**A Computational Routine for Disaggregating Industry Margin Data
to Estimate Product Margin**
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A Computational Routine for Disaggregating Retail Industry Margin Data to Estimate Product Margin Rates

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Abstract

Retail industry product margin rates are used to estimate the retail output proportion of final consumption commodities. The Census Bureau collects data on *industry* margin rates, but it does not collect *product* margin rate data. To estimate retail industry-by-commodity output, industry margin rates are disaggregated by product. A number of controls are available for disaggregating industry data. This paper introduces a formal computational method for disaggregating industry margin data using Bayesian statistics and simulation. The routine is capable of accurately imposing multiple controls simultaneously. The method's accuracy is demonstrated by an evaluation of its industry product margin rate estimates. In addition to producing accurate disaggregate estimates, the method is fast and its estimates are replicable. The computational method has a broad range of applications beyond the estimation of industry-by-product margin rates.

1 Introduction

The Industry Economics Division (IED) of the Bureau of Economic Analysis (BEA) estimated 2,858 retail industry product margin rates in compiling the 1997 United States Benchmark Input-Output Tables.[1] These industry product margin rates were estimated by disaggregating the retail industry margin data available for 73 retail industry groupings (see table 1 at the end of the paper for a list of the industry groupings). The process of estimating 2,858 industry-by-product margin rates based on only 73 industry data points requires introducing data constraints—additional information and assumptions—into the estimation process. Data constraints confine the range of possible disaggregate estimates.

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[1] Ann Lawson, Kurt S. Bersani, Mahnaz Fahim-Nader, and Jiemin Guo, "Benchmark Input-Output Accounts of the United States, 1997," *Survey of Current Business* 82 (December 2002): 19-109.

Yet data constraints are only as useful as the precision with which they are imposed in the estimation process.

This paper explains how a disaggregation routine using Bayesian statistics and simulation imposes multiple data constraints simultaneously to estimate industry-by-product margin rates quickly and accurately with respect to the available data. The paper has two parts. Section 2 explains the methodology—formalizing the estimation problem in terms of maximizing a joint conditional distribution. Section 3 discusses some empirical results of the computational routine. The paper concludes with comments on general applications and extensions of the routine.

2   Methodology

Assumptions

The methodology for estimating industry-by-product margin rates incorporates two Census Bureau data tabulations and one assumption that relates the tabulations to one another.

Data Tabulations: The industry margin rates for 73 NAICS retail industry groupings (see table 1).[2]

The proportion of industry product sales-to-total industry sales (see table 3).[3]

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[2] The Census Bureau's Annual Retail Trade Survey program provides BEA with retail industry margin rate data.
[3] The proportion of total industry sales comprised of sales of each merchandise line is calculated using data from the *Retail Merchandise Line Sales* subject series of the 1997 Economic Census.

Relational Assumption: The correlation between the industry margin rate and a product line's proportion of industry sales is intermediated by the (unknown) product margin rates. This implicitly means that there is no direct relationship between the industry margin rate and a product line's proportion of industry sales.

Evaluating the relationship between industry margin rates and the product proportions of industry sales is difficult for two reasons. First, product margin rates vary across industries, so a correlation based on observations from different industries cannot be directly related to individual industries.[4] Second, the revenue proportions for many products tend to covary with revenue proportions for other products; for example, industries that sell more cars than average tend to sell more tires than average as well. This covariance can bias the product rate estimates if it is not controlled in the estimation process. These two complications are nearly impossible to overcome without formal computational methods.

Model

Formalizing the disaggregation problem enables the use of computational methods that are *fast*, *accurate*, and *replicable*. The computational routine proposed herein is designed to encourage analysts to spend more time designing the economic assumptions driving the disaggregation process—and less time computing the disaggregate estimates.

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[4] The variance of product margin rates across industries also precludes the use of regression for estimating product margin rates.

The first step in formalizing the estimation process is to precisely define estimation. *Estimation* is the process of approximating the values of unknown variables using available data and well-defined assumptions. The optimal *estimate* is determined by finding the matrix of unknown variables that maximizes the joint probability of the observed data and the estimation matrix conditional on the methodological assumptions. The model developed in this section formulates the maximization problem in computationally tractable terms.

The joint probability of the industry margin rates, the industry product sales-to-total industry sales proportions, and an arbitrary matrix of industry-by-product margin rate estimates is represented as:

$$\text{Probability}\left(\vec{m},\, X,\, \hat{Y}_i \mid assumption\right), \quad (1)$$

where $\vec{m}$ is a vector of industry group margin rates (from table 1), X is an industry-by-product matrix of each product's proportion of total industry sales revenue (from table 3), $\hat{Y}_i$ is an arbitrary matrix of industry-by-product margin rate estimates, and 'assumption' is the relational assumption stated above.

Joint probability (1) can be reformulated into terms that make maximizing the joint probability function computationally tractable. The problem is rearranged using Bayes' Theorem:

$$P\left(\vec{m},\, X,\, \hat{Y}_i \mid assumption\right) = P(\hat{Y}_i \mid assumption)*P\left(\vec{m},\, X \mid assumption,\, \hat{Y}_i\right), \quad \text{(a)}$$

$$P\left(\vec{m},\, X,\, \hat{Y}_i \mid assumption\right) = P(X \mid assumption)*P\left(\vec{m},\, \hat{Y}_i \mid assumption,\, X\right), \quad \text{(b)}$$

and, because the right side of (a) is equal to the right side of (b):

$$P(\hat{Y}_i | \vec{m}, X, \text{assumption}) = \frac{P(\vec{m}, X | \hat{Y}_i, \text{assumption}) P(\hat{Y}_i | \text{assumption})}{P(\vec{m}, X | \text{assumption})}. \quad (c)$$

