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A DPP Evaluation of Efficiency Gains from Channel-Manufacturer Cooperation on Case Counts.

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Abstract

While US manufacturers customize the number of units per case to minimize grocers' costs, European manufacturers do not. To study the costs to this European policy to grocers, case counts were optimized with modified DPP model. Optimization reduced direct costs from 10.4% of sales to 4.8%. Findings were robust across store classes indicating that customized case counts have improved the US's systems efficiency relative to Europe's.

A DPP EVALUATION OF EFFICIENCY GAINS FROM CHANNEL-MANUFACTURER COOPERATION

Introduction

As a key merchandising decision, the allocation of shelf space to products has rightly been treated often in the scientific marketing journals (Andersen 1979, Preston and Mercer 1990, Zufryden 1987). The literature, however, has been more concerned with optimizing space allocations, generally using advanced mathematical programming techniques, than with implementing the calculated optima. For example, Bultez and Naert (1988) carefully optimized products' space allocations in relation to the elasticity of sales to shelf space but were unable to implement their solution due to unnamed "practical considerations".

In practice, throughout Europe[1] , products' shelf space allocations are often dictated by a "practical consideration": the physical volumes of products' cases. The physical volume of a product's case - the case volume - can determine the shelf space which products receive because, since grocers deliver to their stores from central warehouses in caselots and since stores haven't backrooms, grocers must place the entire case on the shelf. Ireland (1993) corroborated this supposition in an empirical study: products which come in bigger cases got proportionately more space. Case volumes may even influence space allocations in chains with backrooms such as Spain's Dia or Germany's Aldi which follow a "one case plus" stocking rule: a

1 The terms "European" and "American" are used to refer to *prevailing* practices throughout the UE, and the United States respectively. It is recognised, however, that both entities display enormous variety.

procedure which requires that every product be allocated at least one casevolume of shelf space.

If case counts and case volumes are optimum from the stand point of grocers' costs, then the relation between case volumes and shelf space allocations is only a curiosity. However, there is easily visible and abundant evidence supporting the contention that over-high case counts are increasing grocers' in-store inventory. For example, Ireland and Farrán (1990) found that five Spanish supermarket chains carried an average of 22 days of on-shelf inventory despite the prevalence of *daily* delivery. Indeed, some products had up to *two years* of on-shelf inventory.

More compelling evidence of casecounts' sub-optimality throughout Europe is that such multinationals as Procter and Gamble and Unilever offer only one casecount per SKU[2]. Thus, a traditional "Mom and Pop" store has to order the same case quantity as a giant hypermarket! Moreover, both slow selling expensive Scotch whisky and fast selling cheap wine both come 12 bottles to the case. It seems fair to state that if casecounts are neither modified by channel nor by product characteristics then actual casecounts are suboptimal for some products and some grocers. One may well ask, if "one size fits all", then why do these giants customize casecounts for important clients in the United States?

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2 Assessment of European practices are based on telephone conversations with salesmen from five multinational consumer goods companies, a trade association and the six chains mentioned. Concurrence was unanimous.

It may be then, that the key to optimizing space allocations in Europe is to get manufacturers to optimize case counts so that grocers can implement optimal space allocations. Optimizing case counts in practice requires at least 1) an optimization model which considers the impact of case volumes on in-store holding costs (DPP doesn't) and 2) compelling evidence that optimization is worthwhile.

This paper will supply both requisites for optimization in two parts. 1) An optimization model will be developed by modifying the AECOC (1989) DPP model to include the effect of case volumes on in-store inventory. 2) Evidence of optimization's worth will be developed by determining optimum case counts for 583 carefully selected products using empirical cost and productivity data from six grocery chains. Minimized costs will be compared to current costs to determine potential gains from optimization. Sensitivity analyses will test the results' validity for other store classes and cost structures including the presence of backrooms.

At first glance, this research may seem less interesting to US than to European marketers because US manufacturers are willing to customize case counts for important retailers. This customization may have reduced the difference between optimal and actual case counts in the US. Moreover, almost all US stores have backrooms which mitigate the cost of holding in-store inventory by shifting inventory from expensive shelf space to relatively cheap backroom storage. Finally, sophisticated US grocers may be better able to determine ideal case counts than Europeans.

