Walmart in Mexico: The Impact of FDI on Innovation and Industry Productivity*

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Abstract

This paper examines the impact of foreign direct investment on the industry structure, productivity performance, and the rate of innovation of domestic firms by studying the entry of Wal-Mart into Mexico following the 1994 North American Free Trade Agreement. We present a dynamic industry model in which firms decide whether to sell their products through Walmex, or use traditional retailers. Walmex provides access to a larger market, but it puts continuous pressure on its suppliers to improve their product's appeal, and it forces them to accept relatively low prices. Simulations of the model show that the arrival of Walmex separates potential suppliers into two groups. Those with relatively appealing products choose Walmex as their retailer, whereas those with less appealing products do not. For the industry as a whole, the model predicts that the associated market share reallocations, adjustments in innovative effort, and exit patterns increase productivity and the rate of innovation. The results accord well both with results from our interviews with Mexican manufacturers and with preliminary regression results based on a panel of Mexican producers.

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1 Introduction

In the mid 1980s, Mexico began dismantling its extensive system of trade barriers and constraints on foreign direct investment. This opening process, in combination with Mexico's growing middle class, attracted Wal-Mart into Mexico in 1991. Beginning from a joint venture with an existing Mexican retailer, Wal-Mart took majority control of its investment in 1997, becoming Wal-Mart of Mexico (*Walmex*). And by 2003 it had become Mexico's largest private employer (Case 2004), transforming not only the retail sector, but the consumer goods industries that supply it. We analyze the effects of Wal-Mart's presence in Mexico on patterns of industrial evolution among Mexican producers of consumer goods.

More precisely, we develop a dynamic model of consumer goods producers in which firms decide whether to sell their products through *Walmex* or traditional retailers. The main advantage of selling through *Walmex* lies in a larger market, both nationally and possibly in form of export opportunities. The downside is continuous pressure to raise the quality of the product, lower one's price, or a combination of the two. An agreement with *Walmex* also requires new R&D investments to upgrade technology, thereby ensuring compatibility with *Walmex*'s operations.

Simulations of the model show that the arrival of *Walmex* leads to a striking bisection among its potential suppliers. Only firms that sell relatively high-appeal products (conditional on price) choose to sell through *Walmex*, whereas low-appeal firms choose to continue selling through traditional retailers. These two types of supplying firms also choose contrasting technology upgrading strategies: *Walmex* firms invest more in technology upgrading,

especially at the upper end of the quality distribution, whereas technology investments of firms not going through *Walmex* fall. Intuitively, the R&D investments necessary to cooperate with *Walmex* are only optimal to incur for firms that sell relatively much to begin with, and these are the high-appeal firms. Our model thus predicts the impact of FDI on many dimensions of firm behavior that observers have emphasized.

In addition, the model has predictions on other key firm choices. Firms that sell through *Walmex* see their quality-adjusted price and mark-up fall, especially those producing moderate- as opposed to high-appeal products. Also, R&D/marketing investments fall among non-*Walmex* firms, while they go up at the top end of the product appeal distribution. Interestingly, for the marginal firms that just decide to sell through *Walmex*, capital investments tend to fall; in this case, concerns over current-period profits take precedence over profit opportunities in the future. Finally, the model predicts that *Walmex*'s appearance induces market share reallocations towards high-appeal firms, and the exit of some relatively low-appeal firms—a pattern that has been widely documented. For the industry as a whole, we find that productivity (and the price-adjusted average quality) increases, and the rate of innovation as measured by R&D investments does so as well.

The evidence we present regarding these predictions comes from two sources. First, we conducted interviews with Mexican firm representatives and industry experts. Those interviewed frequently mentioned that *Walmex*' entry had considerably sharpened the distinction of high- versus low-performing firms. They also stated that, among firms choosing to deal with *Walmex,* the productivity effects were often positive.[1] Second, we analyze plant-level

[1] We have conducted two series of interviews on which we are drawing, in the years 2005 and 2007; results

panel data on Mexican manufacturers of consumer goods. These data, obtained from the Mexican Statistical Office (INEGI), allow us to examine whether the predicted patterns on industry restructering, productivity, and innovation are most striking in regions where *Walmex* has established a presence. The results discussed below suggests that, at least broadly speaking, this is the case.

There is a large literature emphasizing the impact of FDI in host countries.[2] Our research adds to this in a number of dimensions. First, the credibility of our argument is strengthened by relying both on case-study techniques, as in McKinsey (2003), and formal regression analysis as in Javorcik (2004) and Keller and Yeaple (2008). Second, by modeling a specific mechanism, our theory of multinational entry helps to interpret the FDI effects that empirical studies have found,[3] while the model simulations yield insights on which aspects of firm behavior are quantitatively most important. Third, we shed new light on a whole range of firm activities, including sales, pricing, wage payments, investment, technology upgrading, as well as the exit margin. This makes for a richer empirical analysis than in Sjoholm and Lipsey (2006), for example, where the focus is mainly on wage effects.

It is increasingly recognized that if firms are intrinsically heterogeneous in terms of their productivity or the quality of their output, a change in business conditions can yield responses that differ dramatically across firms.[4] Our work contributes to this literature by providing

from the 2005 interviews are summarized in Javorcik, Keller, and Tybout (2008).

[2]Surveys of the literature include Keller (2007), Lipsey and Sjoholm (2005), as well as Görg and Greenway (2004).

[3]The reduced-form impact of global retail chains on supplying industries is estimated in Javorcik and Li (2008).

[4]In particular, a number of recent papers in the trade literature link product market conditions to joint adjustments in market shares and investments in innovation (Yeaple 2005; Ederington and McCalman 2008; Bustos 2007; Constantini and Melitz 2007; Atkeson and Burstein 2007; Verhoogen 2008.)

specific evidence in the context of Wal-Mart's entry into the Mexican market. And, to the best of our knowledge, it is the first to consider the impact of changes in retailing on the supplier industry.

This paper also contributes to the growing literature on the causes and effects of Wal-Mart's operations.[5] Wal-Mart's success in becoming the world's largest private employer has generated much interest among economists and politicians alike. While Wal-Mart's size and prowess in terms of logistics and distribution are key elements of our analysis, our focus is not on Wal-Mart *per se*, but on the effects of its entry into a large and growing new market.[6] Wal-Mart's entry into U.S. regions has been found to be associated with lower retail prices (Basker 2005a), while the evidence on job creation has been mixed mixed (Basker 2005b). Using a model of strategic competition to analyze market share reallocation between two major-Wal-Mart and Kmart– and a fringe of smaller retailers, Jia (2006) finds that Wal-Mart is largely responsible for the demise of small discount retailers. Holmes (2006) examines the dynamic pattern of store openings in the U.S. to estimate Wal-Mart's implied gain from establishing stores near to each other, due perhaps to the sharing infrastructure, distribution centers, and advertising expenditures. Unlike most of this literature, we focus on Wal-Mart's upstream effects on manufacturers rather than its effects on other retailers.

For areas outside the U.S., our research adds a quantitative dimension to the existing work that is primarily qualitative in nature (McKinsey 2003, Durand 2007, Javorcik, Keller, Tybout 2008). Moreoever, we complement earlier regression analysis with evidence on how

[5] See Basker (2007) for an overview.

[6] Any research that strictly focuses on Wal-Mart would also need to account for the more limited success of its FDI in Brazil in the 1990s; see McKinsey (2003).

Wal-Mart's entry affects behavior from a dynamic industry model, with endogenous entry, exit, and market share reallocations at the level of the individual suppliers.

Finally, we also contribute to the growing literature that employs dynamic industry models. A key limitation in this area has been that in order to study Markov Perfect Nash equilibria, let alone to provide econometric estimates, often the models had to be kept too simple to be convincing for empirical analysis. Here, we are able to develop a model that is plausible for the problem at hand. This is possible by computing approximate instead of exact equilibria, using the recently developed methods of Weintraub, Benkard, and Van Roy (2007).

The remainder of the paper is as follows. Section 2 provides background on Wal-Mart's entry into the Mexican retail market. We also report the main lessons drawn from firm interviews and the earlier study of Mexican detergent producers by Javorcik, Keller, and Tybout (2008). Section 3 introduces the basic trade-off that suppliers contemplating selling through Wal-Mart face. The model and its assumptions, equilibrium, the solution algorithm, and simulation results are presented in section 4. Reduced-form regression results are presented in section 5, while section 6 summarizes the results and offers a number of conclusions.

2 The Wal-Mart invasion in Mexico

2.1 Mexico's opening up to foreign retail chains

As the Mexican economy began to open in the mid-1980s, its retail sector began a process of deep transformation. This transformation was accelerated in 1991 by the entry of Wal-Mart

and has had profound implications not only for the retail sector but also for the supplying industries. Mexican producers of consumer goods were heavily protected until the mid 1980s. Thus retailers based in the United States whose strength was in dealing with US-based suppliers stayed out. But as tariffs fell over the following half-decade, Mexican retailers began to offer more consumer goods imported from the United States. And when NAFTA locked in place commercial policy reforms while extending national treatment to foreign investors, the Mexican market became attractive to large United States-based retail chains.[7] This attraction was heightened by Mexico's large population, its growing middle class, and its increasing urbanization.

Participation by foreign retailers in the Mexican market began when executives at several of the major Mexican retailers approached their counterparts in Texas and California concerning possible collaboration. And for their part, major retail chains in the United States took increasing interest in Mexico as the NAFTA negotiations progressed.[8] These events triggered a wave of joint ventures between Mexican and foreign chains. In 1991, the largest Mexican firm involved in retailing, Aurrera (part of the Mexican commercial group CIFRA), formed a joint venture with Wal-Mart. Then, in 1992, Comercial Mexicana entered into a joint venture with Price-Costco. Finally, in 1994 the Mexican supermarket chain Gigante entered into joint ventures with the French retailer Carrefour and with Office Depot. Only one important Mexican supermarket chain, Soriana, remained independent.

[7] See Chavez (2002). Tegel (2003) also concludes that Mexico's unilateral liberalization and signing of the GATT in 1987 were key to the entrance of foreign retailers.

[8] Chavez (2002) observes that "members of the chambers and associations of retailers were invited by their governments to take part in the negotiating commissions representing their sectors and members . . . (fn 1, p. 505).

After familiarizing themselves with Mexico, and having brought their own strengths with them, some foreign retailing firms felt that they no longer needed local collaborators. Most importantly, Wal-Mart bought controlling interest in Aurerra in 1997 and became Wal-Mart de México (*Walmex*). For its part, the French retailer Carrefour left its partnership with Gigante, but remained in the Mexican market.[9] In 2005, however, Carrefour sold its 29 Mexican hypermarkets to a domestic chain Chedraui.

With the influx of foreign retailers, a handful of major chains came to dominate the market, and many of the smaller retailers were forced to shut down. By 2001, "only 4 chains dominated the market: Wal-Mart de México with almost half (45.6 percent), Comerical Mexicana with a little over a fifth (20.6 percent), Gigante (15.5 percent) and Soriana (14 percent)" (Chavez 2002, p. 507). By 2002, *Walmex*'s total sales had grown to 10.1billion (Tegel 2003), and by 2006 to 18.3 billion (Wal-Mart de Mexico 2006).

2.2 Changes in business practices

The growing dominance of *Walmex* helped to induce two fundamental changes in the Mexican retail sector. First, the sector modernized its warehousing, distribution, and inventory management. Second, it changed the way it interacted with its suppliers.

[9] "Many Mexican food retail analysts speculate that Carrefour used its relationship with Gigante to get to know the domestic market, and then shifted its strategy to operate solo . . ." (Chavez 2002, p. 512).

