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APPENDIX I: PART J

CAPITAL GOODS PRICING

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CAPITAL GOODS PRICING[1]

PROBLEMS AND PROSPECTS

A person must indeed be bold or foolhardy to attempt to treat a subject as complex as capital goods pricing, and I have never been considered bold. The subject implies some sort of agreement—or at least a meeting of the minds—on the definition of capital goods, on the nature of pricing and index number theory. This agreement has not been reached generally. These terms are inexact in their usage (and sometimes paradoxically seem to convey more meaning to the layman than to the professional). They do convey sufficient impression, however, so that we can together examine the Bureau of Labor Statistics program in this area with respect to its general scope and coverage, and the areas of greatest concentration of pricing of capital goods. Having done this, we will explore very briefly some questions of concept, some views and actions on the ever-present problem of quality change and point toward some aspirations for improvement of data in the months and years ahead.

AVAILABILITY OF CAPITAL GOODS PRICE INDEXES

Those of you who are familiar with the WPI know it as an aggregated index consisting of a combination of price indexes for some 2,200 commodities. These items do not cover all economic activity but relate to the first significant sales—usually f.o.b plant—of the commodities as they move through primary markets. This restriction to "first sales" and the early tradition that the index covers only commodities (and the statistical and collection difficulties) have operated to discourage in practice (though not necessarily in theory) the pricing of equipment installed on site or of public and private capital, such as commercial and residential buildings, roads, powerlines, as well as the more complicated of the items which fall in the manufacturing sector itself. The WPI—despite its name—does not cover the wholesale level of activity. Goods moving in interplant transfer between plants of the same company are also omitted.

Those capital items which are included in the WPI are found almost solely in the "equipment" portion of the "plant and equipment" category of capital. Thus the "producer finished goods" category of the WPI constitutes over 600 commodities carrying about 11 percent of the total weight of the index. One half of the items and about half the weight are in the category "Finished Goods for Manufacturing Industries"; the remainder are in "Finished Goods for Nonmanufacturing." A fairly good array of industrial machinery is pres-

[1] Prepared at the request of the Wealth Inventory Planning Study, George Washington University, Washington, D.C., for presentation at a symposium held on Dec. 9, 1963. The views expressed are those of the author, and do not necessarily reflect the position of the Bureau of Labor Statistics.

ent, from machine tools to agricultural machinery and various special purpose machines, passenger cars and motor trucks, as well as some sheet metal products, commercial furniture, etc. The value of shipments in 1958 of all such equipment represented in the WPI accounts for almost all the value of gross private domestic investment in producers' durable equipment ($23 billion). An additional $35 billion is new construction and is unpriced and unrepresented. The Bureau actually prices commodities which account for from 35 to 40 percent of new investment in producers' durable equipment; price changes for the remaining 60 percent are imputed to the priced items. Table 1 shows in greater detail price coverage by SIC four-digit industries which are important producers of capital equipment.