Despite these objections, this research should interest Americans. First, most US grocers aren't sophisticated. In fact, Farris, Olver, and DeKluyver (1989) reported that only 23% of US chains even have working DPP systems. Apparently, 77% of US grocers can't use DPP models to optimize case counts because they haven't the necessary data or model. This research will make an optimization model available to US grocers and, more importantly, demonstrates its value. Second, the model is altered to simulate US supermarketing realities: backrooms and a variety of sales levels and cost structures. Finally, this study compares the case of manufacturer determined case counts to the optimal situation in which each grocer determines his case counts. This is roughly *equivalent to measuring the benefits in system efficiency obtained in the US by tailoring product case counts through relationship marketing.*

Background

This research often refers to Direct Product Profit (hereafter DPP), the best known and most widely accepted model of supermarket costs and revenues (Stern and El Ansary 1982). DPP is a rigorously standardized activity based costing (ABC) system developed in its modern, micro computer based format by a team of experts from industry, academia and the supermarket trade (FMI 1985, AECOC 1989). DPP allocates revenues (sales price, discounts, terms of trade) and direct costs (space, transport and handling) to individual products to give a complete view of the contribution each makes to grocers' profits.

Figure 1 describes the DPP calculations for dry (nonperishable) grocery products. The DPP equations require two classes of inputs: 1) cost rates: the expenses incurred in manipulating and storing products as they pass through the warehouse, transport and store and 2) data specific to each SKU such as its volume, price, wholesale cost, terms of trade, the number of units per case and cases per pallet.

Figure 1
Calculation of DPP per Unit and Weekly DPP

	Weekly DPP		DPP per Unit
	Weekly Sales		Product's Price
-	Cost of Goods Sold	-	Cost of Good Sold
=	Weekly Gross Margin	=	Gross Margin
+	Adjustments to Price	+	Adjustments to Price
=	Adjusted Weekly Gross Margin	=	Adjusted Gross Margin
-	Direct Product Costs	-	Direct Product Costs
=	Weekly Direct Product Profit	=	Direct Product Profit per Unit

Calculation of DPP per Unit and Weekly DPP

Cost rates such as interest and labor rates are constants, but are applied to products in relation to what has become known as a "cost driver". For example, products incur financial holding costs in relation to their prices and labor costs in relation to handling time.

DPP provides a rigorous methodology for collecting and organizing raw cost data and a framework for "what-if" analyses of the impact of product or logistic system changes on direct product profits. Unfortunately, the algorithms used in the "what if?" analyses may not predict actual changes in costs very well. Such prediction errors are, a fault common to all activity based costing models (Kaplan 1987, Morris and Noreen 1991, Hayes, Wheelwright and Clark 1988).

However, DPP models increase normal prediction error by assuming that the number of units place on the shelf is entirely at grocers' discretion. As noted above, this assumption is often incorrect. This research modifies the European Unified DPP Model (AECOC 1989) so that the physical volume of a product's case influences shelf space allocations .

The Conceptual Model

Space Allocation as a Function of the Case Count

As the minimum order quantity is the case count, each product will receive at least one case volume of shelf space where the case volume equals the product of the case count and volume (cubic inches) per unit. Higher case counts thus force grocers to increase on-shelf inventories and space allocations (equation 1).

$$\text{Space Allocation} = \text{safety stocks} + \beta(\text{Case Volume}) \qquad (1)$$
$$\text{s. t.} \quad \text{Sales/Delivery} \leq \text{Case Count}$$

Products can "earn" more than one case volume of shelf space through higher sales. Specifically, for those products which sell more than one case between deliveries, the shelf allocation will not be less than the unit sales between deliveries (equation 2).

$$\text{Space Allocation} = \beta(\text{Sales Volume}) + \text{safety stocks} \qquad (2)$$

$$\text{Where Sales Volume} = \frac{\text{Unit Sales/Week}}{\text{Deliveries/Week}} \times (\text{Volume/Unit})$$

$$\text{s. t.} \qquad \text{Sales/Delivery} > \text{Case Count}$$

Ireland (1993) found overwhelming empirical support for both equations 1 (R^2 = 0,808, df 529, p=.001 and 2 (R^2 = 0,828, df 48, p=.001)[3]. Moreover, 99% of products' space allocations were greater than one case volume; even products selling less than one case per month!