The former changes partly reflected the growing availability of information technology. But they also reflected the innovations that Walmex imported from the United States. *Walmex* not only introduced the system of channeling deliveries from suppliers through centralized warehouses, it also requires delivery trucks to have appointments and drivers to carry standard identification cards. Those that miss appointments are subject to fines. Shipments must be on standardized palettes (rentable from *Walmex*), they must be shrink-wrapped with corner protectors, and they are subject to third-party quality audits.

Walmex has maintained two separate distribution systems in Mexico: one for its supermarket chains and one for Sam's chain of wholesale stores.[10] Many producers serve both types of distribution centers. The principle difference between the two is the size of product packaging. All suppliers have the option of delivering their products to a single distribution center, but those with multiple plants around the country are encouraged to deliver to multiple centers. A single truck-load is the usual unit of delivery volume, though three centers are able to receive deliveries of smaller sizes and aggregate them into full truck-loads. Distribution centers specialize in terms of product type: dry goods, clothing, and perishables, including frozen products. Only part of perishables sold in *Walmex* stores is channeled through distribution centers. Many perishables are purchased locally. The distribution center in Laredo (United States) channels imports coming from the United States to Mexico.

Centralized distribution system, the use of palettes and other innovations brought by

[10] Its clothing store chain Suburbia and restaurant chain VIP support separate distribution centers as well.

Walmex have diffused to the other major retail chains. According to Tegel (2003), in the early 2000s *Walmex* was "the only Mexican retail chain that has its own centralized distribution system. Suppliers thus can deliver their goods just once to any of 11 *Walmex* depots scattered across the country, rather than to each individual store." Interviews conducted for this study in 2005 and 2007 revealed that since the time of Tegel's writing, other major retailers have followed suit and introduced centralized warehousing and the use of palettes.

Despite this diffusion of retail practices, *Walmex* still has remained a technological leader in Mexico. This is partially due to *Walmex* making new improvements to its distribution system and partially due to local competitors choosing to adopt only some but not others *Walmex*'s innovations. For example, in 2003 all perishables sold by *Walmex* were packaged into carton boxes and wooden crates. By 2007, 90% of them were packaged in replenishable plastic containers (RPCs). RPCs have many advantages over carton boxes and wooden crates. They are more sanitary and better keep the desired temperature. They also reduce the handling costs as they have a standardized weight, are more stable and easier to move, fit exactly on a pallet and can be easily stocked one on top of another. Finally, they are more environmentally friendly. The leading Mexican supermarket chain, Soriana, already uses this technology and some others are in the process of introducing it. Mexican supermarket chains, however, do not copy all technologies introduced in Mexico by *Walmex*. For instance, Soriana is the only retailer, besides *Walmex*, that has a cold chain. Other retailers do not see the need or are not willing to invest in the cold chain, possibly because they would not find it profitable to compete in meat sales with open markets. Similarly, *Walmex* is the

only retailer that uses computerized tracking of sales and inventories and is able to provide suppliers with daily sales and inventory figures at the level of individual stores.

The profound changes in the retail sector, initiated by *Walmex* and later introduced by other retailers, have resulted in a significant decline in distribution costs faced by Mexican suppliers. The spectacular expansion of Walmex has also allowed many suppliers to reach a larger segment of Mexican population without incurring additional distribution cost.

The benefits of the retail revolution have, however, come at a price of *Walmex*'s hard-nosed style of negotiation with its suppliers. Famously, Wal-Mart keeps negotiations with its suppliers as stark as possible both in terms of the bargaining environment and in terms of the number of negotiable contract features. And because it controls such a large share of the retail market, this often amounts to a take-or-leave-it offer. In the United States, the company is exceptionally private about its business practices and its suppliers are very reluctant to discuss details (Fishman 2003).[11] However, former suppliers are more willing to talk. They agree that Wal-Mart's uniquely large market share gives it extraordinary bargaining power and allows it to drive its suppliers' profit margins very low. For standardized products, it demands annual price reductions, so those firms that are unable to frequently introduce new goods–and thus avoid establishing a benchmark price–are squeezed relatively more (Fishman 2003). Those suppliers that balk at Wal-Mart's demands are simply discontinued, and new suppliers are brought in.

[11] One company that helps businesses work with retailers commented "'If Wal-Mart takes something the wrong way, it's like Saddam Hussein. You just don't want to piss them off." (Fishman, 2003)

Evidence on retail prices in the United States confirms that the "Wal-Mart squeeze" (Fishman 2003) is real, and quantitatively important. Using region-specific prices of several specific consumer goods, Basker (2005a) develops an econometric model of price adjustments when a new Wal-Mart enters a region. Controlling for serial correlation, seasonal effects, city fixed effects, and endogenous opening dates, she finds that the long run effect of a new Wal-Mart is to drive down retail prices by from 1 percent to 13 percent, depending upon the product.

Basker's (2005a) findings are consistent with anecdotal evidence, which suggests that "when Wal-Mart enters a market, its everyday low prices are anywhere from 5 percent to 25 percent lower for identical goods." (Business Planning Solutions 2005). They are also consistent with more aggregated econometric analyses that link region-specific consumer commodity-price indices to the share of Wal-Mart stores in local retailing (Business Planning Solutions 2005).

Despite the high downward pressure exerted by Wal-Mart on prices, doing business with Wal-Mart offers several benefits in the Mexican setting. First, the distinguishing feature of Wal-Mart in Mexico is its reputation as a reliable payer. Wal-Mart pays the agreed upon amount on time, while other supermarket chains are often late with payments or subtract arbitrary fees from the payment.[12] Second, the high creditworthiness of Wal-Mart allows its

[12] According to interviews with Mexican entrepreneurs, supermarket chains often match rebates offered to consumers by their competitors. While Wal-Mart will cover the costs of such impromptu rebates, other

suppliers to benefit from factoring. Factoring involves selling commercial trade receivables in order to obtain working capital. Thus rather than waiting 30 or 90 days to receive a payment from Wal-Mart, a Wal-Mart supplier may sell for a small fee its account receivables and immediately obtain working capital. In many countries, factoring has become an important source of financing-especially short term working capital-for small and medium-size enterprises.

2.3 The geography of Walmex' growth

In Figures 1 to 4, we show the growth of Wal-Mart de Mexico in terms of geographic space over the years 1993 to 2007. This also highlights some differences to Wal-Mart's evolution in the United States. Figure 1 shows the location of various formats of Wal-Mart shops in the year 1993 across the thirty-two Mexican provinces. Since differences in demand play a key role for Wal-Mart's expansion, we have shaded the provinces in terms of population density. The darker the color, the higher is population density, which in 1993 attains its maximum in the area of the Mexico City (*Distrito Federal*).

Among the different Wal-Mart formats, we distinguish *Bodega Aurrera*, which is a lower end grocery chain, *Superama*, which is a basic big box store that does not sell food, and *Walmex Supercenters*, which is a big box store that does sell groceries. Finally, *Sam's Club* is a bulk version of the *Supercenter*. We also note the location of *Walmex* distribution centers, of which there are nine large ones by now.

supermarket chains try to pass on the suppliers of discounted goods.

Wal-Mart's expansion in Mexico differed from that in the United States in that in Mexico, Wal-Mart stores were present relatively quickly in all parts of the country, whereas in the United States Wal-Mart gradually radiated out from Bentonville, Arkansas (see Holmes 2006). This is only to some extent due to the fact that Wal-Mart started out its operations in Mexico through a joint venture with *Aurrera*: while in 1993 most of *Aurrera*'s locations were in the highly populated central areas of Mexico, already by the year 1997 Wal-Mart had stores in the far North-West as well as in the South-East of Mexico (Figure 2).

At the same time, as Figures 3 and 4 indicate, the concentration of *Walmex* stores remains higher in the central provinces of Mexico throughout the period of 1993 to 2007. We also see that the establishment of distribution centers generally follows the opening of stores.

The following section discusses the major trade-off that suppliers of *Walmex* face.

3 The Impact of *Walmex* on the Supplying Producers

Wal-Mart does two things that consumers like. First, it brings together many products that they wish to purchase in convenient locations, thereby decreasing their transactions costs. Thanks to its computerized inventory and sales tracking system, Wal-Mart employees and suppliers have access to daily sales and inventory figures. None of the other supermarket chains in Mexico has a similar system. As a result, according to the interviewed executives Wal-Mart is the only chain that is "never out of stock." Second, Wal-Mart offers a given quality of its merchandise at very competitive prices. The first effect increases demand for

products marketed through Wal-Mart and would by itself induce any producer to want to use Wal-Mart as a retailer. In the absence of Wal-Mart, increasing the market size would involve supplying a large number of small corner stores directly or through wholesalers. Doing so, however, would involve higher transportation costs which in turn would translate into consumers being charged higher prices.

The second effect, downward pressure on the quality-adjusted price, is obviously undesirable from producers' perspective. It constrains the ability of manufacturers to exercise market power and forces lower prices on them than they would have otherwise chosen. Interviewed suppliers in Mexico reported being asked for a "logistics discount", i.e., recognizing the decrease in logistics and distribution costs stemming from its centralized sourcing system Wal-Mart wants to share in the suppliers' savings. Similarly, recognizing that benefits of scale economies achieved by suppliers thanks to Wal-Mart's expansion of their markets, Wal-Mart expects annual declines in prices from all of its suppliers. Even large multinationals may have a hard time resisting price cuts, as according to one executive, if Wal-Mart does not like the way negotiations are going in Mexico, it will escalate them to the level of US headquarters of both firms.

The ability of Wal-Mart to demand quality increases and/or price cuts also stems from the fact that by lowering the distribution costs it has turned many small producers previously operating in their local markets into national suppliers, selling under their own brands or Wal-Mart's store brands. While major industry players often own a fleet of truck which

they use to distribute their products nationwide, smaller producers are usually unable to bear the cost of product distributing beyond their locality. By allowing small producers to deliver their products locally and have them distributed nationwide, Wal-Mart turned small producers into viable competitors of the large players.

Producers weigh these two effects when deciding whether to use Wal-Mart as a retailer. Of course, suppliers' decisions are affected by the decisions of the competitors. It is quite possible that, when the option to retail through Wal-Mart first appears, only a single firm finds it profitable to become a Wal-Mart supplier. But once it has done so, the menu of prices faced by consumers is perturbed, and non-Wal-Mart suppliers will typically be forced to adjust their prices downward in response to the lower prices of the Wal-Mart good. Once this has occurred, other producers pay a smaller penalty in terms of price reduction by switching to Wal-Mart. But they also stand to gain less in terms of market share than the first switcher, since the population of Wal-Mart consumers would now be shared by multiple firms. If the first effect dominates, it is possible that a snowballing could occur once Wal-Mart successfully woos a critical mass of firms, many others find it optimal to switch as well. And the heightened competitive pressures introduced by Wal-Mart may well drive some marginally profitable firms to exit the market entirely. The reduction in payoffs as more and more firms share the Wal-Mart consumers is offset to some degree when Wal-Mart acts as a trading company for its supplier, expanding their consumer base by shipping their goods to foreign Wal-Marts.

In addition to pricing decisions, the presence of Wal-Mart affects incentives to engage in process or product innovation. Anecdotal evidence suggests that making product improvements allows suppliers to escape the mandatory price cuts. Similarly, suppliers can obtain higher prices by introducing new product varieties. Interviewees in Mexico repeatedly reported that Wal-Mart wants to source products that are different from those supplied to the competing supermarket chains.

