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A Factor Analysis of Supermarket Management Practices

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Abstract: Empirically based management practice indices are constructed using results from factor analysis of data from 344 stores in the 2000 Supermarket Panel. These indices are compared to six management indices based on expert opinion. The empirical indices group variables differently and provide a more compact summary of supermarket management practices.

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The decade of the 1990s was a time of great change in the supermarket industry. By the early 1990s, mass merchants such as Wal-Mart were posing a serious competitive threat as they expanded their scope of operations into food retailing. At the same time, advances in information technology were making new, potentially more efficient business practices possible, including category management, computer assisted ordering, and vendor managed inventory. Finally, in the late 1990s tight labor markets, the new competitive threat of on-line shopping and increasing consolidation of supermarket chains posed significant new management challenges at the store level.

In 1999, The Retail Food Industry Center at the University of Minnesota established the Supermarket Panel. This annual survey of supermarket managers provides information on store characteristics, operations, and performance. The Panel is unique because the unit of analysis is the individual store and the same stores are tracked over time. This makes it possible to trace the impacts of new technologies and business practices as they are adopted.

After a pilot test of the Panel in 1999 with 100 non-randomly selected stores, full-scale operation for the Panel began in 2000. A random sample of 2,000 stores was selected from a list of nearly 32,000 supermarkets in the U.S. that accept food stamps. Questionnaires were mailed to these stores in January 2000. A total of 344 stores responded with useable surveys. These 344 stores include supermarkets in forty-nine states, representing a wide range of ownership structures and formats. Across all Panel stores, King, Wolfson, and Seltzer (p. 5) report that median values for annual store sales, selling area, weekly sales per checkout, and weekly sales per square foot are quite similar to those reported in the *67th Annual Report of the Grocery Industry* published by *Progressive Grocer*. The median level for sales per full-time equivalent

employee is higher for Panel stores than the figure reported by *Progressive Grocer*, but this may be due to differences in the definition of a full-time employee.[1]

The Panel survey instrument includes a large number of questions about store-level management practices. Responses to these questions are summarized by index scores for six key management areas: (1) supply chain practices, (2) human resource practices, (3) food handling, (4) environmental practices, (5) quality assurance, and (6) service offerings. These make it easier for managers to assess relative strengths and weaknesses and identify areas for increased management attention. They also are used in statistical analysis of store performance.

Because 2000 was the first year of full-scale operation for the Panel, construction of these indices was based on expert opinion rather than empirical analysis. Now that data are available, it is possible to assess whether the grouping of management practices under these indices is appropriate and to determine whether they are actually measuring distinct aspects of store management. Factor analysis is an appropriate tool for this assessment.

This paper presents results from a factor analysis of the management practice indices from the 2000 Supermarket Panel. In the sections that follow, we first describe the components of the six management practice indices. We then introduce and present results for two factor analysis models designed to determine how appropriately the indices characterize store practices over a broad range of management activities. Finally, we compare the performance of the original indices and factors based on the two models in regression models that predict four key store performance measures.

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[1] See King, Wolfson, and Seltzer for a more complete discussion of data collection procedures for the 2000 Supermarket Panel and a detailed descriptive profile of the Panel stores.

The Original Management Practice Indices

Complete definitions of the six management practice indices are provided in sections 3 through 8 and Appendix C of King, Wolfson, and Seltzer. The primary objective in constructing the indices was to develop summary measures of management practices in key areas that could be helpful to store managers and useful in statistical analyses of the Panel data. In most cases, individual variables included in an index were weighted equally and added together since there were no previous studies that had constructed such indices.