TABLE 1.—*Price coverage for capital goods industries*

SIC code	Industry title	Value added in 1958 (thousands)	Price coverage [1] (percent)
35	Machinery, except electrical		
3511	Steam engines and turbines	$568,643	45.8
3519	Internal combustion engines (except automotive and aircraft)	499,328	34.5
3522	Farm machines and equipment industry	1,087,836	39.1
3531	Construction machinery industry	1,022,801	9.6
3532	Mining machinery and equipment	165,831	28.4
3533	Oilfield machines and equipment	336,788	66.9
3534	Elevators and moving stairways	126,270	13.5
3535	Conveyors	192,892	52.6
3536	Hoists, cranes, and monorails	92,759	19.2
3537	Industrial trucks and tractors	117,500	51.9
3541	Metal-cutting machine tools	420,961	25.9
3542	Metal-forming machine tools	176,021	13.9
3544	Special dies and tools	780,090	1.0
3545	Machine tools accessories and measuring devices	348,580	36.4
3548	Metalworking machinery, except machine tools	332,397	26.4
3551	Food products machinery	268,639	21.1
3552	Textile machinery	214,199	39.2
3553	Woodworking machinery	112,936	34.5
3554	Paper industries machinery	123,758	0
3555	Printing trades	188,881	44.6
3559	Special industrial machinery	431,117	3.2
3561	Pumps and compressors	542,037	16.2
3562	Ball and roller bearings	407,744	36.4
3564	Blowers and fans	145,050	11.0
3565	Industrial patterns	78,108	0
3566	Power transmission equipment	384,372	34.0
3567	Industrial furnaces and ovens	96,450	56.6
3569	General industry machines, not elsewhere classified	281,423	1.2
3571	Computing and related machines	579,103	22.7
3572	Typewriters	168,877	67.4
3576	Scales and balances	49,125	54.4
3579	Office machines, not elsewhere classified	173,424	62.3
3581	Automatic vending machines	64,694	69.8
3582	Commercial laundry equipment	65,580	0
3584	Vacuum cleaners, industrial	4,256	0
3585	Refrigeration machinery	598,032	19.7
3586	Measuring and dispensing pumps	64,689	1.3
3589	Services industry machines, not elsewhere classified	120,900	.8
3599	Machine shops industry	959,099	3.7
36	Electrical machinery, equipment, and supplies		
3611	Electric measuring instruments	419,396	12.2
3612	Transformers	364,212	44.4
3613	Switchgear and switchboard apparatus	555,044	40.9
3621	Electric motors and generators	813,124	24.2
3622	Industrial controls	281,890	19.1
3623	Welding apparatus	112,709	39.2
3624	Carbon and graphite products	102,483	64.1
3629	Electric industrial goods, not elsewhere classified	137,547	.3
3631	Household cooking equipment	181,091	60.4
3632	Household refrigerators	433,369	61.9
3633	Household laundry equipment	324,480	73.7
3634	Electric housewares and fans	301,033	24.0
3635	Household vacuum cleaners	84,180	83.9
3636	Sewing machines	61,991	25.2
3639	Household appliances, not elsewhere classified	162,664	44.2
3641	Electric lamps	270,498	43.2
3642	Lighting fixtures	397,378	59.2

See footnote at end of table.

TABLE 1.—*Price coverage for capital goods industries*—Continued

SIC code	Industry title	Value added in 1958 (thousands)	Price coverage [1] (percent)
3643	Current carrying devices	$294,189	9.2
3644	Noncurrent carrying devices	214,607	22.8
3651	Radio and TV receiving sets	593,953	65.8
3652	Phonograph records	93,073	85.3
3661	Telephone and telegraph apparatus	740,855	7.5
3662	Radio and TV communication equipment	1,297,583	1.6
3671	Electron tubes, receiving	285,799	79.5
3672	Cathode ray picture tubes	67,472	96.3
3673	Electron tubes, transmitting	165,803	0
3679	Electronic components, not elsewhere classified	914,811	.1
3691	Storage batteries	150,061	25.7
3692	Primary batteries, dry and wet	75,431	46.6
3693	X-ray and therapeutic apparatus	58,436	9.5
3694	Engine electrical equipment	366,626	35.7
3699	Electrical products, not elsewhere classified	73,581	15.8
37	Transportation equipment		
3713	Truck and bus bodies	145,608	4.9
3715	Truck trailers	131,140	7.3
3717	Motor vehicles and parts	6,473,927	91.3
3721	Aircraft	3,399,163	0
3722	Aircraft engines and parts	1,615,671	0
3723	Aircraft propellers and parts	112,301	0
3729	Aircraft equipment, not elsewhere classified	1,797,203	.2
3731	Ship building and repairing	913,687	.7
3732	Boat building and repairing	157,309	0
3741	Locomotives and parts	152,086	59.2
3742	Railroad and street cars	167,576	28.0
3751	Motorcycles, bicycles, and parts	52,125	49.5
3791	Trailer coaches, housing type	127,683	0
3799	Transportation equipment, not elsewhere classified	38,215	15.0
	Selected industries from major group 25, furniture and fixtures:		
2521	Wood office furniture	38,427	57.3
2522	Metal office furniture	173,673	66.6
2531	Public building furniture	112,881	6.1

[1] Price coverage is the percentage of an industry's shipments represented by the value of individual products which are priced directly. Individual products are those represented by 7-digit census codes. Although every product variant within a 7-digit code may not be directly priced, commodities within the same product code are considered to be relatively homogeneous and are, therefore, assumed to have identical price movements. For some priced products, census values have been withheld for disclosure reasons. In computing the price coverages, these product values are considered to be zero. Hence, for some industries, actual price coverage is greater than that shown in this table.

