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A New Shopping Experience

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I. INTRODUCTION

Computer age technology has become an integral part of the supermarket industry. Innovations such as central meat processing, warehouse automation, and Universal Price Code scanning are becoming common aspects of our supermarket trip. Although the corner grocery store may not show signs of new technology, surely the huge supermarket down the road cannot hide that it is a product of the computer age. The trend toward computer age technology is certainly more apparent in larger stores. Also, larger stores have themselves become a trend. It is not obvious whether advanced technology has spurred the growth of supermarkets, or whether the increasing size of supermarkets has initiated new innovations. Either way, the growing size of supermarkets has been accompanied by new technology.

For instance, the recent integration of scanning into supermarkets is making a notable impact on the industry. The numerous benefits derived from scanning can be applied to a store of any size. Nevertheless, the costs of scanning must be at least compensated for by the savings in a reasonable amount of time. At what sales volume do the costs of scanning convert into savings? Are larger stores more cost efficient? Is there a cost difference due to the use of scanners between independents and chains? What do the answers to these questions imply for the future of the supermarket industry? This paper pursues possible answers for these questions.

In the second section, I will explore the history of technological advancements in the supermarket industry, for the history of change in the supermarket industry offers clues about the future. Then, I will construct my model and discuss my data. Subsequently, I will report the results to support the hypothesis that technology is making a significant impact in the supermarket today. Further, conclusions will be drawn to explain the empirical test results. And finally, interesting topics for future research will be suggested.

II. HISTORY

The grocery business is in a constant state of change. Even before the supermarket was called a grocery store, it was called the general store. The general store provided all the basic necessities during the era of the cracker barrel and potbellied stove. Stocked with hardware, leather harnesses, clothing, and staple foods, the general store is thought to be the ancestor of the modern supermarket. Many items were stored bulk in barrels or kept in containers behind the counter from which the grocer would serve his customers. Personal attention and service, barter, and customer credit embodied the tradition of the general store.

These same traditions were carried forward by the more specialized grocery stores and meat markets. This specialization was made possible by increased demand through increased population and urbanization. The increased specialization in food items set these new markets apart from the general store. Nevertheless, personal attention remained prevalent in these stores.

About 1912, a few southern California food retailers began referring to their stores as "self-service". Made possible by innovative packaging techniques, the self-serve concept was the most significant advancement leading to the modern supermarket. The official introduction to self-service was at the now famous Piggly Wiggly store of Clarence Saunders in Memphis in 1916.[1] However,it was in the West, with its favorable climate, mobility by automobile, low land prices, and "pioneer spirit", that the idea took hold. By 1920, self-service had been established as an improved means of food retailing, appealing both to customers and to proprietors as well, and its acceptance was the first step in increasing productivity through a labor-saving technique.[2]

An interesting concept surfaced in 1919, when Henry Ford opened the first of many Ford Commissary Stores. These stores were constructed mainly to serve Ford Motor employees but were open to the public as well. The distinguishing characteristics of these outlets were their large volume, wide product assortment, private labels, and an order picking and assembly system similar to mass production which provided for grocery prices up to thirty percent lower than Detroit area retailers. Large numbers of the grocery industry responded by threatening to boycott Ford vehicles, which led Ford to close his stores in 1927. This specific format never reappeared, and large volume supermarkets did not gain popularity until the 1930's.[3]

Technological advance in supermarkets was influenced by the emergence of national markets. For example, ever since the end of the Civil War, the railroads were expanding across the United States. By rail, consumers were offered a variety of products from all over the nation instead of only from local suppliers and producers. This was beneficial to the consumer except for the high information costs involved. However, a major breakthrough occurred when a set of authenticating institutions developed. These institutions staked their reputation on reducing risks to the consumer by guaranteeing that any new brand or new product that they put on the market met a given standard. Hence, the creation of brand names, such as Singer Sewing Machines. Soon to follow, was the department store, like Marshall Field's and Montgomery Ward, with established common quality, conditions of credit, and delivery of goods sold under their roof.[4]

Many of today's largest chains or their predecessors were formed during the end of the 19th century.[5] The Great Atlantic and Pacific Tea Company was the first food chain in America. Originally, George Huntington Hartford and George F. Gilman bought imported tea by the shipload to sell at discount prices. By 1850, A & P had generated enough business to justify opening retail outlets in New York City.

A line of groceries had been added by 1865, and the chain included twenty-five stores. In 1880, A & P celebrated its 100th grand opening. In 1872, another early food chain started was the Jones Brothers Tea Company, later to be named the Grand Union Company. The Grand Union is one of the largest retail grocery companies today. Still even before the turn of the century, B.H. Kroger formed the Great Western Tea Company. Today, the firm carries the Kroger Company title and is the second largest food chain in the country.[6]

Chain stores applied the brand name concept to retailing also by assuring customers of reliability through their size and regional or national reputation. Although the format of the individual retail grocery store remained unchanged through the period 1910-1920, there was a high rate of growth in chain organizations.

Chains had many advantages over independent retailers. Centralized administrative control and vertical integration with wholesaling and manufacturing operations reorganized the entire supply system and resulted in major cost savings for them. In some cases, chains controlled suppliers by placing huge bulk orders, which resulted in sizeable discounts. Other suppliers refused to grant discounts to chains in order to maintain favorable relations with their independent customers. Even without the price break, chains could save on costs through efficient distribution networks and by centralizing inventories.

At times, customers found the chain stores less friendly than their neighborhood stores. A & P, for example, opened "economy" grocery stores that operated on a strictly "cash and carry" basis. Although this policy saved the customers money indirectly through lower product prices, consumers were used to having delivery and credit services available to them.[7] Nevertheless, improved communication and transportation greatly aided the chain movement, and the competitive advantage of chains over nonintegrated independents led to an increasing number of chains. In 1910, there were 2000 chain stores. Astonishingly, by 1930, this figure had increased to 80,000, and chains were conducting one-third of the nation's retail food business.[8]

Along with the rise in chains came the growth of cooperative and voluntary wholesalers. A cooperative retail chain is an organization which functions as a wholesaler, advertises, or conducts other functions cooperatively. These not-for-profit organizations are run for the benefit of the retail outlet owners, thereby providing a form of horizontal and retail integration.

