THE CONSTRUCTION OF INDUSTRY PRODUCTIVITY MEASURES

by:

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Good morning. I am pleased to be here today to take part in your annual meeting. This morning I thought I would provide you with some background on the Bureau's productivity measurement program and tell you about some of the measures that are available. After that, I will go over a few of the concepts that underlie the indexes and then discuss the construction of the retail food measure that we publish.

As some of you may know, BLS has been measuring productivity for many years. One of the earliest studies was done in 1898 by Carroll D. Wright, who was the first Commissioner of Labor Statistics. He did a study of productivity change in 60 manufacturing industries and this study provided evidence of the savings in labor that resulted from mechanization in the last half of the 19th Century. Today, the Bureau of Labor Statistics is responsible for developing and publishing the government's official productivity measures.

Measurement Program

The productivity measures that we develop are based primarily on data that have already been collected--either by other Government agencies or private organizations. The measurement program we have is quite extensive. First, we have measures for the major sectors of the economy. Each quarter we publish data for the private business sector, nonfarm business, nonfinancial corporations, and manufacturing.

Next, we have measures for individual industries. Currently we publish over 90 industry measures and we try to add about five each year. These measures now cover about one third of the employees in the nonfarm business sector. (Attachment 1). In addition to these published industries, we also have unpublished measures of productivity for the 400 industries within the manufacturing sector. Although we do not publish them because of limitations in the data, we do make them available on request for research and analytical purposes.

We also have an international comparisons program. Comparisons of productivity for the manufacturing sector as a whole are available for 10 foreign countries, including Canada, Japan, and the major European Nations.

Our office is also responsible for constructing productivity measures for agencies within the Federal Government. These indexes now cover about 65% of the civilian workforce. Unlike the other measures, the productivity indexes for the Federal government are based on the direct collection of data from the participating agencies.

Productivity Concepts

Productivity is, in its broadest context, a type of efficiency measure. However, the measures of labor productivity do not reflect the direct efficiency of the employees. An industry's productivity trend is affected not only by changes in labor effort, but also by capital and all of the other factors in the production process. The labor productivity measures, therefore, reflect the influence of all of these factors, not just labor effort.

At times, productivity measurement is thought to be the same as work measurement. However, there is a difference. Work measurement analysis examines work activities in the production process. The concern is to assess resource requirements under a given set of technological conditions. This contrasts with productivity measurement which is concerned with the results of work activity and the relationship between final outputs and inputs.

There is also a difference between productivity and effectiveness. As I mentioned, productivity is a type of efficiency measure. Effectiveness measures attempt to quantify the impact of a program on society. These measures, however, deal with the consequence of the production process and the emphasis shifts from the relationship of outputs to inputs to the consumer or recipient of the outputs.

Industry Measures

As I mentioned, the industry productivity measures that we develop are based on data that have already been collected. Since these data were not (and are not) collected for the purpose of productivity measurement, we have to adapt the data so that it will fit the idea measurement framework as closely as possible. We use data not only from other Government agencies, but also from trade associations and companies to develop our indexes.

We use several criteria to select the industries we develop for publication. First, since we have limited staff, we try to do the industries that have the largest employment. Secondly, we look at the employment coverage within each sector. In 1975, our measures covered 23 percent of the manufacturing employment but only 5 percent of the trade and service employment. Because of the low coverage in trade and services, we focused our efforts in this area. As a result, our measures now cover about 31 percent of the employment within these sectors. Other criteria we use include the importance of the industry in the economy and, of course, the availability of data.

The industry productivity growth rates are quite diverse. Over the last 5 years productivity growth ranged from about 11 percent per year for corn milling to -3.6 percent per year for bituminous coal mining. (Attachment 2).

Output Criteria and Concepts

The general method we use to construct our measures is to develop both an index of output and an index of input such as employee-hours. The productivity index is derived by dividing the output index by the input index.

We have several criteria for selecting the output indicators that we use. (Attachment 3). First, the preferred output index is based on the physical quantity of final, individual products. Intermediate output is not counted. For example, if an automobile establishment makes an engine and also assembles the automobile, we count only the completed automobile in the output measure. The engine, which in this establishment is an intermediate product, is included as part of the completed automobile.