Price indexes for the capital goods in the WPI became available at different dates as the index grew. Items of farm equipment were in the index in 1912 or 1913, as were motor vehicles. Some commercial furniture dates back to 1926. Most of the impetus to pricing machinery came with the 1952 major revision of the index, however, when many machinery indexes were added to the indexes often retroactively to 1947. Specially computed indexes (not in the WPI) and some component product detail are available back to 1939 for machine tools, construction machinery, and general auxiliary machinery.

While (with some exceptions) the Bureau of Labor Statistics is not engaged in pricing capital goods other than those described above, some work is being done by others.

The Bureau of Reclamation prepares an index of irrigation and hydroelectric costs and the Interstate Commerce Commission computes an index of railroad construction costs. A number of private agencies produce local and national indexes of construction costs. The Department of Commerce prepares a "composite" construction cost index which is built up from component price and cost indexes from various private and public sources. The methods, sources, and construction of these is so varied, however, that it is difficult to say how satisfactory they are. According to the report of the Price Statistics

Review Committee,[2] "with the exception of the Bureau of Public Roads for a composite mile of highway, and the Interstate Commerce Commission series for railways and pipelines, these cost indexes do not approximate cost * * *. For the most part, they are, instead, indexes of wage rates and building materials prices weighted together in accordance with their importance in the cost of a unit of construction of some specified type in a base period." Indexes of capital goods prices which are constructed as weighted materials input and wage-rate combinations fail to reflect the technological productivity changes which take place in the capital goods producing industry. Variations in profit margins are also neglected. These indexes do provide historical data for a considerable number of years, however, and must serve in the absence of better statistics.

Current investigations by the Bureau of the Census are also noteworthy. Two principal types of construction are being priced: Family houses built for sale and publicly financed apartment houses in New York City. The multiple regression approach is being used to isolate and evaluate price determining factors in the construction of family houses. The pricing of apartment houses in New York involves the use of detailed figures from bidders on the cost of units of work such as excavation, plumbing, electric, and heating installations. These studies are still in embryo, and some inconsistencies of basic data are under scrutiny. I am told that preliminary results of the apartment house price index seem reasonable: (1) There has been less secular increase in the census index than in the conventional indexes in which labor and materials indexes are combined. This could result from the failure of the conventional series to take proper account of productivity increases which the censes index adjusts for inherently. (2) The new index is more responsive to short-run changes in cycle. This could reflect the changes in "cushion" or profit margins which occur as the industry experiences favorable or unfavorable conditions.

PURPOSES, CONCEPTS, PROBLEMS

Purposes, concepts, and problems can never be viewed independently by the student of price change. A purpose which will serve one user very well will prove unsatisfactory to another and each use will imply a different concept of price and pose different measurement problems. The difficulty faced by an agency such as BLS is that the users of data have varied needs and the Bureau's limited resources can satisfy the users only partially. This has led to some fuzziness in concepts and revisions of techniques over time. When one recalls that the WPI began in 1890 it is remarkable that concepts have remained as uniform as they have.

It is fair to state that in common with pricing for other products and services, capital goods are priced for three general purposes—for themselves, i.e., for comparison of capital goods price trends with those of other products or with labor rates in capital goods industries, at a fairly detailed level. Another purpose is for deflation of capital

[2] "Government Price Statistics," hearings before the Subcommittee on Economic Statistics of the Joint Economic Committee of the United States, pt. I, Jan. 24, 1961, app. B, Construction Price Indexes, p. 87.

goods expenditures in order to arrive at some measure of real expenditure, cost, or output or productivity of capital. The third purpose is macro-analysis in which aggregations of indexes are used in broad studies of domestic and foreign price levels, inflation, valuation of wealth, interindustry analysis, and other topics relating to the general economic well-being of the Nation. This last purpose views pricing of capital goods as part of the large family of price measures which the Federal Government is coming to regard as a vital part of the general structure of statistical data on prices, production, manhours, payrolls, etc.—generally tied into the framework of the Standard Industrial Classification and through this to the national accounts. This purpose stresses *comparability* of pricing *scope* with other economic data, *breadth* of coverage or at least representation, and availability of data through *time*.