Similarly, the voluntary retail chain is a group of independent retailers associated with a wholesaler for buying, advertising, and other production functions. In contrast to a cooperative, however, voluntary chains operate for profit, but are still founded on the mutual benefits received by functioning in an integrated manner.[9] Although independents are increasing affiliation in order to achieve some of the advantages of the integrated operation of chains, they are still most likely at a cost disadvantage. This is because independent affiliation is voluntary , the affiliates do not act as a whole unit, and therefore, there is no central management team with authority over the members, as there is in a chain, to assure complete vertical integration. For example, the buying manager at Jewel's headquarters may work out a price break with Coke. All Jewels, then, are told that Coke will be this week's sales item, and by following directions, each Jewel partakes in the sale. In contrast, at Certified Grocers, a cooperative, the buying manager may work out the same deal with Coke, but, in this case, not all members of the cooperative may take advantage of the deal and there is no control over whether the members will put Coke on sale this week. Also, there are a number of independents who are not affiliated in any way and therefore, are not vertically integrated at all.

Another interesting concept was developed during the 1920's--the combination store. This was not the combination store of today, which is defined as a food and drug store in the same retail unit. The combination at that time joined fresh meats, fresh fruits and vegetables, dairy products, and dry groceries together under one roof. Store size doubled as the industry took advantage of improvements in communication, transportation, and refrigeration.[10]

The origin of the word "supermarket" is obscure, but the word's first appearance is associated with Alber's Super Markets, Incorporated, which were operated in Cincinnati beginning in November, 1933.[11] However, another source claims that the first supermarket opened in August, 1930, under the name of King Kullen Grocery Company, under the direction of Michael Cullen, which grew to fifteen stores in its first six years.[12] Cullen's fame stemmed from his creative invention in 1937 of a "folding basket carrier" to haul groceries about the store. His innovation evolved into the shopping cart of today. It is easy to see that the supermarket of today has undergone many transformations in order to reach its current state.

With a strong, expanding American economy, the supermarket industry grew both in numbers of stores and in the size of individual stores. Whereas in 1932 there existed 300 supermarkets, by 1958 29,920 supermarkets existed, and today, 152,000 chains, independents, and convenience stores are in existence.[13] The once dominant conventional format of supermarkets has adapted to accommodate the changing needs of modern society. With a greater number of working women and rising food costs, supermarkets have become larger, more efficient and more accessible during evenings and weekends.

Convenience stores cater to rushed workers. Combination food and drug stores, superwarehouses, and now hypermarkets, all compete for the busy, one-stop shopper. Warehouse or "box" stores attract the price conscious.

From an industry which once flourished due to an ever-increasing rate of population growth, retail food outlets now face a different marketplace. Slowed population growth due to rising costs and working mothers combined with an increased average sales per store have forced stores to find their niche in the market in order to compete for sales.

During the inflationary bind on consumers during the late 1970's, stores drove prices down in order to gain market share. A slimmer profit margin provided motivation for the development of cost-saving techniques such as central meat processing, warehouse automation, and Universal Price Code (UPC) scanning.

Throughout the 1980's, technology has embraced the supermarket and has turned consumers' shopping trips into a kind of experience different from what it used to be. In order to survive in America's fast-paced, highly competitive marketplace, supermarkets must do everything well, not just a few things. As Business Week puts it, "There are two kinds of supermarkets: the quick and the dead."[14] Now, the rewards go the innovators, the risk-takers, while trouble befalls those companies that lag behind.

Companies must meet the demands of the one-stop shoppers. Everything from motor oil to videocassettes to carry-out food to film processing are being offered through the single retail outlet of the supermarket. These superstores accounted for 14% of the nation's supermarkets in 1986, whereas in 1980, only 9% of supermarkets carried the extensive variety found in today's superstores or hypermarkets.[15]

Hypermarkets, which cover more than 100,000 square feet, sell everything from lawnmowers to computers. One of the first giant stores in the U.S., Bigg's in Cincinnati, was the brainchild of Super Valu Stores in Minneapolis--- Lazard Fieres, and Euromarche--- a chain of hypermarkets throughout France, where the name originated. The store generates about $2 million in weekly sales of approximately 70,000 items. In contrast, the average supermarket carries about 15,000 items and rings up $175,000 weekly.[16]

Chains are becoming privy to the key to success for many independents---service and locality. Combining large size with service, Ralphs Grocery Company of Cincinnati will be opening fourteen-100,000 square foot Ralphs Giant stores in Southern California. Although items will be displayed in shipping boxes and customers will bag their own groceries, Ralphs will still be offering a number of full-service departments. Bakeries, delicatessens, and fish counters will be part of the shopping route. Also, independent retailers will sublease space near the checkout lanes to sell frozen yogurt, cookies, and costume jewelry. In addition, Ralphs will cater to the ethnicity of the area they service. In localities with large Mexican populations, stores will provide freshly made tortillas and popular Mexican brands of food. Other stores may offer large Vietnamese or Japanese sections.[17] Hence, chains are striving to put some personality back into the shopping trip while maintaining the advantages of shopping at a large store.

Because convenience is attracting more and more

Because convenience is attracting more and more customers, the big chains are also being innovative with services. For example, Safeway, as well as many other chains, are keeping a majority of their stores open around the clock.[18] Yet another service innovation is the debit machine which would reduce cash purchases and bank transaction costs.[19] In the New England region, Hannaford Brothers uses talking computers to tell shoppers where to locate a certain item.[20] Further, in order to compete with the fast-food industry, which eats into supermarket sales, retailers are also offering a variety of take-out foods, salad bars, and hot and cold delicatessens. Also, convenient precooked meats are outselling raw meats by wide margins in some stores. For example, Kroger offers a line of over thirty-five precooked meats that can be heated up in the microwave in minutes.[21] The success of the counterattack against fast-food competition can be seen in the fact that 1986 was the first year since 1980 that supermarket sales increases of 2.7% were more than double the increases of 1.3%in the fast-food industry.[22]