Second, there has to be sufficient product detail. Products that require more labor time to produce should have more importance (or weight) in the index. If the data are aggregated too much and they are not homogeneous in terms of the labor requirements, bias can occur if there is a change in the product mix. (Attachment 4).

Because we are developing labor productivity indexes, the appropriate weights to use for combining products are employee-hour weights. If employee-hour weights are not available, we have to use substitute weights such as unit labor costs or unit values. The substitute weights should be proportional to employee-hour requirements. If, for example, product "A" costs twice as much as product "B," then, ideally, product "A" should require twice as much labor time as product "B." Plant visits and interviews with people knowledgeable about the industry help us to determine whether there is proportionality between unit hours and the substitute weights.

In many manufacturing industries, the individual products are grouped into various product classes. At this higher level of aggregation, information on employment and hours is available every five years from the Census of Manufacturers. This information allows us to use a two level weighting system which results in an output index that is conceptually closer to the preferred measure.

First, individual products are combined into product class indexes using unit value weights. Then, using the information on employment and hours reported for each product class, we develop employee hour weights to combine the product class indexes into an overall measure. (Attachment 5).

If physical quantity information is not available, we can use a technique known as deflated value to compute the output measure. In its simplest form, the value of shipments or production is divided by a price index to remove the effects of changing price levels. The technique is referred to as deflated value because the adjustment for price change is most often downward. A measure based in part on deflated value is conceptually equivalent to a physical output index constructed with unit value weights. Presently, about half of our published industry measures are based on deflated value including the measure for retail food stores and the measures for the other trade and service industries.

An output index that is being developed should be adjusted for quality change if the change to a product would also change the labor time required in the base year for its production. To illustrate this point, let's assume that in the first year, automobiles are made without anti-pollution equipment. In the second year, the automobiles are made with the anti-pollution equipment. In this example, we would make an adjustment to the measure because the base year labor requirements to produce the automobiles would have changed. If we did not make this adjustment, the measure could show a productivity decline even though such a decline might not have occurred.

The indexes should also reflect the activity of the industry or organization being measured. The industry measures that we develop are based on gross concepts. That is, the data used reflect not only the industry's activity, but also the material inputs supplied by other industries. For example, in the bakery products industry the value of the bread and the other baked goods includes not only the value added by the bakery, but also the value of the flour which was purchased from another industry. If there are significant changes in the value added and purchase relationships, (also known as changes in vertical integration) we would have to make an adjustment to the measure.

Finally, the productivity indexes should reflect each year's workload. That is, the final output that is produced should correspond with the employment and hours that are utilized. The shipbuilding industry provides a good example of what we call the cycle time problem. If, for example, a ship takes 5 years to build and we count it only when all the work has been completed, it implies that nothing was done during the previous four years. This, of course, is not true. The problem we face is how to allocate the work that is done over the full five-year period.

Employment and Hours

I want to turn now to the data sources used for developing employment and hours. The two primary sources of employment information are the BLS and the Bureau of the Census. Employees and hours from both sources are each considered to be homogeneous and additive. This means that the engineer, the president of the company and all other persons are counted equally in the measure. At the present time, adequate information is not available to separately weight the categories of workers. Both BLS and Census publish data on total employment, production workers and production worker hours. Information on nonproduction worker hours, however, are not available on a continuing basis from any Government agency. For our measures, we make estimates of the hours for nonproduction workers using unpublished data from BLS surveys of employee compensation in the private nonfarm economy.

There are some differences in coverage between the BLS and Census surveys. BLS collects information on all the hours of production workers whether worked or paid for; Census collects hours at the plant. Hours at the plant is closer to an hours worked concept which is preferred for productivity measurement. However, indexes based on hours paid, will be identical to indexes based on hours worked if there is no change in paid time off.

BLS includes employment in Central Administrative Offices, Census does not. BLS also provides broader coverage than the Census Bureau. The Census Bureau for example, does not collect annual employment and hours data for any of the trade and service industries. For our published measures, we use the series that we believe gives the most accurate portrayal of the labor input trends. Some industries use BLS input, others use Census input.

For retail food and the other trade and service industries, the primary source of data is the BLS. However, these statistics are supplemented with information from other agencies to ensure complete coverage of the industry's work force. Data from the IRS are used for the number of partners and proprietors. Data from the current population survey are used for the number and average hours of unpaid family workers, and for the average hours of partners and proprietors. We also use the Census of Population to obtain estimates of the average hours for paid supervisors.