It is well known, of course, that, in theory, each specific purpose calls for a specific kind of index number of prices. At the aggregate level it can be demonstrated quite easily that the use of a Laspeyres, fixed-weighted, *price* index for deflation results in a *quantity* measure of the Paasche type. If a Laspeyres quantity index is desired, a Paasche (changing weight) price index is needed as a deflator. Paasche-type price indexes are hard to derive, however, owing to the dearth of current value or quantity data in detail. For this reason, an approximation to a fixed-weight quantity index can be obtained if price indexes in sufficient detail at the individual commodity level are available to deflate value data in the same detail. Summing the deflated detailed values yields a quantity series with fixed weights, i.e., in a quantity index of the Laspeyres type. Thus the Commerce Department—wishing a series on GNP in constant dollars—must either deflate total value by a Paasche (changing weight) price index, which is unavailable, or deflate individual values by commodity price indexes and sum.

These broader problems of concept and their attendant algebra have received wide treatment and I mention them only in passing. Of more fundamental importance is the question of concept of price change at the detailed commodity level. Questions of concept and their consequent measurement problems are common to all price series in some degree, but in the area of capital equipment they are especially severe. Let us start with a general statement concerning what users of price time series can be presumed to require as a minimum: "A price series (index) should compare the payment (or receipt) for *one unit* of an *item* or *service* with the *payment* for an *identical unit* at another time." In practice, of course, the index maker must define markets, volume of sales and many other factor. But as a simple statement the proposition does not seem too inexact until one attempts to apply it to the real world of prices. At this point the phrase "identical unit" has different meanings to different users depending on their purpose. Should pricing be in terms of identical units of physical quantity or of utility? An index of prices of truck tires will rise more rapidly than one based on truck-tire-miles, for example, because of improved durability of the tires (and better roads). If earth-moving machinery is purchased for the purpose of moving earth (as it is) should not price per machine be replaced by price per cubic yard of dirt-moving capacity per hour? In this case the unit priced is no longer the machine

but the work performance. Should price per light bulb be replaced with price per lumen-hour taking into account the expected life of the lamp?

Obviously, the answer to these and similar questions cannot be categorically settled. In deciding among alternative purchases, the buyer of construction equipment has a legitimate use for an index which measures the utility of the machine to him, i.e., a price index which declines when machines become more efficient even if the price tag remains constant. He and many market analysts, economists, and businessmen also need to measure the price movements for goods of similar *physical* characteristics, for this is the form in which goods are bought and sold in the market. For this purpose the appropriate index is one unadjusted for utility change *unless accompanied* by a change in physical specification.

Considerable thought and experiment has been devoted to defining the unit of measure and to the isolation of price determining factors embodied in changes in utility. Among the early efforts Andrew Court [3] suggested a technique wherein specification changes are related (by means of a multiple regression technique) to price. Derived implicit specification prices from cross sectional data were used in pricing the time series. More recently Richard Stone used a similar approach in "Quantity and Price Indexes in National Accounts." [4] Zvi Griliches of the National Bureau of Economic Research also used the approach in a staff paper for the Stigler Committee. Messrs. Dean and de Podwin have also provided recent, interesting expositions in the field of electrical equipment. In the Griliches paper, automobiles is the subject of the experiment and factors considered are horsepower, weight, length, type of engine, type of transmission, etc.

The findings of this experiment pointed to an overstatement of the WPI passenger car index, yet Griliches stated that limitations of the "hedonic" (regression) approach are such that "it is not yet recommended that such adjustment should be made routinely as part of the price index computations." Among the examples of limitations: weight in cars is not per se desirable but serves as a proxy for size. For instance, if aluminum were substituted for steel and if the hedonic approach were used mechanistically the resulting weight decrease would automatically be treated as a quality deterioration. Richard Stone, after showing a high correlation between price and alcoholic content for various types of wine points out that "there are evidently a number of other quality characteristics that influence price. In a refined analysis it would be necessary to track these down * * *." I for one concur, but despair of carrying the approach really into the labyrinth of subjective preference and in capital goods as well as in wine, subjective preference or taste is the realm that sets the glutton off from the connoisseur.