An innovative, yet unproven technology, termed electronic retailing, can provide convenience to shoppers by turning a supermarket into a hypermarket without the costs. Professor Robert L. Miller, came up with the idea of creating a free-standing computer, called a kiosk, that would do the duty of a portable catalog showroom, selling hardgoods at discounts of 20% to 40%. Rini Supermarkets, a member of

Stop-n-Shop, bought kiosks to place near their high-traffic bakery departments. They found that the kiosks brought people in because they broadened what the store had to offer. Rini Supermarkets receives 5% of the gross sales per unit, which could pay for the $5000 machine in a year or less.[23]

Even at the distribution level, technology is demonstrating its worth. If a shopper drinks a sour sip of milk, he will demand a refund---or worse, switch stores. Annual spoilage losses can cost the retail grocer up to 15% to 20% of the value of perishables like dairy and fish products.[24] A retailer who could solve the spoilage problem would clearly have a competitive edge. Now, a system created by firms such as LifeLines Technology and I-Point Technologies, Ltd. claims to have resolved the problem. A time/temperature monitor system keeps watch continuously on the remaining shelf-life of perishables all the way throughout the distribution chain. "Current open-dating practices and spot temperature checks...are inadequate because they fail to take into account fluctuations in temperature that invariably occur in distribution," says Robert Rose of I-Point.[25] Although currently a very expensive proposition, temperature monitoring may be a growing market due to the competitive edge it can give to retailers in satisfying consumers' increasing demands for freshness. Eventually, it may become more costly not to take advantage of the monitors than to use them.

In the next decade, it is possible that debit machines will become as common as checks. Or perhaps someday all warehouses will consider spoilage monitors to be a given. Whether or not these advancements are made remains to be seen.. However, technology is now making its presence known at the checkout counters, in the warehouse, and on every shelf in the supermarket through the phenomena of scanning. Scanners are those computerized checkout machines that read the bar code on the can of soup or on the box of cereal. More than half of America's supermarkets are equipped with scanners, and at least one out of four uses a central computer system to help operate the business. Interestingly, according to Supermarket News, on the average, 51% of chain-store operated supermarkets have scanning, while only 40% of independently operated stores use scanning.

Although scanning is sometimes viewed as common today, it is a very recent innovation. While scanning actually hit the market in 1978, the technology did not take hold until about 1983. Additionally, it was not until a year or two ago that the myriad of information retrievable with scanning began to be processed and used to make a supermarket more efficient.

In 1978, the implementation of scanning could partially be called the result of cost-push inflation and increased competition. Due to the oil embargo of OPEC nations in the early seventies, almost all prices in general began to rise. With the increased squeeze on the dollar, workers demanded higher salaries which spilled over into rising supply prices, and cost-push inflation. The combination of higher wages and slowed population growth made competition increasingly tight. Management could not cut back too far on the quality of their merchandise, but they were forced to take all measures to reduce costs in order to retain market share and to compete for the customers' decreased purchasing power. In some stores, service became the object of cost reduction. Thus, the emergence of the "box" stores such as Pick N' Save and Aldi. Customer reactions were weak, and it took many adjustments and a significant cost savings before the customer could accept taking product directly from cardboard boxes and bagging his/her own groceries.

Other stores tried central meat processing, or "boxed beef", because the beef is pre-cut and pre-processed. These features helped to cut down on expensive unionized meat cutters. Personal produce weighing began to phase out as labor costs continued to rise over the capital costs of installing scales at the front-end registers. All of these labor-saving methods were helpful in cutting costs, but by the early eighties, with double-digit interest rates, a revolution needed to occur---thus, the birth of scanning.

Initially, scanning resulted in labor savings and then mushroomed into a variety of cost reductions in other areas. The most obvious benefit of scanners came at the checkout counter. Only a crackerjack cashier could compete on an electronic register with the twenty-five to thirty items per minute which can be processed using scanners. On the other hand, an average cashier falls substantially short, only being able to check between twelve and fifteen items per minute.[26] In addition to the quicker checking rate, scanning reduces training time and subsequently reduces training costs due to the easy operation of scanners. An even greater possibility for labor savings, though, is the reduced time that stockers spend pricing goods or changing prices. Through the bar code pricing system, prices are not marked on each individual item but are programmed into a main computer. Customers are informed of prices by display signs or shelf tags. On the front end, costs are further reduced.

From the time that scanning was first implemented in 1978 until about 1986, labor savings were the only way in which stores took advantage of scanning. The mounds of detailed information made available through scanning only seemed to be a useless by-product of the scanning process. However, due to increasingly tough competition within the last two years, management has begun to study, analyze, and manipulate the information that has been available to them all along. Today, scanning's benefits have far outreached its initial expectations as scanning data are used for inventory control, shelf space allocation, and product choice.[27]

The scanning process in a complete distribution chain can reduce costs both at the retail level and at the wholesale level. Here, the chain network can best utilize all phases of the scanning process. First, raw data are transmitted from stores and warehouses to a mainframe computer, usually located at either a chain's headquarters or at a cooperative's base. The data include sales records from checkout stands, data on product delivery schedules, employee work schedules, energy use, and the length of time products remain in warehouses before being shipped out to stores. Then, the numbers are tallied, crunched, and separated in order to aid in decision making on which products to carry, how and where to display them, and how to make their storage and delivery more efficient. For example, headquarters can determine which brands of pickles make the most money and then cut back on the least profitable or unprofitable brands. The computer can be used to make estimates in determining how profitable a new brand of pickles might be. The numbers might also suggest that products would be more efficiently delivered directly to the stores than passed through the central warehouse first. Once headquarters draws conclusions based on the numbers, it sends its recommendations back to the store and to warehouse managers. These instructions, sometimes called "Plan-a-Grams", include detailed layout of every shelf, showing the store manager where to position the up to 17,000 items carried by supermarkets. These plans sometimes even include the pricing of the goods.[28]

The combination of scanning and a type of analysis, which utilizes individual product profit calculations, called direct product profitability (DPP) has opened the eyes of many retailers. The concept of DPP was born in the 1960's, but it was not until the 1980's that the cost of the mainframe computer fell enough to allow the concept to catch on. DPP analysis can identify which items are reducing profit and offers clues on how to aid the situation. At times, the results are surprising. For example, house brands turn out to be a drag on profits when compared with faster-moving, better advertised name brands. Also, paper products with their bulkiness and low price are poor performers. Although stores must sell toilet paper, DPP analysis suggests limiting the variety of brands and avoiding expensive advertising campaigns for these items.[29]