It is important to include this information in the labor input measure because the impact is significant. In 1958, 31 percent of the retail food work force was made up of partners, proprietors and unpaid family workers. They have declined rapidly since then, but they still account for about 10 percent of the employment.

Retail Food Stores Measures

At this time I would like to go over the construction of the retail food output measure with you in some detail. The schematic diagram (Attachment 6) shows how the output index is constructed. Before I begin, I have two general comments. First, we have to construct a measure for all retail food stores combined, because data are not available to construct seperate measures for each type of store. Second, the term "benchmark" refers to indexes that are calculated every 5 years from Census data. For most of our industries--not just retail food--we adjust the annual or intercensal year indexes to those constructed from Census data. We do this because the Census data are usually more comprehensive than the annual data both in coverage and in the amount of detail that is available.

The first part of the retail food measure is the index for grocery stores. We estimate the sales of various store departments and then deflate them with appropriate components of the consumer price index. Bakery products, for example, are deflated with a combination of price indexes relating to baked goods. Currently, we estimate the sales for 13 broad categories of merchandise.

Next, we combine indexes of the deflated sales into an overall grocery store measure using labor cost weights. We develop the labor cost weights from data on the labor cost component of gross margins published by the Department of Agriculture.

As the schematic shows, we use similar techniques to develop the measures for specialty food stores. After the sales are deflated, the indexes for each type of store--such as meat markets and fish markets--are combined with employment weights into the overall output index for specialty food stores.

Finally, the measures for both grocery stores and specialty food stores are aggregated into the total retail food output index. Presently, the index for grocery stores has about 84 percent of the weight in the measure, which is almost the same as it was in 1963.

This concludes my presentation this morning. I hope I have given you a better understanding our our productivity measurement program, and a flavor for some of the concepts and procedures that we use to develop the industry measures.

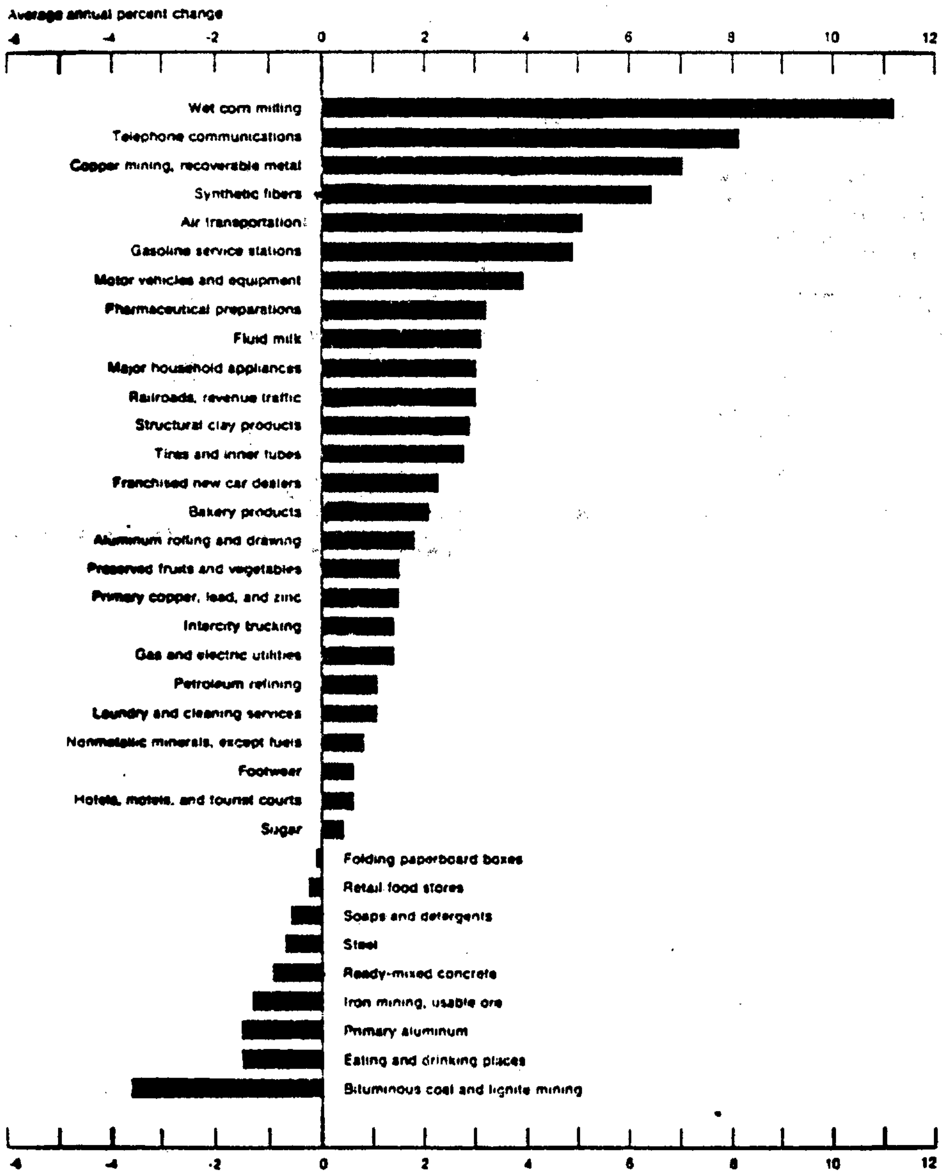
Selected industries: Employment, 1978, and average annual rates of change in output per employee hour, 1973–78