Several forces are often at play when firms choose how much to invest in innovation. One, often associated with Schumpeter, states that firms invest more to invent a new product if the product's expected profits are higher, and profits are higher the more monopoly power a firm has. A second force concerns the return to distancing one's firm from competitors. In a setting where Wal-Mart controls the price for a given quality, these two payoff are influenced by the fact that the quality-adjusted prices are already held below a firm's unconstrained optimal level. The question is whether the increase in market size by selling through Wal-Mart outweighs the negative effect on the incentives to innovate that are imposed by Wal-Mart demanding a relatively high quality relative to price from its suppliers.

4 The Model

Drawing on Pakes and McGuire (1994), Pakes and Ericson (1995), and Weintraub, Benkard and van Roy (2007), we now develop an industrial evolution model that captures these main consequences of *Walmex*'s presence. The model characterizes supplying firms' pric-

ing decisions, retailer choices, investments in product quality improvements, and entry/exit decisions.

The structure of our model is similar to Weintraub et al's (2007), with the twist that firms choose how to retail their products. Specifically, forward-looking, risk-neutral firms make optimal decisions as they compete against each other in an infinite-horizon dynamic game. Time is measured in discrete increments, and within each period the following sequence of events occurs:

1. Taking into consideration its scrap value, its current product quality, and other firms' product qualities, each incumbent firm decides whether to continue operating or shut down. Those that do not shut down also decide how much to invest in quality improvement.

2. Each potential entrant calculates the present value of the profit stream from a new firm, takes stock of sunk entry costs, and decides whether to become a producer next period.

3. Taking stock of Walmex's take-it-or-leave-it price offer and minimum quality requirements, each incumbent firm decides whether to use Walmex as its retailer or deal with traditional retailers.

4. Incumbent firms compete in the spot market and generate their current period operating profits. (Those that are selling through Walmex must offer their goods at Walmex's dictated prices; others are free to choose their own price.)

5. The outcomes of firms' investments in quality improvements are realized, and the industry takes on a new state.

6. The next period begins.

4.1 The profit function

To develop firms' profit functions, we begin with a logit demand system that allows for a retailer effect. Let $\mathbf{I}_t$ denote the set of incumbent firms in period t, each of which produces a single, differentiated project. Also let firm j's product have "quality" or "appeal" level ξ_{jt} relative to goods outside the industry of interest, and (suppressing time subscripts) express the net indirect utility of product j for the i^{th} consumer as:

$$\begin{aligned} U_{ij} &= \theta_1 \ln(\xi_j) + \beta_w w_j + \theta_2 \ln(Y - P_j) + \epsilon_{ij} \\ &\stackrel{def}{=} \overline{U}_{ij} + \epsilon_{ij}. \end{aligned} \tag{1}$$

Here $\beta_w > 0$ measures the extra appeal of product j when it is available at Walmex, w_j is a dummy variable that takes a value of unity if producer j sells through Walmex, Y is the (exogenous) expenditure level of a typical household, and ϵ_{ij} is a Type I extreme value disturbance that picks up unobserved idiosyncratic features of consumer i. The parameter β_w is positive because, when a product is available at Walmex, it becomes more accessible to the average consumer.[13]

[13] Holmes (2007) also uses a logit specification, but makes the opposite assumption that consumers lose satisfication by shopping at Walmart rather than other retailers.

Assuming that each consumer purchases a single unit of the product that gives her the highest indirect utility, and letting the mass of consumers be measured by M, it is well known that (1) implies the total demand for product j is

$$Q_j^D = h_j \cdot M$$

where:

$$h_j = h(j|\mathbf{w}, \mathbf{P}, \boldsymbol{\xi}) = \frac{\exp\left[\overline{U}_{ij}\right]}{\sum_\ell \exp\left[\overline{U}_{i\ell}\right] + 1}, \tag{2}$$

$\mathbf{w} = \{w_j | j \in \mathbf{I}\}$, $\mathbf{P} = \{P_j | j \in \mathbf{I}\}$, and $\boldsymbol{\xi} = \{\xi_j | j \in \mathbf{I}\}$. Further, if all firms sell all of their output through traditional retailers (i.e., $w_j = 0 \; \forall \; j \in I$), the set of pure strategy Bertrand-Nash prices satisfies (2), (1) and:

$$P_j = C_j + \frac{Y + \theta_2 C_j (1 - h_j)}{1 + \theta_2}, \; j \in \mathbf{I} \tag{3}$$

where C_j is the marginal cost of production for firm j (Berry 1994).

We make several assumptions at this point. First, firms differ in terms of their product quality, but not their marginal costs. Thus, we hereafter drop the j subscript on C. Second, each supplier either sells through traditional retailers or through Walmex, but not both. While this is not entirely realistic, it will be close to the truth in markets where local retailers and Walmex are both present, since the latter will underprice the former and capture most of the market. Third, Walmex's take-it-or-leave-it price offer to any supplier j—hereafter

denoted $\overline{P}_j$—depends upon ξ_j according to:

$$\overline{P}_j = P_0 + \theta_3 \ln(\xi_j),\ \theta_3 > 0. \tag{4}$$

$\mathbf{w} = \{w_j | j \in \mathbf{I}\}$ and $\boldsymbol{\xi} = \left\{\xi_j | j \in \mathbf{I}\right\}$. This specification not only makes the return to investments in product quality positive for Walmex suppliers, it implies that when firms experience quality declines relative to the outside good they will be forced to cut their prices as discussed above. Finally, in addition to the pricing constraint (4), we assume that Walmex imposes a minimum quality standard on all its suppliers: $\xi_j \geq \overline{\xi}\ \forall j \in \mathbf{W}^1$, where $\mathbf{W}^1$ $=\{j | w_j = 1, j \in \mathbf{I}\}$ is the set of suppliers who do business with Walmex.

Since there are no sunk costs associated with starting or stopping a Walmex relationship, suppliers choose their retailers period by period, without worrying about the implications of their current choices for their future retailing options. When the subset $\mathbf{W}^1$ of incumbent firms chooses to use Walmex as their retailer, and the remaining incumbent firms $\mathbf{W}^0$ $=\{j | w_j = 0, j \in \mathbf{I}\}$ compete pure Bertrand-Nash in prices, the set of prices for these non-Walmex firms—hereafter denoted $\mathbf{P}^0 = \{P_j | j \in \mathbf{W}^0\}$—solves (1), (2) and (3), given that Walmex firms' prices are fixed at $\overline{\mathbf{P}}^1 = \left\{\overline{P}_j | j \in \mathbf{W}^1\right\}$. The associated profits for the j^{th} non-Walmex firm are

$$\pi_j = \pi(j, w_j = 0 | \mathbf{w}_{-j}, \boldsymbol{\xi}) = (P_j - C) \cdot h_j \cdot M$$

where h_j is given by the share equation (2) evaluated at $\mathbf{P} = \overline{\mathbf{P}}^1 \cup \mathbf{P}^0$, $\boldsymbol{\xi}$,and $\mathbf{w}$, and the vector $\mathbf{w}_{-j} = (w_1, w_2, ..., w_{j-1}, w_{j+1,}.., w_N)$ collects the retailing decisions of all firms *except*

firm j. Analogously, if firm j were to switch from traditional retailers to Walmex, and all other firms were to stick with their initial retailing choices, j would earn operating profits:

$$\pi_j = \pi(j, w_j = 1|\mathbf{w}_{-j}, \boldsymbol{\xi}) = \left(\overline{P}_j - C\right) \cdot h_j \cdot M$$

where h_j is given by (2) evaluated at the same $\mathbf{w}_{-j}$ and $\boldsymbol{\xi}$ but at the new equilibrium price vector. Firms' retailer choices are Nash equilibria so, given the choices of other supplier firms, no firm will wish to adjust its choice of retailer. Thus in all equilibria:

$$\begin{aligned} [\pi_j(j, w_j &= 1|\mathbf{w}_{-j}, \boldsymbol{\xi}) - \pi_j(j, w_j = 0|\mathbf{w}_{-j}, \boldsymbol{\xi})] \cdot w_j \\ +[\pi_j(j, w_j &= 0|\mathbf{w}_{-j}, \boldsymbol{\xi}) - \pi_j(j, w_j = 1|\mathbf{w}_{-j}, \boldsymbol{\xi})] \cdot (1 - w_j) \geq 0 \ \ \forall\, j. \end{aligned}$$

While it may be possible to do so, we have not yet been able to prove that Nash equilibria in retailing choices are unique. Accordingly, we limit our attention to equilibria in which all firms above some quality threshold sell their product through Walmex, and all firms below that threshold sell their product through traditional retailers. Doing so allows us to establish a mapping from $\boldsymbol{\xi}$ to $\mathbf{w}$, and to thereby express the profits of all incumbent firms as a function of the vector $\boldsymbol{\xi}$ alone. Hereafter we will express the profits for firm j when the industry is in state $\boldsymbol{\xi}$ as $\pi^*\left(\xi_j, \boldsymbol{\xi}_{-j}\right)$,where $\boldsymbol{\xi}_{-j}$ gives the product quality levels for all incumbent firms except $j's$. (Thus $\boldsymbol{\xi}$ =$\xi_j \cup \boldsymbol{\xi}_{-j}$.)

4.2 The dynamic problem

Although current period retailing decisions do not affect future period earnings, there are two features of our model that make it forward-looking. First, entry and exit are not frictionless. When entrerpreneurs create new firms, they incur sunk start-up costs (hereafter ϕ_e), and when they shut down their firms they receive its scrap value (hereafter $\phi_s < \phi_e$). Their entry and exit decisions thus involve comparisions of expected future profit streams with entry costs and scrap values, respectively. Second, each firm's product appeal/quality (ξ) evolves over time, and the processes that these appeal/quality indices follow are dependent upon firms' R&D expenditures and advertising.

We now summarize the dynamic optimization problem that firms solve and the associated industry dynamics. Define r_j to be the current level of R&D/advertising undertaken by the j^{th} producer in order to influence its product appeal next period, hereafter denoted ξ'_j. Further, assume that for any firm j, all realizations on ξ_j s are elements of a discrete ordered set $\left\{\xi^1, ..., \xi^K\right\}$, $\xi^i < \xi^{i+1}\ \forall i \in I^+$, that ξ_j moves at most one position in the ordered set per period, and ξ_j is measured relative to the appeal of goods outside the industry. Then, if R&D efforts are successful with probability $\frac{ar_j}{1+ar_j}$, and if outside goods improve one step in quality with exogenous probability δ, firm j's product quality evolves according to:

$$\begin{aligned}
\Pr\left[\xi'_j = \xi^{i+1} | \xi_j = \xi^i\right] &= \tfrac{ar_j}{1+ar_j} \cdot (1-\delta) \\
\Pr\left[\xi'_j = \xi^{i} | \xi_j = \xi^i\right] &= \left(1 - \tfrac{ar_j}{1+ar_j}\right)(1-\delta) + \tfrac{ar_j}{1+ar_j}\delta \\
\Pr\left[\xi'_j = \xi^{i-1} | \xi_j = \xi^i\right] &= \left(1 - \tfrac{ar_j}{1+ar_j}\right)\delta
\end{aligned} \tag{5}$$

At the beginning of each period, each incumbent firm takes stock of its current product quality and the product quality of all of its rivals. It then decides whether to continue operating or shut down. If it does continue operating, it also chooses an R&D level, r, and a retailing strategy, w. To characterize these decisions, let the state of the industry be summarized by $\mathbf{s} = (s_1, s_2, ..., s_K)$, where s_i is the number of firms that are currently at the i^{th} quality level level Similarly, let $\mathbf{s}_{-j}$ be the same vector, except in that it leaves firm j out of the count.[14] Then firm j chooses its R&D level to solve:

$$V\left(\xi_{j,}, \mathbf{s}_{-j}\right) = \max\left[\phi_s, \max_{r_j}\left\{\pi^*\left(\xi_{j,}, \mathbf{s}_{-j}\right) - c_r \cdot r + \beta E_{\Omega_j}\left[V.\left(\xi'_{j,}, \mathbf{s}'_{-j}\right)\right]\right\}\right] \tag{6}$$

Here c_r is the unit cost of R&D, β is the one period discount factor, and the expectation operator is based on firm j's beliefs about the transition density for the industry state, excluding itself: $\Omega_j\left(\mathbf{s}'_{-j}|\mathbf{s}_{-j}\right)$. This perceived transition density in turn reflects firm j's perceptions of the policy functions that other firms in the industry use to make their exit or entry decisions and to choose their R&D spending levels.

