

Explaining Cross-Country Productivity Differences in Retailing

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Abstract

In poor countries, measured productivity of the retail sector tends to be much lower than in the U.S. I present evidence that this productivity gap is largely accounted for by the limited presence of “modern” retailers, such as supermarkets and hypermarkets, in poor countries. Modern retailers in poor countries are almost as productive as those in the U.S., but they account for a much smaller share of overall retailing. So why aren’t modern retailers more prevalent in the developing world? I argue that the viability of large-scale retail stores in poor countries is limited by low rates of car ownership and low levels of income per square mile. I formalize this hypothesis in a spatial model in which the diffusion of modern retail stores is driven by auto ownership and household income. The idea that technology adoption is driven by the demand side appears promising for explaining productivity differences more broadly.

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1 Introduction

One of the most important questions in macroeconomics is why output per capita is so much lower in the developing world than in advanced economies. A recent consensus points to total factor productivity (TFP) differences as the primary determinant of country income differences. Unfortunately, explaining TFP differences has proven quite challenging, and the enormous TFP gaps between rich and poor countries remain largely unaccounted for. In this paper I attempt to help explain TFP through an in-depth examination of cross-country differences in retailing. Retailing is an important sector in its own right, with a private employment share of 15% - 20%, which makes it roughly as large as manufacturing. In addition, I argue the lessons learned from retailing are potentially applicable to a large segment of private economic activity, and help shed light on TFP differences more broadly.

My empirical findings from retailing suggest that frontier technologies are often readily available in poor countries, almost as productive as when used in rich countries, yet operated only to a small extent in the developing world. In retailing, the frontier technology is the large-scale high-volume store, such as the hypermarket or supermarket, which I refer to as "modern" stores. I present evidence that modern stores located in poor countries are almost as productive as those located in the US, using measures of either output per worker or TFP. This fact is surprising given that the overall gap in retailing productivity is so high. I also document that modern stores constitute a small fraction of overall retail employment, with the bulk of employment in "traditional" retailers, such as "mom and pop" grocery stores and street vendors. In contrast, the majority of retail workers in the US are employed in modern stores, with just a small fraction in traditional stores. These two facts suggest that overall productivity in retailing is driven in large part by the composition of employment across the two store types.

So why aren't modern retailers more prevalent in the developing world? The hypothesis that I present in this paper is that modern stores take their efficiency in large part from scale economies, and that in order to recoup their fixed costs of operating on a large scale, they require sufficiently large markets. In smaller markets where income per square mile and car ownership rates are low, modern stores are largely unviable. In poor countries, low income and high transport costs mean that few modern stores can be supported, and hence smaller traditional retailers prevail. Under this view, the demand side of the market determines in large part the degree of diffusion of the modern stores.

This paper’s emphasis on the demand side as the driver of technology adoption appears new to the literature. Most papers on technology adoption and productivity differences emphasize the role of the production side of the economy. Examples include Parente and Prescott (1994) on labor unions impeding new technologies, Schmitz (2005) on competition and productivity, and Restuccia and Rogerson (2003) and Klenow and Hsieh (2006) on misallocation of inputs across productive units. In contrast, this paper argues that household income and the prevalence of complementary household durables drives the choice of technologies employed in the economy, at least in some sectors. This distinction is important in that the set of policies for which demand-induced technology adoption are relevant differ substantially from the policies relevant for the production side. Since cars serve as complements to modern retail technologies, policies that hinder car ownership by households will also hinder adoption of the modern stores. Policies of this kind are in fact common in poor countries. The market for imported used cars, which could serve as a large source of inexpensive autos for households, is completely banned in many developing countries, and severely restricted in a number of others. Taxes on gasoline are also typically higher in poor countries, and public investment into roads much substantially lower.

I formalize my hypothesis in a general equilibrium version of the Salop (1979) circular city model. Households live along the circumference of the circle and decide where to shop, choosing from spatially-differentiated stores. Households can elect to buy a car, which reduces transport costs and also provides utility directly. Retail stores come in two types: modern and traditional. Modern stores have a low marginal cost of providing the consumption good, but have a fixed cost of operating, while traditional stores have a high marginal cost and no fixed cost. In equilibrium, the number of modern retailers that operate depends positively on household income and the fraction of households with cars.

To assess the quantitative implications of the model, I calibrate the model to a representative U.S. district in terms of income and car ownership rates. The calibration matches price and productivity differences across store types and average shopping times, among other things. I plan to test the calibrated model by re-solving it for a representative Mexican county, holding all parameters the same except for income and car ownership rates, which I can match to Mexican data. I can then compute the model’s implied shares of retail employment in modern and traditional stores, and overall TFP in Mexican retailing. I plan to use the parameterized model to assess the effects of removing bans on used car

imports on retail TFP.

While my paper is most closely related to the literature on TFP differences and technology adoption, it also complements the recent literature on the rise of modern retail stores in the U.S. Basker (2006) and Holmes (2006) are two prominent examples that explore the rise of Wal-Mart, which is now the world's largest retailer. Jarmin, Klimek and Miranda (2005) document the increasing importance of retail chains in the US. The paper in this literature most related to mine is by Foster, Haltiwanger and Krizan (2006), who show that virtually all the labor productivity gains in retail trade in the US over the 1990s are accounted for by more productive retail establishments replacing less productive ones. My story is consistent with this finding in the sense that higher productivity levels in my model result from increased use of the modern retail technology, and less use of the less-productive traditional retailers, as opposed to productivity growth at either type of establishment.

My work is also related to that of Syverson (2004), who explores the effects of market size on productivity through selection. In his framework, productivity is higher in larger markets because tougher competition among firms causes the least productive to exit. In my model, in contrast, it is the household side which leads to higher productivity in larger markets. In markets with higher income and more cars, lower transportation costs by households and higher expected sales per store allows more of the high-productivity producers to overcome their fixed costs. A final related paper is by Buera and Kaboski (2006), who study the recent rise of the service sector in the US. In their model, service industries exhibit a market-to-home cycle as an economy becomes richer. My model shares the feature that household durable goods play a key role in the transition from traditional to modern service industries.

2 Retailing in Developed and Developing Countries

2.1 The Importance of Retailing

In this section I present the key empirical features of the retail sectors of rich and poor countries. I begin with the importance of retailing for the aggregate economy. In terms of employment, retailing is roughly equal in size to manufacturing, a sector that has received considerably more attention in the literature on cross-country productivity differences. In

Table 1, I present the private-sector employment shares of retailing in the U.S. and two developing countries, Mexico and Brazil, using national accounts data. I also present the employment share in manufacturing for comparison, and the combined share of retail trade and wholesale trade. In all three countries retail alone constitutes around 15% of private employment, just slightly less than manufacturing. Including wholesaling, a closely related economic activity, the employment share surpasses that of manufacturing in all three cases, with shares approaching 20%.