Supply Chain Practices The supply chain index is designed to be an indicator of a store's ability to participate in supply chain initiatives. It has two equally weighted components: technology adoption and decision sharing. The technology component measures a store's adoption of eight store-level technologies related to supply chain management: (1) electronic data interchange (EDI), (2) electronic-assisted receiving, (3) scan-based trading, (4) computer assisted ordering, (5) electronic shelf tags, (6) product movement analysis, (7) plan-o-grams for shelf-space allocation, and (8) loyalty card programs. The first four are associated with technologies and business practices that link the store to its suppliers. The second four are associated with product selection, promotions, and merchandising. These eight technologies are equally weighted, and the score for this component is simply the percent of technologies adopted. The decision sharing component measures the extent to which parties outside the store are involved in store-level decisions in five key areas: (1) pricing, (2) advertising, (3) space allocation, (4) display merchandising, and (5) promotions. Store managers were asked who has primary responsibility for decisions in each of these areas for four products: apples, dry cereal, direct store delivery (DSD) snacks, and fluid milk. This component is the percent of these twenty

decisions (five for each of four products) for which someone outside the store has primary responsibility. The overall supply chain score is the simple average of the two component scores.

Human Resource Practices The human resources index measures adoption of "progressive" human resource practices. It has three equally weighted components: training, use of full-time employees, and compensation and benefits. The training component is based on hours of training during the first six months of employment for new hires in cashier, deli, and other positions. The use of full-time employees component is simply the percent of employees classified as full-time. The compensation and benefits component measures the use of performance-based compensation and the presence of benefits such as health and disability insurance in the compensation packages of four employees types: store managers, department heads, other full-time employees, and part-time employees. Each component is scored on a 100 point scale, and the overall index is simply the average of the three components.

Food Handling The food handling score measures adoption of practices that promote food safety and quality.[2] It has six components: (1) conformity with target temperatures for self service meat, dairy products, and self service deli; (2) conformity with recommended frequency for temperature checks in self service meat, dairy products, self service deli, and frozen food cases; (3) conformity with recommended frequency for store sanitation audits; (4) use of "sell by" or "use by" dating information for poultry, red meat, seafood, and deli products; (5) conformity with recommended inventory rotation practices for meat, dairy, self service deli,

[2] This index was developed by Professor Ted Labuza from the Department of Food Science and Nutrition at the University of Minnesota.

and frozen foods; and (6) provision of training on food safety for deli and meat department employees. Each component is scored on a 100 point scale, and the overall index is a weighted average of the components.

Environmental Practices The environmental practices index measures adoption of practices that promote environmental quality. It has two equally weighted components. The first is the store's adoption rate for three consumer-oriented environmental practices: (1) environmentally friendly products, (2) organic products, and (3) recycling services. The second is the store's adoption rate for three environmental practices related to store operations: (1) energy efficient lighting, (2) refrigeration management, and (3) store waste recycling. The overall environmental practices score is the simple average of these two adoption rates.

Quality Assurance The quality assurance index measures adoption of quality assurance practices. It has three equally weighted components, each measured on a 100 point scale. The first is the adoption rate of three formal tools for assessing customer satisfaction: (1) customer focus groups, (2) customer satisfaction surveys, and (3) mystery shopper programs. The second component indicates the extent to which stores emphasize quality assurance in their marketing programs by stressing perishables excellence and strong service. The third component is based on four components of the food handling index: (1) temperature checks, (2) sanitation audits, (3) inventory rotation, and (4) food safety training. The overall quality assurance score is the average of scores for these three components.

Service Offerings The service offerings index measures the breadth of services offered by a store. The overall score is the percentage of the following services that are offered: (1) bagging, (2) carryout, (3) custom meat cutting, (4) fax ordering, (5) Internet ordering,

(6) fresh prepared meals, (7) hot meals for home meal replacement (HMR), (8) special checkout lane for HMR customers, (9) pharmacy, (10) post office, (11) in-store banking, (12) videos, and (13) strong service featured in store marketing programs.