Finally, there is a large pool of potential entrants who stand ready to create new firms. They do so when the expected profit stream covers their entry costs, ϕ_e, so the mass of entrants each period is just large enough to drive profits for the marginal entrant to zero, except in the corner case where even a single entrant expects negative net returns. New entrants start with some relatively modest product appeal, ξ_e.

[14] This vector contains the same information as $\boldsymbol{\xi}_{-j}$, but it is smaller dimension, and it does not track individual firms through time. Since firms need only keep track of the state of the industry, and not of the individual shocks to their various competitiors, it is better suited for analysis of the dynamic equilibrium.

4.3 Equilibrium

Equilbrium behavior obtains when all firms correctly solve their optimization problems and their beliefs about industrial evolution patterns (as characterized by $\Omega(\cdot)$) are consistent with the realized Markov process for industry states. Several methods for identifying this kind of equilibrium have been developed; we rely on the approach developed by Weintraub et al. (2007).[15]

The basic idea is the following. So long as the number of incumbent firms is fairly large, the industry state is insensitive to the idiosyncratic outcomes of R&D investments at individual firms. Accordingly, each firm's optimal behavior is approximated by its behavior under the assumption that $\mathbf{s}_{-j}$ is time-invariant. (That is, $\Omega_j\left(\mathbf{s}'_{-j}|\mathbf{s}_{-j}\right)$ is a degenerate distribution.) The associated equilibrium concept is dubbed an "oblivous equilbrium" by Weintraub et al (forthcoming) to highlight their assumption that firms ignore the variations in $\mathbf{s}_{-j}$ due to idiosyncratic product appeal shocks. Our simulations are based on the Matlab code Weintraub has provided on his web site, edited to allow for endogenous retailer choice as discussed above. Details on the solution algorithm can be found in Weintraub et al. (2007).

4.4 Model Simulations

In principle, it would be possible to estimate the model developed above. However, this would require detailed information on the sales of individual firms – prices, qualities, and retailers–

[15] The main challenge is to deal with the fact that the number of possible industry states s is very large, and number of transition probabilities summarized by $\Omega_j\left(\mathbf{s}'_{-j}|\mathbf{s}_{-j}\right)$ is the square of this very large number. Ackerberg et al. (forthcoming) provide a useful discussion of solution techniques in the context of dynamic model estimation.

and such data are not readily available. We therefore demonstrate some implications of our model by calibrating parameter values that generate plausible size distributions of suppliers, entry/exit patterns, R&D patterns, and mark-ups. Then we shut down the option to sell through Walmex and examine the associated adjustments in behavior. The key parameter values for these simulations are as follows:

Parameter	Without *Walmex*	With a *Walmex* option
C	1.5	1.5
β_w	1.0	1.0
$\overline{\xi}$	n.a.	2.0
θ_3	n.a.	0.4

Figure 5 presents the simulation results. The first (upper-left) panel of Figure 5 shows that in the absence of *Walmex*, all firms have substantial mark-ups, and price increases slightly with product quality (the smooth line at a price of about 2.4).[16] When the option to sell through *Walmex* is offered to firms, the lower quality firms decline to do so, even some with quality above the minimum acceptable to *Walmex*. Accordingly, these firms continue to price around 2.4, maintaining a large mark-up over their marginal cost of 1.5. On the other hand, those with quality of roughly 2.2 find it worth their while to sell through *Walmex* and take a major price cut because they gain access to a much larger consumer base. The higher the firm's quality, the more attractive *Walmex* is, since their market share increases almost

[16] The lack of price sensitivity to quality reflects the fact that even high-quality firms have small market shares, so changes in its product appeal does not lead to large changes in their market power.

in proportion to their size, and since *Walmex* is willing to let high quality firms charge higher prices.

It is noteworthy that the firms with quality just high enough to induce them to use *Walmex* are not better off in the *Walmex* equilibrium than in the no-*Walmex* equilbrium. To the contrary, they would have preferred that *Walmex* had never become an option for anyone. However, once the option is there, competition from suppliers who use it causes these firms do worse if they rely on traditional retailers than if they cut their prices and tap into *Walmex*'s large consumer base.

The upper-right panel of Figure 5 shows that the lowest quality firms that sell through *Walmex* invest less in innovation—and thus innovate less frequently—than they would have if they had not had a *Walmex* option (the *Walmex* case has a higher maximum innovation, for the highest-quality firms). This is also true of those firms that opt to remain with traditional retailers. The reason is that these firms lose market share (and profit margin) relative to the high quality firms when *Walmex* becomes a retailing option. Accordingly, the returns to successful innovation for these firms become smaller. We find a similar pattern for capital investment (Figure 5, lower left).

The final panel of Figure 5 shows that, although *Walmex* increases industry-wide sales by making products more accessible and lowering their prices, it strongly reduces the number of suppliers. This is a simple consequence of the fact that firms at all but the highest quality levels experience a reduction in operating profits when *Walmex* shows up. So, against the positive welfare effects of *Walmex* for consumers who are able to consume their favorite brands at a more convenient location and a lower price, one must weigh the capital losses

imposed on entrpreneurs whose profitability is reduced, sometimes to the point of exit, and the welfare losses of consumers who preferred the brands that are driven from the market.

We now turn to the question of whether our model's characterization of supplier reactions to *Walmex* is consistent with evidence from Mexican manufacturing establishments.

5 The impact of Wal-Mart's entry in Mexico: regression evidence

5.1 Data

Our analysis is based on establishment-level data from the *Encuesta Industrial Anual* (EIA) and the *Encuesta Industrial Mensual* (EIM) administered by the *Instituto Nacional de Estadísstica Geografía e Informática* (INEGI) in Mexico. The Encuesta Industrial Anual is an annual industrial survey that covers about 85 percent of Mexican industrial output, with the exception of "maquiladoras." The EIA was started in 1963 and then expanded in subsequent years, with the last expansion taking place in 1994 after the 1993 census. In our analysis, we use the information for the 1993-2002 period. The unit of observation is a plant described as *"the manufacturing establishment where the production takes place."* Each plant is classified by industry (*clase*) on the basis of its principal product. The industry classification is equivalent to the 6-digit level Mexican System of Classification for Productive Activities (CMAP).

Our sample includes 6,867 plants spread across 205 classes of activity. The sampling

framework is based on the 1993 industrial census. In each of the selected 205 *clases* the survey samples the largest firms until the coverages reaches 85% of the sectoral output. In sectors with fewer than 20 plants, all entities are surveyed. Moreover, all plants with more than 100 employees are automatically included in the sample. In addition to standard plant-level data, the EIA survey includes details of plant-level activities associated with production upgrading, such as investment in physical assets, R&D expenditure and technology purchases. This feature of the dataset makes it particularly suitable to examine the question at hand.

The *Encuesta Industrial Mensual* is a monthly survey that is collected by INEGI to monitor short-term trends and dynamics. The survey has been run in parallel with the EIA and has covered the same plants. The EIM panel is available for the period 1994-2004 covering 205 *clases*. The principal difference with EIA is its periodicity (being this monthly instead of yearly), its data content (it includes the quantity and value of domestic sales, which allows for calculation of unit values) as well as the level of aggregation (plant-product rather than plant level).We aggregate monthly EIM data into annual observations.

The EIM contians information on 3,396 unique products. Each *clase* contains a list of possible products, which was developed in 1993 and remained unchanged during the entire period under observation. For instance, the *clase* of *distilled alcoholic beverages* (identified by the CMAP code 313014) lists 13 products: gin, vodka, whisky, liquors, coffee liquors, liquor "habanero", "rompope", prepared cocktails, prepared from agave, brandy, rum, table wine, alcohol extract for liquor preparation. The *clase* of *small electrical appliances* contains 29 products, including vacuum cleaners, coffee makers, toasters, toaster oven, 110 volt heaters and 220 volt heaters (within each group of heaters the classification distinguishes

between heaters of different sizes: less than 25 liters, 25-60 liters, 60-120 liters, more than 60 liters). These examples illustrate the narrowness of product definitions and the richness of micro-level information available in our dataset.

5.2 Empirical strategy

To shed some light on whether our model's characterization of supplier reactions to *Walmex* is consistent with evidence from Mexico, we estimate a series of reduced form regressions. These regressions examine the relationship between establishment-level outcomes and the presence of *Walmex* stores in the establishment's state of operation. Thus our identifying assumption is that establishments located in proximity to *Walmex* should be affected to a larger extent than those located farther away. In our view, this assumption is quite plausible for two reasons. First, producers located close to a *Walmex* stores may be better informed about the type of products sold by *Walmex*, their characteristics and pricing. Second, information collected during interviews with *Walmex* executives, Mexican firms and industry experts suggests that *Walmex* makes an effort to source from producers located in the region of *Walmex* operations. This effort is made in order to appeal to the tastes of local consumers, cut down on transportation costs and build goodwill in local communities.

Furthemore we also take into account that not all establishments are potential *Walmex* suppliers because of the products they produce. Therefore we build a variable identifying *Walmex* products, food and non-food products typically sold by *Walmex,* from non-*Walmex* products, mainly intermediate inputs and other goods not typically purchased by house-

holds.[17] The interaction between the number of *Walmex* stores and the dummy capturing that an establishment produces a product sold by *Walmex* should jointly identify those firms that are potentially affected by the expansion of *Walmex*.

Finally, and critically, we allow the effects of Walmex to depend upon firms' product appeal. Since our model implies that firms with more appeal will be larger, we use lagged size as our our appeal measure, and we distinguish the best firms with a dummy (*Topplant*) that take a value of unity if the firm's lagged size falls in the top quartile.

Our estimation equation takes the following form:

$$\begin{aligned} lnX_{it} &= \alpha + \beta_1 ln(NumberofWalmexshops)_{st} + \beta_2 WalmexProduct_i + \beta_3 Topplant_{it-1} \\ &+\beta_4 ln(NumberofWalmexshops)_{st} * WalmexProduct_i \\ &+\beta_5 ln(NumberofWalmexshops)_{st} * Topplant_{it-1} + \beta_6 WalmexProduct_i * Topplant_{it-1} \\ &+\beta_7 ln(NumberofWalmexshops)_{st} * WalmexProduct_i * Topplant_{it-1} \\ &+\alpha_r + \alpha_j + \alpha_t + \varepsilon_{it} \end{aligned}$$

where X_{it} is the outcome variable for establishment i operating at time t. The number of *Walmex* shops is defined as the sum of the number of *Walmex* supercenters, Bodega shops, Sam's and Superamas operating in state s at time t. Recall that while the first three store types sell groceries and other consumer products, Superama is an apparel store. The variable

[17] The list was drawn based on information available on Wal-Mex website, store visits and detailed industry descriptions.