	Percent of Private Employment, 2004		
Sector/ Country	U.S.	Brazil	Mexico
Retail Trade	12.8%	13.7%	15.4%
Retail & Wholesale Trade	16.1%	19.7%	18.1%
Manufacturing	13.1%	19.3%	16.5%

Table 1: Importance of Retail Sector in Aggregate Economy

Retail trade is important for other reasons than its size. Since most consumer purchases occur at retail establishments, the efficiency of retail establishments is an important determinant of the overall price level of consumer goods in an economy. An inefficient retail sector leads to higher final goods prices, which affects all households directly. Similarly, the gains from improving the productivity of retailing and lowering prices can potentially lead to large improvements in household welfare.

2.2 Composition Effects Explain Much of Retail Productivity Gap

I now document the main empirical result about retailing, which is that most of the productivity gap between rich and poor countries is driven largely by the composition of employment across types of retail stores. I start by documenting that productivity in modern retail stores, as measured by either output per worker or TFP, is almost as high in poor countries as in the US. Then, I document that the share of employment in modern stores is low in poor countries and high in the U.S.

The main challenge in measuring retail productivity is measuring output. Unlike manufacturing plants, which have a clearly defined physical output, retail establishments provide a service which is not directly measurable. In this study I focus on *value added* as my output measure, which is "the best simple measure of retailing output" (Baily & Solow, 2001).¹ The labor input measure I use, while differing slightly from country to country, always include both paid and unpaid workers. The inclusion of unpaid workers is crucial in retailing, since so many establishments (in poor countries especially and in the U.S. historically) are operated by proprietors without paid employees.

Detailed evidence on productivity by type of retail store has become available in the McKinsey Productivity Studies. The studies were conducted in the late 1990s and early 2000s by the McKinsey Global Institute working in collaboration with numerous academic economists with expertise in productivity measurements. Martin Baily and Robert Solow, who were both collaborators in the studies, offer an overview of the McKinsey findings and more detailed description of their methods (Baily & Solow, 2001). McKinsey classifies all retail establishments as one of two basic types: traditional or modern. Modern stores are comprised of hypermarkets, supermarkets, convenience stores, specialty stores, and department stores, and are characterized primarily by their large scale of operation. Traditional stores consist of street vendors, open-air markets, and counter grocery stores. These stores are typically associated with a small scale of operation and independent ownership.²

Figure 1 displays output per worker by type of store and for the sector as a whole, for the U.S. and three developing countries, Thailand, Turkey and Poland. The most striking finding on this figure is that the productivity level of modern retailers is almost as high in the developing countries as in the US. Thailand has value added per worker of around 107% of the US average, just slightly below the US modern store average, while Turkey and Poland are just below at around 80% of the US average.³ The relative parity of modern retailers in the developing world and the US is surprising, given the vast productivity

¹See Baily (1993) or Bosworth & Triplett (2004) for a discussion of the alternative output measures used in retailing including the limitations of each measure.

²See the data appendix for more on the studies I employ and McKinsey's methodology.

³McKinsey also conducted a similar analysis in four other developing countries that I'm aware of: Brazil, Mexico, Russia, and India. For Brazil, Mexico and Russia only the food retail sector was studied and McKinsey similar found similar results to the ones presented here. For India, however, retailers at all levels had extremely low output per worker: 20% of the US level in modern stores and just 3% in traditional stores, with an average labor productivity of 9% of the US level. According to McKinsey this is because of government policy that total restricts entry of foreign retailers, which would presumably be modern, and (2) forces all retailers to hire extra "un-needed" labor.

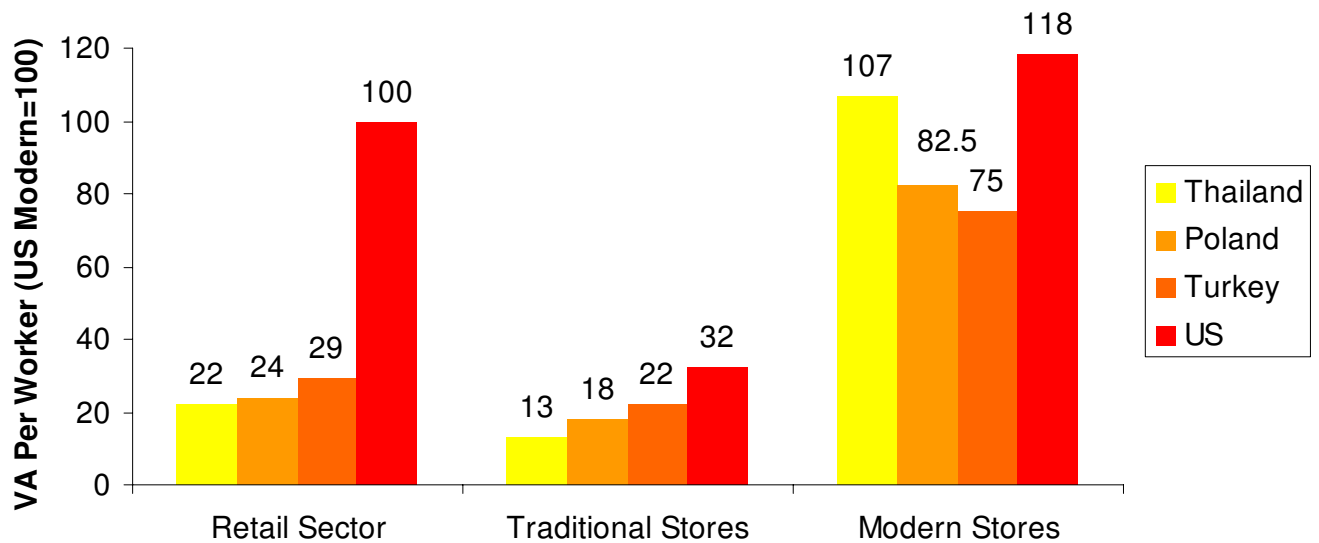


Figure 1: Labor Productivity for Retail Sector and by Type of Store, 1990s.

gap in the aggregate, and given that (to the best of my knowledge) no other study has documented that the most productive firms in developing countries are roughly on par with the most productive in the US. One reason why this finding might be true in retail, and not necessarily other sectors, is that many of the modern retailers present in the developing world are in fact operated by European or US chains. For example, the French retailer Carrefour has extensive operations in Poland, Turkey and Brazil, among other places, and is the leading retailer in Brazil. Similarly, Wal-Mart is the leading retailer in Mexico. Given that so many modern retailers are in fact operated by developed-country firms, it seems reasonable that these firms can operate their technology at home and abroad at a comparable productivity level.

Note also in Figure 1 that the overall output-per-worker gap in retailing is quite large. How can this be true given that productivity is so comparable in each type of store? The answer is that the share of employment in modern retail stores differs drastically across these different countries.⁴ Figure 2 shows the share of employment in each type of store in each country. Around 90% of all retail workers in the developing countries are in

⁴Guner, Ventura and Xu (2006) argue that the size distribution of retail stores is directly affected by government policy. For example in Japan, retail establishments above a certain size threshold area strongly restricted, leading to disproportionately many small retail stores. My paper differs in that I consider market-induced firm size distributions.