Along with the losers, there are some unexpected winners that arise from DPP analysis. The freezer section is surprisingly a big profit boost. Once considered too costly due to high energy prices, frozen goods actually outdo the average grocery item two to one because of their high markups.[30] Products delivered directly to the store such as soft drinks, snack items, and magazines bring in higher profits than previously suspected because store employees are not used to stock them.[31]

With the possession of all this scanning data, stores can be of great use to manufacturers. The numbers generated through scanning can be sold to manufacturers, or manufacturers can pay to test their new packaging ideas or products using scanning data. Further, through the use of specialized check cashing cards issued to voluntary customers, data can be retrieved about the local market preferences, or about the type of products that are bought together. The number of uses for scanning data far exceeds those listed above. In short, the utilization of scanning data results in cost reductions that easily surpass initial estimates.

In some cases, it appears that scanning has now become a necessity. For example, in the Northeast, unemployment figures are at their lowest in years. Employers struggle to find employees to work in supermarkets for a wage that would keep the stores competitive. In Boston, specifically, the unemployment level is approximately 3%, which is below a normal level of unemployment. The going wage for a supermarket worker in the region is between $12 to $20 per hour. Stores, such as Stew Leonard's in Stamford, Connecticut, have to bus people in from lower income areas in order for their stores to function properly. Therefore, it is evident that any labor saving device in stores with such high labor costs is welcome.[32]

III. THE MODEL

It seems evident that the use of scanning can result in labor savings, as well as some further saving. However, are these cost savings significant? Furthermore, does the fact that a greater percentage of chain stores than independents use scanning suggest that chain operations are better organized to take advantage of the cost savings of scanning use? I hypothesize that use of scanning does in fact produce significant cost savings over non-scanning stores, and that chains experience a significant cost advantage over independents. My hypothesis also claims that larger stores do experience lower average costs than smaller stores.

In order to test my hypothesis, I began by estimating two cost curves. The first cost curve, TC1, represented the costs for a traditional supermarket, (equipped only with electronic registers), and the second cost estimation, TC2, represented the costs for a scanning store. Both cost curves were estimated using three measures of cost in a supermarket--inventory cost, labor cost, and capital cost. The general equation is:

(1) TC = inventory cost + labor cost + capital cost

If there is a significant cost advantage to scanning, the total costs for a scanner store will be significantly lower than the total for a non-scanner store. If independents experience a cost disadvantage, then the total costs for the independents will be significantly higher than chains' costs. If larger stores are more cost efficient, then the average costs of the smaller stores will be higher than those of the larger stores.

The costs were estimated with data for independents and chains, each grouped by five different sales levels. (See Appendix A)

The first variable, inventory costs, is the average value of inventory holdings at the different sales levels multiplied by the cost of holding that inventory. These figures were taken from the trade magazine, Supermarket News. Inventories are assumed to be constant between scanning and non-scanning stores because the data did not differentiate between inventory holdings for scanning and non-scanning stores. The most risk-free rate of return, the rate on a three-month Treasury bill was used as a proxy for the opportunity cost of holding inventory. The T-bill rate corresponding to the timeliness of the data from the Federal Reserve Bulletin was 8.5%. Therefore, the inventory cost is:

(2) inventory cost = (inventory value)(.085)

Furthermore, the labor cost variable was also assumed to be constant between scanning and non-scanning stores. The number of full-time equivalents at each sales level were multiplied by the average wage of supermarket employees at the time, or $7.36 per hour. A full-time equivalent, in this case, is equal to one full-time employee or two part-time employees. The data on the number of full-time equivalents was provided by Supermarket News, while the average wage estimate came from Standard and Poor's Industry Surveys. To annualize the wage, the numbers of hours in a full-time week, 40, times the number of weeks per year, 52, were added. Thus, the equation for the labor cost is:

(3) labor cost = (# of full-time equivalents) ($7.36) (40) (52)

For the final variables in the total cost equation, the construction is a bit more complex. The same inventory costs and wage costs were used for both the traditional and the scanning stores. But to distinguish the difference in capital costs between traditional check out stores and scanner stores, I estimated two total cost curves, TC1 and TC2. When estimating the capital costs, I assumed that in the TC1 equation, all the stores were using the traditional registers, while in the TC2 equation, I assumed that all stores were equipped with scanners. I also assumed that the number of checklanes did not vary between scanning and non-scanning stores. Again, the data on the average number of checklanes in each sales category for both independents and chains was extracted from Supermarket News.

In order to generate cost data for scanners, I created a questionnaire and sent it out to twenty scanning manufacturers. (See Appendix B) I received completed surveys from five firms. As a followup, I phoned one of the responders. He provided me with the data on per register costs for both scanning and electronic registers. Also, he gave me the estimated life for both types of registers and the estimated cost savings due to scanning.

First, consider the cost of a traditional electronic register, $4000 per checklane. Then, this figure multiplied by the average number of checklanes for each sales level produces the total capital cost. In order to annualize this cost, the total cost must be divided by the average life of the equipment. Stores generally tend to remodel in ten year cycles which would be when they would modernize their registers. Due to this remodeling cycle, ten years was used as the average life span . To achieve an annualized traditional register cost, the average total register cost is divided by ten years. The traditional register cost variable, capital cost 1, was constructed with the equation:

(4) capital cost 1 = ($4000)(# of checklanes)/(10)

Combining the three formulas for inventory cost, labor cost, and capital cost, the total cost equation for a traditional supermarket, TC1, is:

(5) TC1 = (.085)(inventory value) + (# of full-time equivalents)($7.36)(40)(52) + ($4000)(# of checklanes)/(10)

Now, by dividing both sides by total sales, an average cost figure, AC1, can be derived.