Grocers' Profits as a Function of the Case Count

Grocers' profits can be driven by case counts on both the revenue and the cost sides. A store's revenue may be expected to increase with the available shelf space and with the variety of products carried. That is to say that big stores should sell more than small stores and that stores with more stock keeping units (SKUs) should sell more than stores with fewer. Unfortunately, shelf space is limited. Increasing the shelf space allocation per SKU thus requires a proportional reduction in the number of SKU offered. In short, larger case volumes increase the shelf space per SKU and thus reduce the number of SKU carried.

This reduction in the number of SKU will lead to a corresponding reduction in store revenue given the minimal assumption that the elasticity of grocers' revenue to the number of SKU is greater than it is to Space per SKU. This proposition seems

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3 Beta for equation 2 was measured as 1.4. Beta for equation 3 was measured as 1.2.

self-evident as otherwise, at the extreme, stores would carry only one product. Thus, grocers' revenue should be a decreasing function of the case count because over-high case counts increase the space allocated per SKU and limit the number of SKU stocked. Since higher case counts decrease grocers' revenues, the case count which minimizes grocers' costs will always be equal to or greater than the case count which maximizes grocers' profits.

This research will concentrate on minimizing grocers' costs rather than maximizing profits, because the case counts which minimize grocers' costs are greater than those which maximize grocers' profits. Optimizing costs rather than profit thus reduces the possibility of finding that optimal case counts are less than actual case counts and will decrease the probability of supporting the hypothesis tests.

Grocers' Costs Associated With the Case Count

As grocers can't order less than one case from the warehouse, case counts drive grocers' order quantities and order quantities drive grocers' costs. It is useful to segregate the costs associated with the order quantity (the case count) into those which decrease with the case count (order costs) and those which increase (holding costs). These costs will be explored below.

Grocers' Order Costs

Grocers' order costs are the costs associated with renewing on-shelf inventory. They include keying orders into hand held computers, selecting products one case at a time in the warehouse, opening cases in the store etc. The key point to understand about order costs is that they are fixed per order (case) so that if the quantity ordered (the case count) is increased, the order cost per unit ordered decreases. Calling total order cost per SKU per period C_O:

$$C_O = \frac{\text{Unit Sales/Period}}{\text{Case Count}} \times \frac{\text{Cost}}{\text{Order}} \qquad (3)$$

Grocers' Holding Costs

Holding costs can be usefully divided into two classes: financial and space. The financial holding costs which increase with higher case counts are the opportunity costs of tieing up funds with in-store inventory. Financial holding costs per period are the product of the interest rate per period, the wholesale price per period and the average units of inventory held on the shelf.

Financial holding costs increase with the average units of inventory held on the shelf which is, as was made clear in equations (1) and (2), an increasing function of the case count for products which sell less than one case between deliveries (the vast majority). It is thus clear that case counts greater than the unit sales between deliveries increase financial holding costs.

Space holding costs - also known as occupancy costs - refer to store costs which can not be allocated to a particular product on a more directly causal basis than the shelf space which it occupies. These costs include, for example, electricity, rent, depreciation and the store manager's salary. Since space is a scarce resource, DPP models allocate these costs to products based on the cubic feet of shelf space which they occupy.[4] The current research modifies these models to reflect the belief that space costs are best allocated to products in relation to the square feet of shelf frontage occupied rather than the cubic meters. The reasoning behind this change is twofold. First, the first product placed on the shelf greatly diminishes the value of the space behind it. Certainly, no manufacturer would pay for space *behind* his competitors' products.

Second, this treatment is consistent with the practice observed in six different Spanish supermarket chains (see Ireland 1993). Products' facings are maintained as products sell and units are brought from the back to the front so that the frontage allocated is not diminished. An implication of allocating space in relation to the square feet of shelf frontage occupied is that space costs do not decrease as inventory is sold, *unless* a facing is removed. The shelf frontage (square feet) which a product occupies is calculated as:

$$\text{Feet}^2 \text{ Occupied} = \text{Product Height} \times \text{Product Width} \times \frac{\text{Product Depth}}{\text{Shelf Depth}} \times U \quad (4)$$

Where U is the average number of units held on the shelf. The results of (4) are rounded up to the nearest integer. Essentially, (4) determines the number of facings required by the products on the shelf. It is based on the assumption that a