SIC code	Industry	Employment, 1978 (thousands)			Output per employee hour: Average annual rate of change, 1973–78 (percent)[1]		
		All employees	Production workers	Non-production workers	All employees	Production workers	Non-production workers[2]
	Mining						
1011	Iron mining, crude ore	24	20	4	(3)	0.6	(3)
1011	Iron mining, usable ore	24	20	4	(3)	−1.3	(3)
1021	Copper mining, crude ore	30	23	7	(3)	7.0	(3)
1021	Copper mining, recoverable metal	30	23	7	(3)	7.0	(3)
111,121	Coal mining	208	172	36	(3)	−3.5	(3)
121	Bituminous coal and lignite mining	205	170	35	(3)	−3.6	(3)
14	Nonmetallic minerals, except fuels	119	94	25	(3)	.8	(3)
142	Crushed and broken stone	39	33	6	(3)	1.6	(3)
	Manufacturing						
2026	Fluid milk	118	(3)	(3)	3.1	(3)	(3)
203	Preserved fruits and vegetables	252	205	47	[4]1.5	[4]1.7	[4]0.6
2033	Canned fruits and vegetables	96	78	18	[4]1.7	[4]1.9	[4]−.4
204	Grain mill products	145	98	47	[4]4.9	[4]5.5	[4]3.3
2041	Flour and other grain mill products	26	16	10	3.7	4.9	−.1
2043	Cereal breakfast foods	17	13	4	[4].8	[4].9	[4].1
2044	Rice milling	5	4	1	[4]3.8	[4]1.7	[4]13.2
2045	Blended and prepared flour	8	6	2	[4]−1.9	[4].4	[4]−8.1
2046	Wet corn milling	13	9	4	[4]11.2	[4]10.5	[4]13.1
2047,48	Prepared feeds for animals and fowls	76	50	26	[4]6.2	[4]7.3	[4]3.9
205	Bakery products	235	137	98	2.1	2.5	1.4
2061,62,63	Sugar	33	24	9	.4	1.5	−3.3
2061,62	Raw and refined cane sugar	20	14	6	[4]1.3	[4]1.9	[4]−.5
2063	Beet sugar	13	10	3	[4].5	[4]1.4	[4]−5.8
2065	Candy and confectionery products	58	46	12	.2	−.7	3.9
2082	Malt beverages	51	34	17	7.5	7.0	8.8
2086	Bottled and canned soft drinks	136	48	88	6.2	6.9	5.8
2111,21,31	All tobacco products	49	41	8	3.2	4.2	−2.5
2111,31	Cigarettes, chewing and smoking tobacco	41	34	7	3.4	4.5	−2.5
2121	Cigars	8	7	1	3.6	3.3	7.5
2251,52	Hosiery	63	57	6	8.1	7.4	14.2
2421	Sawmills and planing mills, general	190	171	19	1.4	1.5	.4
2435,36	Veneer and plywood	77	68	9	2.7	2.6	3.7
251	Household furniture	330	281	49	1.1	1.4	−1.2
2511,17	Wood household furniture	156	138	18	[4]−.6	[4].5	[4]−11.0
2512	Upholstered household furniture	102	84	18	[4]2.5	[4]2.6	[4]2.3
2514	Metal household furniture	32	26	6	[4]1.5	[4]1.6	[4]1.1
2515	Mattresses and bedsprings	33	26	7	[4]3.8	[4]4.3	[4]2.0
2611,21,31,61	Paper, paperboard, and pulp mills	267	204	63	2.1	2.7	−.2
2651	Folding paperboard boxes	46	36	10	−.1	−.1	.1
2653	Corrugated and solid fiber boxes	107	79	28	2.6	3.1	1.1
2823,24	Synthetic fibers	89	70	19	6.4	6.5	6.2
2834	Pharmaceutical preparations	149	69	80	3.2	3.8	(3)
2841	Soaps and detergents	40	25	15	[4]−.6	[4]−.2	[4]−1.5
2851	Paints and allied products	69	36	33	3.9	4.4	3.3
2911	Petroleum refining	165	104	61	1.1	1.1	1.3
3011	Tires and inner tubes	127	92	35	2.8	2.9	2.7
314	Footwear	158	138	20	.6	.5	1.1
3221	Glass containers	77	68	9	2.0	2.2	.8
3241	Hydraulic cement	32	26	6	1.2	1.3	.8
325	Structural clay products	51	40	11	2.9	3.5	(5)
3251,53,59	Clay construction products	38	31	7	3.4	3.7	1.4
3251	Brick and structural clay tile	23	19	4	3.1	3.5	1.1
3253	Ceramic wall and floor tile	9	7	2	[4]3.0	[4]3.1	[4]2.3
3255	Clay refractories	13	9	4	1.4	2.7	−3.2
3271,72	Concrete products	80	59	21	[4].8	[4]1.4	[4]−1.1
3273	Ready-mixed concrete	86	(3)	(3)	[4]−.9	(3)	(3)
331	Steel	560	441	119	−.7	−.2	−2.5
3321	Gray iron foundries	150	125	25	.8	1.2	−1.7
3324,25	Steel foundries	64	50	14	−.6	.2	−4.1
3331,32,33	Primary copper, lead, and zinc	22	18	4	1.5	1.6	.9
3331	Primary copper	14	12	2	3.0	3.0	2.9
3334	Primary aluminum	35	29	6	−1.5	−1.6	−1.2
3351	Copper rolling and drawing	32	25	7	1.5	1.5	1.5
3353,54,55	Aluminum rolling and drawing	62	50	12	1.8	1.7	1.9
3411	Metal cans	65	55	10	2.3	2.4	1.8
3621	Motors and generators	136	102	34	[4]−.7	[4]−.1	[4]−2.5
3631,32,33,39	Major household appliances	100	81	19	3.0	2.9	3.2
3631	Household cooking equipment	27	20	7	4.1	4.7	1.9
3632	Household refrigerators and freezers	37	31	6	1.2	.9	2.8