(6) AC1 = [(.085)(inventory value) + (# of full-time equivalents) ($7.36)(40)(52) + ($4000)(# of checklanes)/(10)]/total sales

Consider next the cost of scanners. There are two different kinds of scanners---the hand-held wand scanner and the counter-mounted or slot scanner. The hand-held wand scanner is mainly used in stores which have a smaller number of items per transaction such as a clothing store. Conversely, the counter-mounted scanner is best utilized in stores with a high number of items per transaction, like a supermarket. Thus, I used the cost of a counter-mounted version. The per checklane cost of a scanner with all the capabilities of creating the information discussed earlier is $6500. This figure was multiplied by the average number of checklanes per store at each sales level. Again, because stores tend to remodel or reformat every ten years, and it is usually during that remodeling that checklanes are updated, ten years was used as the average life span. Consequently, to achieve an annualized scanner cost, the total scanner cost per store was divided by ten years.

In a phone conversation with Datachecker's Tony Van Seventer, I discovered that, on the average, scanning saves a supermarket 2% of sales, 1/2% of which is attributable to labor savings and 1 and 1/2% of which is attributable to all other savings. Therefore, in order to demonstrate that scanners reduce costs, I deducted 2% of annual sales from the annual cost of scanners. Hence, the formula for the annual capital cost of scanning is:

(7) capital cost 2 = [($6500)(# of checklanes)/(10)]-
(.02)(annual sales).

By joining the three equations together, the annual total cost of a scanning store, TC2, is:

(8) TC2 = (.085)(inventory value) + (# of full-time
equivalents) ($7.36)(40)(52) + [($6500)(#
of checklanes)/(10)-(.02)(annual sales)]

In addition, average cost, AC2, can be derived by dividing both sides of the former equation by annual sales.

(9) AC2 = [(.085)(inventory value) + (# of full-time
equivalents) ($7.36)(40)(52) + (($6500)(#
of checklanes) /(10))-(.02)(annual sales)]
/annual sales

By using the AC1 and AC2 equations, the cost advantage of scanning and higher volume can be seen graphically. With sales being the independent variable and average cost as the dependent variable, it appears that the use of scanning as well as an increase in sales does result in some savings. (See Appendix C) However, to support that the cost difference between scanning and non-scanning stores is statistically significant, a regression must be run. For the regression, the TC1 and TC2 variables must be combined into a single dependent variable, "totalcost". (See Appendix D) This equation permits the rest of the hypothesis to be tested with the addition of two dummy variables. The first dummy variable, "NoSc/Sc", represents the difference between scanning and non-scanning stores; 1 representing non-scanning stores and 0 representing scanning stores. If scanner-using stores are more efficient, the coefficient to this dummy variable will be positive and significant. Then, by creating another dummy variable, "in/chain", the cost difference between independents and chains can be tested. Independents are represented by 1 and chains with 0. If independents do experience significantly higher costs than chains, the coefficient for this variable should also be positive and significant. The sales variable was also included in the regression in order to remove the pattern of higher costs for progressively higher volume stores. Thus, the complete regression to run in order to test my hypothesis is:

(10) totalcost=B0 + B1(NoSc/Sc) + B2(in/chain) + B3(sales)+e

In the regression, B1, B2, and B3, are the coefficients which estimate the influence of the variables, (NoSc/Sc), (in/chain), and (sales), respectively, on total cost. Now that the model has been explained, the results can be reported and conclusions can be formed. It must be noted that the costs were roughly approximated due to data limitations. Therefore, the results may be indicative rather than decisive.

IV. REGRESSION AND RESULTS

The results of the average cost curve analysis support the hypothesis well. The average cost curve representing scanning is considerably lower than the curve corresponding to non-scanning stores. The cost advantage to scanning is further supported by the regression results. The cost advantage of size is not quite as clear. It appears that there is a considerable drop in average cost between the sales volumes of $2-$4 million and $4-$6 million. Beyond that sales level, the cost advantages seem to remain constant. However, there may be another considerable drop in average cost, beginning in the $10-$12 million sales category. This additional drop in average cost is hinted at by the seemingly low average cost for the chain store using scanning with sales volume between $10 and $12 million.

The results to the regression support part of my hypothesis, although they do not support all of it. (See Appendix E) The results to the regression read:

(10) totalcost= -95502.07 + 138295.00(NoSc/Sc)+
(3.28115)
55187.30(in/chain)+236261.01 (sales)
(1.30936) (31.70927)

Durbin-Watson Statistic= 1.056376

Adjusted R-Squared= 0.981624

Standard error= 94246.63

The numbers in the parentheses are t-statistics designating the level of significance of the coefficients. The B2 coefficient, 138295.00, is interpreted to mean that costs are $138,295.00 higher per million dollar in sales for the average supermarket that does not use scanning than for those that do. The t-statistic, 3.28115, is significant at the .005 level, which means that the influence of scanning on costs is very significant. In turn, the B3 coefficient, 55187.30, means that chains experience $55,187.30 lower annual costs per million dollars on the average than independents. The t-statistic corresponding to B3 is 1.30936 and is significant at the .209 level. Here, the cost difference between independents and chains is not statistically significant at the 5% level. The Durbin-Watson statistic[34] is a little low, meaning that there may be a pattern in the data not measured by the coefficients above. A very good fit to the data was achieved, shown by the high adjusted R-Squared, 0.981624. Overall, the results were very interesting although not completely supportive of my hypothesis.

IV. CONCLUSIONS AND DIRECTIONS FOR FURTHER RESEARCH

The results have some important implications about the current state of the supermarket industry, as well as for the future. The stores which are experiencing a very significant cost advantage are those stores utilizing scanning. This can be seen by viewing the average cost curves in Appendix A, as well as by the significant, positive regression coefficient. Not only is the scanning curve lower than the non-scanning curve, but average costs seem to decrease dramatically between the sales level of $2-4 million and that of $4-6 million. It may be that there are economies of scale, such as bulk discounts that are the cause of this decrease. Or the economies caused by scanning may be contributing to this decrease. This theory could be tested by an interaction dummy variable representing the influence of size on the magnitude of savings due to scanning. However, due to the constraining range of the data, this theory was not tested. If the data did extend beyond the $12 million sales volume, I believe that the savings due to scanning would be even more apparent. This is because once a supermarket becomes large enough to justify the implementation of a mainframe computer in the back room, the per-register cost becomes much less than, and in fact, minimal, compared with the $6500 cost figure that was used for the stores in the relevant sales range. Apparently, many stores have realized this significant cost advantage combination because as sales volume increases for both independents and chains, there is a greater percentage of stores which employ scanning. If stores have discovered the cost advantage of this combination, it would partially explain the trend toward increasingly greater size stores.