4 Many academics have always contended (eg. Buzzel, Salmon and Vancil 1965) that space costs should not be allocated because they are basically fixed. However, more space is always available by eliminating products in the current assortment. The cost of the space foregone by not eliminating products is the opportunity cost of eliminating current products less the profit available from new products. Sheeline (1988) indicates that this market for space is active and liquid. Average space costs serve as an approximation of this marginal opportunity cost. Various space costs are considered in the sensitivity analyses including no space costs.

facing is added when no more units fit in the space behind previous facings. This causes the space cost function to be stepped (Figure 2)[5]. Multiplying "$Feet^2$ Occupied" by the cost of space per square foot per period converts space occupied into space costs per period.

The steps in the space cost function are only coincidentally of equal length. While the length of the first step is determined by the inventory required to last between deliveries from the warehouse, the lengths of subsequent steps are determined by the ratio of the product's depth to the shelf depth (see Figure 2).

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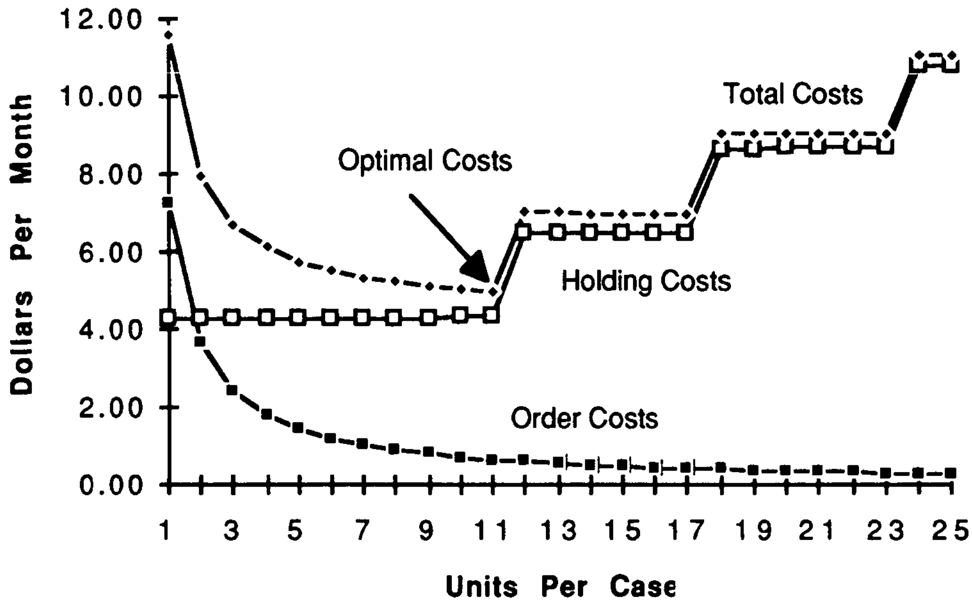
5 All stores in our sample had shelf depths of .5 meters although hypermarket shelves are often .8 meters deep. Were shelf depths random it would be pointless to calculate facings. Paul Farris pointed out that using square feet instead of cubic feet cures a problem with DPP models: they allocate double space costs to deep bottom shelves. Products on bottom shelves are thus penalized twice: once by their unfortunate location and then again by receiving more overhead than, presumably better, waist high shelves.

Figure 2
Retailers' Total Costs As a Function of the Case Count Plot of Actual Cost Data For Average Product



Summing the costs which increase with the number of units per case (order costs) and those which decrease (holding costs) generally produces a unique minimum, as shown above in Figure 2. This is the case count which minimizes grocers' costs. Optimal case counts and potential savings can be expected to vary widely among products.

Recapitulating, the European Unified DPP model was modified by allocating space costs in relation to the shelf frontage occupied and by assuming that the case count drives space allocations for low selling products while sales between deliveries drives space allocations for fast selling products. The resulting model of supermarket costs as a function of the case count may be used to determine the optimal case count for a given product in a given chain.[6]

Are Actual Case Counts Optimal For Grocers?

Circumstantial evidence indicates that current case counts are greater than optimal. Specifically, this evidence includes the use of backrooms in some stores, the abundance of dissimilar products which have identical case counts throughout Europe and the fact that actual on-shelf inventory is so much greater than the inventory needed to last between deliveries (Ireland and Farran 1990 observed an average of 22 days). These observations lead to proposition 1.