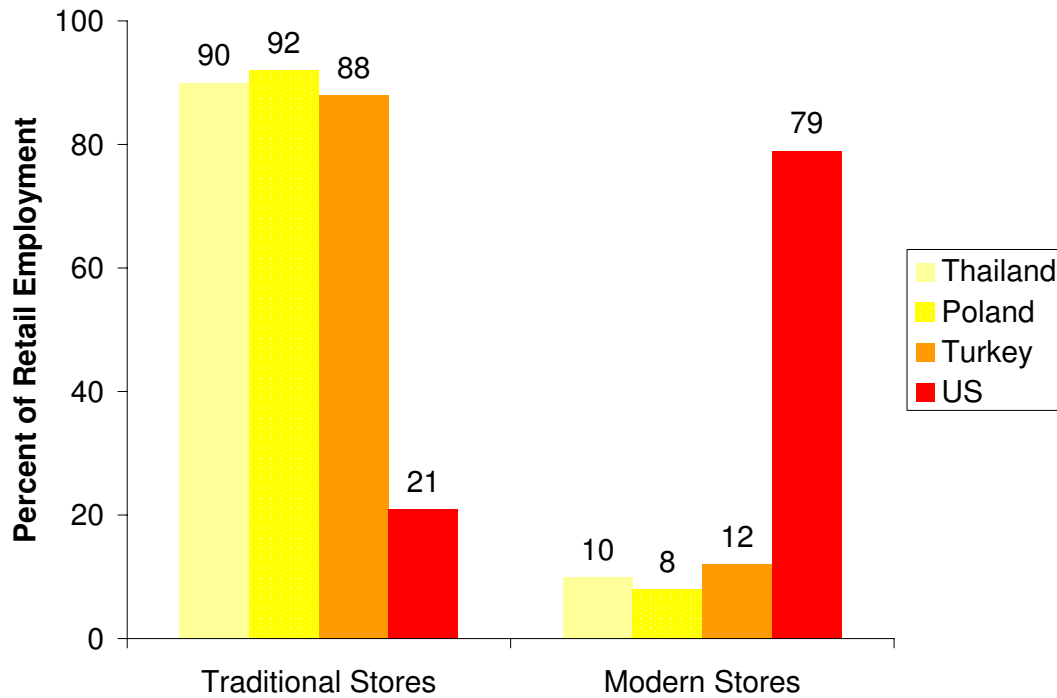


Figure 2: Employment Composition in Retailing, 1990s.

traditional stores, whereas just 21% of retail employment in the US is in traditional stores.⁵ The two figures together imply that the retail productivity gap between the U.S. and the developing world is largely explained by the low employment share of modern retailers in the developing countries.

A crucial question is to whether TFP is higher in modern retailers than traditional ones, since value added per worker measures reflect differences in other inputs such as capital and land. I address this question by computing TFP measures for the US retail sector, and for Mexico, by type of store, for 1998. I calculate TFP as the Solow residual from a Cobb-Douglas production function with labor share equal to 0.5, 0.6 and 0.7. I choose these values to be in line with Hall & Jones (1999) and Klenow & Rodriguez-Clare (1997). The capital stock measure is the value of capital structures, capital equipment and land. Labor

⁵I find that this stark contrast between the U.S. and the developing world appears clearly in publicly available data from the U.S., Mexico and Brazil. For the U.S. I calculate that 77% of retail employment in 2002 was in establishments with 10+ workers, 66% was in establishments with 20+ workers, and 44% percent was in establishments with 50+ workers. For Mexico these figures are just 34% with 10+ workers, 27% with 20+ workers, and 18% with 10+ workers. Brazil is quite similar to Mexico. I conclude that by any measure, retail employment is overwhelmingly found in large stores in the U.S. and small stores in developing countries.

input is the number of paid and unemployed employees. My definition of a modern store is a store with 10 or more workers, and a traditional store with less than 10 workers.⁶

My results are presented in Table 2. The TFP gap in retailing between Mexico and the U.S. is around 50%, which is in line with the overall TFP gap in Mexico (and Latin America more broadly) as measured by Cole et al (2005). As in the output-per-worker calculations, TFP in modern stores is close to the U.S. level, ranging from 67% to 82% of the U.S. retail sector. Furthermore, TFP is substantially higher than in traditional stores.⁷ In the last row of the table, I compute a simple measure of the importance of the composition effect in explaining the TFP gap, which is the fraction of the TFP difference that would be explained if all Mexican employment were in modern stores. The results show that around 40% to 50% of the TFP gap is explained by the composition effect.⁸

2.3 Modern Stores, and the Roles of Income Density & Car Ownership

Until now we have seen that the under-representation of modern stores is the proximate cause of a large fraction of retail productivity differences across countries. In this section I present evidence that income density and the extent of car ownership by households play key roles in the presence of modern establishments.

First I show that in the cross-section of geographic districts in the Mexico, districts with higher income per square mile have a much higher fraction of employment in modern stores. I also show that car ownership rates across districts are highly correlated with modern store prevalence. As my measure of modern store prevalence I use the share of food retail employment in supermarkets. I compute this fraction for each Mexican county. In the U.S. as my modern definition I use the share of employment in stores with 20 or more workers. While this comparison is obviously imperfect, it is the closest comparison possible using official data from the U.S. and Mexico.

⁶Results differ only slightly for a cutoff of 15 workers or 20 workers.

⁷The finding of higher measured TFP in larger stores is consistent with the McKinsey studies, which report substantial first-hand evidence that efficiency of operations is superior in modern stores. Traditional retailers were found in general to have poor relations with suppliers, frequently wasting more resources than modern retailers changing suppliers or organizing deliveries and purchases. Traditional stores were also reported to have a poor match between demand and staffing levels, especially in their non-use of employees for stocking during non-peak periods. Modern retailers were said to do this much better. Other examples given include poorer product offerings and inefficient management techniques.

⁸One limitation of this measure is that part-time employees and full-time employees are counted equally in the labor input. Since larger stores tend to use part-time employees with higher frequency than smaller stores, true TFP differences might be even larger than the ones presented here.

		Employment Share	TFP ($\alpha=0.5$)	TFP ($\alpha=0.6$)	TFP ($\alpha=0.7$)
U.S.	Retail Sector	-	100	100	100
Mexico	Retail Sector	-	60	51	44
	Traditional Stores	0.76	51	42	35
	Modern Stores	0.24	82	74	67
	<i>Composition Effect</i>	-	0.54	0.47	0.41

Table 2: Retail TFP & Employment Composition, Mexico, 1998.

Figure 3 shows the results of the first comparison. For each county in the U.S. and Mexico, I compute the share of retail employment in modern stores and the “income density,” or income in 2000 dollars per square mile. I then divide the counties into income density quartiles, and plot the average modern employment share in each quartile. In the U.S., modern employment shares are high in low and high income density areas with a share around 65% of retail employment. The share is slightly increasing in density for the lower three quartiles of density.⁹ In Mexico, in contrast, the share is lower everywhere than the U.S. with a share that rises rapidly with income density. In the Mexican counties with the highest income per square mile, over 50% of employment is in modern stores, which is nearly at the U.S. level. In contrast, in Mexican counties where income is the lowest per square mile, virtually none of the employment is in modern stores, with a share below 10%.