There are problems associated with larger size, also. There must be a fairly large size market that can support approximately $1 million in weekly sales, which is the minimum breakeven sales volume for many hypermarkets and superstores. Actually, these superstores may even be an outsized member of the supermarket family, which would drop them out of supermarket classification entirely.

It is possible that actually the cost curve for supermarkets today is a combination of the two formerly constructed average cost curves. The curve is estimated such that at lower sales volumes, the curve lies nearer the non-scanning curve, whereas, at higher sales levels, the curve approaches the scanning curve. (See Appendix F) This is because at lower sales and , in turn, having smaller size, stores tend to continue using the traditional register. Perhaps, this because smaller stores sense that they could not make efficient use of scanners. Possibly, the advantages that larger stores receive such as volume manufacturer discounts is forcing the smaller stores to decrease their profit margins so much that these stores can not afford to remodel their checklanes. Perhaps the smaller stores, too, see the trend toward larger stores and are avoiding new capital costs because they feel that they may not be around much longer. Also, smaller stores have been around longer and are therefore more likely to continue to use the traditional registers, whereas, most of the newer, larger stores had scanners installed since their opening. Also, smaller, family-owned stores may use family members as employees. These family members may put in more time than the average employee or work for wages lower than what larger chains pay in order to keep the family in business. Whatever the motives of smaller stores to remain with traditional registers, it may not be long before not only traditional registers but smaller stores become obsolete. These conclusions support recent growth of such large, scanner-equipped supermarkets as Cub Foods.

Even though the B2 coefficient is not statistically significant, the coefficient is positive indicating that chains do experience some cost advantage over independents. Nevertheless, the continuing augmentation of affiliated independents seems to have diminished that advantage. Also, the fact that independents are less unionized than chains at all sales levels may suggest that chains see more of a cost advantage to scanning than do independents. Sharper, more complete data may result in a significant outcome.

Therefore, the results indicate that the current trends toward larger size stores, chains (or vertical integration of some type), and scanning will continue into the future. Surely, the traditional register will become a relic of the past Also, the implications for the family owned "mom and pop" store on the corner do not look promising. On a wider scope, if these superstores do succeed, competition in the industry may drastically decrease. Larger stores need a large volume in order to support their costs which means less stores per a given market. Oligopolies may even begin to form. Nevertheless, once these stores begin to support artificially high food prices with exorbitant profits, the free market will ideally dictate the entrance of new firms into the industry which will bring profits into the normal range. Once again, history repeats itself as the invisible hand shows its strength by sifting the inefficient firms out of the industry. Consequently, the supermarket industry of today may very well be quite different in the future. Surely, technology will be a major force in shaping the shopping experience as it has in the past.

From this study, there are many possible directions for further research. I made many crude assumptions in order to work with the data that I had available to me. The same hypothesis with future data or more accurate or wider range data would be interesting to investigate. A follow-up study testing the interaction between scanning and chains or between larger stores and scanning would be very intriguing. Also, an analysis of the trends through history and into the future may or may not support my predictions for the future. In short, it is evident that the supermarket industry is undergoing a constant of change, and those changes can be fascinating to analyze and use to make further predictions about the future of the supermarket.

APPENDIX A

Total Cost Data

Inventory cost + Labor cost + Capital cost 1 = TC1

InvCost	Wage Exp	ElecReg $	TC1	Scan 2%s	TC2
16490.00	737501.44	1760	755751.44	-57140.00	696851.44
22865.00	799463.80	2120	824448.80	-56555.00	765773.80
21335.00	1147700.70	2240	1171275.70	-96360.00	1072675.70
26435.00	1148083.40	2400	1176918.40	-96100.00	1078418.40
32555.00	1646231.80	2720	1681506.80	-145580.00	1543206.80
33915.00	1621776.00	2880	1658571.00	-135320.00	1520371.00
32215.00	2290579.00	2960	2325754.00	-175190.00	2147604.00
43520.00	2218245.10	3200	2264965.10	-174800.00	2086965.10
34935.00	2786431.20	3520	2824886.20	-214280.00	2607086.20
44625.00	2509954.30	3480	2558059.30	-214345.00	2340234.30

Inventory cost + Labor cost + Capital cost 2 = TC2

*All questions refer to supermarket scanning systems.

1)Name of your company:

2)What is the cost of a software system that includes the following features?

- -inventory management
- -point of sale
- -sales analysis
- -purchasing and receiving
- -accounts payable
- -payroll
- -general ledger

$______________________

3)What is the total cost of a hardware system with specifications:
-1 checklane, 1 workstation, 1 printer, and 1 disk drive?

$______________________

4)What would be the cost per additional checklane? $____________
-per additional workstation? $____________
-per additional printer? $____________
-per additional disk drive? $____________

5)What would be the average annual maintenance cost of a system (such as the one described in question #3)? $____________

6)What is the average annual maintenance cost per checklane? $__________
-per workstation? $__________
-per printer? $__________
-per disk drive? $__________

7)What amount of hardware (# of checklane scanners, # of workstations, # of printers, and # of disk drives) do supermarkets with the following weekly sales volume require?

-$60,000 weekly sales?

-$150,000 weekly sales?

-$300,000 weekly sales?

-$500,000 or more weekly sales?