Walmex Product identifies those establishment that are potential *Walmex* suppliers. As the theoretical model predicts that top producers should be affected differently, in our empirical exercise we include a dummy to identify top producers based on their total revenues and allow for the impact of *Walmex* to be different for these plants. The dummy is equal to one if the establishment is in the top quartile of the size distribution within its 4-digit industry, and zero otherwise. Therefore, while the interaction between interaction between the number of *Walmex* stores and the dummy Walmex Product identfies the average impact of Walmex for all potential suppliers, the triple interaction between these two variables and the dummy "Top plant" identifies the effect that Walmex has on the most advanced establishments. The dummy identifying top plants is lagged one period. The model also controls for industry[18], region[19] and year fixed effects.

In order to identify potential heterogenous effects across different types of products we perform our regressions not only on the full sample, but also on the subsample of consumer goods and the subsample of food products. Further, we present OLS as well as results with plant fixed effects. The latter control for unobserved plant characteristics that are constant over the sample period, which could well be important for avoiding spurious correlation. At the same time, this within-estimator is known to exacerbate any measurement error that might be present. At this point, we do not strictly prefer one of the estimators.

[18] At a disaggregation equivalent to four digits we can separately identify fifty sectors.

[19] Seven different regions are identified: *Northern Frontier, North, North-East, Center-North, Center-South, South, Mexico City Region.*

Sales The results for the first outcome of interest, domestic sales expressed in real terms, are presented in Table 1. The theory predicts that the best firms are more likely to accept a deal with *Walmex*, which allows them to enjoy higher market shares and expand their sales, while the firms choosing not to sell to *Walmex* see their sales squeezed down. The data support this conclusion. The average impact of increasing the number of *Walmex* stores in the sate is indeed negative for potential suppliers, but, as expected, it is positive for top firms, which are best positioned to do business with *Walmex* and in this way reach a larger number of consumers. This effect is present in all three OLS regressions, and it is particularly strong for food producers. In specifications with plant fixed effects, the coefficient on the triple interaction, representing the effect of *Walmex* presence on top suppliers, is positive in all three specifications but reaches conventional signficance levels only in the case of food.

Innovative activity Next we consider outcomes related to innovative activity. We focus on two different measures of innovative activities: R&D spending and outlays on technology acquisition (both expressed in real terms), as these are most likely to capture alternative strategies to innovate. As evident from Table 2, we find that top establishments tend to have higher R&D spendings in general. While the expansion in the number of *Walmex* stores in the state does not spur any additional innovative effort on the part of the average (potential) supplier, this situation is different in the case of top producers. The top plants producing *Walmex*-type products tend to increase their R&D spendings as the number of *Walmex* shops in their state goes up. This effect is statistically significant in OLS regressions on the full sample and the subsample of consumer goods. The lack of significance in other

specifications may not be that surprising: there may be less room for innovation in the case of food products and plant fixed effect may be picking up a lot of variation in the innovative activity.

Our OLS findings for technology acquisition are similar (see Table 3). The top plants producing *Walmex*-type products tend to increase their outlays on technology acquisition as the the number of *Walmex* stores in their state increases. Again, this pattern is present in the full sample and the subsample of consumer goods. A ten-percent increase in the number of *Walmex* stores in the state is associated with a 1.4 percent and a 2.8 increase in R&D and technology acquisition expenditure, respectively. Using the fixed effects estimator, we find less support: in fact, for the average good, technology outlays of top plants may be lower than for the average plant (significant at a 10% level). For Food products, however, the average plant tends to reduce technology outlays by more than top plants, which is consistent with our theory.[20]

Performance outcomes Innovating activity is likely to translate into different performance outcomes. Thus next we consider three other aspects of producer behavior: labor productivity, average wage and probability of becoming an exporter. The results for labor productivity are presented in Table 4 and suggest that the entry of *Walmex* tends to have a negative impact on the productivity of the average establishment producing *Walmex*-type products. This effect is stastically significant almost across the board (in four of six specifi-

[20]In general, these fixed effects results are imprecisely measured, which might be due to lack of time series variation relative to the fixed effects. In future work we will examine this further, also by varying the definition of "top plant".

cations). However, this effect is not present in the case of establishments with more product appeal, as in the full sample the coefficient on the triple interaction term is positive and statistically significant. The latter pattern is consistent with the theoretical predictions.

When we focus our attention on the wages (Table 5), another potential measure of improved performance at the plant-level, the observed pattern is also in line with the theory. In the full sample and in the subsample of consumer goods, we find that the entry of *Walmex* is associated with an increase in the average wage in the top establishment.

Innovation and upgrading product quality might make it easier for *Walmex* suppliers to become exporters. It is also possible that *Walmex* may offer its suppliers contracts for sales to its US stores. The results of linear probability models, presented in Table 6, are in line with this scenario. We find that while top producers are more likely to export, the probability of exporting goes up for top producers of *Walmex*-style goods with the increase in the presence of *Walmex* in the state. The effect is present in the full sample and the subsample of consumer goods.

Pricing behavior The next outcome of interest is the pricing behavior. We use a price index compiled using the information on unit values of products sold in Mexico by a given establishment. The price index is set to 100 for 1993. The price index for period t is compiled on the basis of products that were sold both at time t and t-1. Changes in prices are weighted by the share of the product sales in the establishment's total sales.

Our model predicts that conditional on product quality, the entry of *Walmex* leads to a relative decline in the price of firms that sell through *Walmex* (see Figure 5, upper-left panel).

Interestingly, the fixed effects results of Table 7 suggest that the average plant producing a *Walmex* product tends to charge a higher price as *Walmex* stores proliferate in the state; this may be in part due to state-specific trends. At the same time, the price charged by top plants typically declines relative to the average plant's price, which is consistent with the prediction of our model.

Investment The final outcome considered is investment in physical capital. Not surprisingly, we find that top producers tend to invest more than other establishments. Further, the results in Table 8 suggest that an increase in the number of *Walmex* stores is negatively correlated with investment among potential suppliers in the state. While there is some tentative evidence that the top 25% suppliers cut their investment less strongly, the difference is not significant at standard levels.

Exit In Table 9, we present results on how the probability of exit might be related to Walmex entry. Recall that our model simulations suggest that there are fewer firms when Walmex is present. We find that the probability of exit increases with the number of Walmex shops in the state, and that the probability of exit is generally lower for top quality plants. Both of these results are plausible. However, the results also suggest that the arrival of Walmex lowers the probability of exit for the average plant producing a Walmex product (and this effect might be somewhat lower for top-quality plants). While our model simulations indicate that there may not be a strong difference between the exit pattern of low- and high-quality plants (see Figure 5, lower-right panel), this finding may indicate that the arrival of Walmex also goes hand in hand with general plant-survival enhancing changes in the

Mexican economy, such as infrastructure or education improvements. In future work we plan to investigate this further.

5.3 Robustness check

We performed two robustness checks. First, we redefined the dummy for top firms based on the *initial* sales (i.e., sales in 1993, the first year of the sample) rather than sales at time t-1. The results obtained are very similar to those discussed above, so to save space we do not include them in the paper. Second, we also analyzed the impact of *Walmex* entry over a larger time horizon. This specification is an alternative to the fixed-effect estimation and has the advantage of eliminating the noise due to short-term fluctuations in our variables of interests.Rather than using triple interactions, we split the sample into subsamples of *Walmex*-type and other products. We further distinguished between food products, perishables and non-food products. As using the definition of a top establishment based on lagged sales is harder to interpret in this context, we focused on initial sales instead. The patterns found are broadly consistent with our conclusions.

6 Summary and conclusions

This paper studies the entry of Wal-Mart into Mexico following the 1994 NAFTA agreement using a dynamic industry model in which firms decide whether or not to sell their products through Wal-Mart. The advantage of doing business with Wal-Mart is a larger market and possible efficiency gains. The disadvantage of selling through Wal-Mart is continuous

pressure to raise product quality at a given price.

Simulations of the model show that the arrival of Wal-Mart leads to a striking bi-forcation among its potential suppliers. Only firms that sell relatively high-quality products sell through Wal-Mart, whereas low-quality firms do not. At the industry-level, the model predicts that productivity and the rate of innovation may increase, in part because of firm exits. These simulations accord generally well both with results of firm interviews conducted in Mexico and with the results of reduced-form regression based on Mexican plant-level data.

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Table 1: Domestic Sales

	All goods		Consumer goods		Food	
	OLS	**FE**	**OLS**	**FE**	**OLS**	**FE**
Log GDP State	-0.101**	1.365***	0.092	1.316**	-0.398***	-0.272
	[0.040]	[0.415]	[0.067]	[0.665]	[0.077]	[0.865]
Log No. of WM Shops in state	0.074**	-0.194**	0.056	-0.219	0.749***	0.022
	[0.030]	[0.081]	[0.053]	[0.138]	[0.110]	[0.361]
Dummy WM Product	1.424***		1.993***		3.341***	
	[0.139]		[0.189]		[0.271]	
Top quartile lag	3.756***	0.751***	3.604***	0.635**	4.883***	2.153**
	[0.054]	[0.153]	[0.105]	[0.310]	[0.309]	[0.987]
Log No. of WM Shops in state X Top quartile lag	0	0.231***	0	0.261***	-0.580***	-0.322
	[0.018]	[0.053]	[0.032]	[0.097]	[0.138]	[0.329]
Dummy WM Product X Top quartile lag	-0.509***	-0.301	-0.248	-0.232	-1.754***	-1.72
	[0.111]	[0.361]	[0.161]	[0.513]	[0.325]	[1.045]
Log No. of WM Shops in state X Dummy WM Product	-0.070**	0.161	-0.215***	0.453***	-0.505***	-0.217
	[0.035]	[0.131]	[0.044]	[0.170]	[0.103]	[0.358]
Log No. of WM Shops in state X Dummy WM Product X Top quartile lag	0.113**	0.167	0.130**	0.107	0.751***	0.751**
	[0.044]	[0.166]	[0.058]	[0.227]	[0.145]	[0.376]
N	53909	53909	20040	20040	9657	9657
r2	0.297	0.08	0.322	0.085	0.292	0.06

Table 2: R&D Expenditures

	All goods		Consumer goods		Food	
	OLS	**FE**	**OLS**	**FE**	**OLS**	**FE**
Log GDP State	-0.075***	0.152	-0.126***	-0.394	-0.121***	-0.457
	[0.021]	[0.281]	[0.031]	[0.427]	[0.044]	[0.542]
Log No. of WM Shops in state	0.033**	0.016	0.071***	0.125	0.106***	0.433***
	[0.016]	[0.053]	[0.024]	[0.097]	[0.037]	[0.135]
Dummy WM Product	0.02		0.199**		0.067	
	[0.064]		[0.085]		[0.075]	
Top quartile lag	0.878***	-0.005	0.577***	-0.129	0.359**	0.477**
	[0.051]	[0.081]	[0.092]	[0.129]	[0.153]	[0.217]
Log No. of WM Shops in state X Top quartile lag	-0.049***	0.034	-0.009	0.068	0.01	-0.132
	[0.017]	[0.028]	[0.027]	[0.046]	[0.082]	[0.108]
Dummy WM Product X Top quartile lag	-0.453***	0.07	-0.620***	0.078	0.103	-0.41
	[0.116]	[0.180]	[0.150]	[0.230]	[0.187]	[0.271]
Log No. of WM Shops in state X Dummy WM Product	0.019	-0.033	0.018	-0.067	-0.01	-0.342***
	[0.015]	[0.080]	[0.019]	[0.117]	[0.027]	[0.132]
Log No. of WM Shops in state X Dummy WM Product X Top quartile lag	0.138***	-0.022	0.261***	-0.077	0.052	0.142
	[0.044]	[0.084]	[0.057]	[0.108]	[0.093]	[0.139]
N	53909	53909	20040	20040	9657	9657
r2	0.098	0.003	0.119	0.004	0.039	0.006