The BLS approach to the to the quality problem

Consequently, the BLS is following what is today, for us, a more workable approach to quality adjustment—making the adjustment only when accompanied by physical specification changes which can

[3] "Hedonic Price Indexes, with Automotive Examples," A. T. Court, American Statistical Association, Dec. 27, 1938.
[4] Published by the Organization for European Economic Cooperation, November 1956.

be "costed out" and then only when in the judgment of the commodity specialists they do not involve purely subjective factors. Under this principle the introduction of a more comfortable seat in a tractor would not be subject to adjustment normally. If, however, tractors of identical specification other than the seat were selling in the same market at the same time—or if the comfortable seat were a separately priced option—we would bow to the judgment of the market and make the adjustment. Recently, we had one of our rare opportunities to choose between an adjustment in the price of a fluorescent lamp for factory and commercial use. The new longer life light was introduced by some manufacturers at no change in quoted price and our choice was to take the price reduction on the basis of the length of life expectancy or to use the ratio indicated by the market price (of other reporters) for both types of light selling side by side on the market. We chose an estimate based on the latter. Recently we could have made an adjustment in the price of an off-highway dump truck on the basis of a combination of specification changes including horsepower, load-carrying capacity, gross weight, and net weight. Here, we were unwilling to assume that the percentage changes in physical characteristics were proportional to price change and, in the absence of data on the cost of the additional features, a link was taken. This had the effect, of course, of assuming that the entire reported price change was due to quality improvement. To the extent there really was a price increase, the BLS index is too low for this item.

While it is always hazardous to assign reasons for the actions of an organization, I will propose several that I feel are behind the Bureau's reluctance at present to adopt the kind of quality adjustments based on the correlation approach:

1. Current data are generally lacking to enable the computations to be made except retroactively and too late for current index calculations.

2. Where they are available, more research is required to separate out those changes which would generally be acknowledged to be quality changes from the more controversial, subjective factors of style and preference.

3. Most important, the Bureau is not convinced that certain adjustments *should* be made. The Bureau needs and will seek guidance concerning the principal purposes to which price indexes for capital goods will be put. The resolution of purpose may determine the more basic question—whether certain adjustments *should* be taken even if data are available.

This last statement leads to a discussion of one specific purpose of capital goods pricing—measurement of the productivity of capital. Edward F. Denison [5] has examined three approaches to viewing the productivity of capital:

1. The cost approach—in which the quantity of capital would remain the same in year 2 as in year 1 if the same number of physical units of a particular capital item are produced (even though work performance per machine had increased) unless there is a cost change.

[5] "Theoretical Aspects of Quality Change, Capital Consumption, and Net Capital Formation," Edward F. Denison in "Problems of Capital Formation," National Bureau of Economic Research, 1957.

2. Capital input proportional to total output—in which a machine in year 2 costing the same as in year 1 but capable of twice the output in a given time would be measured as two machines.

3. Capital stock measured by the contribution of capital to production—in which consideration would also be given to reduction in the work force required to run the machine.

Denison feels choice 3 is of interest but not feasible because of measurement problems. Choice 2 defeats his purpose. If the quantity of machines is to be measured in terms of machine output, then the productivity ratio, output per machine, must remain constant over time. This approach adjusts out of the measure the very factor which should remain in and which is to be measured. He settles on choice 1 and tells us that adjustment for quality change should be made only where accompanied by cost change.[6]

The policy of BLS, then is consistent with Denison's need—adjustment for quality (specification) change is made only where a cost change is present. In practice, the Bureau often obtains from reporters the cost of added (or deleted) features on machinery, autos, trucks, and a variety of other goods and makes an appropriate adjustment by adding (or subtracting) the cost to the price of the earlier model to attain price comparability with the new model. Where this is not possible, a judgment is made and either a direct price comparison or a link is taken depending on whether the reported price change is deemed mostly due to genuine price change or to quality change.

Other problems of pricing

Problems other than quality change inhibit development of truly accurate and timely pricing of capital goods, in areas where BLS is now pricing. While the usual standard discounts (cash, trade, quantity, etc.) are reported and used, many "special deals" to a few customers are not. If these are unusual, and not made generally available to customers, they should not enter into construction of a price index, but in times of severe competition special discounts may and do become widespread. BLS has on the whole found reporters unwilling to report these (there are exceptions) and long-run plans are being drawn up to see whether a study of buyers' prices can point the way to true transaction prices. Such a study would require the examination of customers' invoices to determine the net market price paid. In the meantime, reliance must be placed on the hope that manufacturers ultimately adjust list prices toward reality (though after a time lag) when the quoted list price with discounts drifts away from the market transaction price.