Factor Analysis Models of Store Management Practices

The development of the six management practice indices can be viewed as an attempt at data reduction based on expert opinion. Responses to a large number of survey questions were combined into six overall measures. Factor analysis is a statistically-based tool for data reduction. As described in the user documentation for the *Stata* statistical software package used for the analysis in this study (StataCorp., Volume 1, p. 460):

> Factor analysis is concerned with finding a small number of common factors (say q of them) that linearly reconstruct the p original variables
>
> $$y_{ij} = z_{i1}b_{1j} + z_{i2}b_{2j} + \ldots + z_{iq}b_{qj} + e_{ij}$$
>
> where y_{ij} is the value of the ith observation on the jth variable, z_{ik} is the ith observation on the kth common factor, b_{kj} is the set of linear coefficients called factor loadings, and e_{ij} is similar to a residual but known as the jth variable's unique factor.

In principal components analysis, the number of factors, q, is equal to the number of original variables, p, and all the variation in the original variables is explained by the linear combination of factors. In factor analysis, the number of common factors is limited, and factor loadings are transformed for easier interpretation by using an appropriate rotation technique. In effect, then, factor analysis can be used to create a new set of measures that parsimoniously represent much of the variation in the original data.[3]

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[3] Books by Harmon, by Gorsuch, and by Kline provide good overviews of factor analysis methods.

Two factor analysis models are considered in this study. Variable names and definitions for the original variables in each model are presented in Table 1. In the first model, the original variables are simply the six management indices. In the second model, the original variables are twenty components of the six management indices.[4] Results from the first factor analysis model should indicate whether or not the six indices are actually measuring distinct aspects of store management practices. Results from the second factor analysis should indicate whether or not scores for index components are actually associated with underlying factors that correspond to the indices.

A three step process was used in conducting both factor analyses. First, a principal components analysis was performed and a scree test was used to determine the number of factors to retain. The scree test is based on a graph of successive eigenvalues of the transformed correlation matrix. The point at which the plot abruptly levels out signals the cutoff point for retained factors. Second, the factor analysis was performed again with the limited number of factors. Finally, the factors were rotated to facilitate interpretation. Two types of rotations can be performed: orthogonal and oblique. An orthogonal rotation requires the factors to remain uncorrelated while an oblique rotation does not. Since there was no prior evidence to warrant the assumption of orthogonal factors, an oblique rotation, promax, was used.

Rotated factor loadings for the two models are presented in Table 2. To make the table easier to read and the results easier to interpret, only factor loadings greater than 0.25 in absolute

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[4] These twenty components include, without duplication, all the variables used to construct the original indices except two variables that indicate whether or not a store emphasizes perishables excellence and strong service in its marketing programs. More than 95% of stores answered "yes" to both these questions. These variables were included in the quality assurance and service offerings indices.

Table 1. Variable Definitions and Abbreviations for Factor Analysis Models

Variable Definition	Abbreviation	Model 1	Model 2
Supply Chain Index	SCScr	X	
• Data sharing technologies	SCData		X
• Category management technologies	SCCatMan		X
• Decision sharing, pricing, advertising, promotions	SCDSPAP		X
• Decision sharing, shelf space and merchandising	SCDSSM		X
Human Resources Index	HRScr	X	
• Training for deli, cashier, other	HRTrain		X
• Percent full-time employees	HRPerFt		X
• Use of performance-based compensation	HRPerPay		X
• Non-cash benefits	HRBen		X
Food Handling Index	FHScr	X	
• Target temperatures	FHTTemp		X
• Temperature checks	FHTChk		X
• Sanitation audits	FHSanAud		X
• Dating information	FHDating		X
• Inventory rotation	FHInv		X
• Food safety training	FHTrain		X
Environmental Practices Index	EPScr	X	
• Consumer-oriented environmental practices	EPCon		X
• Store operations environmental practices	EPStore		X
Quality Assurance Index	QAScr	X	
• Customer satisfaction assessment tools	QACSat		X
Service Offerings Index	SOScr	X	
• Fax and Internet ordering	SOFaxInt		X
• Home meal replacement services	SOHMR		X
• Other services	SOOther		X