SIC code	Industry	Employment, 1978 (thousands)			Output per employee hour: Average annual rate of change, 1973–78 (percent)[1]		
		All employees	Production workers	Non production workers	All employees	Production workers	Non production workers[2]
3633	Household laundry equipment	20	17	3	2.2	1.7	4.1
3639	Household appliances not elsewhere classified	16	12	4	5.9	5.7	7.0
3641	Electric lamps	38	33	5	3.1	3.3	1.4
3645,46,47,48	Lighting fixtures	73	55	18	[4]1.0	[4]1.7	[4]−1.0
3651	Radio and television receiving sets	92	67	25	[4]2.1	[4]3.8	[4]−3.7
371	Motor vehicles and equipment	997	776	221	3.9	3.5	5.2
	Other						
401 Class I	Railroad transportation, revenue traffic	473	413	60	3.0	3.1	2.0
401 Class I	Railroad transportation, car miles	473	413	60	.9	1.1	−.1
4213 part	Intercity trucking	770	([3])	([3])	[6]1.4	([3])	([3])
4213 part	Intercity trucking (general freight)	475	([3])	([3])	[6]1.9	([3])	([3])
4511	Air transportation	322	([3])	([3])	[6]5.1	([3])	([3])
4612,13	Petroleum pipelines	19	14	5	[4].5	[4]2.1	([3])
4811	Telephone communications	993	([3])	([3])	8.1	([3])	([3])
491,92,93	Gas and electric utilities	711	[7]579	[8]132	1.4	[7]2.1	([3])
54	Retail food stores[9]	2,474	([3])	([3])	−.2	([3])	([3])
5511	Franchised new car dealers	849	([3])	([3])	2.3	([3])	([3])
5541	Gasoline service stations[9]	788	([3])	([3])	4.9	([3])	([3])
58	Eating and drinking places[9]	4,609	([3])	([3])	−1.5	([3])	([3])
7011	Hotels, motels, and tourist courts[9]	1,025	([3])	([3])	.8	([3])	([3])
721	Laundry and cleaning services[9]	410	([3])	([3])	1.1	([3])	([3])