Assuming k exclusive and exhaustive discrete values of $\hat{Y}_i$, the denominator in the right-hand side of (c) is written as a weighted sum of the conditional probabilities $P(\vec{m}, X | \hat{Y}_i)$ where the weights are $P(\hat{Y}_i)$:

$$P(\hat{Y}_i | \vec{m}, X, \text{assumption}) = \frac{P(\hat{Y}_i | \text{assumption}) P(\vec{m}, X | \hat{Y}_i, \text{assumption})}{P(\vec{m}, X | \hat{Y}_1, \text{assumption}) P(\hat{Y}_1) + \ldots + P(\vec{m}, X | \hat{Y}_k, \text{assumption}) P(\hat{Y}_k)}. \quad (2)$$

The terms on the right side of equation (2) are computationally straightforward:

    1)   Under a uniform distribution assumption, each possible Y_i is equally likely; therefore, $P(\hat{Y}_i | \text{assumption})$ is uniformly distributed over possible $\hat{Y}_i$ values;

    2) $\hat{Y}_i * X' = \vec{m}$ is either true or false; therefore, $P(\vec{m}, X | \hat{Y}_i)$ is either 1 or 0;

    3)   The right-hand side denominator of equation (2) is the summation of k numerators, which is computed after the numerator has been evaluated for k values of Y.

Equation (2) formalizes the estimation problem in a computationally desirable form. The next step is to set out a computational method for evaluating equation (2) for each matrix $\hat{Y}_i$.

<u>Estimation Procedure</u>

Equation (2) is evaluated using simulation. Simulation relies on the same random sampling intuition employed in economic surveying. Because the different values that a random variable assumes occur with frequencies defined by the variable's probability distribution, a random sample of variable values can be used to estimate its probability distribution. For example, to estimate the price distribution of XYZ bar soap sold by drug stores in Washington DC, a statistician would identify a representative sample of Washington drug stores, record the XYZ bar soap price at each store, and construct a price distribution estimate from the survey sample. Similarly, simulation traverses the problem space of the disaggregation problem and records random samples of possible solutions in order to construct a probability distribution. The exact probability distribution of the estimation set could (hypothetically) be constructed by taking a 'census' of every point in the problem space. In practice, a large number of points in the problem space are sampled and used to construct the probability function of the estimation matrix (Y).

Evaluating equation (2) using simulation begins with sampling a matrix $\hat{Y}_i$ from the uniform probability function $P(Y|assumption)$. Next, the equation $\hat{Y}_i * X' = \vec{m}$ is evaluated; if the equation is true $P(\vec{m}, X|\hat{Y}_i)$ is 1 (otherwise $P(\vec{m}, X|\hat{Y}_i)$ is 0). After thousands of $\hat{Y}_i$'s are sampled, the sample frequencies of $\hat{Y}_i$ are used to estimate the probability distribution of Y conditional on $\vec{m}$, X, and the assumption. The probability distribution's most probable matrix $\hat{Y}_i$ is the estimation matrix that maximizes joint probability (1). In other words, the simulation routine yields the most probable set of estimates of the industry-by-product margin rates.

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<u>Model Extensions</u>

The simulation approach also facilitates the inclusion of additional data constraints.

Additional data constraints can substantially improve the accuracy of disaggregate

estimates, but they also substantially increase the computational complexity of the

disaggregation problem. In contrast to non-formal approaches which make imposing even

one constraint difficult, simulation can accommodate as many data constraints as

computational resources permit. Three additional data constraints for the retail product

margin rate problem are easily incorporated into the simulation procedure. Each of the

additional constraints is explained in turn.

Deterministic bounds are imposed for each industry product margin rate.[5] All

product margin rates are bound within 0 and 100 percent of the respective product's

industry sales revenue. An important corollary of this constraint is that no product margin

rate can assume a value that causes another product rate to breach the boundaries—binding

many margin rates on intervals much smaller than [0, 100]. Formally, the deterministic

bounds for an industry product margin rate are:

$$\max\left(0, \frac{(m\mid\theta)-(1-x)}{x}\right) \leq y \leq \min\left(\frac{(m\mid\theta)}{x}, 1\right),$$

where m is the industry margin rate, x is the product's proportion of industry sales, θ

represents industry product margin rates that have already been estimated, and y is the

(unknown) industry product margin rate. These bounds make each industry product rate

dependent on every other product rate within the same industry. Thus while in the basic

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[5] The use of deterministic bounds in the routine is motivated by King's (1997) ecological inference method, which combines ecological regression (Goodman 1953) and the method of bounds (Duncan and Davis 1953).

model each industry product rate is directly related to every other industry product margin rate for the same product, the intra-industry product rate relationships relate every industry product rate estimate to all other industry product rate estimates. The introduction of bounds therefore facilitates the sharing of information *across* and *within* industries: Each industry product rate estimate 'borrows strength' from every other estimate.

A second constraint ensures that the average product margin rates for an estimation matrix $\hat{Y}_i$ accurately aggregate to the overall average industry margin rate. That is, the following equation must be true:

$$r = \vec{b}_i * \vec{p}',$$

where r is the average industry margin rate, $\vec{b}_i$ is a vector of average product margin rates from estimation matrix $\hat{Y}_i$, and $\vec{p}$ is a vector of each product's average proportion of industry sales.

The third additional constraint is introduced by calculating the distribution of each product margin rate across industries. This requires a two stage process. In the first stage, the distribution of each product rate is estimated across industries. The second stage uses mean and distribution estimates from the first stage to bind industry product margin rates within 2.5 standard deviations of the respective product's average product margin rate.[6]

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[6] Product margin rates vary across industries, but product margin rates exhibit some similarities across industries. The product margin rate applied by any given industry is generally in the same neighborhood as the average product margin rate applied by industries selling the product. The 2.5 standard deviation criterion is a subjective constraint that confines industry product margin rates within a relatively large neighborhood about the average product margin rate. For products that exhibit relatively more margin rate variance across industries, the 2.5 standard deviation constraint can be expanded; for products that exhibit relatively less margin rate variance across industries, the constraint can be further restricted.