> P_1: A substantial number of actual case counts will be higher than optimal for grocers' profits.

Support for proposition 1 might be statistically significant but commercially unimportant. It is therefore proposed that the savings from reducing case counts to their optima will produce savings large enough to pay for a remedy, such as breaking (delivery to the store in individual units). A commercially quoted charge for breaking could amount to 3% of the sales price[7].

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6 If the store has a backroom, units which are not place on the shelf are transferred to the backroom where they incur decreased space costs but the same finance costs. Case counts do not affect grocers' revenues if backrooms are used.

7 Breaking charges are complex. They depend upon a product's volume and weight plus a fixed charge for sending a truck to the store which varies with the store location, its proximity to other delivery points and the time "window" during which delivery is allowed. A chain in Madrid assured us that these charges amounted to less than 2% of the sales price for health and beauty aid products. Our data indicate that this charge should be slightly higher for other families which have lower price to volume ratios. The charge should not, however, be higher than 3% of the sales price on average.

P_2: Optimizing case counts will provide cost savings to grocers in excess of 3% of the sales price for a substantial number of products.

Method

To test the research propositions, empirical cost and productivity data were collected from six of the twenty largest supermarket chains in Spain using the European Unified DPP Model's (AECOC 1989) conventions and calculations. The stores surveyed ranged from 2,000 to 25,000 square feet and stocked from 900 to 5,500 SKU, representing the full variety of Spanish supermarkets.

As proposition 1 posits that case counts are generally too high (or the equivalent, that holding costs dominate order costs), a generalizable test requires that the data used minimize costs associated with high case counts (holding costs) while maximizing costs associated with low case counts (order costs). Holding costs were minimized by using the lowest interest and space costs found among the six chains: interest rate of 13.0%, space costs of $12.00/square foot/month (the sample's highest holding costs were interest 15.7%, space costs of $27.87/square foot/month). Order costs (cost per order times orders per period) were maximized by selecting the store with the highest cost per order found in the sample and by using product sales data from a chain with extremely high sales per SKU ($111.11/SKU/month) which leads to many orders per period (the lowest sales per SKU were ($19.42/SKU/month). If lowering case counts offers useful savings with this carefully biased data, then greater savings are almost certainly available in any Spanish supermarket.

These data provide a double bias against finding confirming the propositions. First, optima will be higher than with any real-world combination. Second, the low holding costs and high order costs will understate potential savings.

Perishable products and products which do not come in boxes were eliminated from the sample as they do not meet the assumptions of the model. Seasonal products were eliminated as well as their average space allocations for the year could not be determined from the ex post sales data available. These considerations reduced the sample to a carefully selected 583 SKU.

Results

Optimal case counts were calculated for all products in the sample. Optimized costs are contrasted with actual costs below in Table 1.

Table 1
Potential Cost Savings Through Optimization of Case Counts For Products Which Pass Through the Warehouse

	Actual Cost Per Month ($)	Optimized Cost Per Month ($)	Cost Savings Per Month ($)	Cost Savings Per SKU ($)	Cost Savings As a % Of Sales
All SKU (N=583)	5,141	3,312	1,828	3.14	2.72
Optimal Case Count<Actual (N=421)	2,925	1,348	1,576	3.74	5.59
Optimal Case Count>Actual (N=135)	2,121	1,869	252	1.87	0.68
Optimal Case Count=Actual (N= 27)	95	95	0	0.00	0.00

Proposition 1 posits that manufacturers produce over-high case counts. The vast majority of optima (76%) were reached by reducing the case count thus supporting proposition 1. While higher case counts would lower grocer costs for some products (19%), many of these products required increases of just one or two units to achieve optimality. Moreover, as may be observed in Table 1, the average savings produced by increasing case counts were smaller (0.68% of sales) than those produced by reductions in case counts (5.59% of sales). In short, proposition 1 is well supported.

Reducing over-high case counts to their optima would lower direct costs related with the casecount from 10.4% of sales to 4.8%. Alternatively, one could view these projected cost savings as $18,918 per store per year. As this chain has over one hundred stores, the savings amounts to some $1,890,000 per year - almost tripling current before-tax profits of about $1,000,000.