[1] Based on the linear least squares trends of the logarithms of the index numbers.
[2] Rates of change for nonproduction workers are subject to a wider margin of error than other rates shown.
[3] Not available.
[4] 1973–77.
[5] Less than 0.05 percent.
[6] Output per employee.
[7] Nonsupervisory personnel.
[8] Supervisory personnel and force account construction workers.
[9] Data relate to all persons.

Growth in output per employee hour in selected industries, 1973-78



Attachment 3

Criteria for Output Measures

-- Represents final products or services of the organization

-- Sufficient detail to insure product homogeneity

-- Reflects changes in quality

-- Reflects activities of the organization

-- Reflects each year's workload

Attachment 4

Product Detail Problem

19 inch television sets

	ULR	Y_o	Y_i	Weighted	Aggregate
Black and white	1	5	8	5	8
Color	2	7	4	14	8
		12	12	19	16
Index		100.0	100.0	100.0	84.2
		no change		decrease	

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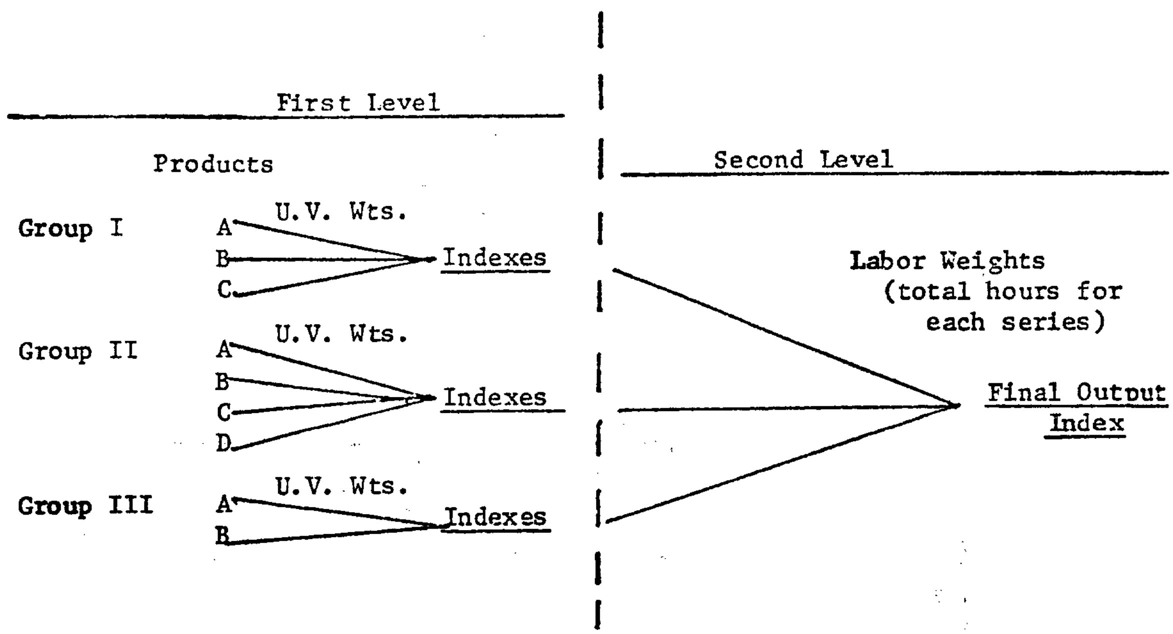
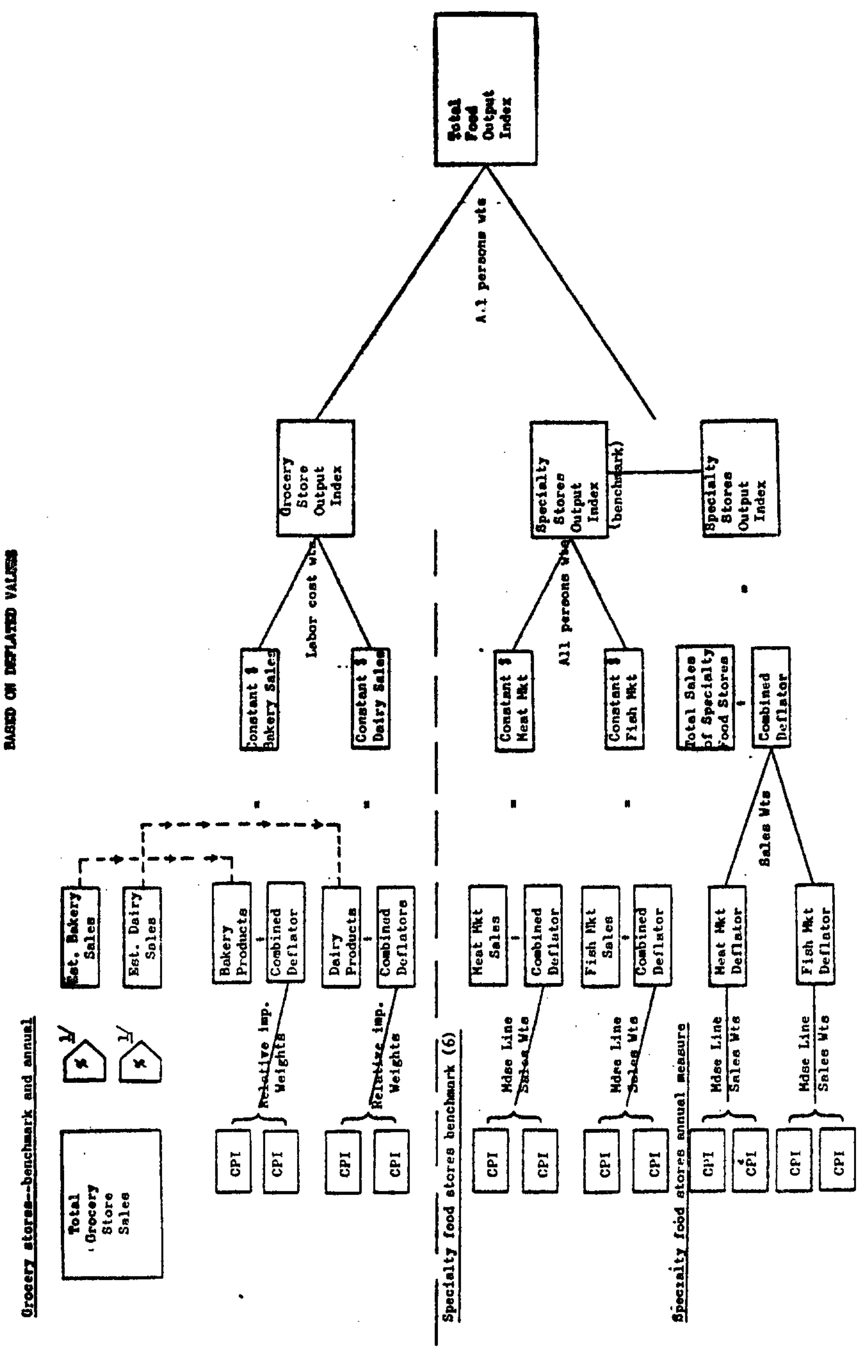
1. The unit labor requirements are different.
2. A shift in the type television set manufactured would create a bias.
3. Use of product detail with appropriate weights insures a correct measure.

Attachment 5

Two Level Weighting System



SIC 54 - RETAIL FOOD
BENCHMARK AND ANNUAL OUTPUT MEASURE
BASED ON DEFLATED VALUES



1/ Merchandise line sales.

SOURCE: Bureau of Labor Statistics and the Bureau of the Census.