This constraint is applied to all merchandise lines, with the exception of those that exhibit significant margin rate variance across industries.[7]

The data constraints used to estimate the industry-by-product margin rates reported in the next section are summarized as follows:

(1) The product proportion of industry sales matrix (table 3);

(2) The assumption that (unknown) product margin rates intermediate the covariance between the industry margin rate and a product's proportion of industry sales;

(3) The deterministic conditional bounds for each industry product margin rate

$$(y): \quad \max\left(0, \frac{(m \mid \theta) - (1-x)}{x}\right) \leq y \leq \min\left(\frac{(m \mid \theta)}{x}, 1\right);$$

(4) The accurate aggregation of an estimation matrix Y_i's average product margin rates to the overall average industry margin rate;

(5) The confinement of most industry product margin rates within a 2.5 standard deviation range of the respective product's (first stage) average margin rate.

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[7] For the broad line estimates presented in the next section, the constraint was not applied to groceries, transportation vehicles, and other merchandise because industry margin rates for these lines tend to vary significantly across industries.

3   Evaluation of Estimation Results

The simulation methodology was used to estimate the industry-by-product margin rates for 41 broad merchandise lines[8] and 173 detailed merchandise lines sold by each of the 73 industry groups for which margin data are available.[9] (Broad line margin rate estimates are reported in the Appendix.) The estimates produced by the proposed quantitative methodology help demonstrate the method's reliability.

Quantitative methodologies such as the one proposed herein are designed to make systematic use of quantitative information. *Good* quantitative methods outperform clinical methods when both methods make use of the same input variables. Thus a good quantitative method can reveal how accurately a clinical method makes systematic use of data. But estimates based on precise clinical methods—clinical methods that accurately make systematic use of information—can also be used to evaluate the accuracy of an unproven quantitative method. Because IED employs meticulous clinical methods[10] in making margin rate estimates, IED margin rate estimates serve as a good initial check of the accuracy of the proposed method for estimating margin rates.

The estimates produced by the simulation routine and the estimates produced by IED's clinical procedures were compared for both detailed and broad merchandise lines.[11] Overall, the industry product margin rate estimates were similar—with greater similarity in

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[8] The Census Bureau's merchandise line classification system delineates 43 broad retail lines. Subsumed under the broad lines are 292 detailed merchandise lines. Table 2 presents descriptions of the 43 broad merchandise lines.

[9] Industry product margin rates were estimated for all broad merchandise lines comprising more than 2.5 percent of industry sales revenue.

[10] IED estimates are produced by analysts with industry specializations. The clinical evaluation of data for an industry, therefore, incorporates an analyst's specialized knowledge of the industry and its products—as well as other analysts' knowledge of the industry's suppliers and consumers.

[11] Comparison tables are omitted here because the IED merchandise line margin rate estimates are not part of BEA's public data files. IED retail margin rate estimates for many commodity categories are available in the "1997 Standard Make and Use Tables at the detailed level" public use file, which can be downloaded from the BEA web site (http://www.bea.gov).

broad line estimates than detailed line estimates.[12] This similarity suggests that the

simulation routine's results are intuitively justified.

The simulation routine and IED's clinical approach both seem to make effective

use of the *available* information. But how accurate are the estimates with respect to the

true values of the estimated margin rates? Retail industry product margin rate data are not

regularly published by any government agency. One of the few sources of retail industry

product margin rate data was compiled by the marketing group at University of Chicago

Graduate School of Business. The University of Chicago dataset contains product margin

rate information for 29 product categories sold by 96 stores run by Dominick's Finer

Food—one of the largest grocery store chains in the Chicago metropolitan area.[13] Of

course, the product margin rates of one grocery store chain operating in a single

metropolitan area are imperfect proxies for national grocery store industry product margin

rates, but, because the grocery store industry is competitive, Dominick's Finer Food's

product margin rates serve as a useful proxy for eight Census merchandise line categories

where comparable University of Chicago product categories exist.

In general, the product margin rate data for Dominick's corroborate the accuracy of

the simulation routine. Comparisons for the eight comparable (detailed) merchandise line

categories are presented in Table A (page 12). For all eight merchandise lines, the

difference between Dominick's rate and the estimated margin rate can be reasonably

explained by difference in the specific product sales composition of the merchandise line

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[12] Subjective knowledge plays an important role when a product comprises a small portion of industry sales revenue and/or the product is sold by few industries. These conditions typically apply to detailed merchandise lines. In the future, the incorporation of subjective estimate bounds in the disaggregation routine should significantly improve detailed line estimates.
[13] The University of Chicago Graduate School of Business Marketing Group's Dominick's Finer Food database is available at the following web site: http://gsbwww.uchicago.edu/research/mkt/.

Table A

Comparison of Simulated 1997 Grocery Store Product Margin Rate Estimates and Dominick's Finer Food Average Product Margin Rates for June 6, 1996 to May 14, 1997

Census Merchandise Line	Simulated Grocery Store Margin Rate Estimate	Dominick's Product Category	Dominick's Average Margin Rate
Bottled, canned, or packaged soft drinks	35	Bottled, canned, or packaged soft drinks	31
Beer & ale	22	Beer	24
Candy	38	Candies, gums and bars displayed at the check-out registers	43
Cigars, cigarettes, tobacco, & smokers' accessories	33	Cigarettes (single and ten packs)	45
Nonprescription medicines	37	Pain reliever and related products	38
Other hygiene needs (including deodorants; hair & shaving products; etc.)	27	Male and female grooming products such as deodorants, shaving cream, razors, etc.	35
Paper & related products (including paper towels, toilet tissue, wraps, etc.)	25	Paper towels	21
		Bathroom tissue	20
Soaps, detergents, & household cleaners	23	Bar soap products for general uses	26
		Liquid and powder laundry detergents	23
		Shampoos and conditioner	34
		Liquid dish detergent for hand wash, liquid and powder automatic dish detergents	24

Source: University of Chicago Graduate School of Business, Marketing Program

category (between the national average and Dominick's) and by the magnitude with which Dominick's unique product margin rate can be expected to potentially deviate from the national average product margin rate.