Proposition 2 postulates that savings would be greater than 3% of sales - the amount necessary to pay for breaking - for a "substantial" number of products. Reducing case counts to their optima produced savings greater than 3% of sales for 48% of all products which come in boxes. Moreover, as was shown in Table 1, reducing case counts to their optimum produces an *average* savings of 5.6% of sales. Both figures support proposition 2 strongly. Table 2 details cost savings by percentiles. Optimizing case counts for 10% of these products (42 SKU) offers an impressive average cost savings of 59.6% of sales or $13.30 per SKU/Month per Store.

Table 2
Costs Savings Achievable By Reducing Case Counts (By Percentile)

Percentile	Cost Reduction $/Month/SKU/Store	Cost Reduction as % of Sales
>90	13.30	59.6
80-89	6.14	18.9
70-79	4.42	12.8
60-69	3.54	8.6
50-59	3.05	6.4
40-49	2.58	4.5
30-39	1.88	3.2
20-29	1.42	2.3
10-19	1.00	1.4
00-09	0.16	0.4
Average	3.74	5.6

N=421

A word of caution: while these impressive figures come from the store class which would benefit *least* from reduced case counts and while costs and productivities were assembled from several chains so as to *minimize* calculated savings, projected direct cost savings are not the same as real cost savings. Most of the projected cost savings come from forecast reductions in space costs. Such reductions do not come automatically. Management must reduce space allocations as proposed and find alternative uses for the liberated shelf space to realize these cost reductions. However, given the active and liquid market for space in US supermarkets (Thierren 1989) converting space savings into cash should not be difficult.

The Results' Robustness

The above results' generality is questionable because the sales data pertains to one chain. Sensitivity analyses will therefore be conducted with various levels of sales, order costs and space costs to simulate various store classes and cost structures including stores without backrooms.

Sensitivity Analyses With Several Levels of Sales, Space and Order Costs

Case counts were again optimized using the same assumptions and model as before but with various levels of sales, order and space costs. As may be seen in Table 3, the percentage of optimal case counts which are lower than the actual case count decreases as sales and order costs increase. With actual space costs and sales, increasing order costs four times (from one half actual order costs to twice actual order costs) only decreased the percentage of optima less than actual case counts from 75% to 69%. On the other hand, increasing sales four times decreased the percentage of optima less than the actual from 82% to 58%.

Table 3
Percentage Of Optima Less Than Actual: Various Sales, Space and Order Costs

	Space Costs/2			Space Costsx1		
	Sales/2	Salesx1	Salesx2	Sales/2	Salesx1	Salesx2
Order Costsx2	78	68	53	79	69	56
Order Costsx1	82	72	57	82	72	58
Order Costs/2	86	75	61	82	75	60

It seems then, that optimal case counts are more sensitive to sales than to order costs. This last result is especially interesting to US and UK supermarkets which probably have low order costs and relatively low sales per SKU compared to the sample (due to the extreme variety of products held). Such supermarkets would benefit from lower case counts for 82% - 86% of the products tested if they haven't backrooms. Varying space costs produced no important effects.

One important conclusion may be drawn from these tests. Despite the extreme ranges tested, lowering case counts would reduce costs for at least 53% of all products tested indicating that important cost savings are available from decreasing case counts in any store class.

Are the Results Valid for Stores With Back Rooms?

The results analyzed above are widely applicable to Spanish supermarkets, but what about US and British supermarkets with backrooms? Can the results be made to apply? They can, if one accepts the premise that, in the presence of backrooms, higher case counts increase backroom inventory rather than on-shelf space allocations. This premise seems to have face validity. If cases are delivered to the store from the warehouse and a limited number of units are placed on the shelf - say two facings - any inventory not placed on the shelf must be placed in the backroom.