Table 2. Rotated Factor Loadings for Models 1 and 2

	Model 1			Model 2			
Variable	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**
SCScr			0.4591				
• SCData				0.6429			
• SCCatMan				0.5553			
• SCDSPAP					0.8282		
• SCDSSM					0.8163		
HRScr			0.4094				
• HRTrain						0.4217	
• HRPerFt							
• HRPerPay							
• HRBen				0.6645			
FHScr		-0.7532					
• FHTTemp							
• FHTChk							
• FHSanAud						0.3270	
• FHDating							0.3615
• FHInv							0.4931
• FHTrain						0.3584	
EPScr	0.5798						
• EPCon				0.5678			
• EPStore				0.5834			
QAScr		-0.6716					
• QACSat				0.5385			
SOScr	0.5859						
• SOFaxInt						0.4207	
• SOHMR				0.2497		0.3888	
• SOOther				0.3156		0.3571	

value are reported. Three factors were retained in Model 1. Each factor loads on two indices. Factor 1, which loads on environmental practices and service offerings, can be interpreted as a "services" factor, since consumer services are also an important component of the environmental practices index. Factor 2, which loads on the food handling and quality assurance indices, can be interpreted as a "quality control" factor. Because the factor loadings are negative for each index, however, higher scores for this factor are associated with less attention to quality control. Finally, Factor 3, which loads on the supply chain and human resources indices, can be interpreted as an "operational efficiency" factor. The results for this model suggest that the six indices are not measuring independent sets of store management practice characteristics.

Four factors were retained for Model 2. Factor 1 loads on components of five of the six original indices. Since all might be considered progressive management practices, this can be interpreted as a "progressiveness" factor. Factor 2 loads on the two decision sharing components of the supply chain index and so can be interpreted as a "decision sharing" factor. Factor 3 loads on the three components of the original service offerings index, training from the human resource and food handling indices, and food sanitation audits and can be interpreted as an "outstanding service" factor. This is actually a logical combination of variables since training and good sanitation practices are needed to deliver outstanding service, especially in the area of home meal replacement. Finally, Factor 4 loads on dating and inventory rotation practices and can be interpreted as a "fresh food" factor. The results for this model suggest that the original indices may not have grouped variables correctly. Variables from several of the original indices load on the "progressiveness" and "outstanding service" factors, and subsets of the supply chain and food handling indices are separated out in the "decision sharing" and "fresh food" factors.

Using Alternative Management Practices Models in Predicting Store Performance

King, Wolfson, and Seltzer use the six management indices, along with other variables describing store and market characteristics, in regression analyses designed to identify factors associated with superior store performance. In this section we report results for regressions in which we substitute factor scores based on the two factor analysis models for the management indices.[5] We consider four key performance measures: (1) weekly sales per square foot of selling area, (2) sales per labor hour, (3) annual inventory turns, and (4) annual percentage sales growth.

The regression model for each performance measure includes four groups of explanatory variables.

- **Market Characteristics** variables include: population density (**PopDen**) and median household income (**HHInc**) for the zip code in which the store is located and a binary variable indicating whether the store is located in a metropolitan area (**SMSA**).

- **Store Characteristics** variables include: store selling area (**SellSize**), three binary variables indicating store format – superstore/upscale (**US**), food/drug combination (**FD**), and warehouse (**WH**) with conventional being considered the base format – the number of stores owned and operated by the store's owner (**Gsize**), and binary variables indicating whether the store is part of a self-distributing group (**SelfDist**) and if the store has a union workforce (**Union**).[6]

- **Competitive Strategy** variables include four non-mutually exclusive binary variables indicating whether the store considers itself to the price leader (**PLeader**) quality leader (**QLeader**) service leader (**SLeader**), and/or variety leader (**VLeader**) in its local market.

- **Management Practices** variables in the base model include the six management indices: supply chain (**SCScr**), human resources (**HRScr**), food handing (**FHScr**), environmental practices (**EPScr**), quality assurance (**QAScr**), and service offerings

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[5] A store's factor score is constructed by multiplying the transposed vector of factor scoring coefficients by the vector of component variable values for the store. See Harmon (pp 363-376) for a good discussion of scoring procedures.