Overall, the claim that the proposed computational routine accurately implements the data constraints available for disaggregating industry margin data is supported by the similarity of its product margin rate estimates with estimates produced by clinical methods and with Dominick's Finer Food's product margin rates.

5   Conclusions and Future Extensions

The routine presented in this paper demonstrates how estimation based on clinical intuition can be successfully implemented quantitatively. Indeed, the clinical approach to estimation is basically a process of making inferences using intuition to evaluate quantitative data. Thus when the premises of intuitive inference are explicit, effective quantitative methods can be designed by mathematically formalizing the intuitive relationships.[14]

Several intuitive relationships commonly used to disaggregate data are implemented in the simulation routine developed to disaggregate retail industry margin data. In fact, the estimation of retail industry product margin rates is merely a specific example of the disaggregation problem often encountered in producing economic estimates. The routine described in this paper can be applied to many other estimation processes in which the disaggregation problem arises.

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[14] Inference is the process of drawing the conclusion from the premises. In economic estimation, most inference rules are easily mathematically formalized. Computationally evaluating the data with respect to the inference rules is more precise than clinical inference.

Of course, quantitative methods lack the analyst's *subjective* capacity for making inferences about unknown quantities. This shortcoming is evident in several of the disaggregation results produced by the routine—estimates an analyst would readily flag as suspicious. Fortunately, most of the subjective information an analyst employs in disaggregating data can be formalized as a range of values an estimate can assume; for example, the analyst may (very reasonably) assume that the new car dealer industry margin rate for new cars is less than the overall new car dealer industry margin rate. Incorporating subjective information in the disaggregation routine promises to significantly improve disaggregate estimates. A future paper will describe an extension to the disaggregation routine that incorporates subjective information.

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Tables 1 - 3

NAICS	Industry Description	Industry Margin Rate
441	Motor Vehicle and Parts Dealers	19.81
44111	New Car Dealers	16.96
44112	Used Car Dealers	*
44121	Recreational Vehicle Dealers	*
441221	Motorcycle Dealers	*
441222	Boat Dealers	*
441229	All Other Motor Vehicle Dealers	*
4413	Automotive Parts, Accessories, and Tire Stores	36.89
442	Furniture and Home Furnishings Stores	42.23
44211	Furniture Stores	*
44221	Floor Covering Stores	*
44229	Other Home Furnishings Stores	*
443	Electronics and Appliance Stores	25.16
443111	Household Appliance Stores	*
443112	Radio, Television, and Other Electronics Stores	*
44312	Computer and Software Stores	*
44313	Camera and Photographic Supplies Stores	*
444	Building Material and Garden Equipment and Supplies Dealers	26.71
4441	Building Material and Supplies Dealers	25.89
44413	Hardware Stores	*
4442	Lawn and Garden Equipment and Supplies Stores	*
445	Food and Beverage Stores	26.04
4451	Grocery Stores	25.39
4452	Specialty Food Stores	34.43
44523	Fruit and Vegetable Markets	*
445291	Baked Goods Stores	*
445292	Confectionery and Nut Stores	*
445299	All Other Specialty Food Stores	*
44531	Beer, Wine, and Liquor Stores	26.93
446	Health and Personal Care Stores	31.74
44611	Pharmacies and Drug Stores	26.81
44613	Optical Goods Stores	*
44619	Other Health and Personal Care Stores	*
447	Gasoline Stations	22.05
448	Clothing and Clothing Accessories Stores	41.47
44811	Men's Clothing Stores	44.01
44812	Women's Clothing Stores	39.36
44813	Children's and Infants' Clothing Stores	*
44814	Family Clothing Stores	39.84
4481	Clothing Stores	46.66
44821	Shoe Stores	41.53
44831	Jewelry Stores	*
44832	Luggage and Leather Goods Stores	*
451	Sporting Goods, Hobby, Book, and Music Stores	37.79
45111	Sporting Goods Stores	*
45112	Hobby, Toy, and Game Stores	*
45113	Sewing, Needlework, and Piece Goods Stores	*
45114	Musical Instrument and Supplies Stores	*
451211	Book Stores	*
451212	News Dealers and Newsstands	*
45122	Prerecorded Tape, Compact Disc, and Record Stores	*

* indicates margin rate that the Census Bureau provides BEA but does not make publicly available

NAICS	Industry Description	Industry Margin Rate
452	General Merchandise Stores	26.73
4521	Department Stores	28.30
4521101	Conventional Department Stores	*
4521102	Discount or Mass Merchandising Department Stores	22.13
4521103	National Chain Department Stores	*
45291	Warehouse Clubs and Superstores	19.64
45299	All Other General Merchandise Stores	34.80
453	Miscellaneous Store Retailers	43.33
45311	Florists	*
45321	Office Supplies and Stationery Stores	*
45322	Gift, Novelty, and Souvenir Stores	*
45331	Used Merchandise Stores	*
4539	Other Miscellaneous Store Retailers	*
453991	Tobacco Stores	*
45393	Manufactured (Mobile) Home Dealers	*
454	Nonstore Retailers	42.81
45411	Electronic Shopping and Mail-Order Houses	42.82
45421	Vending Machine Operators	*
454311	Heating Oil Dealers	*
454312	Liquefied Petroleum Gas (Bottled Gas) Dealers	*
454319	Other Fuel Dealers	*
45439	Other Direct Selling Establishments	*

* indicates margin rate that the Census Bureau provides BEA but does not make publicly available