Because products can be stored more densely in backrooms than on store shelves, backroom space costs should be lower than on-shelf space costs. However, as was observable in Table 4, reducing space costs produces no important change in the percentage of optima which were less than the actual (both averaged 72% across varied sales and order costs). In fact, as shown in Table 4, lowering case counts would reduce costs for 31% (245 of 583) of the SKU *even were space costs completely eliminated and order costs doubled!*

Table 4
Percentage Of Optima Less Than Actual: No Space Costs

	Space Cost x 0			Space Cost x 1		
	Sales/2 %	Salesx1 %	Salesx2 %	Sales/2 %	Salesx1 %	Salesx2 %
Order Costs x 2	42	31	12	79	69	56
Order Costs x 1	58	42	23	82	72	58
Order Costs / 2	87	58	42	82	75	60

The key point which we would like to draw from the sensitivity analyses is that the proposition tests are very conservative both with regard to the model used and to the sampled data. Results are extremely robust. It seems fair to state that 1) all supermarkets would benefit more from reduced case counts than in the base case and 2) a majority of actual case counts are greater than optimum for all European grocers regardless of their sales, order costs or space costs. These results may also serve to measure the importance of the efficiency gains which have been achieved in the US by optimizing case counts.

Discussion and Conclusions

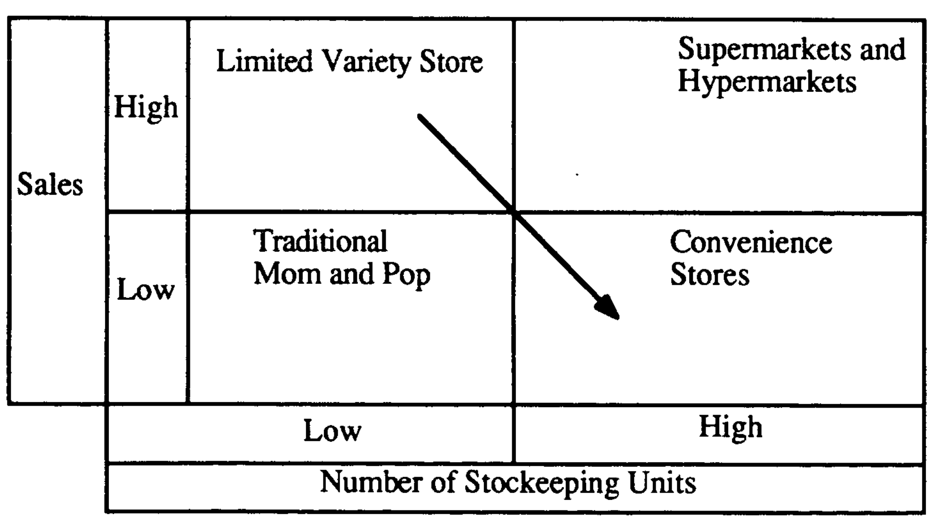
Reducing Excess Costs Due To Over-High Case Counts

The problem of reducing excess costs due to over-high case counts is treated in two steps: 1) identifying opportunities for worthwhile savings and 2) delineating options to lower costs.

Identifying Opportunities For Savings

According to the conceptual model and consistent with the results of the sensitivity tests, the grocer's basic marketing strategy largely determines optimal case counts (Figure 3). A store with high sales and low variety (high sales per SKU) has less to gain from optimizing case counts than does a store with a large assortment and low sales. This explains why convenience stores (for example, 7-11 in the US and Japan) deliver in unit quantities, as often as thrice daily, while low-variety high-volume stores, such as Germany's Aldi or Spain's Dia, deliver weekly and in case quantities.

Figure 3
The Relationship Between Store Strategy and the Value of Lower Case Counts



Arrow Indicates Direction of Value of Lower Casecounts

In viewing Table 5 which presents cost savings by family, it's obvious that bulky, slow moving families such as paper products offer more room for improvement than do fast moving, low priced compact products such as tetrapacked tomato paste. The fact that the potential savings from optimization varies with the product family simplifies the managerial task of determining which products are good candidates for optimization.

Table 5
Potential Savings From Optimizing the Case Count by Family (Selected Families)

Families In Order Of Potential Cost Savings in $/Month/SKU		Families in Order of Potential Cost Savings As % of Family's Sales	
Marmalade, Jams	1.16	Milk	1.1
Honey	1.21	Brandy	1.3
Health and Beauty Aids	1.33	Clear Spirits	1.4
Tomato Paste	1.43	Health and Beauty Aids	1.5
Spices	1.83	Canned Fish	1.8
Canned Vegetables	1.85	Tomato Paste	1.8
Wine	2.23	Honey	3.1
Clear Spirits	2.43	Wine	3.4
Canned Fruit	2.44	Canned Vegetables	3.5
Canned Fish	2.69	Marmalade, Jams	4.4
Cleaning Liquids	2.77	Cleaning Liquids	5.0
Canned Stews, Soups	2.80	Canned Stews, Soups	5.0
Cleaning Products	3.22	Canned Fruit	5.0
Aperitifs	3.31	Detergents	6.1
Brandy	3.38	Liquors	6.8
Liquors	3.62	Sparkling Wines	7.1
Pet Food	4.17	Aperitifs	7.4
Sparkling Wines	4.32	Cleaning Products	8.0
Milk	4.56	Spices	9.3
Cereal	10.19	Paper products	10.0
Paper products	12.34	Pet Food	10.0