Table 3: Technology acquisition outlays

	All goods		Consumer goods		Food	
	OLS	**FE**	**OLS**	**FE**	**OLS**	**FE**
Log GDP State	-0.222***	0.341	-0.355***	0.893*	-0.344***	-0.108
	[0.030]	[0.322]	[0.047]	[0.504]	[0.059]	[0.589]
Log No. of WM Shops in state	0.152***	-0.083	0.328***	-0.029	0.284***	0.155
	[0.022]	[0.059]	[0.035]	[0.103]	[0.054]	[0.147]
Dummy WM Product	0.338***		0.346***		0.298***	
	[0.090]		[0.125]		[0.115]	
Top quartile lag	1.588***	0.334***	1.503***	0.031	-0.225	0.242
	[0.071]	[0.099]	[0.147]	[0.172]	[0.184]	[0.147]
Log No. of WM Shops in state X Top quartile lag	0.076***	0.009	0.119***	0.131**	0.198	-0.120*
	[0.024]	[0.036]	[0.045]	[0.063]	[0.126]	[0.066]
Dummy WM Product X Top quartile lag	-1.179***	0.093	-1.131***	0.289	0.869***	0.156
	[0.161]	[0.257]	[0.226]	[0.358]	[0.237]	[0.279]
Log No. of WM Shops in state X Dummy WM Product	0	-0.019	-0.093***	-0.154	-0.054	-0.194
	[0.021]	[0.091]	[0.027]	[0.127]	[0.043]	[0.139]
Log No. of WM Shops in state X Dummy WM Product X Top quartile lag	0.277***	-0.191*	0.285***	-0.269**	0.005	-0.071
	[0.064]	[0.101]	[0.084]	[0.133]	[0.141]	[0.115]
N	53909	53909	20040	20040	9657	9657
r2	0.162	0.005	0.191	0.006	0.073	0.005

Table 4: Labor productivity

	All goods		Consumer goods		Food	
	OLS	**FE**	**OLS**	**FE**	**OLS**	**FE**
Log GDP State	0.007	0.064	-0.055***	-0.053	0.005	-0.620**
	[0.013]	[0.132]	[0.020]	[0.209]	[0.028]	[0.309]
Log No. of WM Shops in state	0.016	0.035	0.129***	-0.005	-0.007	0.289**
	[0.010]	[0.025]	[0.016]	[0.042]	[0.039]	[0.140]
Dummy WM Product	-0.002		0.145**		-0.266***	
	[0.047]		[0.067]		[0.093]	
Top quartile lag	1.020***	0.177***	0.647***	0.152**	0.868***	0.269
	[0.023]	[0.038]	[0.039]	[0.077]	[0.122]	[0.239]
Log No. of WM Shops in state X Top quartile lag	-0.041***	0.025*	0.045***	0.03	0.034	-0.028
	[0.008]	[0.013]	[0.013]	[0.024]	[0.056]	[0.088]
Dummy WM Product X Top quartile lag	-0.051	-0.048	0.300***	-0.093	0.068	-0.16
	[0.054]	[0.085]	[0.074]	[0.113]	[0.133]	[0.252]
Log No. of WM Shops in state X Dummy WM Product	-0.017	-0.076*	-0.061***	-0.093*	-0.01	-0.332**
	[0.011]	[0.043]	[0.013]	[0.054]	[0.036]	[0.139]
Log No. of WM Shops in state X Dummy WM Product X Top quartile lag	0.128***	0.017	0.031	0.026	0.073	0.092
	[0.022]	[0.039]	[0.029]	[0.047]	[0.062]	[0.098]
N	48726	48726	18285	18285	8558	8558
r2	0.287	0.054	0.323	0.057	0.26	0.072

Table 5: Average wage

	All goods		Consumer goods		Food	
	OLS	**FE**	**OLS**	**FE**	**OLS**	**FE**
Log GDP State	-0.001	0.413***	-0.028**	0.424***	-0.011	0.209*
	[0.007]	[0.059]	[0.011]	[0.098]	[0.014]	[0.110]
Log No. of WM Shops in state	0.032***	0.004	0.088***	-0.025	0.083***	-0.04
	[0.006]	[0.011]	[0.009]	[0.019]	[0.019]	[0.037]
Dummy WM Product	-0.145***		-0.084**		-0.029	
	[0.025]		[0.035]		[0.047]	
Top quartile lag	0.523***	0.022	0.300***	-0.011	0.043	-0.016
	[0.012]	[0.018]	[0.023]	[0.037]	[0.057]	[0.055]
Log No. of WM Shops in state X Top quartile lag	-0.006	0.014**	0.034***	0.022*	0.083***	0.054*
	[0.004]	[0.006]	[0.007]	[0.011]	[0.031]	[0.031]
Dummy WM Product X Top quartile lag	-0.135***	-0.011	0.011	0.009	0.348***	0.015
	[0.025]	[0.035]	[0.037]	[0.054]	[0.061]	[0.062]
Log No. of WM Shops in state X Dummy WM Product	0.022***	0.080***	-0.024***	0.073***	-0.018	0.054
	[0.006]	[0.017]	[0.008]	[0.023]	[0.018]	[0.037]
Log No. of WM Shops in state X Dummy WM Product X Top quartile lag	0.052***	-0.019	0.030**	-0.021	-0.047	-0.046
	[0.010]	[0.014]	[0.014]	[0.019]	[0.032]	[0.034]
N	49633	49633	18515	18515	9046	9046
r2	0.353	0.191	0.404	0.195	0.285	0.143

Table 6: Probability of exporting

	All goods		Consumer goods		Food	
	OLS	**FE**	**OLS**	**FE**	**OLS**	**FE**
Log GDP State	0.028***	-0.001	0.008	-0.005	0.068***	-0.068
	[0.006]	[0.060]	[0.009]	[0.089]	[0.011]	[0.112]
Log No. of WM Shops in state	-0.035***	-0.013	-0.022***	-0.041**	-0.038***	0.012
	[0.004]	[0.010]	[0.007]	[0.019]	[0.012]	[0.021]
Dummy WM Product	-0.052***		-0.234***		-0.129***	
	[0.017]		[0.024]		[0.026]	
Top quartile lag	0.278***	-0.003	0.267***	0.01	-0.057*	0.021
	[0.011]	[0.019]	[0.024]	[0.046]	[0.032]	[0.044]
Log No. of WM Shops in state X Top quartile lag	-0.005	0.022***	0	0.018	0.042***	-0.004
	[0.004]	[0.007]	[0.007]	[0.014]	[0.016]	[0.018]
Dummy WM Product X Top quartile lag	-0.207***	-0.027	-0.185***	-0.037	0.161***	-0.044
	[0.024]	[0.037]	[0.034]	[0.056]	[0.039]	[0.055]
Log No. of WM Shops in state X Dummy WM Product	-0.020***	0.016	-0.006	0.028	-0.045***	0.013
	[0.004]	[0.017]	[0.005]	[0.022]	[0.010]	[0.022]
Log No. of WM Shops in state X Dummy WM Product X Top quartile lag	0.042***	0.011	0.024**	0.012	-0.030*	0.03
	[0.009]	[0.015]	[0.012]	[0.019]	[0.018]	[0.023]
N	53909	53909	20040	20040	9657	9657
r2	0.183	0.017	0.187	0.018	0.205	0.009

Table 7: Prices

	All goods		Consumer goods		Food	
	OLS	**FE**	**OLS**	**FE**	**OLS**	**FE**
Log GDP State	-0.008*	0.064	0.006	0.101	-0.021***	0.109
	[0.004]	[0.063]	[0.007]	[0.098]	[0.007]	[0.099]
Log No. of WM Shops in state	-0.006*	-0.01	-0.010*	-0.053**	-0.002	-0.066**
	[0.003]	[0.011]	[0.005]	[0.021]	[0.008]	[0.029]
Dummy WM Product	0.036***		0.037**		0.013	
	[0.013]		[0.019]		[0.021]	
Top quartile lag	0.061***	0.008	0.002	0.014	0.069***	0.031
	[0.007]	[0.014]	[0.015]	[0.029]	[0.024]	[0.043]
Log No. of WM Shops in state X Top quartile lag	0.011***	0.004	0.024***	0	-0.018	-0.01
	[0.003]	[0.005]	[0.005]	[0.009]	[0.012]	[0.021]
Dummy WM Product X Top quartile lag	-0.047***	0.008	0.018	0.02	-0.050*	-0.02
	[0.014]	[0.030]	[0.020]	[0.042]	[0.026]	[0.050]
Log No. of WM Shops in state X Dummy WM Product	0.016***	0.130***	-0.004	0.148***	0.020***	0.096***
	[0.003]	[0.016]	[0.004]	[0.024]	[0.007]	[0.029]
Log No. of WM Shops in state X Dummy WM Product X Top quartile lag	0.004	-0.002	-0.001	0.001	0.026**	0.019
	[0.005]	[0.012]	[0.007]	[0.017]	[0.012]	[0.024]
N	40627	40627	15621	15621	7606	7606
r2	0.506	0.69	0.557	0.727	0.653	0.797