Table 2   Broad Merchandise Line Descriptions   1 of 1

Code	Description of Broad Merchandise Line
100	Groceries & other foods for human consumption off the premises
120	Meals, unpackaged snacks, sandwiches, & nonalcoholic beverages
140	Packaged liquor, wine, & beer
150	Cigars, cigarettes, tobacco, & smokers' accessories (excluding sales from vending machines operated by others)
160	Drugs, health aids, & beauty aids (including cosmetics)
180	Soaps, detergents, & household cleaners
190	Paper & related products (including paper towels, toilet tissue, wraps, bags, foils, etc)
200	Men's wear
220	Women's, juniors', & misses' wear
240	Children's wear (including boys' (sizes 2 to 7 & 8 to 20), girls' (sizes 4 to 6x & 7 to 14), & infants' & toddlers' clothing & accessories)
260	Footwear (including accessories)
270	Sewing, knitting, & needlework goods (including fabrics, patterns, sewing supplies, notions, yarns, laces, trimmings, needlework kits, etc)
280	Curtains, draperies, blinds, slipcovers, & bed & table coverings
300	Major household appliances (including vacuum cleaners, refrigerators, dehumidifiers, dishwashers, etc)
310	Small electric appliances (including mixers, blenders, can openers, toasters, frypans, & personal care appliances)
320	Televisions, video recorders, video cameras, video tapes, etc (including parts & accessories)
330	Audio equipment & musical instruments & supplies (including radios, stereos, CDs, sheet music, etc)
340	Furniture & sleep equipment
360	Flooring & floor coverings
370	Computer hardware, software, & supplies
380	Kitchenware & home furnishings (incl cookware, cooking access, dinnerware, giftware, decorative access, mirrors, closet & bathroom access, etc)
400	Jewelry (including watches & watch attachments, novelty jewelry, etc)
420	Books
440	Photographic equipment & supplies
460	Toys, hobby goods, & games (including video & electronic games & wheel goods, except bicycles)
490	Optical goods (including eyeglasses, contact lenses, sunglasses, etc)
500	Sporting goods (including boats, bicycles, parts & accessories, etc)
580	Recreational vehicles, parts & accessories
600	Hardware, tools, & plumbing & electrical supplies
620	Lawn, garden, & farm equipment & supplies, cut flowers, plants & shrubs, fertilizers, etc
640	Dimensional lumber & other building/structural materials & supplies
670	Paint & sundries
680	Manufactured (mobile) homes
690	Wallpaper & other flexible wallcoverings
700	Automobiles, vans, trucks, & other powered transportation vehicles (motorcycles, motor scooters, motorbikes)
720	Automotive fuels
730	Automotive lubricants (oil, greases, etc)
740	Automotive tires, tubes, batteries, parts, & accessories
780	Household fuels (oil, LP gas, wood, & coal)
800	Pets, pet foods, & pet supplies
850	All other merchandise
9810	All other merchandise
9900	Nonmerchandise receipts, excluding sales & other taxes

NAICS	100	120	140	150	160	180	190	200	220	240	260	270	280	300	320	330	340	360	370	380	400
441																					
442													5.1				50.6	21.3		13.2	
443														13.7	11.7	13.0			42.0		
444																					
445	71.0		8.1	3.3	6.5	2.6	2.6														
446	4.5				75.2																
447	10.7		2.9	6.9																	
448								18.8	35.5	6.0	17.2										14.4
451								3.3			3.4	4.4				15.6					
452	13.5				9.4			8.1	13.1	5.3	3.5		3.6							3.7	
453				3.6													3.0		4.0	3.0	
454	8.0				9.3				6.3							3.3			19.0		
4413																					
4441																					
4442																					
4451	74.4		3.4	3.3	7.0	2.8	2.8														
4452	94.4																				
4481								25.7	50.0	8.3	5.3										
4521	3.9				10.6			10.8	18.1	7.0	3.4		4.6								
4539				7.9																	
44111																					
44112																					
44121																					
44211																	86.1			3.6	
44221																		87.2			
44229													22.2				6.5			55.7	
44312																			91.8		
44313															4.4						
44413																					
44523	94.5																				
44531	4.3		87.2	5.2																	
44611	4.5				78.6																
44613																					
44619	10.3				84.0																
44811								88.7	3.8		3.5										
44812									91.1												
44813					4.1					84.0							6.3				

Table 3

Industry-by-Product Revenue Proportions of Industry Sales

NAICS	100	120	140	150	160	180	190	200	220	240	260	270	280	300	320	330	340	360	370	380	400
44814								30.2	38.7	8.1	7.5										
44821								4.6			89.1										
44831																					92.9
44832								2.7	3.1		2.7										
45111								9.6	4.1		10.7										
45112																	4.1			5.4	
45113												79.9	5.3								
45114																91.3					
45122															15.6	74.1					
45291	40.9			4.3	6.4		2.9				4.2									2.6	
45299	8.9				8.4			4.0	5.3											8.0	5.4
45311																				2.6	
45321																	9.0		17.9	11.5	3.3
45322																3.0	9.6			5.4	4.2
45331								6.2	15.5	5.8											
45393																					
45411					13.0			3.1	9.6							4.6			29.0	2.6	2.9
45421	71.1	19.3		3.9																	
45439	25.4				8.2									5.1		2.9	4.6		3.0	6.0	
441221																					
441222																					
441229																					
443111														67.7	12.2	2.9					
443112														7.9	20.3	26.3			20.3		
445291	98.5																				
445292	94.2																				
445299	85.1	5.8																			
451211																5.9					
451212	7.8			12.0																	
453991	3.3		2.7	86.4																	
454311																					
454312																					
454319																					
4521101					10.8			18.8	36.4	6.3	7.5		4.5							4.5	3.5
4521102	6.6				13.7	4.3		6.5	10.6	7.2			4.7								
4521103								13.7	17.4	7.2	4.3		4.6	11.3	3.8						