[6] The union workforce variable was not included in the human resource index because decisions on unionization are often outside the control of store management

(**SOScr**). For Model 1 they include scores based on rotated loadings for the three retained factors: **Services**, **Quality Control**, and **Operational Efficiency**. For Model 2 they include scores based on rotated loadings for the four retained factors: **Progressiveness**, **Decision Sharing**, **Outstanding Service**, and **Fresh Food**.

For each performance measure, the statistical model is a simple linear equation including all the variables in each category, a constant term, and an additive error term. Heteroskedasticity was not expected to be a problem, since the dependent variables are either output/input ratios or percentage changes. On the other hand, multicollinearity was expected to be a problem, since correlations are high among some of the explanatory variables. Finally, stores with missing values were dropped from the analysis for each performance measure. Therefore the sample size differs across regressions.

Regression results for weekly sales per square foot of selling area, a common measure of efficiency in space utilization, are presented in Table 3. Overall goodness of fit is similar for the original model and Model 1 but is slightly lower for Model 2. Signs and statistical significance levels for parameters in the first three variable groups are similar across the three models. Higher sales per square foot levels are associated with higher population density, superstore/upscale and warehouse formats, unionization, and price and service leadership. On the other hand, stores with larger selling areas tend to have lower levels of sales per square foot. One management practice variable is statistically significant at the 5% level in each model – the supply chain score in the original model, the operational efficiency factor in Model 1, and the progressiveness factor in Model 2. Considering the factor loadings, the results for Model 2 suggest that the technology component of the original supply chain index is more closely associated with sales per square foot than is the decision sharing component.

Table 3. Regression Results for Weekly Sales per Square Foot

	Original Indices		Model 1		Model 2	
	Coef.	t	Coef.	t	Coef.	t
Constant	5.798009	3.004 **	8.689401	6.698 **	8.348495	6.413 **
MARKET CHARACTERISTICS						
PopDen	0.000302	2.130 **	0.000313	2.284 **	0.000334	2.380 **
HHInc	-0.000014	-0.443	-0.000014	-0.483	-0.000014	-0.461
SMSA	1.229171	1.547	1.194019	1.533	1.002897	1.250
STORE CHARACTERISTICS						
SellSize	-0.000142	-5.077 **	-0.000143	-5.504 **	-0.000125	-4.664 **
US	2.851495	3.142 **	2.865911	3.208 **	2.656039	2.870 **
FD	1.598191	1.610	1.591015	1.623	1.597956	1.585
WH	3.498068	2.417 **	3.478849	2.616 **	3.102200	2.219 **
Gsize	0.000149	0.336	0.000164	0.375	0.000009	0.019
SelfDist	-0.159585	-0.207	-0.113200	-0.154	0.135713	0.182
Union	2.332461	3.296 **	2.395206	3.490 **	1.918322	2.647 **
COMPETITIVE STRATEGY						
Pleader	1.873111	2.930 **	1.906825	3.039 **	2.004984	3.082 **
Qleader	0.214523	0.268	0.234860	0.308	0.213303	0.271
Sleader	1.252109	1.772 *	1.220732	1.759 *	1.013601	1.441
Vleader	-0.044648	-0.061	-0.055840	-0.078	0.122746	0.166
MANAGEMENT PRACTICES						
Original Indices						
SCScr	0.036976	2.062 **				
HRScr	0.045727	1.529				
FHScr	-0.016773	-0.814				
EPScr	0.018116	1.263				
QAScr	-0.005459	-0.178				
SOScr	-0.014944	-0.637				
Model 1						
Services			-0.698837	-0.684		
Quality Control			0.462871	0.908		
Operational Efficiency			2.658485	2.545 **		
Model 2						
Progressiveness					1.172022	2.376 **
Decision Sharing					0.271522	0.706
Outstanding Service					-0.509623	-1.118
Fresh Food					-0.800859	-1.504
Observations	140		140		140	
R-squared	0.4492		0.4475		0.4277	
Adj R-Squared	0.3566		0.3705		0.3426	

* Denotes statistical significance at the 10% level for a two-tailed test.
** Denotes statistical significance at the 5% level for a two-tailed test.