Car ownership rates are also highly correlated with modern store prevalence. For Mexico, I find that the cross-county correlation of the modern retailer share and the auto ownership rate is 0.61. This is evidence supporting the view modern stores and cars tend to be located in the same geographic areas.

⁹This finding is consistent with the findings of Campbell and Hopenhayn (2005), who document that larger U.S. cities have larger retail establishments on average.

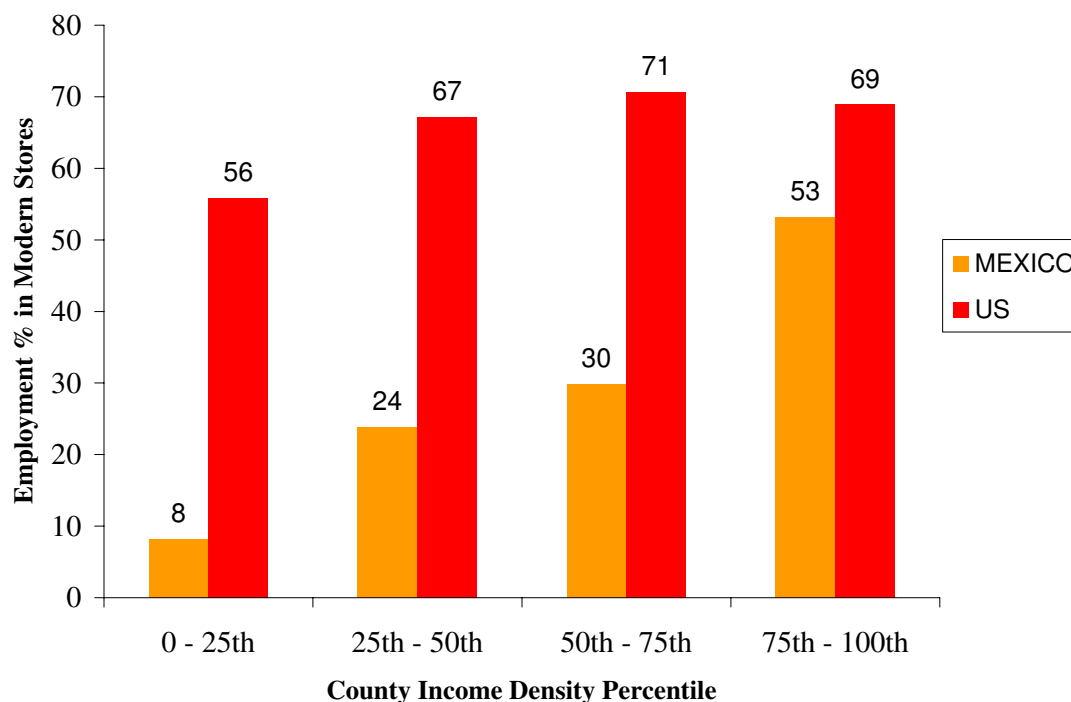


Figure 3: Percent Employment in Modern Stores by County Income Density, U.S. (2002) and Mexico (1999).

Since my definition of modern and traditional stores are not perfect and are not even directly comparable between Mexico and the U.S., I add an additional analysis, which looks directly at the location of all stores of the largest three retail chains in the two countries. In the US, these retail chains are Wal-Mart, The Home Depot, and Target, and in Mexico the chains are Wal-Mart, Gigante and Comercial Mexicana. The store locations are taken from the website of each chain, and aggregated to the county level using the zip code of each store.¹⁰ Table 3 presents the results of this analysis. The first two columns contain the fraction of households in urban and rural counties, and the fraction of total household income that is earned in each area. Mexico and the US are similar in that around 75% of the population resides in urban areas, and that urban areas generate around 80% of total household income. The key difference is in the distribution of retail stores from the chains in question. Around 75% of the stores in the U.S. are located in urban areas, compared with 94% of the stores in Mexico. So while the shares of modern retailers in the U.S. are roughly comparable to the population and income shares, the retailer stores from the largest chains in Mexico are disproportionately urban. Note that auto owner-

¹⁰The data appendix presents more detail on the calculations involved in this analysis.

ship is disproportionately urban in Mexico as well, with 37% of households owning cars in urban areas and just 15% in rural areas.

		Percent of Total Population	Percent of Total Income	Percent of Modern Stores
US:	Rural	24.7%	19.4%	27.9%
	Urban	75.3%	80.6%	72.1%
		100.0%	100.0%	100.0%
Mexico:	Rural	23.7%	17.7%	6.5%
	Urban	76.3%	82.3%	93.5%
		100.0%	100.0%	100.0%

Table 3: Distribution of Stores of The Largest Three Retail Chains, US & Mexico, 2006

As a final piece of evidence, I show that the rise of automobiles in the U.S. parallels the rise of modern stores. Of course real income grew drastically over the same period in the U.S. Figure 4 displays the average size of a retail establishment from 1933 to the present in the U.S. as well as in Mexico and Brazil. The average retail establishment in 1933 in all three countries had around 3 workers. Since that point, the average store size in the U.S. has risen steady to around 6 in the 1960s and around 10 in the present. In stark contrast, the average store size in Brazil and Mexico is virtually unchanged since the 1930s.¹¹¹² One of the many structural changes occurring in the U.S. since the 1930s and earlier was the rise of automobile ownership.¹³ Car ownership rates in the U.S. in the 1930s were around 33% whereas they are 90% today. In the developing world, however, car ownership rates were low over this entire period. In Brazil and Mexico, the percent of households having automobiles is around one third. In 2000, just 33.1% of Brazilian households and 32.4% of Mexican households had at least one car.

¹¹I find nearly identical trends for the fraction of retail employment at stores with 20+ employees. In the U.S. this which rose from roughly 25% in the U.S. in the late 1930s to 66% today. In Mexico and Brazil, the shares risen only modestly over the period, topping out at around 30% today.

¹²While the increasing retail store size since 1960 has been documented by Jarmin, Klimek and Miranda (2005), the fact that the U.S. average store size was comparable to that of poor countries in the 1930s appears to be new to the literature on retail trade.

¹³In a related study, Kopecky and Suen (2006) construct and quantify a model of suburbanization and the rise of automobile ownership, and find that their model can account simultaneously for the two facts.