Table 3

Industry-by-Product Revenue Proportions of Industry Sales

NAICS	420	440	460	490	500	580	600	620	640	670	680	700	720	730	740	780	800	850	9810	9900
441												74.9			11.3					9.5
442																				3.1
443		2.7																6.3	2.7	6.0
444							28.6	15.7	41.8	6.2										
445																				
446				5.3														2.8		
447													70.1							
448																				
451	15.9		15.9		22.9															
452																		3.7		
453								6.9			16.6						6.7	41.7		3.0
454													2.5			13.9		10.0		7.4
4413															86.6					7.4
4441							32.9	4.6	48.5	7.2										
4442								84.2											2.9	3.1
4451																				
4452																				
4481																				
4521																		3.7		
4539											38.1						15.4	28.7		
44111												85.6			3.5					10.3
44112												95.7								3.1
44121						89.9														6.9
44211																				
44221																				8.4
44229																		5.0		
44312																				4.5
44313		72.3																		20.9
44413							52.6	12.6	7.3	11.6										
44523								3.0												
44531																				
44611																				
44613				95.0														3.3		4.2
44619																				2.5
44811																				
44812																				
44813																				

Table 3

Industry-by-Product Revenue Proportions of Industry Sales

NAICS	420	440	460	490	500	580	600	620	640	670	680	700	720	730	740	780	800	850	9810	9900
44814																		2.6		
44821																				
44831																				3.2
44832																		87.1		
45111					69.2															2.5
45112			67.3															14.6		
45113																		11.1		
45114																				7.6
45122																			3.8	
45291														2.7					5.7	
45299			4.4				6.1											9.3		
45311								80.2										8.4		6.2
45321																		65.8		5.9
45322			3.6															63.4		
45331	5.8																	30.7		
45393											97.0									
45411																		12.2		
45421																				2.7
45439	5.4																	17.6		
441221					9.3							74.9								9.1
441222					88.6															9.0
441229					40.0							6.4						42.5		8.0
443111																				6.0
443112																		12.0	5.3	6.2
445291																				
445292																				
445299																				
451211	78.0																	8.7		
451212	4.9		2.8															66.7		
453991																		2.5		
454311													19.6			68.3				4.7
454312													4.3			86.6				3.7
454319																95.2				
4521101																				
4521102			5.7															5.3		
4521103							6.3													6.8

Appendix:
Simulation Routine Industry-by-Product Margin Rate
Estimates for Broad Merchandise Lines

NAICS	Industry Description	Industry Margin Rate	Product Description	Product Proportion of Industry Sales Revenue	Product Margin Rate
441	Motor Vehicle and Parts Dealers	19.8	Automobiles, vans, trucks, & other powered transportation vehicles (motorcy	0.749	17.9
			Automotive tires, tubes, batteries, parts, & accessories	0.113	18.6
			Nonmerchandise receipts, excluding sales & other taxes	0.095	36.8
44111	New Car Dealers	17.0	Automobiles, vans, trucks, & other powered transportation vehicles (motorcy	0.856	14.1
			Automotive tires, tubes, batteries, parts, & accessories	0.035	24.0
			Nonmerchandise receipts, excluding sales & other taxes	0.103	38.1
4413	Automotive Parts, Accessories, and Tire Stores	36.9	Automotive tires, tubes, batteries, parts, & accessories	0.866	37.0
			Nonmerchandise receipts, excluding sales & other taxes	0.074	35.3
442	Furniture and Home Furnishings Stores	42.2	Curtains, draperies, blinds, slipcovers, & bed & table coverings	0.051	36.1
			Furniture & sleep equipment	0.506	38.9
			Flooring & floor coverings	0.213	52.2
			Kitchenware & home furnishings (incl cookware, cooking access, dinnerware,	0.132	42.4
			Nonmerchandise receipts, excluding sales & other taxes	0.031	37.1

Product margin rates for broad merchandise lines comprising at least 2.5 percent of the industry's revenue.

NAICS	Industry Description	Industry Margin Rate	Product Description	Product Proportion of Industry Sales Revenue	Product Margin Rate
443	Electronics and Appliance Stores	25.2	Major household appliances (including vacuum cleaners, refrigerators, dehum	0.137	22.4
			Televisions, video recorders, video cameras, video tapes, etc (including pa	0.117	21.5
			Audio equipment & musical instruments & supplies (including radios, stereos	0.130	33.8
			Computer hardware, software, & supplies	0.420	21.3
			Photographic equipment & supplies	0.027	34.8
			All other merchandise	0.063	31.1
			All other merchandise	0.027	25.4
			Nonmerchandise receipts, excluding sales & other taxes	0.060	36.5
444	Building Material and Garden Equipment and Supplies Dealers	26.7	Hardware, tools, & plumbing & electrical supplies	0.286	26.2
			Lawn, garden, & farm equipment & supplies, cut flowers, plants & shrubs, fe	0.157	34.4
			Dimensional lumber & other building/structural materials & supplies	0.418	23.6
			Paint & sundries	0.062	30.5
4441	Building Material and Supplies Dealers	25.9	Hardware, tools, & plumbing & electrical supplies	0.329	27.7
			Lawn, garden, & farm equipment & supplies, cut flowers, plants & shrubs, fe	0.046	36.5
			Dimensional lumber & other building/structural materials & supplies	0.485	22.6
			Paint & sundries	0.072	32.7

Product margin rates for broad merchandise lines comprising at least 2.5 percent of the industry's revenue.