Regression results for sales per labor hour are presented in Table 4. Overall goodness of fit for this measure of efficiency in labor utilization is best for Model 2 and is similar for the original model and Model 1. Once again, parameter signs and significance levels are similar across all three models for explanatory variables in the first three groups. Labor efficiency is positively associated with population density and unionization. In addition, price leadership has a positive sign that is statistically significant at the 10% level in Model 2. None of the management practices variables is statistically significant in the original model or Model 1. The progressiveness factor has a positive coefficient that is statistically significant at the 5% level in Model 2. This makes good sense, since this factor contains adoption rates for technologies that may enhance labor productivity. Once again, then, the grouping of management practice variables in Model 2 yields statistical results with more meaningful interpretation.

Regression results for annual inventory turns, a measure of efficiency in managing product inventory, are presented in Table 5. The overall goodness of fit for Model 2 is slightly better than that for the original model, and both these models perform considerably better than Model 1. In all three models, unionization and quality leadership are strongly associated with higher inventory turn levels, and the binary variable for membership in a self distributing group has a positive, statistically significant parameter for the original model and Model 2. On the other hand, lower inventory turn levels are associated with higher population density and the food/drug combination and warehouse formats. Three of the six management indices have statistically significant coefficients in the original model – human resources with a positive coefficient and environmental practices and quality assurance with negative coefficients. It is difficult to develop a plausible explanation for these particular indices being linked strongly to

Table 4. Regression Results for Sales per Labor Hour

	Original Indices		Model 1		Model 2	
	Coef.	t	Coef.	t	Coef.	t
Constant	57.121660	3.646**	94.231800	9.306**	98.331430	9.993**
MARKET CHARACTERISTICS						
PopDen	0.003470	2.592**	0.003653	2.804**	0.004047	3.125**
HHInc	0.000126	0.520	0.000151	0.650	0.000020	0.092
SMSA	-4.547183	-0.744	-4.331418	-0.726	-4.906164	-0.829
STORE CHARACTERISTICS						
SellSize	-0.000088	-0.425	-0.000132	-0.665	-0.000104	-0.530
US	-7.865636	-1.139	-7.886537	-1.163	-6.025246	-0.890
FD	2.382587	0.314	2.009831	0.269	4.427972	0.601
WH	15.565160	1.399	18.530490	1.825	13.599720	1.312
GSize	0.002627	0.793	0.002514	0.769	0.000587	0.179
SelfDist	-3.391764	-0.570	-3.454071	-0.597	-3.012216	-0.527
Union	20.092240	3.632**	19.644740	3.665**	18.365100	3.396**
COMPETITIVE STRATEGY						
PLeader	7.093616	1.470	7.134465	1.501	9.151503	1.936 *
QLeader	-1.858092	-0.301	-0.891820	-0.149	0.151317	0.026
SLeader	-4.253926	-0.743	-4.088733	-0.727	-6.136457	-1.115
VLeader	1.916913	0.335	1.739104	0.309	2.330580	0.425
MANAGEMENT PRACTICES						
Original Indices						
SCScr	0.106285	0.789				
HRScr	0.238946	0.992				
FHScr	-0.108128	-0.661				
EPScr	0.181326	1.519				
QAScr	0.302204	1.248				
SOScr	-0.061139	-0.322				
Model 1						
Services			3.240626	0.371		
Quality Control			-0.961885	-0.223		
Operational Efficiency			9.288145	1.126		
Model 2						
Progressiveness					14.207450	3.683**
Decision Sharing					-0.477550	-0.175
Outstanding Service					-4.651837	-1.311
Fresh Food					1.670579	0.423
Observations	119		119		119	
R-squared	0.4692		0.4646		0.4858	
Adj R-Squared	0.3608		0.3745		0.3933	

* Denotes statistical significance at the 10% level for a two-tailed test.
** Denotes statistical significance at the 5% level for a two-tailed test.