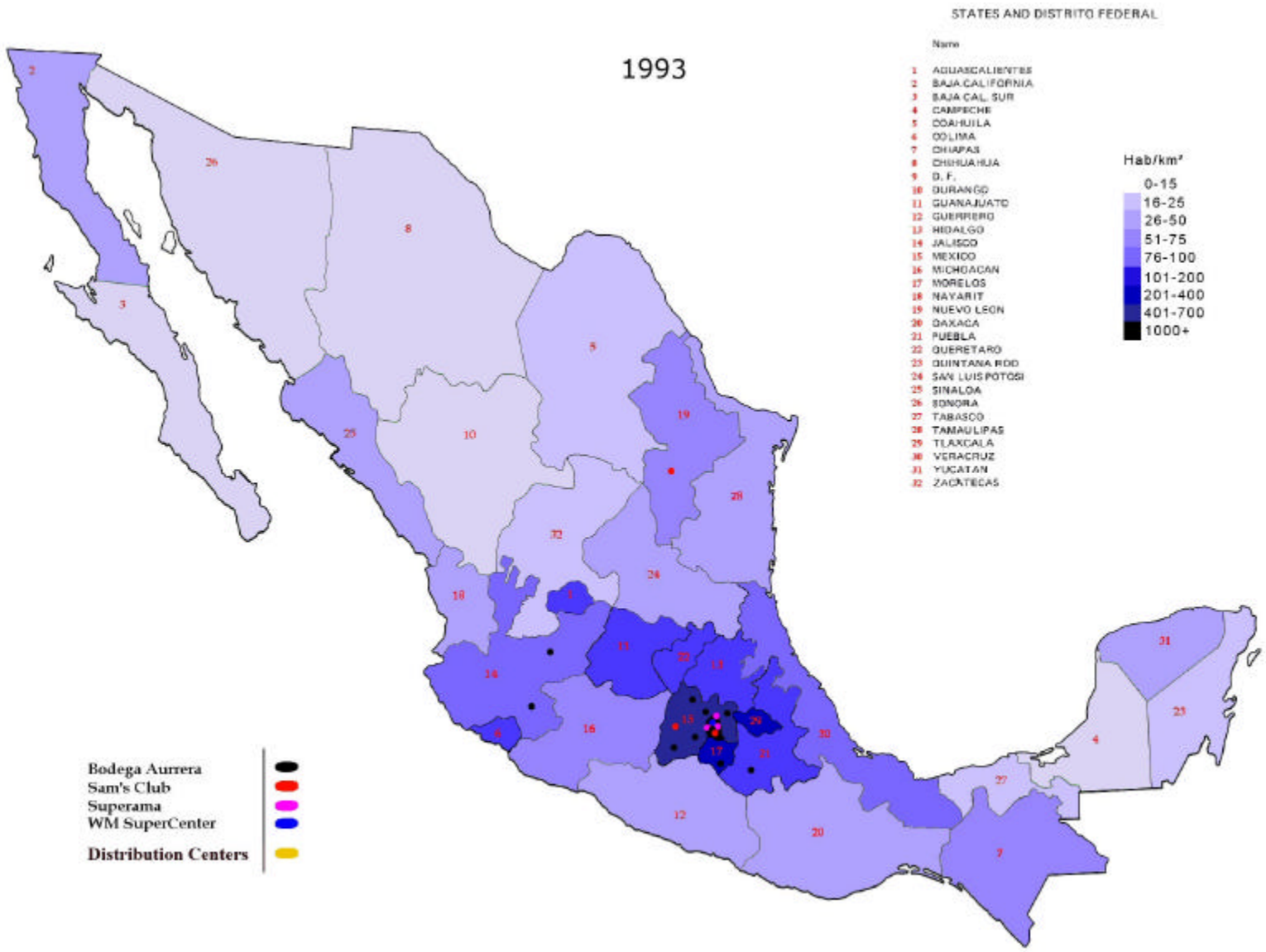
Table 8: Capital investment

	All goods		Consumer goods		Food	
	OLS	**FE**	**OLS**	**FE**	**OLS**	**FE**
Log GDP State	-0.234***	-0.191	-0.261***	0.04	-0.186**	-0.624
	[0.042]	[0.465]	[0.068]	[0.766]	[0.090]	[1.017]
Log No. of WM Shops in state	0.091***	0.003	0.090*	0.264	0.239**	0.710**
	[0.032]	[0.090]	[0.053]	[0.168]	[0.098]	[0.295]
Dummy WM Product	0.865***		1.155***		1.741***	
	[0.134]		[0.190]		[0.222]	
Top quartile lag	2.568***	0.951***	1.887***	0.915***	2.025***	1.578**
	[0.084]	[0.146]	[0.169]	[0.309]	[0.368]	[0.639]
Log No. of WM Shops in state X Top quartile lag	-0.026	-0.145***	0.150***	-0.088	-0.187	-0.521**
	[0.028]	[0.051]	[0.050]	[0.097]	[0.183]	[0.234]
Dummy WM Product X Top quartile lag	-0.398**	-0.354	0.323	-0.042	0.182	-1.026
	[0.185]	[0.363]	[0.271]	[0.535]	[0.406]	[0.725]
Log No. of WM Shops in state X Dummy WM Product	-0.092***	-0.612***	-0.103**	-0.781***	-0.228***	-0.933***
	[0.034]	[0.143]	[0.043]	[0.206]	[0.084]	[0.289]
Log No. of WM Shops in state X Dummy WM Product X Top quartile lag	0.039	0.024	-0.15	-0.186	0.198	0.416
	[0.071]	[0.151]	[0.096]	[0.213]	[0.196]	[0.283]
N	49655	49655	18565	18565	8928	8928
r2	0.231	0.137	0.234	0.128	0.192	0.15

Table 9: Exit

	All goods		Consumer goods		Food	
	OLS	**FE**	**OLS**	**FE**	**OLS**	**FE**
Log GDP State	-0.002	-0.048*	-0.003	-0.095**	0.001	0.025
	[0.003]	[0.027]	[0.005]	[0.044]	[0.005]	[0.049]
Log No. of WM Shops in state	0.004*	-0.001	0.009**	-0.005	-0.006	0
	[0.002]	[0.006]	[0.004]	[0.010]	[0.008]	[0.019]
Dummy WM Product	-0.008		0.006		-0.017	
	[0.008]		[0.011]		[0.018]	
Top quartile lag	-0.039***	-0.008	-0.022**	0.014	-0.034*	-0.023
	[0.004]	[0.009]	[0.009]	[0.021]	[0.021]	[0.030]
Log No. of WM Shops in state X Top quartile lag	0.002	-0.009***	-0.006**	-0.019***	-0.001	-0.001
	[0.001]	[0.003]	[0.003]	[0.007]	[0.009]	[0.010]
Dummy WM Product X Top quartile lag	0.002	-0.004	-0.011	-0.039	-0.005	0.011
	[0.007]	[0.016]	[0.012]	[0.028]	[0.022]	[0.033]
Log No. of WM Shops in state X Dummy WM Product	-0.002	-0.026***	-0.006**	-0.033***	0.005	-0.011
	[0.002]	[0.008]	[0.003]	[0.012]	[0.008]	[0.019]
Log No. of WM Shops in state X Dummy WM Product X Top quartile lag	0.004	0.011*	0.012***	0.029***	0.007	0.001
	[0.003]	[0.006]	[0.004]	[0.010]	[0.009]	[0.012]
N	47683	47683	17765	17765	8825	8825
r2	0.012	0.039	0.017	0.045	0.012	0.031

FIGURE 1


1993
STATES AND DISTRITO FEDERAL
Name
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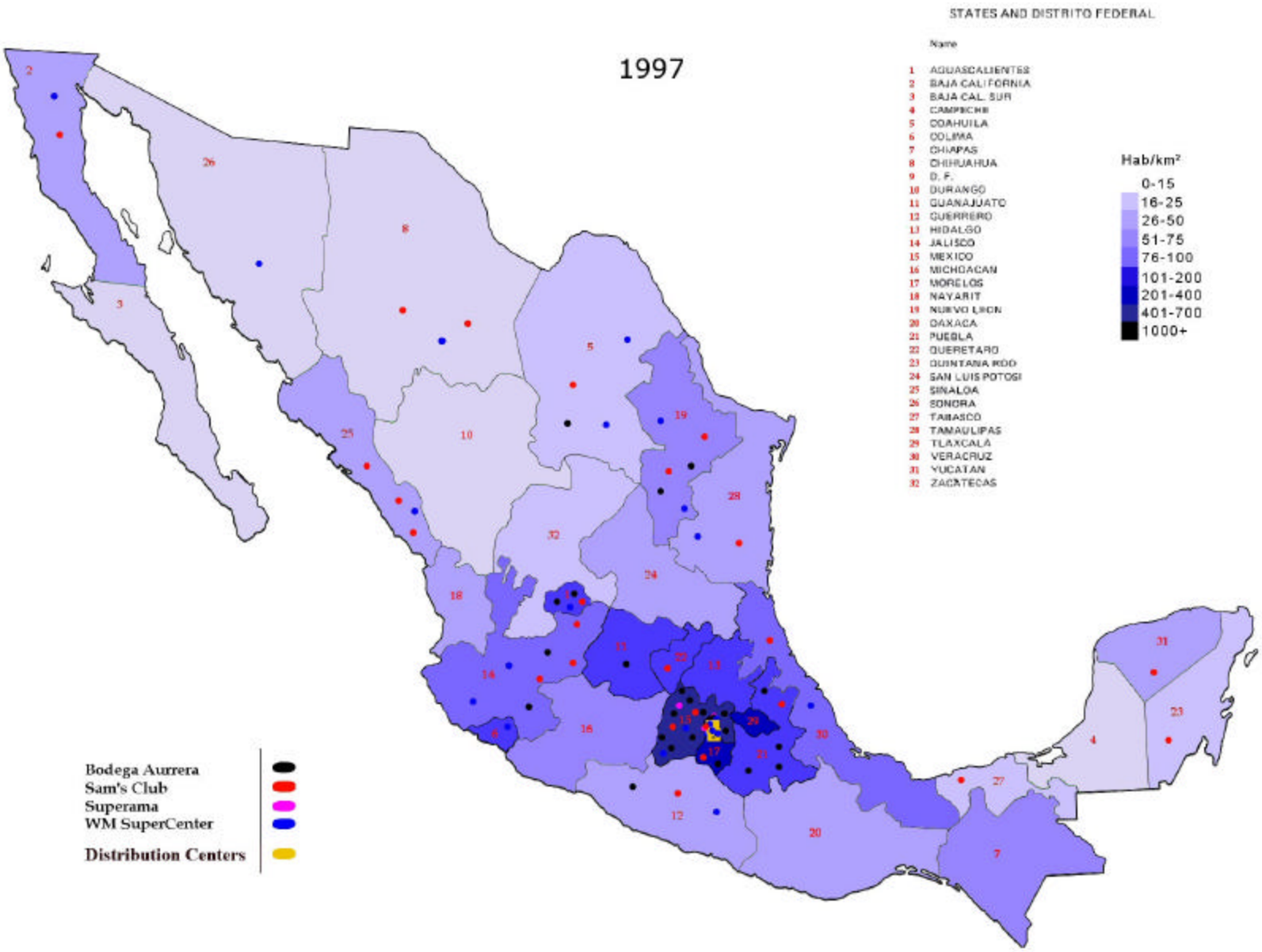
3 BAJA CAL. SUR
4 CAMPECHE
5 COAHUILA
6 COLIMA
7 CHIAPAS
8 CHIHUAHUA
9 D. F.
10 DURANGO
11 GUANAJUATO
12 GUERRERO
13 HIDALGO
14 JALISCO
15 MEXICO
16 MICHOACAN
17 MORELOS
18 NAYARIT
19 NUEVO LEON
20 OAXACA
21 PUEBLA
22 QUERETARO
23 QUINTANA ROO
24 SAN LUIS POTOSI
25 SINALOA
26 SONORA
27 TABASCO
28 TAMAULIPAS
29 TLAXCALA
30 VERACRUZ
31 YUCATAN
32 ZACATECAS
Hab/km²
0-15
16-25
26-50
51-75
76-100
101-200
201-400
401-700
1000+
Bodega Aurrera
Sam's Club
Superama
WM SuperCenter
Distribution Centers