NAICS	Industry Description	Industry Margin Rate	Product Description	Product Proportion of Industry Sales Revenue	Product Margin Rate
445	Food and Beverage Stores	26.0	Groceries & other foods for human consumption off the premises	0.710	25.4
			Packaged liquor, wine, & beer	0.081	25.2
			Cigars, cigarettes, tobacco, & smokers' accessories (excluding sales from v	0.033	30.9
			Drugs, health aids, & beauty aids (including cosmetics)	0.065	31.5
			Soaps, detergents, & household cleaners	0.026	25.6
			Paper & related products (including paper towels, toilet tissue, wraps, bag	0.026	28.2
4451	Grocery Stores	25.4	Groceries & other foods for human consumption off the premises	0.744	24.9
			Packaged liquor, wine, & beer	0.034	23.2
			Cigars, cigarettes, tobacco, & smokers' accessories (excluding sales from v	0.033	32.7
			Drugs, health aids, & beauty aids (including cosmetics)	0.070	29.8
			Soaps, detergents, & household cleaners	0.028	23.4
			Paper & related products (including paper towels, toilet tissue, wraps, bag	0.028	25.2
4452	Specialty Food Stores	34.4	Groceries & other foods for human consumption off the premises	0.944	34.2

Product margin rates for broad merchandise lines comprising at least 2.5 percent of the industry's revenue.

NAICS	Industry Description	Industry Margin Rate	Product Description	Product Proportion of Industry Sales Revenue	Product Margin Rate
44531	Beer, Wine, and Liquor Stores	26.9	Groceries & other foods for human consumption off the premises	0.043	43.0
			Packaged liquor, wine, & beer	0.872	25.8
			Cigars, cigarettes, tobacco, & smokers' accessories (excluding sales from v	0.052	32.0
446	Health and Personal Care Stores	31.7	Groceries & other foods for human consumption off the premises	0.045	46.5
			Drugs, health aids, & beauty aids (including cosmetics)	0.752	28.7
			Optical goods (including eyeglasses, contact lenses, sunglasses, etc)	0.053	55.8
			All other merchandise	0.028	44.7
44611	Pharmacies and Drug Stores	26.8	Groceries & other foods for human consumption off the premises	0.045	39.8
			Drugs, health aids, & beauty aids (including cosmetics)	0.786	25.7
			All other merchandise	0.033	36.5
			Optical goods (including eyeglasses, contact lenses, sunglasses, etc)	0.950	71.1
			Nonmerchandise receipts, excluding sales & other taxes	0.042	38.1
			Groceries & other foods for human consumption off the premises	0.103	71.7
			Drugs, health aids, & beauty aids (including cosmetics)	0.840	46.7
			Nonmerchandise receipts, excluding sales & other taxes	0.025	38.3

Product margin rates for broad merchandise lines comprising at least 2.5 percent of the industry's revenue.

NAICS	Industry Description	Industry Margin Rate	Product Description	Product Proportion of Industry Sales Revenue	Product Margin Rate
447	Gasoline Stations	22.0	Groceries & other foods for human consumption off the premises	0.107	39.4
			Packaged liquor, wine, & beer	0.029	24.3
			Cigars, cigarettes, tobacco, & smokers' accessories (excluding sales from v	0.069	32.4
			Automotive fuels	0.701	18.3
448	Clothing and Clothing Accessories Stores	41.5	Men's wear	0.188	41.3
			Women's, juniors', & misses' wear	0.355	38.9
			Children's wear (including boys' (sizes 2 to 7 & 8 to 20), girls' (sizes 4	0.060	40.4
			Footwear (including accessories)	0.172	42.5
			Jewelry (including watches & watch attachments, novelty jewelry, etc)	0.144	47.0
44811	Men's Clothing Stores	44.0	Men's wear	0.887	44.5
			Women's, juniors', & misses' wear	0.038	36.6
			Footwear (including accessories)	0.035	40.2
44812	Women's Clothing Stores	39.4	Women's, juniors', & misses' wear	0.911	38.9
44814	Family Clothing Stores	39.8	Men's wear	0.302	40.5
			Women's, juniors', & misses' wear	0.387	38.6
			Children's wear (including boys' (sizes 2 to 7 & 8 to 20), girls' (sizes 4	0.081	40.1
			Footwear (including accessories)	0.075	40.2
			All other merchandise	0.026	48.6

Product margin rates for broad merchandise lines comprising at least 2.5 percent of the industry's revenue.

NAICS	Industry Description	Industry Margin Rate	Product Description	Product Proportion of Industry Sales Revenue	Product Margin Rate
4481	Clothing Stores	46.7	Men's wear	0.257	48.3
			Women's, juniors', & misses' wear	0.500	47.1
			Children's wear (including boys' (sizes 2 to 7 & 8 to 20), girls' (sizes 4	0.083	42.2
			Footwear (including accessories)	0.053	42.4
44821	Shoe Stores	41.5	Men's wear	0.046	39.1
			Footwear (including accessories)	0.891	41.7
451	Sporting Goods, Hobby, Book, and Music Stores	37.8	Men's wear	0.033	39.2
			Footwear (including accessories)	0.034	39.2
			Sewing, knitting, & needlework goods (including fabrics, patterns, sewing s	0.044	47.0
			Audio equipment & musical instruments & supplies (including radios, stereos	0.156	40.7
			Books	0.159	43.1
			Toys, hobby goods, & games (including video & electronic games & wheel good	0.159	34.9
			Sporting goods (including boats, bicycles, parts & accessories, etc)	0.229	29.2
			All other merchandise	0.069	47.2

Product margin rates for broad merchandise lines comprising at least 2.5 percent of the industry's revenue.