Table 5. Regression Results for Annual Inventory Turns

	Original Indices		Model 1		Model 2	
	Coef.	t	Coef.	t	Coef.	t
Constant	23.326190	3.068**	18.019420	3.837**	19.804690	4.111**
MARKET CHARACTERISTICS						
PopDen	-0.001403	-2.637**	-0.001253	-2.357**	-0.001116	-2.296**
HHInc	-0.000147	-1.336	-0.000174	-1.579	-0.000181	-1.798
SMSA	4.347022	1.486	3.715374	1.257	3.497997	1.239
STORE CHARACTERISTICS						
SellSize	0.000003	0.027	0.000041	0.381	-0.000005	-0.048
US	0.782148	0.215	0.683257	0.192	0.381669	0.115
FD	-11.729650	-3.095**	-8.599085	-2.374**	-9.325903	-2.663**
WH	-8.884632	-2.066**	-9.810598	-2.335**	-9.015442	-2.192**
GSize	0.001221	0.632	0.000002	0.001	0.000794	0.422
SelfDist	5.455817	1.867 *	4.497111	1.525	5.702450	2.088**
Union	8.892669	3.534**	8.334577	3.365**	7.130675	2.994**
COMPETITIVE STRATEGY						
PLeader	-1.103641	-0.460	-1.176143	-0.497	-0.197608	-0.087
QLeader	8.906931	2.976**	7.788750	2.706**	7.622502	2.801**
SLeader	-3.489916	-1.264	-2.588364	-0.965	-3.022232	-1.228
VLeader	0.632459	0.256	-0.094281	-0.039	-1.732318	-0.774
MANAGEMENT PRACTICES						
Original Indices						
SCScr	0.027276	0.489				
HRScr	0.218579	2.074**				
FHScr	0.054585	0.697				
EPScr	-0.097083	-2.072**				
QAScr	-0.221524	-1.895**				
SOScr	-0.011718	-0.139				
Model 1						
Services			-7.921053	-2.102**		
Quality Control			0.960322	0.590		
Operational Efficiency			6.939750	1.850 *		
Model 2						
Progressiveness					-0.429920	-0.257
Decision Sharing					3.754289	3.419**
Outstanding Service					-4.249783	-2.450**
Fresh Food					-0.816268	-0.504
Observations	88		88		88	
R-squared	0.4208		0.3712		0.4320	
Adj R-Squared	0.2479		0.2184		0.2838	

* Denotes statistical significance at the 10% level for a two-tailed test.
** Denotes statistical significance at the 5% level for a two-tailed test.

inventory management. Two factors have statistically significant coefficients in Model 1 – services with a negative sign and operational efficiency with a positive sign. Recall that the services factor loads on the environmental practices and service offerings indices, while the operational efficiency factor loads on the supply chain and human resources indices. Finally, two factors have statistically significant signs in Model 2. The coefficient for the decision sharing factor has a positive sign, indicating that the presence of decision sharing relationships with parties outside the store is associated with superior inventory management. This is consistent with expectations. The coefficient for the outstanding service factor has a negative sign, suggesting that stores with strong service offerings may carry higher inventory levels for a wider range of products in order to be able to consistently meet customer expectations.

Regression results for annual sales growth are presented in Table 6. Model 2 clearly has the best overall goodness of fit, followed by the original model and Model 1. Higher levels of sales growth are associated with higher population density and price and quality leadership in all models and with higher median household income in the original model and Model 1. On the other hand, lower sales growth is associated with the warehouse format and membership in larger ownership groups in all models, with a service leadership strategy in Models 1 and 2 and with larger selling area in Model 2. Only one management practice index has a statistically significant coefficient in the original model, but it is difficult to explain why more progressive human resource policies would be associated with lower sales growth. No management practice factors have statistically significant coefficients in Model 1, but two factors have statistically significant coefficients in Model 2. Increases in the decision sharing factor score are associated with lower sales growth. One possible interpretation for this is that adaptation to local conditions, which is