Options For Reducing Costs

There are several possible avenues for attacking the problem of sub-optimal case counts. The use of backrooms - breaking in the store - is a possible avenue for eliminating the link between case volumes and space allocations. Backrooms are less common in Europe than in the US because its inner city stores were built long ago. In that era, it was normal to offer small assortments of basic goods and backrooms were unnecessary. Managers are now unwilling to give up valuable floor space to a backroom which they see as a waste of space. Moreover, many case counts were found to be superoptimal even were backrooms used and assumed to have no space costs. Backrooms, then, are not a definitive solution

Breaking - opening cases in one's warehouse and delivering individual units to the store - is a solution used by convenience stores and certain supermarket chains. The most sophisticated of the large Spanish supermarket chains - Mercadona - began breaking for some products in 1990. Breaking offers the advantage of autonomous decision making but is costly.

The most difficult route for reducing costs is probably for grocers to negotiate with manufacturers to reduce case counts. Stern and El Ansary (1982) produced a review of some economic approaches for inducing cooperation among channel members, none of which seem to have been successful in Europe. The apparently successful cooperation in the US raises the questions, "How was cooperation achieved in the US?" and "Why not in Europe?"

One could, of course, posit that the lack of cooperation is due to European grocers' lesser sophistication. However, European grocers, and especially the British chains, are very knowledgeable. Moreover, Safeway, an American chain, is present in the UK and suffers along with the rest. Another possible explanation is that European grocers lack the power to coerce cooperation. This theory doesn't hold water either: European grocers generally dominate their countries more than do US grocers (three British chains have 60% and one Swiss chain 80% of their countries' respective grocery markets).

My favorite theory to explain this lack of cooperation in Europe is that the incentives are wrong for manufacturers to cooperate in the absence of backrooms. As one salesman for a multinational consumer goods company told me, "Of course we produce big cases. And wide products too. That way we get more shelf space.[8]" When backrooms are used, the link between case counts and shelf space is broken so manufacturers have no reason *not* to cooperate. British grocers (who generally have backrooms) can't force customization because manufacturers have standardized strategies for all of Europe.

In conclusion, and summarizing this research, it seems that, in Europe, optimum case counts are generally less than actual case counts regardless of the chain or the level of sales, order costs or space costs investigated. The results of the sensitivity tests seem to indicate that optimal case counts are robust across store classes. This indicates that one case count may suffice for all grocers *if* it is near

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8 "Claro que tenemos cajas grandes. Y támbien productos anchos. Así conseguimos más espacio."

optimal. Problem products and families are easily identifiable. The savings from optimizing case counts - 5.6% of sales - are well worth the effort of identifying problem products and taking remedial steps such as breaking or reducing case sizes. Inducing cooperation to optimize case counts is obviously a key problem area.

Limitations of This Research and Suggestions for Further Research

The limitations of the current research open two major areas for future research: heuristics for determining optima, and developing methods for achieving cooperation.

The results of the sensitivity analyses performed here lend credence to the possibility that some rules of thumb may be developed for determining optimal case counts. A simple rule might be, "If your product's family is not a beverage, your base case count should be 12. Subtract one unit for each $1.00 in price and each 20 cubic inches in size." Such rules could help manufactures and grocers reach useful agreements even were the heuristic imperfect.

Finally, and most importantly, a history of the process used in the US to achieve cooperation in the optimization of case counts might provide some insight as to how the European impasse can be ended. The academic literature available to me doesn't explain how US manufacturers came to offer a variety of case counts. Who took the first step? Were trade associations, academics or consultants involved? Without this basic knowledge, it may be that optimization models, however elegant, will be fruitless.

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