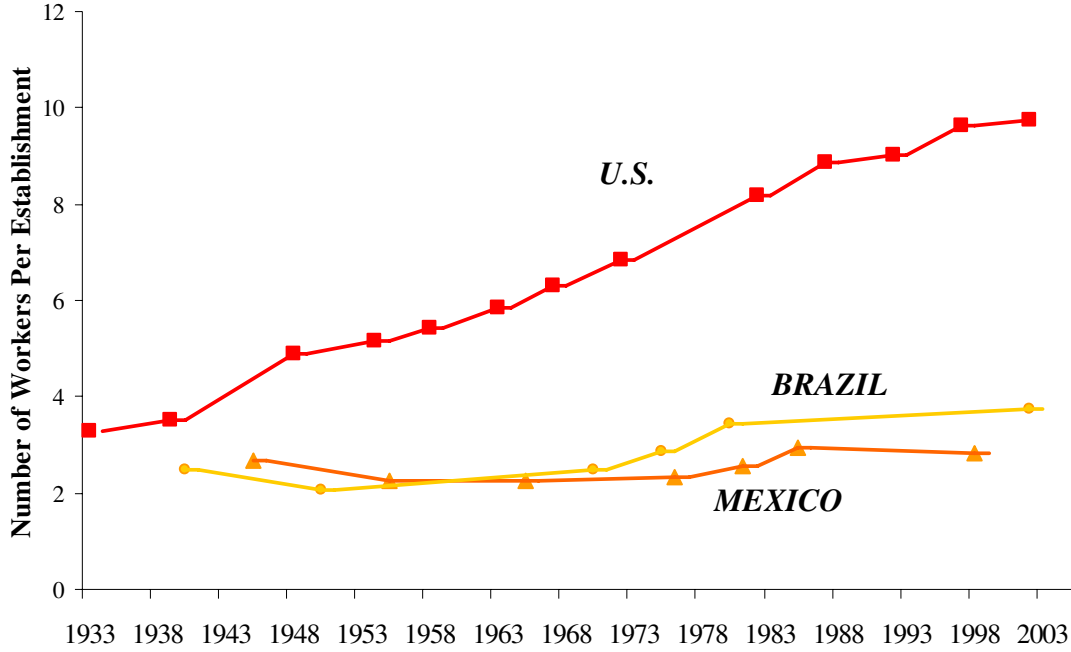


Figure 4: Average Retail Establishment Size, 1933 - 2003, U.S., Mexico and Brazil.

3 Model Economy

I now present a model economy that can be used to qualitatively and quantitatively address the facts presented.

3.1 Production

Time is discrete and runs from 0 to ∞ . In each period, production in the economy occurs in two sectors. The first sector, which I call *industry*, produces an intermediate good that it sells to the second sector: the *retail* sector. Firms operating in the retail sector finish the intermediate goods and sell it as a finished consumption good directly to the households. The production function for firms in industry is given by

$$X_t = Z_t L_t \quad (1)$$

where X_t is output of the intermediate good, Z_t is TFP in industry, and L_t is labor input. The industry TFP term evolves exogenously according to

$$Z_{t+1} = Z_t(1 + g_Z) \quad (2)$$

where g_Z is a known positive constant. The retail sector combines the intermediate good X_t with a retail service that retail stores themselves provide. Retail technology comes in two types: modern M and traditional T , each using just labor as an input. The retail production function is given by

$$Y_t^j = \min[X_t, E_t^j L_t] \quad (3)$$

where Y_t^j and E_t^j are output of final retail goods and production efficiency in a store with technology type $j \in \{M, T\}$, and L_t is labor input. The modern retail technology is more efficient at each point in time, and grows at a faster rate than efficiency of the traditional technology. Formally, retail TFP evolves according to

$$E_{t+1}^M = E_t^M(1 + g_M) \quad (4)$$

and

$$E_{t+1}^T = E_t^T(1 + g_T) \quad (5)$$

where $g_M > g_T$ and $E_0^M > E_0^T$. In a competitive environment, the Leontief assumption in retail production implies that the marginal cost to a retail store using technology $j \in \{M, T\}$ is

$$c_t^j = w_t \left(\frac{1}{Z_t} + \frac{1}{E_t^j} \right). \quad (6)$$

Although the modern technology has a lower marginal cost, we assume that it requires operation on a large scale in order to be used. Formally, the modern technology requires a fixed labor cost $\bar{L}$ in order to operate. The traditional store, in contrast, can be used at any desired scale. The motivation for this assumption comes from the idea that scale economies are crucial for the efficient operations of modern retailers, and that scale plays a relatively unimportant role for smaller stores.

3.2 Spatial Structure

The economy in each period is inhabited by measure one of households who are spaced evenly along the circumference of a circle (Salop, 1979). The circle circumference is normalized to 1. I depart from the standard circular city by explicitly modeling the household side, rather than just positing an inelastic demand for the consumption good. Households are required to transport themselves to a store in order to purchase the consumption good.

3.3 Retail Sector

Retail stores are operated by risk-neutral entrepreneurs who decide which type of store to operate, if any. There is unrestricted entry into the retail sector and hence retail stores earn zero profits in equilibrium. As is standard in the circular city literature, I assume that competition among stores takes the form of a two-stage game. In the first stage, entering stores are placed evenly along the edge of the circle. In the second stage, all stores choose prices and compete under Bertrand competition. More specifically, I assume that there is even spacing for any two modern stores, and even spacing for any two traditional stores. I make no assumption about spacing between traditional and modern stores, for reasons that will become clear shortly. The zero profit condition is that the number of stores of each type that enter in the first stage must yield zero profits for each store in stage two.

The results for traditional stores are easily characterized. Because traditional stores have no fixed operating costs, for zero profits it must be true that traditional stores choose a price p^T equal to their marginal cost c^T . Furthermore, entry must occur for traditional stores until the space between any two traditional stores is zero. If, in contrast, there were positive spacing between any two stores, then each could choose a price above marginal cost, still attracting a positive quantity of purchases, and thereby contradicting the zero-profit condition. So in equilibrium there must be a traditional store at each point along the circumference of the circle. The number of modern stores, N , adjusts such that in stage 2 each of the N stores earns zero profits. As is standard in this literature, for simplicity we allow N to take on non-integer values.

To solve the modern stores' problem, consider first the problem of a single modern entrant. For now assume that the modern entrant faces demand for its consumption good given by $q^M(x, p^M)$ where x is the distance to the store and p^M is the price the store chooses

to charge. In the next section we derive this demand from the household's preferences and constraints. The single store's profit maximization problem is given by

$$\tilde{\Pi} \equiv \max_{p^M} 2 \int_0^{1/2} (p^M - c^M) q^M(x, p^M) dx - w\bar{L} \quad (7)$$

where the marginal cost c^M is given by (6). Integration runs from 0 to $1/2$ because the maximal distance from the modern store is $1/2$. The integral is multiplied by 2 because households come from both sides of the store. Of course $q^M(x, p^M)$ could be zero for x sufficiently large; households sufficiently far away from the modern store may prefer to shop at their local traditional store. As long as $q^M(x, p^M)$ is decreasing in p^M for all x then there will be a unique profit-maximizing price. If the resulting $\tilde{\Pi}$ is positive then a positive number of modern stores will enter in the first place. Otherwise, no modern stores enter and traditional stores service the entire economy.