Table 6. Regression Results for Annual Sales Growth

	Original Indices		Model 1		Model 2	
	Coef.	t	Coef.	t	Coef.	t
Constant	1.019328	18.789**	0.963297	29.005**	0.966616	30.332**
MARKET CHARACTERISTICS						
PopDen	0.000006	1.723 *	0.000007	2.033**	0.000008	2.469**
HHInc	0.000001	1.932 *	0.000002	2.020**	0.000001	1.320
SMSA	0.002132	0.109	-0.004368	-0.224	0.011971	0.640
STORE CHARACTERISTICS						
SellSize	-0.000001	-1.451	-0.000001	-1.583	-0.000001	-2.170**
US	0.008418	0.379	0.008122	0.363	0.033178	1.496
FD	0.008381	0.296	0.005189	0.182	0.010373	0.386
WH	-0.076902	-2.129**	-0.084746	-2.433**	-0.074416	-2.236**
GSize	-0.000025	-2.200**	-0.000024	-2.105**	-0.000019	-1.736 *
SelfDist	0.022474	1.097	0.028135	1.424	0.028490	1.597
Union	0.008789	0.504	0.016340	0.952	0.029532	1.774 *
COMPETITIVE STRATEGY						
PLeader	0.039295	2.536**	0.044046	2.853**	0.055315	3.746**
QLeader	0.039771	1.990**	0.039137	2.009**	0.039967	2.181**
SLeader	-0.028234	-1.610	-0.030519	-1.736 *	-0.034013	-2.076**
VLeader	0.015389	0.818	0.015148	0.801	0.010705	0.600
MANAGEMENT PRACTICES						
Original Indices						
SCScr	0.000450	0.994				
HRScr	-0.001338	-1.737 *				
FHScr	0.000504	0.944				
EPScr	0.000127	0.356				
QAScr	-0.000455	-0.578				
SOScr	-0.000649	-1.133				
Model 1						
Services			-0.020440	-0.778		
Quality Control			-0.011215	-0.868		
Operational Efficiency			0.003901	0.140		
Model 2						
Progressiveness					-0.003379	-0.292
Decision Sharing					-0.034197	-2.690**
Outstanding Service					-0.012948	-1.183
Fresh Food					0.039896	3.185**
Observations	127		127		127	
R-squared	0.3670		0.3372		0.4179	
Adj R-Squared	0.2475		0.2338		0.3209	

* Denotes statistical significance at the 10% level for a two-tailed test.
** Denotes statistical significance at the 5% level for a two-tailed test.

highest when decisions are made at the store level, may promote sales growth. If this is true, it may also help explain the negative sign for the ownership group size variable. Higher levels for the fresh food factor score are associated with higher sales growth, suggesting that attention to this aspect of quality assurance may be a key to faster growth.

Looking across the results for all four performance measures, Model 2 has the best overall fit for three of the four measures, and the results from Model 2 are, in general, easier to interpret. On the other hand, Model 1, which is a statistically-based simplification of the original management indices, performs poorly relative to the other models. Despite the superior performance of Model 2, the original model is also attractive because the indices are linked to facets of management that practitioners recognize as distinct and important. Nevertheless, the results of this analysis call the breakdowns of activities based on expert opinion into question.

Concluding Remarks

The results presented in this paper suggest that information summarized by the six management practice indices developed for the 2000 Supermarket Panel can be represented more parsimoniously and more effectively by scores based on factor analysis. The four retained factors for Model 2 are readily related to recognized management issues. The progressiveness and outstanding service factors load on components of several of the original indices, while the decision sharing and fresh food factors load on components that had been combined with others in the supply chain and food handling indices. Each of the factors for Model 2 was statistically significant in at least one of the performance regressions, indicating that all are associated with store performance.

Data collection for the 2001 Supermarket Panel has been completed. An identical factor analysis will be conducted for these new data to determine whether the results from this analysis are statistically robust.

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