8)What is the average amount of sales one checklane scanner can accomodate in a week? $__________

9)To the best of your knowledge, what % of your systems are being used for:
-inventory control? _____%

-direct store delivery? _____%

-payroll? _____%

-point of sale? _____%

-con't-

-sales analysis? _______%

-purchasing and receiving? _______%

-accounts payable? _______%

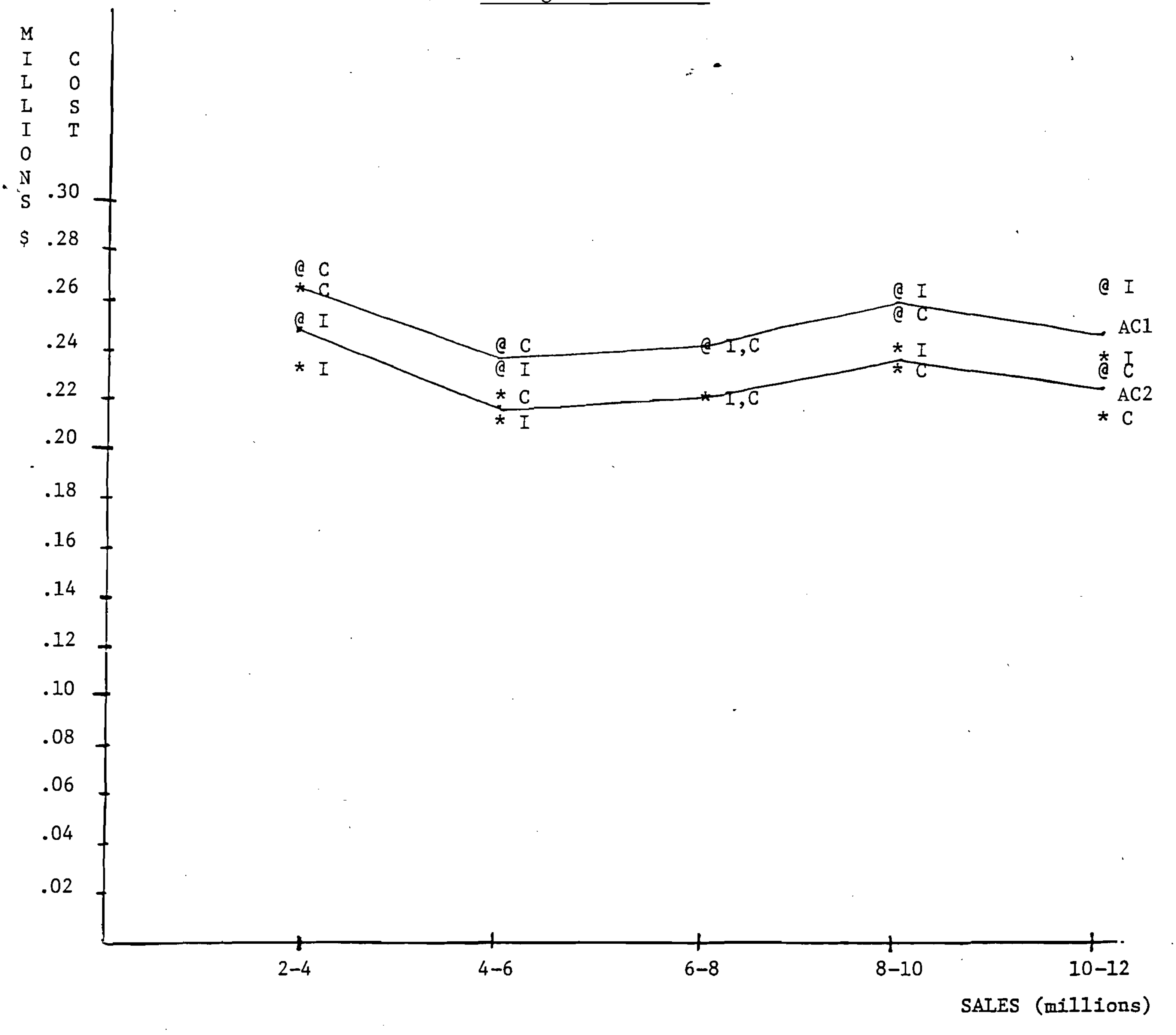
-general ledger? _______%

10)What other information do you feel may be helpful in this research?

Thank you again!!

APPENDIX C

Average Cost Curves



@- Supermarkets without scanning

*- Supermarkets with scanning

I- Independents

C- Chains

APPENDIX D

Regression Data

totalcost= B0+ B1(NoSc/Sc)+ B2(in/chain)+ B3(sales)+ e

totalcos	NoSc/Sc	indchain	Sales
755751.44	1.00	1.00	3.00
696851.44	0.00	1.00	3.00
824448.80	1.00	0.00	3.00
765773.80	0.00	0.00	3.00
1171275.70	1.00	1.00	5.00
1072675.70	0.00	1.00	5.00
1176918.40	1.00	0.00	5.00
1078418.40	0.00	0.00	5.00
1681506.80	1.00	1.00	7.00
1543206.80	0.00	1.00	7.00
1658571.00	1.00	0.00	7.00
1520371.00	0.00	0.00	7.00
2325754.00	1.00	1.00	9.00
2147604.00	0.00	1.00	9.00
2264965.10	1.00	0.00	9.00
2086965.10	0.00	0.00	9.00
2824886.20	1.00	1.00	11.00
2607086.20	0.00	1.00	11.00
2558059.30	1.00	0.00	11.00
2340234.30	0.00	0.00	11.00

Regression Results.

OLS -- DEPENDENT VARIABLE: totalcos

	RIGHT-HAND VARIABLE	ESTIMATED COEFFICIENT	STANDARD ERROR	T_STATISTIC		PROB.
1	NoSc/Sc	138295.000000000	(42148.37501)	T=	3.28115	0.005
2	indchain	55187.307999999	(42148.37501)	T=	1.30936	0.209
3	Sales	236261.013000000	(7450.85045)	T=	31.70927	0.000
4	Constant	-95502.071000000	(63660.09413)	T=	1.50019	0.153

```
SAMPLE SIZE(  1 to    21) =            20          (DF=16)
 SUM OF SQUARED RESIDUALS = 142118841302.297438
          VARIANCE (MSE) =   8882427581.393564
STANDARD ERROR (ROOT MSE) =        94246.631671
                R-SQUARED =            0.984525
       ADJUSTED R-SQUARED =            0.981624
   F-STATISTIC(  3,    16) =          339.319338 (p=0.0000)
        SUM OF RESIDUALS =           -0.000000
  DURBIN-WATSON STATISTIC =            1.056376
```

Analysis of Variance

Source	SUM SQ	DF	MEAN SQ
Due to Regression	9.042E+012	3	3.014E+012
Residual	1.421E+011	16	8.882E+009
Total	9.184E+012	19	4.834E+011