Now let us solve the case of multiple modern stores. To solve the stores' problem, we start with the second stage when the number of modern stores N has already been chosen. What remains is for each of the stores, which are placed evenly, to choose prices to maximize profits taking as given the other stores' prices. For simplicity I will look for a symmetric equilibrium in which modern each modern store charges the same price. Let $\bar{p}^M$ be the price that the other firms are charging, and let p^M be the price of the store whose price will be chosen. Let $\bar{x}(p^M, \bar{p}^M)$ be the maximum distance, given prices p^M and $\bar{p}^M$ from which households will arrive at the store charging p^M . This store's problem is given by

$$\Pi \equiv \max_{p^M} 2 \int_0^{\bar{x}(p^M, \bar{p}^M)} (p^M - c^M) q^M(x, p^M) dx - w\bar{L}. \quad (8)$$

With multiple modern stores, each store competes with traditional stores for the households at a distance less than $\bar{x}(p^M, \bar{p}^M)$, and with the neighboring modern stores for the households at the cutoff distance $\bar{x}(p^M, \bar{p}^M)$ away. Of course lowering price p^M increases this cutoff distance, which takes business away from competitor modern stores. In a symmetric equilibrium¹⁴, each store must choose a profit maximizing price of p^M when faced with competitors pricing at p^M . The number of entering modern stores N must satisfy the condition that optimized profits Π equal 0. Finally, the cutoff distance between any two modern stores $\bar{x}(p^M, p^M)$ must equal $\frac{1}{2N}$, which is half the distance between any two stores. We now turn to the household problem.

¹⁴The formal definition of a symmetric equilibrium is given later in this section.

3.4 Households

Each period t consists of an interval of time of length one. Throughout the paper I index periods by t and instants in time within a particular period by τ . For ease in exposition, I refer to each instant within a period as a *day*, and drop the t subscript. Each day households are endowed with a unit of time that they can spend working, shopping for consumption goods, or taking leisure. At the beginning of each period, the household must decide on an amount of time to spend working each day. One interpretation is that employment requires that the household commit in advance to a fixed work routine. The household also decides whether or not to purchase an automobile A for the duration of the period.¹⁵ Purchasing a car is a discrete choice: $A = 1$ denotes the purchase of a car, and $A = 0$ denotes going without a car. Cars are assumed to be exogenously available at a price p_t^A in period t . Households are heterogenous in the utility they derive from having an auto. The taste for cars is given by α , with α drawn from distribution $H(\alpha)$, with support on $\mathbb{R}^+$.

Each day the household is faced with a shock θ to her utility of the consumption good. Shocks are drawn independently across days and drawn from a known distribution $G(\theta)$ with support on $\mathbb{R}^+$. After the shock realizes, the household must decide how much to consume and where to buy the day's consumption goods. The utility of a household is given by:

$$U = \max \int_0^1 \theta_\tau \log(c^M(\theta_\tau) + c^T(\theta_\tau)) + \log(1 - s^M(\theta_\tau) - s^T(\theta_\tau) - n) d\tau + \alpha A \quad (9)$$

where $c^M(\theta_\tau)$ and $c^T(\theta_\tau)$ are consumption on day τ at M and T stores, $s^M(\theta_\tau)$ and $s^T(\theta_\tau)$ are shopping time at M and T stores, and n is the amount of time working each day. The term αA represents the direct utility gain from having a car. Shopping time is determined by the distance to the store and the time cost of traveling to the store. Formally, if the household is a distance (arc length) d^M from the modern store, the shopping time to the modern store is given by

$$s^M(\theta_\tau) = \tau(A)d^M \quad (10)$$

where $\tau(A)$ is the time needed per unit of distance along the circle. I assume that cars allow for faster transportation: $\tau(1) \equiv \tau_A < \tau_B = \tau(0)$.¹⁶ A similar expression holds for

¹⁵This can be thought of as purchasing one period's use of a car, if the length of a period differs from the useful life of a car.

¹⁶ A stands for "auto" and B for "bus."

$s^T(\theta_\tau)$. Notice that the shopping time is a fixed cost. This stands in contrast to the standard circular city or Hotelling model which feature a per-good transport cost. The per-unit transport cost is unsuitable here because it would imply, for example, that a household with 10 times as much consumption as his neighbor would spend 10 times as much time shopping, which is not an accurate description of shopping times for households. The fixed shopping cost, in contrast, posits that the major cost of shopping is the time spent traveling to the store.

3.5 Solution to Households' Problem

We now solve the problem of a household living at distance d^M to the nearest modern store, a distance of zero to the nearest traditional store¹⁷, having taste α_i for automobiles, facing prices p^M and p^T at traditional and modern stores, and given a wage w . Notice that, because both stores sell the same good, households always choose to shop at exactly one store at each instant in time. So if $c^M(\theta_\tau) > 0$ then $c^T(\theta_\tau) = 0$ and vice versa.

The first-order conditions for choice of how much to work and how much to shop are given by

$$\frac{\theta}{c^M(\theta)} = \lambda p^M \quad (11)$$

$$\frac{\theta}{c^T(\theta)} = \lambda p^T \quad (12)$$

and

$$E \left[\frac{1}{1 - n - s^T(\theta_\tau) - s^M(\theta_\tau)} \right] = \lambda w. \quad (13)$$

The labor supply first-order condition says that the expected marginal disutility of working must equal the expected marginal utility from consuming an extra unit. The modern-traditional shopping cutoffs $\bar{\theta}^A$ and $\bar{\theta}^B$ are given by the household being indifferent about shopping at the modern and traditional store:

$$\bar{\theta} \log(c^M(\bar{\theta})) + \log(1 - n - d^M \tau(A)) = \bar{\theta} \log(c^T(\bar{\theta})) + \log(1 - n). \quad (14)$$

Finally, the household must choose whether to buy a car or not. For the household simply evaluates utility (10) under $A = 0$ and $A = 1$ and the first-order conditions (11), (12), (13),

¹⁷Here we're using the fact that there must be a traditional store at each point along the circumference of the circle, implying that every household has a traditional store at distance 0 from its residence.

and (14), and picks the higher of the two.

The following proposition tells us how the household chooses upon realizing each shock θ_τ .

Proposition 1 Household Shopping Decision. *Given p_M , p_T and d^M there exist threshold shocks $\bar{\theta}^A$ and $\bar{\theta}^B$ such that if $A = 1$ and $\theta_\tau < \bar{\theta}^A$ then $c^T(\theta_\tau) > 0$, and if $\theta_\tau \geq \bar{\theta}^A$ then $c^M(\theta_\tau) > 0$. The same holds for $\bar{\theta}^B$ when $A = 0$.*

The proposition tells us that the choice of where to shop depends simply on how much the household plans to buy. When the household has a particularly high demand for goods, she plans to make a larger purchase, and hence the cost savings from shopping at the modern store outweigh the time cost of traveling across town. Similarly, when the household plans a smaller purchase (just a carton of milk, say), the overall cost savings from the modern store do not warrant the trip, and the close-by traditional store is preferable.

The threshold determines how much the household will spend over the course of the period at modern and traditional stores. It is useful to define the total fraction of a household's expenditure coming from modern stores.

Definition 1 Modern Expenditure Share. *Let $\mu^A(x) \in [0, 1]$ and $\mu^B(x) \in [0, 1]$ represent the fraction of total expenditure at modern stores for households with and without cars, at a distance x from the modern store.*

For simplicity I've put prices as an argument in $\mu^A(x)$ and $\mu^B(x)$, although clearly they are functions of prices as well, since they depend directly on the cutoffs $\bar{\theta}^A$ and $\bar{\theta}^B$. We can now characterize several intuitive yet important results about how the modern shares depend on distance away from the modern store and relative store prices, and the relative size of the shares themselves.