NAICS	Industry Description	Industry Margin Rate	Product Description	Product Proportion of Industry Sales Revenue	Product Margin Rate
452	General Merchandise Stores	26.7	Groceries & other foods for human consumption off the premises	0.135	9.8
			Drugs, health aids, & beauty aids (including cosmetics)	0.094	27.1
			Men's wear	0.081	34.4
			Women's, juniors', & misses' wear	0.131	29.6
			Children's wear (including boys' (sizes 2 to 7 & 8 to 20), girls' (sizes 4	0.053	32.4
			Footwear (including accessories)	0.035	36.4
			Curtains, draperies, blinds, slipcovers, & bed & table coverings	0.036	30.9
			Kitchenware & home furnishings (incl cookware, cooking access, dinnerware,	0.037	40.3
			All other merchandise	0.037	25.2
4521	Department Stores	28.3	Groceries & other foods for human consumption off the premises	0.039	25.1
			Drugs, health aids, & beauty aids (including cosmetics)	0.106	26.3
			Men's wear	0.108	31.5
			Women's, juniors', & misses' wear	0.181	26.2
			Children's wear (including boys' (sizes 2 to 7 & 8 to 20), girls' (sizes 4	0.070	29.3
			Footwear (including accessories)	0.034	36.1
			Curtains, draperies, blinds, slipcovers, & bed & table coverings	0.046	27.4
			Kitchenware & home furnishings (incl cookware, cooking access, dinnerware,	0.036	38.4
			All other merchandise	0.037	20.4

Product margin rates for broad merchandise lines comprising at least 2.5 percent of the industry's revenue.

NAICS	Industry Description	Industry Margin Rate	Product Description	Product Proportion of Industry Sales Revenue	Product Margin Rate
4521102	Discount or Mass Merchandising Department Stores	22.1	Groceries & other foods for human consumption off the premises	0.066	9.6
			Drugs, health aids, & beauty aids (including cosmetics)	0.137	23.1
			Soaps, detergents, & household cleaners	0.043	11.8
			Men's wear	0.065	34.4
			Women's, juniors', & misses' wear	0.106	29.0
			Children's wear (including boys' (sizes 2 to 7 & 8 to 20), girls' (sizes 4	0.072	27.4
			Curtains, draperies, blinds, slipcovers, & bed & table coverings	0.047	22.5
			Toys, hobby goods, & games (including video & electronic games & wheel good	0.057	19.6
			All other merchandise	0.053	10.1
45291	Warehouse Clubs and Superstores	19.6	Groceries & other foods for human consumption off the premises	0.409	9.7
			Cigars, cigarettes, tobacco, & smokers' accessories (excluding sales from v	0.043	35.4
			Drugs, health aids, & beauty aids (including cosmetics)	0.064	33.2
			Paper & related products (including paper towels, toilet tissue, wraps, bag	0.029	24.3
			Footwear (including accessories)	0.042	42.2
			Kitchenware & home furnishings (incl cookware, cooking access, dinnerware,	0.026	44.0
			Automotive lubricants (oil, greases, etc)	0.027	40.8
			All other merchandise	0.057	23.8

Product margin rates for broad merchandise lines comprising at least 2.5 percent of the industry's revenue.

NAICS	Industry Description	Industry Margin Rate	Product Description	Product Proportion of Industry Sales Revenue	Product Margin Rate
45299	All Other General Merchandise Stores	34.8	Groceries & other foods for human consumption off the premises	0.089	35.7
			Drugs, health aids, & beauty aids (including cosmetics)	0.084	31.7
			Men's wear	0.040	40.0
			Women's, juniors', & misses' wear	0.053	34.3
			Kitchenware & home furnishings (incl cookware, cooking access, dinnerware,	0.080	39.8
			Jewelry (including watches & watch attachments, novelty jewelry, etc)	0.054	42.3
			Toys, hobby goods, & games (including video & electronic games & wheel good	0.044	34.6
			Hardware, tools, & plumbing & electrical supplies	0.061	29.9
			All other merchandise	0.093	29.6
453	Miscellaneous Store Retailers	43.3	Cigars, cigarettes, tobacco, & smokers' accessories (excluding sales from v	0.036	36.5
			Furniture & sleep equipment	0.030	45.6
			Computer hardware, software, & supplies	0.040	35.8
			Kitchenware & home furnishings (incl cookware, cooking access, dinnerware,	0.030	43.7
			Lawn, garden, & farm equipment & supplies, cut flowers, plants & shrubs, fe	0.069	39.9
			Manufactured (mobile) homes	0.166	45.8
			Pets, pet foods, & pet supplies	0.067	50.1
			All other merchandise	0.417	43.4
			Nonmerchandise receipts, excluding sales & other taxes	0.030	37.9

Product margin rates for broad merchandise lines comprising at least 2.5 percent of the industry's revenue.

NAICS	Industry Description	Industry Margin Rate	Product Description	Product Proportion of Industry Sales Revenue	Product Margin Rate

Product margin rates for broad merchandise lines comprising at least 2.5 percent of the industry's revenue.

NAICS	Industry Description	Industry Margin Rate	Product Description	Product Proportion of Industry Sales Revenue	Product Margin Rate
454	Nonstore Retailers	42.8	Groceries & other foods for human consumption off the premises	0.080	56.1
			Drugs, health aids, & beauty aids (including cosmetics)	0.093	35.3
			Women's, juniors', & misses' wear	0.063	37.2
			Audio equipment & musical instruments & supplies (including radios, stereos	0.033	39.9
			Computer hardware, software, & supplies	0.190	37.7
			Automotive fuels	0.025	38.9
			Household fuels (oil, LP gas, wood, & coal)	0.139	40.1
			All other merchandise	0.100	57.9
45411	Electronic Shopping and Mail-Order Houses	42.8	Drugs, health aids, & beauty aids (including cosmetics)	0.130	35.9
			Men's wear	0.031	40.6
			Women's, juniors', & misses' wear	0.096	37.0
			Audio equipment & musical instruments & supplies (including radios, stereos	0.046	40.0
			Computer hardware, software, & supplies	0.290	40.2
			Kitchenware & home furnishings (incl cookware, cooking access, dinnerware,	0.026	43.4
			Jewelry (including watches & watch attachments, novelty jewelry, etc)	0.029	46.1
			All other merchandise	0.122	61.8

Product margin rates for broad merchandise lines comprising at least 2.5 percent of the industry's revenue.