(n+J_A)!}\right]*(j)*[R(e_i^{**}, q_i) - cq_i]$$

CHAPTER SEVEN: CONCLUSION

The thesis permits a number of conclusions about the relationship between industrialization, geographic concentration, and trade. Industrialization does not spread across regions in a smooth fashion, rather a process of industrial growth begins in a single industrial center. That is, industrialization and agglomeration are equivalent processes. Industrialization proceeds at first by drawing resources into an initial agglomeration, instead of through the geographic dispersion of new products and processes. Chandler (1989) describes a similar occurrence in the industrial development of Europe and the U.S., which he attributes to plant-level economies of scale. In the process to which we refer, firms perceive constant returns. Firms agglomerate in order to gain access to industry-specific knowledge about markets and production. Knowledge about markets depreciates at an accelerated rate, necessitating a maintained presence in the initial agglomeration in order to continually replenish the stock of knowledge. Knowledge about production becomes manifested in the specific skills of individuals. As production knowledge diffuses among the agents that populate the industrial center, a new reason emerges for firms to agglomerate: to gain access to skilled workers.

Early in industrialization, knowledge about markets and

production remains localized within the initial agglomeration. The localization of knowledge creates gains from trade with the periphery -- regions untouched by industrialization -- and induces firms to disperse from the center. As competition for skilled labor in the center increases, the benefits of being agglomerated diminish. Firms are drawn to the periphery where workers have a lower alternative wage. Firms do not disperse immediately, as periphery workers lack appropriate skills. In the initial stages of industrialization, these skills may be as rudimentary as punctuality. This is not a pejorative statement; industrialization involves a fundamental transformation in the way work is organized. The need to train periphery workers implies firms do not disperse from the center until the gains from trade are substantial.

A single firm, the pioneer, undertakes investments necessary to open a periphery location to production. It is this act that makes the pioneer an innovator: by transferring industry-specific knowledge to the periphery the pioneer enhances the productivity of existing resources. The training the pioneer provides links the periphery by trade to the industrial center. As the sole intermediary in the trading relationship, the pioneer enjoys monopsony power in the periphery. Realizing this latent market power, almost by definition, opens the way for others to share in the gains from trade. Creating or expanding markets confers externalities on agents in both the periphery and the

industrial center. The pioneer firm cannot internalize these effects, but is able to delay entry by other firms. The pioneer maintains an advantage over later arrivals in terms of knowledge about the skills and abilities of local workers. Through rent-sharing arrangements with the most able workers, the pioneer induces later arrivals to postpone entry and prevents employees from becoming competitors. The pioneer thus emerges as a central figure in the industrialization of the periphery.

The pattern of geographic concentration that emerges is dictated by the reference market. Periphery regions function as satellite production centers for the industrial center; they are sub-agglomerations tied to the initial agglomeration. The center continues to supply the periphery with product designs, new technologies, and access to markets. When the reference market changes, such as through an opening to trade, the existing pattern of industry agglomeration is no longer relevant. The reference market ceases to be the original industrial center. The center comes into competition with existing industrial centers in other nations. If the markets in these nations are larger, or in some sense more developed, the home country industrial center is at a disadvantage, as the value of the information a center provides is a function of its size. Sub-agglomerations in the periphery gain autonomy from the home country industrial center. They are free to develop contacts with more prosperous industrial

centers in larger countries. Foreign pioneer firms from large country industrial centers come to the home country in search of new production possibilities.

For a small country, economic opening is a two-edged sword. Integration gives firms access to new markets and new technologies on a scale that would have never been attainable under the closed trade regime. The tradeoff for greater productivity is a loss in control over the production process. Access to large country markets requires firms to cede activities like product development, design, and marketing to firms in large country industrial centers. Small country firms typically assume a vertically specialized role as subcontractors. This status is by no means permanent. Small country firms have the potential to capture high-valued activities from the industrial center, at least in certain industries. A necessary condition for this to occur is the formation of an agglomeration of firms that is sufficiently large to compete with the center. Coordination among firms can hasten this process. While small country firms are not forever doomed to subcontracting, the ability to capture high value-added activities is not given. Understanding what makes firms able to graduate from one level to the next is clearly a subject for further research.

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