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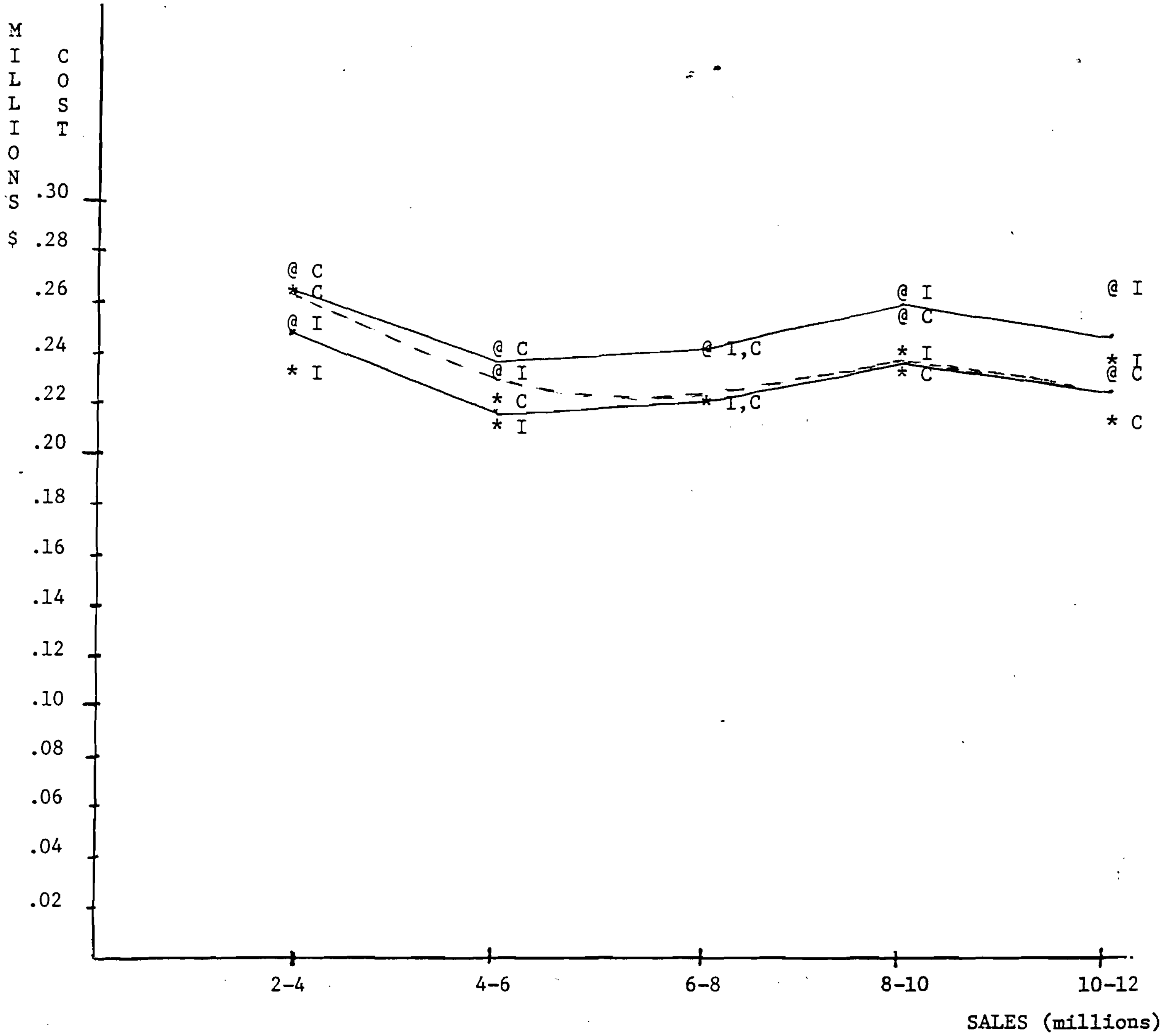
APPENDIX F

Combination Average Cost Curve



@- Supermarkets without scanning

*- Supermarkets with scanning

I- Independents

C- Chains

Endnotes

1 James L. Brock, A Forecast for the Grocery Retailing Industry in the 80s (Ann Arbor: UMI Research Press, 1981), p.12.

2 Willard F. Mueller and Leon Garoian, Changes in the Market Structure of Grocery Retailing (Madison: The University of Wisconsin Press), 1961, p.11.

3 Brock, p.12.

4 Stanley Lebergott, The Americans: An Economic Record (New York: W.W. Norton and Co.,1984), pp. 316-318.

5 Katherine M. Hafner, " There are Two Kinds of Supermarkets: The Quick and The Dead," Business Week, (New York: McGraw-Hill, Inc.), 11 August 1986, p.63.

6 A chain is defined as a firm operating four or more stores.

7 John M. Dobson, A History of American Enterprise (New Jersey: Prentice-Hall, Inc.), 1988, p.193.

8 Brock, p.20.

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12 J. Tevere MacFadyen, "The Rise of the Supermarket," American Heritage (New York: Forbes, Inc.), October-November 1985, pp.22-23.

13 "1986 Store Operations," Progressive Grocer 54th Annual Report,(Stamford, Connecticut: Four Stamford Forum), p.8.

14 Hafner, p.62.

15 Hafner, p.62.

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21 Hafner, p.63.

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23 Marilyn A. Harris, "Electronic Retailing Goes to the Supermarket," Business Week (New York: McGraw-Hill, Inc.), March 1985, pp.78-79.

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26 Tony Van Seventer, Datachecker, Corporation. Phone Interview, 23 February 1988.

27 "UPC Scanning," NCR, pp.7-8.

28 Gary Geipel, "At Today's Supermarket, the Computer is Doing it All, " Business Week, (New York: McGraw-Hill, Inc), 11 August 1986, p.64.

29 Geipel, p.64.

30 Geipel, p.65.

31 Geipel, p.65.

32 Van Seventer.

33 Van Seventer.

34 The Durbin-Watson Statistic measures the occurence of a pattern in the residuals in a regression. For example, if the dummy variable for independent and chains was omitted, there would be a pattern of two positive residuals for the independents and then two negative residuals for the chains. This pattern would then repeat.

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