FIGURE 2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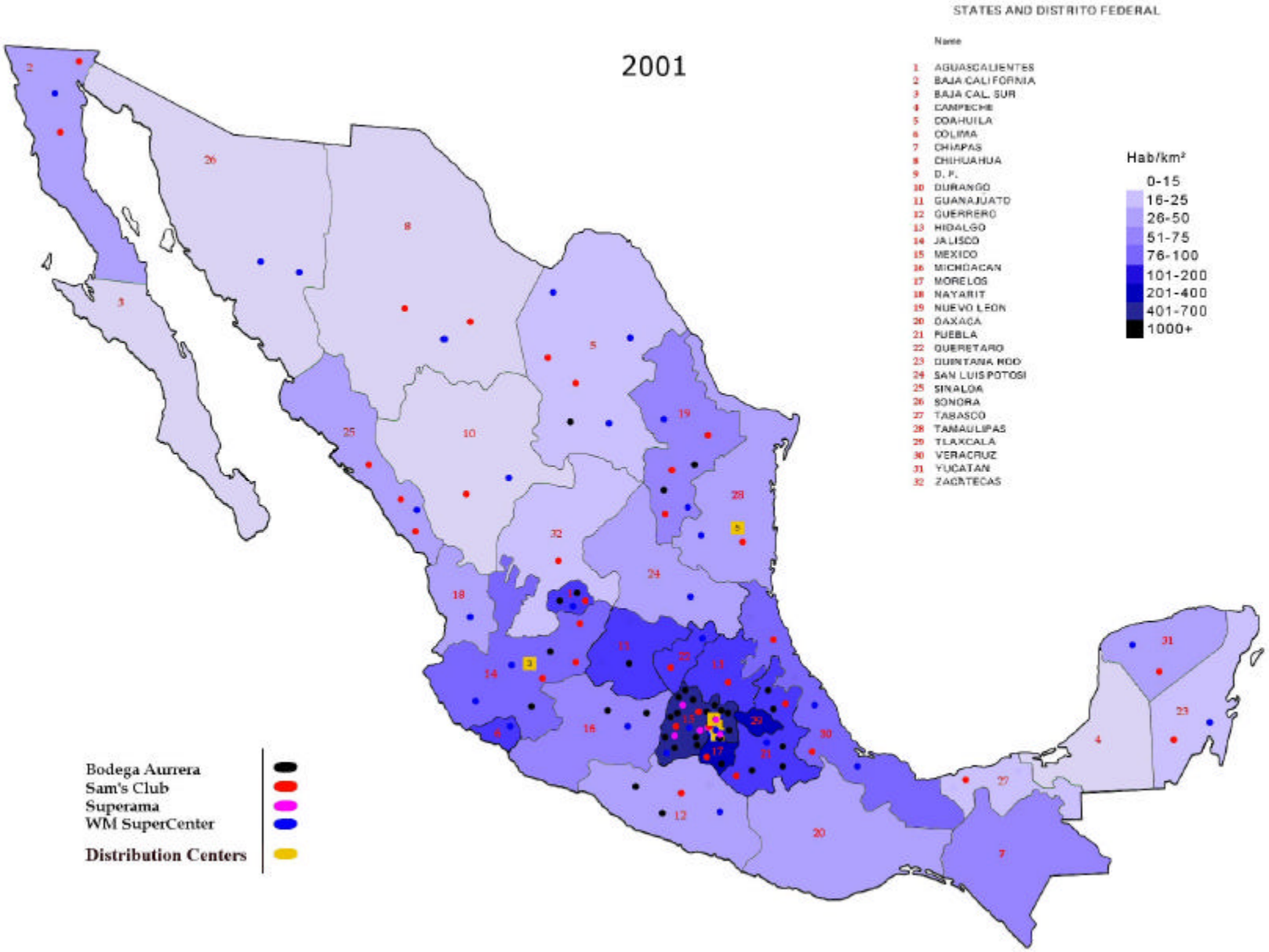
4 CAMPECHE
5 COAHUILA
6 COLIMA
7 CHIAPAS
8 CHIHUAHUA
9 D. F.
10 DURANGO
11 GUANAJUATO
12 GUERRERO
13 HIDALGO
14 JALISCO
15 MEXICO
16 MICHOACAN
17 MORELOS
18 NAYARIT
19 NUEVO LEON
20 OAXACA
21 PUEBLA
22 QUERETARO
23 QUINTANA ROO
24 SAN LUIS POTOSI
25 SINALOA
26 SONORA
27 TABASCO
28 TAMAULIPAS
29 TLAXCALA
30 VERACRUZ
31 YUCATAN
32 ZACATECAS
Hab/km²
0-15
16-25
26-50
51-75
76-100
101-200
201-400
401-700
1000+
Bodega Aurrera
Sam's Club
Superama
WM SuperCenter
Distribution Centers

FIGURE 3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STATES AND DISTRITO FEDERAL
Name
1 AGUASCALIENTES
2 BAJA CALIFORNIA
3 BAJA CAL. SUR
4 CAMPECHE
5 COAHUILA
6 COLIMA
7 CHIAPAS
8 CHIHUAHUA
9 D. F.
10 DURANGO
11 GUANAJUATO
12 GUERRERO
13 HIDALGO
14 JALISCO
15 MEXICO
16 MICHOACAN
17 MORELOS
18 NAYARIT
19 NUEVO LEON
20 OAXACA
21 PUEBLA
22 QUERETARO
23 QUINTANA ROO
24 SAN LUIS POTOSI
25 SINALOA
26 SONORA
27 TABASCO
28 TAMAULIPAS
29 TLAXCALA
30 VERACRUZ
31 YUCATAN
32 ZACATECAS
Hab/km²
0-15
16-25
26-50
51-75
76-100
101-200
201-400
401-700
1000+
Bodega Aurrera
Sam's Club
Superama
WM SuperCenter
Distribution Centers

FIGURE 4

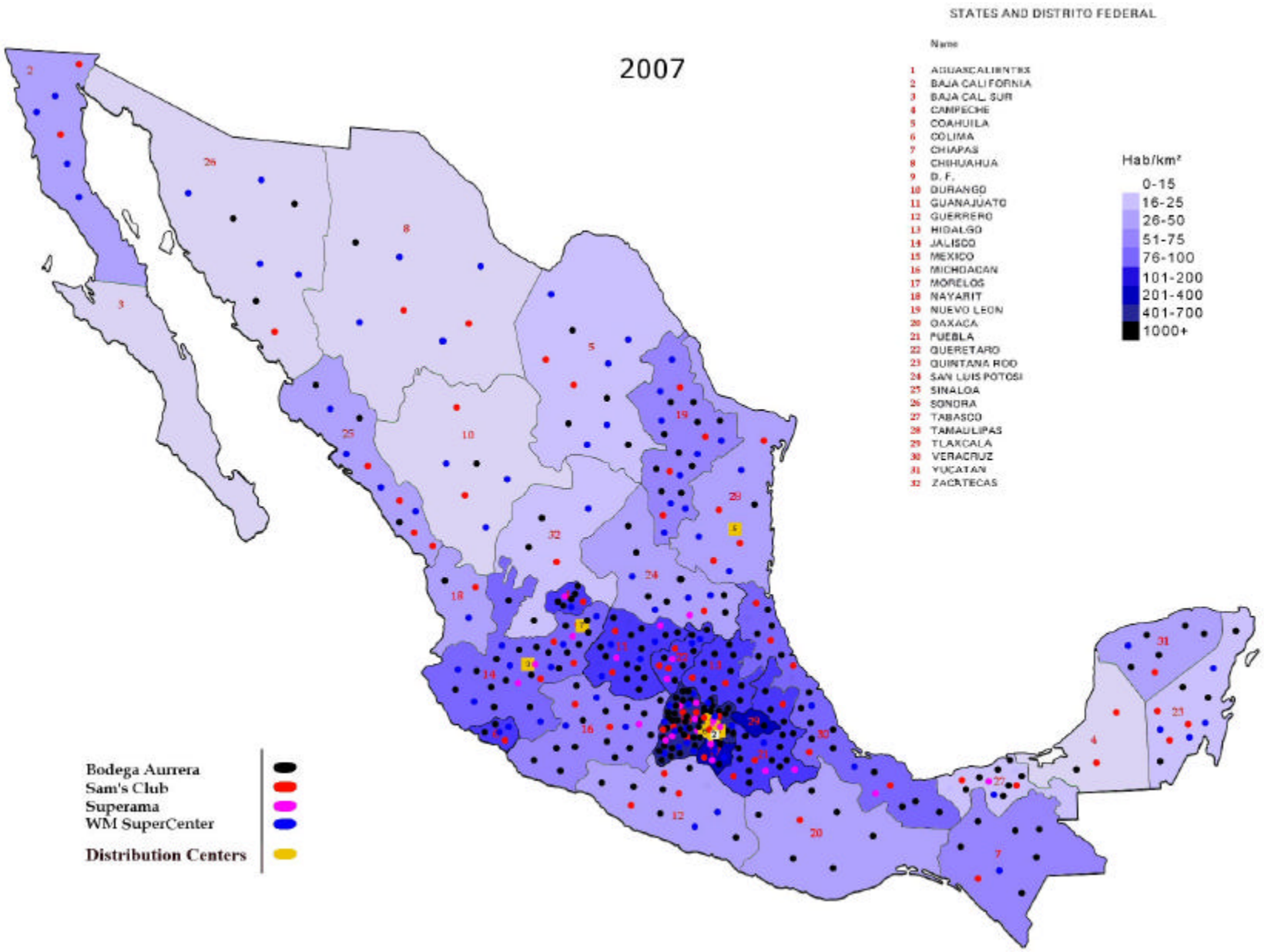
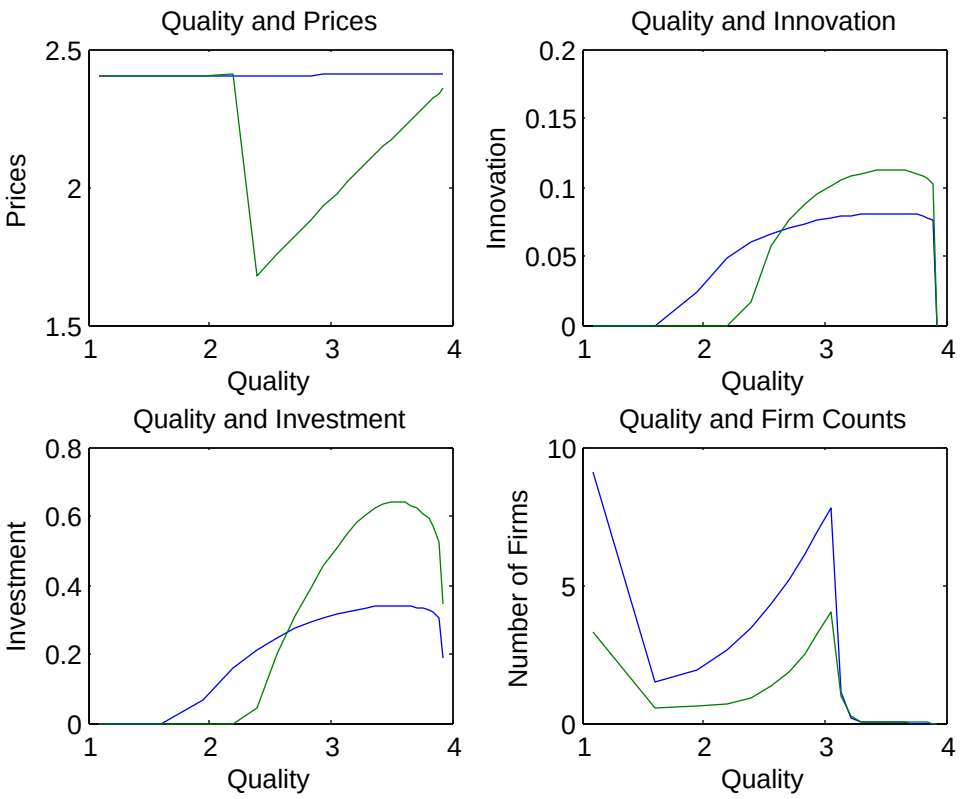

2007
STATES AND DISTRITO FEDERAL
Name
1 AGUASCALIENTES
2 BAJA CALIFORNIA
3 BAJA CAL. SUR
4 CAMPECHE
5 COAHUILA
6 COLIMA
7 CHIAPAS
8 CHIHUAHUA
9 D. F.
10 DURANGO
11 GUANAJUATO
12 GUERRERO
13 HIDALGO
14 JALISCO
15 MEXICO
16 MICHOACAN
17 MORELOS
18 NAYARIT
19 NUEVO LEON
20 OAXACA
21 PUEBLA
22 QUERETARO
23 QUINTANA ROO
24 SAN LUIS POTOSI
25 SINALOA
26 SONORA
27 TABASCO
28 TAMAULIPAS
29 TLAXCALA
30 VERACRUZ
31 YUCATAN
32 ZACATECAS
Hab/km²
0-15
16-25
26-50
51-75
76-100
101-200
201-400
401-700
1000+
Bodega Aurrera
Sam's Club
Superama
WM SuperCenter
Distribution Centers

Figure 5


Quality and Prices
Prices
2.5
2
1.5
1
2
3
4
Quality
Quality and Innovation
Innovation
0.2
0.15
0.1
0.05
0
1
2
3
4
Quality
Quality and Investment
Investment
0.8
0.6
0.4
0.2
0
1
2
3
4
Quality
Quality and Firm Counts
Number of Firms
10
5
0
1
2
3
4
Quality