Proposition 2 Modern Shares, Distance and Prices. *$\mu^A(x)$ and $\mu^B(x)$ are decreasing in x and p^M/p^T . For all p_M , p_T and x , it is true that $\mu^A(x) < \mu^B(x)$*

This result is intuitive: households that live further from a modern store require a larger desired purchase size to justify their (longer) shopping trip, and hence shop less at modern stores. Similarly, the household will shop more at the modern store if the cost savings are larger. Finally, since auto-owning households have lower costs of travel, they are always more likely to shop at the modern store.

3.6 Symmetric Equilibrium

We can now define a symmetric equilibrium for this economy.

Definition 2 A *symmetric equilibrium* consists of retail store prices p^M and p^T , a raw-good price p^X , a wage w , a measure of modern stores N , and household decision rules A , n , $\bar{\theta}^A$, $\bar{\theta}^B$, $\{c_t^M(\theta)\}_\theta$, $\{c_t^T(\theta)\}_\theta$ such that

1. Each traditional store sets a price of $p^T = c^T$ and hence earns zero profits.
2. Each modern store takes prices at other modern stores to be p_M , and has a best-response price of p_M .
3. Each modern store earns zero profits.
4. The distance d^M to the nearest modern store is induced, for each household, by even spacing of modern firms.
5. Given prices, the household decision rules solve each household's problem.
6. Markets for intermediate goods and retail goods clear.

3.7 Prevalence of Modern Retailers

Figure 5 illustrates how modern expenditure shares depend on distance to modern stores in a symmetric equilibrium. M_1 and M_2 represent two of the N modern stores, located at a distance $1/N$ from each other. I denote the modern expenditure shares at M_1 by μ_1^A and μ_1^B , and the same for M_2 . Note that the share decreases with distance from the store for each type, and that auto-owning households spend more at modern stores at each point on the circle.

[TO BE COMPLETED]

4 Calibration & Quantitative Properties of Model

[TO BE COMPLETED]

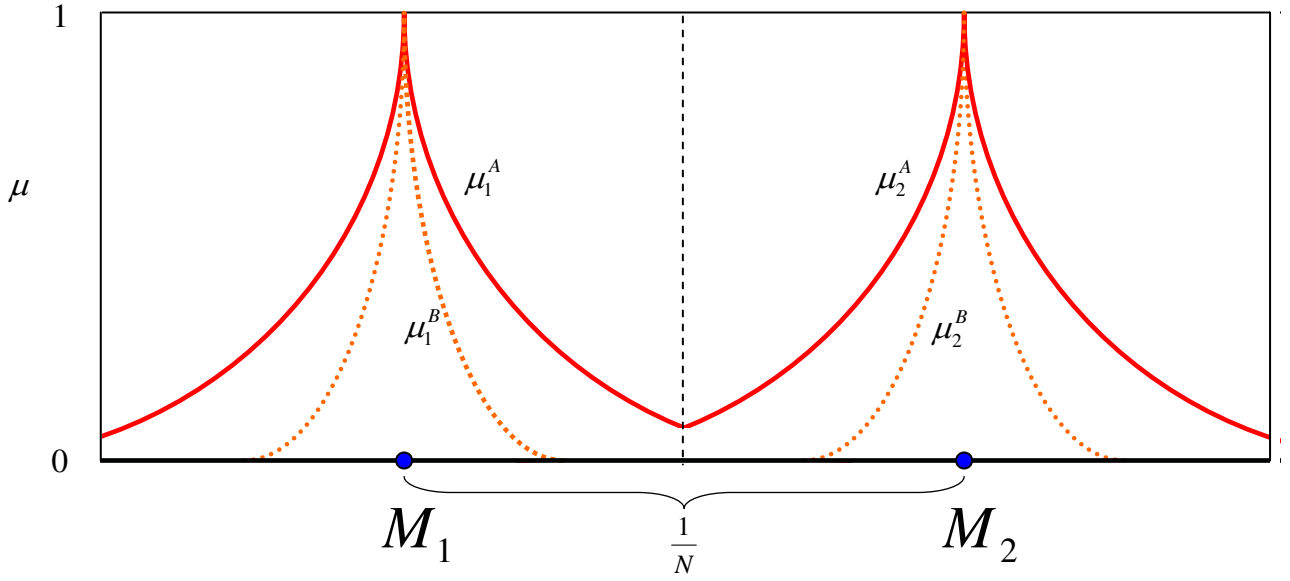


Figure 5: Expenditure Shares at Modern Stores in a Symmetric Equilibrium.

5 Policy Implications & Experiments

5.1 Bans on Used-Car Imports

The quantitative results presented so far suggest that low auto ownership rates are a major factor in the limited presence of modern retailers in Mexico. An important question is whether there are any ways policy makers might affect car ownership rates in poor countries. In fact, one policy that a large number of developing countries share is restrictions on the imports of used cars. These range from outright bans, to prohibitive tariffs, to restrictions on the age of the used vehicle that can be imported. Pelletiere and Reinert (2002) document the extent of restrictions in a large number of developed and developing countries, and find that used car restrictions are widespread and often severe. In 19 of the developing countries studied there are complete prohibitions of used-car imports. In another 27 countries there were other "substantial restrictions" of various kinds.¹⁸ In future work I will attempt to gauge the effect of used-car import bans on car ownership rates, and use my model to compute the corresponding productivity losses in retailing from the bans.

¹⁸Complete bans as of 1999 are reported in Argentina, Algeria, Brazil, Chile, China, Columbia, Ecuador, Egypt, India, Indonesia, Mexico, Pakistan, Paraguay, Philipines, South Korea, Thailand, Turkey, Uruguay, Vietnam.

How much of a rise in car ownership might we expect from the reversal of these policies? In 1950, per capita income in the US was roughly equal to Mexican per-capita income today. Car ownership today is 33% in Mexico. In 1950 in the US, car ownership was around 50%. So plausibly, some combination of allowing used-car imports and better infrastructure could lead to a rise from 33% to 50% in car ownership in Mexico. As a first pass, I plan to use these figures in my quantitative policy analysis.

[TO BE COMPLETED]

6 Alternative Hypotheses

I now discuss a number of alternate hypotheses about why modern stores have such a limited presence in poor countries.

Refrigerators

The advent and dispersion of refrigerators is also likely to have increased the diffusion of modern stores in the United States in the latter half of the 20th century. Fridges allow for larger but less frequent shopping trips, which increases the appeal of lower-priced modern retail stores. In poor countries, fridge ownership rates, like car ownership rates, are also much lower than in the U.S. Are fridges also a limiting factor in the diffusion of modern stores? Qualitatively they most likely are, although perhaps not of first-order importance in a quantitative sense. According to Census micro data from the 2000, fridge ownership rates are around 70% of households in Mexico and 83% of households in Brazil. Given that fridges are so widely owned, the quantitative importance of fridges is likely to be small.

Tax evasion by small stores

When it comes to avoiding taxes and labor regulations, small retail stores have a clear advantage over larger stores, since tax authorities will be less inclined to inquire into missing tax payments for smaller establishments. In poor countries, where tax enforcement is frequently lax, small stores gain a cost advantage over larger stores by evading taxes and costly labor laws. The McKinsey studies conjecture that tax evasion by smaller stores is the single largest factor.