THE GAPS AND CHALLENGES AHEAD

To go further into BLS problems would involve more detail than warranted here. Let us instead turn to some tentative plans.

As indicated earlier, large areas of capital goods remain unpriced. Many of these goods consist of unique or infrequently priced, complex products such as ships, power generators, electronic computers, and

[6] An aside: Denison also states that there may be justification for adjusting consumer goods (CPI or WPI) for use values. This goes beyond the scope of a discussion of capital goods pricing, however.

aircraft. In these cases, where monthly detailed specification pricing is impractical, the usual monthly shuttle form which goes to reporters for entry of the latest quotation is inadequate. Special pricing techniques will have to be developed, and assistance or advice will be appreciated.

The WPI and related industrial pricing programs do provide some instances of special pricing methods which might be extended to the more difficult areas. For example, fabricated structural steel prices for buildings and bridges are obtained from producers who reprice each month an actual job on which they had recently been successful bidder at the time pricing was initiated. Prices are computed on costs of current labor, material, conditions of the market and profit. This method is used in the United Kingdom and the Netherlands for pricing ships. It is my understanding that some of the privately computed construction cost indexes also employ this technique or in some way take account of productivity change.

Our index for hydraulic turbines is prepared for a special purpose (outside the WPI). This index makes use of actual detailed plans (blueprints) of prototypes of steel castings, steel forgings, gray iron castings, and steelplate. Price series so derived are combined by the users with wage series to escalate turbine prices.

The use of the "hedonic" approach, the development of prices from prototypes or simulated plans, and the "recipe" approach wherein prices of component materials and labor costs are weighted and combined will all be thoroughly investigated. (One difficulty with the combination of materials and labor cost input data, of course, is the failure to take into account the changes in productivity which occur. This has been one of the limitations of some of the construction price indexes built up on this basis.)

These techniques will be explored in the coming year and later as the Bureau moves ahead more intensively in its work of constructing an industrial sector price index in which the present WPI data are to be used as a foundation to build a new pricing structure related to the SIC. Initially stress will be on pricing industrial outputs—inputs will come in later years. Current plans call for expanding pricing into new areas modestly in the coming year and more intensively as resources become available. The initial stress will be on expanding coverage in manufacturing, mining, and agriculture. We plan to devote considerable attention to development of techniques for pricing unique goods not made to uniform specifications, such as electronics, shipbuilding, and aircraft.

Ultimately attention will be devoted to other gaps such as wholesale trade, transportation, and construction. Whatever additional pricing of capital goods is undertaken will in all probability be done on a current basis with pricing extending no more than a year back. It is extremely difficult to obtain the assent of reporters to really comprehensive historical pricing, especially for commodities which are not homogeneous and which are subject to frequent specification change.

Some companies maintain historical price indexes for segments of capital goods covering a considerable number of years. Those who need historical prices may find solace in these and in some of the efforts recently put forth by Dorothy Brady of the Wharton School, Univer-

sity of Pennsylvania.[7] Using old records from State agencies as well as earlier price investigations, she has pieced together some indexes from the early 1800's for sailing vessels, steamboats, steam engines and turbine water wheels, lathes, textile machinery, and factory buildings. These and similar series prepared from dustcovered records cannot deal adequately, if at all, with the many changes in specifications, quality, discounts, and markets with which we try to deal today. They may be our only link to the past, however, and further efforts toward reconstruction should be encouraged.

[7] "Relative Prices in the Nineteenth Century," paper presented before the Conference on Research and Wealth, Sept. 4–5, 1963.

NOTE.—At the Wealth Study symposium on valuation and pricing problems, Mr. Clement Winston of the Office of Statistical Standards commented, "* * * BLS ought to show a greater interest in these private series, and possibly make arrangements for a joint operation of the work thus improving series already in use and getting something useful to themselves and others out of it. The use of private data sources might also prove particularly fruitful for constructing price indexes for past years."

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