While tax evasion probably does offer a cost savings to smaller stores, there is reason to believe that tax evasion alone is likely to explain the bulk of retail store composition differences. Brazilian taxes and regulations are considerably more burdensome than those of Mexico, and hence traditional retailers in Brazil should gain a relatively larger cost advantage than those in Mexico. For example Brazil has a large value added tax on food retail goods, while Mexico does not. However we see virtually no difference in the prevalence of modern stores in the two countries. Nevertheless, future research into the importance of tax evasion on the size distribution of establishments in general seems warranted.

Transportation infrastructure

One clear difference between the US and the developing world is the strong system of highways and local roads in the US. Most poor countries have much less in the way of transportation infrastructure. Few or poor quality roads is likely not only to reduce the cost of operation for a large retailer, but to increase the desirability of owning a car for households. This paper argues that the second effect is likely to be important, as well as the first.

Economies of Density

As Holmes (2007) demonstrates, economies of density have been an important factor in the rise of Wal-Mart in the U.S. The ability to locate stores in close proximity to one another has allowed Wal-Mart to economize on shipping, advertising, personnel, and other costs. Unlike the U.S., though, this paper argues that Mexico and other developing countries have few geographic locations that can support such a large store. In this case retail chains in poor countries will be less able to utilize economies of density to decrease their overall costs. A developing-country retail chain would be forced, unlike Wal-Mart in the U.S., to locate stores a great distance from one another, limiting the cost savings from density. Exploring this idea in more detail seems like a promising line of future research.

7 Conclusions

In this paper I argue that retail productivity is low in poor countries primarily due to a very limited presence of modern retail stores. I advance the hypothesis that modern retail stores are uncommon in the developing world because income per square mile and

car ownership rates are low, rendering modern retail stores largely unviable. Under this view, the demand side determines which technologies are adopted. This stands in contrast to other papers in the literature on TFP differences and technology adoption that focus on the production side. The policy implications of demand-induced technology adoption differ drastically from those of the production-side. For example policies that limit automobile ownership rates, which are common in poor countries, serve to limit the adoption of modern retailers. Future work will assess the quantitative effects of the demand-induced technology adoption hypothesis in retailing.

A Data Appendix

A.1 McKinsey Productivity Studies

The studies I employ are Brazil (1995), Mexico (2003) and Russia (1996) (for food retailing), India (1997), and especially Poland (1999a), Thailand (1999b), and Turkey (2001) (for overall retailing). The complete set of reports can be found at www.mckinsey.com/mgi/rp/CSPProductivity/.

To the extent possible, McKinsey follows the US Bureau of Economic Analysis (BEA) in their methods for measuring retail sector value added. For example, when establishment-level measures of purchased intermediates are not available, McKinsey uses the BEA's methodology for estimating gross margins at the establishment level. Of course McKinsey's measures are not perfect; for instance they do not subtract purchased electricity intermediates from value added measures. Nevertheless, other major intermediate inputs are excluded, and McKinsey's estimates are likely to be as reliable as other major output measures for service industries. Finally, in all countries studied, value added is measured in local currency units and then adjusted for purchasing power parity (PPP) to allow direct comparisons to the US.

A.2 Census Micro Data & Geographic Data

For a number of calculations, including car ownership rates, I make use of Census micro data from 2000 for the U.S., Brazil and Mexico. I obtain this data via the Minnesota Population Center's International Public-Use Micro Data (I-IPUMS). I supplement this data with additional data from the U.S. Census Bureau, the Mexican *Instituto Nacional de Estadística, Geografía e Informática* (INEGI), and the Brazilian *Instituto Brasileiro de Geografia e Estatística* (IBGE). These statistical agencies are considered the premier sources of demographic and economic data in their respective countries. All data is publicly available at www.census.gov, www.inegi.gob.mx/inegi/default.aspx and www.ibge.gov.br/home/.

Throughout the study I use the term "county" in Mexico and Brazil to mean *município*, the geographic equivalent to a county. For Mexico, data on county population, income, and area comes from INEGI and CONAPO.

A.3 Official Retail Trade Data

United States

For the years from 1933 through 1967 the census of retail establishments was conducted as part of the Census of Business, which occurred roughly every 5 years but at irregular intervals. In 1972 the Census of Retail Trade was split off from the Census of Business, and conducted every 5 years. The time series of average retail establishment sizes used to construct Fact 4 use the Census of Business through 1967 and the Census of Retail Trade through 2002. The employment shares in large and small retail establishments

Through 1967 the Census of Business provides data on the number of establishments with and without payroll, and on the number of paid employees and active proprietors by size class of establishment. In subsequent years, only data on establishments with payroll and paid employees are available. In order to maintain comparability with the Mexican and Brazilian retail censuses, which contain data on the sum of unpaid proprietors and paid employees, for 1972 and later I impute the number of unpaid proprietors in the U.S. by size category of establishment. To do this, I multiply the average number of proprietors per establishment in each size category in the data pre 1972 by the number of establishments in each size category for each year post 1972. I also include establishments without payroll in my measure of U.S. establishments to maintain comparability with Brazil and Mexico. To maintain consistency across years in the U.S., I impute the number of establishments without payroll from the years 1987 and on, due to a change in the way non-payroll establishments are counted starting in 1987. One noticeable result of my inclusion of establishments without payroll in the U.S. is that my computed average establishment size is lower than other previous studies, in particular that of Jarmin, Klimek and Miranda (2005), who include only establishments with payroll.

For the geographic comparisons of retail store locations used in Fact 3, I use county-level County Business Patterns (CBP) data for 2004 on the size distribution of establishments. While CBP data contains only establishment with payroll, which makes it fundamentally different from the Mexican data to which I compare it, in practice the fraction of personnel associated at establishments in CBP without payroll is quite small.

Mexico

The main official source of data on the retail sector in Mexico is the *Censo Comercial* which has been conducted roughly every 5 years from 1956 to 2004. The data is available

from INEGI. I make use of county-level data from 1999, which is available for purchase from INEGI.

Brazil

Time series and county-level data on retail establishments comes from the Brazilian *Censo Comercial*, conducted at irregular intervals from 1970 through 2002, and earlier from the *Censos Comercial e Dos Serviços* for 1940, 1950 and 1960. I use county-level data from 2002, which is available for purchase from IBGE.

A.4 Retail Chain Store Location Data

My sources for the store location data for the largest chains is as follows. The Wal-Mart data comes from Emek Basker's Wal-Mart database. I use all stores present in the latest year in her database, namely 2001. For Home Depot, Target, Gigante, Wal-Mart Mexico, and Comercial Mexicana, I collected the locations of each store from the stores' web sites in the fall of 2006. For each store I use the zip code to map the store into one particular county, which is possible since every U.S. and Mexican zip code lie exclusively within one county. I acquired the mapping from zip codes to counties for the U.S. and Mexico from *Zip-codes.com* and *Estafeta Mexicana*, which are commercial firms. I end up with a total of 5,605 stores for the US, and 857 for Mexico.

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