Volume Title: A Critique of the United States Income and Product Accounts

Volume Author/Editor:

Volume Publisher: Princeton University Press

Volume ISBN: 0-870-14178-3

Volume URL: http://www.nber.org/books/unkn58-1

Publication Date: 1958

Chapter Title: Seasonal Adjustment of the Income and Product Series

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Chapter URL: http://www.nber.org/chapters/c0568

Chapter pages in book: (p. 549 - 582)

Seasonal Adjustment of the Income and Product Series

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The Nature of Seasonal Variations in Major Income and Product Series

I IMAGINE that not one statistician in a hundred could describe the pattern of seasonal variations in gross national product. The statistician is usually concerned to put seasonal factors as far out of sight as possible. I propose, however, to begin by describing the seasonals in GNP and its several components; after that I shall attempt to evaluate the quality of the seasonal adjustment.

For the purpose I shall use the implicit seasonal adjustments provided by the published data, which can be calculated by taking the differences between original and seasonally adjusted data, or the ratios of one to the other. The adjustment factors so derived are implicit because in actual practice the National Income Division makes separate adjustments for each of the several components from which estimates are built up, and derives adjusted data for aggregates by adding together adjusted components. An incidental result of their procedure is that even though the adjustment factors for the components may remain constant from one year to the next, the implicit adjustment factors for the aggregates are bound to vary. Consequently a single year's figures provide only a sample of the adjustments. In what follows I shall refer to the results for several years since the quarterly estimates began, namely 1939, 1944, 1948, and 1954.[1]

Let us start with total gross national product as estimated from the product side (Table 1, first four columns, and Chart 1). According to this estimate, GNP usually increases seasonally throughout the calendar year, but especially rapidly in the last quarter. In 1954 the seasonal increase alone lifted GNP $22 billion between the first and fourth quarters, and dropped it $23 billion from the fourth quarter of 1954 to the first of 1955. These are not negligible changes. In that

[1] The sources used throughout are: 1939-1951: *National Income Supplement, 1954, Survey of Current Business,* Dept. of Commerce; and 1952-1954: *Survey of Current Business,* July 1955.

TABLE I

Seasonal Factors in Two Estimates of Gross National Product and the Statistical Discrepancy

Quarter	Gross National Product				Gross National Product, Exclusive of Statistical Discrepancy				Statistical Discrepancy			
	1939	*1944*	*1948*	*1954*	*1939*	*1944*	*1948*	*1954*	*1939*	*1944*	*1948*	*1954*
1. Absolute Factors (*billion dollar annual rate*): Original minus Seasonally Adjusted Data												
I	— 2.8	— 3.2	— 7.1	— 9.1	— 2.2	— 1.6	— 5.2	— 6.4	— 0.6	— 1.6	— 1.9	— 2.7
II	— 1.9	— 2.6	— 4.7	— 1.6	+ 0.1	+ 0.3	— 1.3	— 0.7	— 2.0	— 2.9	— 3.4	— 0.9
III	— 1.4	— 0.9	— 1.5	— 2.4	— 0.1	0.0	+ 1.2	+ 2.5	— 1.3	— 0.9	— 2.7	— 4.9
IV	+ 6.1	+ 6.7	+13.2	+13.3	+ 2.6	+ 1.4	+ 6.0	+ 4.8	+ 3.5	+ 5.3	+ 7.2	+ 8.5
I[a]	— 2.1	— 3.6	— 7.9	— 9.7	— 2.4	— 2.5	— 6.2	— 6.6	+ 0.3	— 1.1	— 1.7	— 3.1
2. Indexes: Original divided by Seasonally Adjusted Data												
I	96.8	98.4	97.1	97.5	97.5	99.2	97.9	98.2				
II	97.9	98.8	98.2	99.6	100.1	100.1	99.5	99.8				
III	98.5	99.6	99.4	99.3	99.9	100.0	100.5	100.7				
IV	106.5	103.1	105.0	103.6	102.8	100.7	102.3	101.3				
I[a]	97.8	98.4	97.0	97.4	97.5	98.9	97.6	98.2				
3. Quarter-to-Quarter Change in Absolute Factors (*billion dollar annual rate*)												
I-II	+ 0.9	+ 0.6	+ 2.4	+ 7.5	+ 2.3	+ 1.9	+ 3.9	+ 5.7	— 1.4	— 1.3	— 1.5	+ 1.8
II-III	+ 0.5	+ 1.7	+ 3.2	— 0.8	— 0.2	— 0.3	+ 2.5	+ 3.2	+ 0.7	+ 2.0	+ 0.7	— 4.0
III-IV	+ 7.5	+ 7.6	+14.7	+15.7	+ 2.7	+ 1.4	+ 4.8	+ 2.3	+ 4.8	+ 6.2	+ 9.9	+13.4
IV-I[a]	— 8.2	—10.3	—21.1	—23.0	— 5.0	— 3.9	—12.2	—11.4	— 3.2	— 6.4	— 8.9	—11.6
4. Quarter-to-Quarter Change in Seasonally Adjusted Data (*billion dollar annual rate*)												
I-II	+ 0.3	+ 3.8	+ 7.6	— 0.7	— 0.3	+ 3.7	+10.1	+ 1.5	+ 0.6	+ 0.1	— 2.5	— 2.2
II-III	+ 3.5	+ 4.7	+ 6.4	+ 1.2	+ 2.2	+ 0.7	+ 4.7	+ 0.4	+ 1.3	+ 4.0	+ 1.7	+ 0.8
III-IV	+ 1.3	+ 2.4	+ 2.1	+ 8.3	+ 3.3	+ 2.6	+ 2.4	+ 6.1	— 2.0	— 0.2	— 0.3	+ 2.2
IV-I[a]	+ 3.4	+ 4.7	— 4.1	+ 8.2	+ 1.8	+ 5.9	— 6.2	+ 8.2	+ 1.6	— 1.2	+ 2.1	0.0

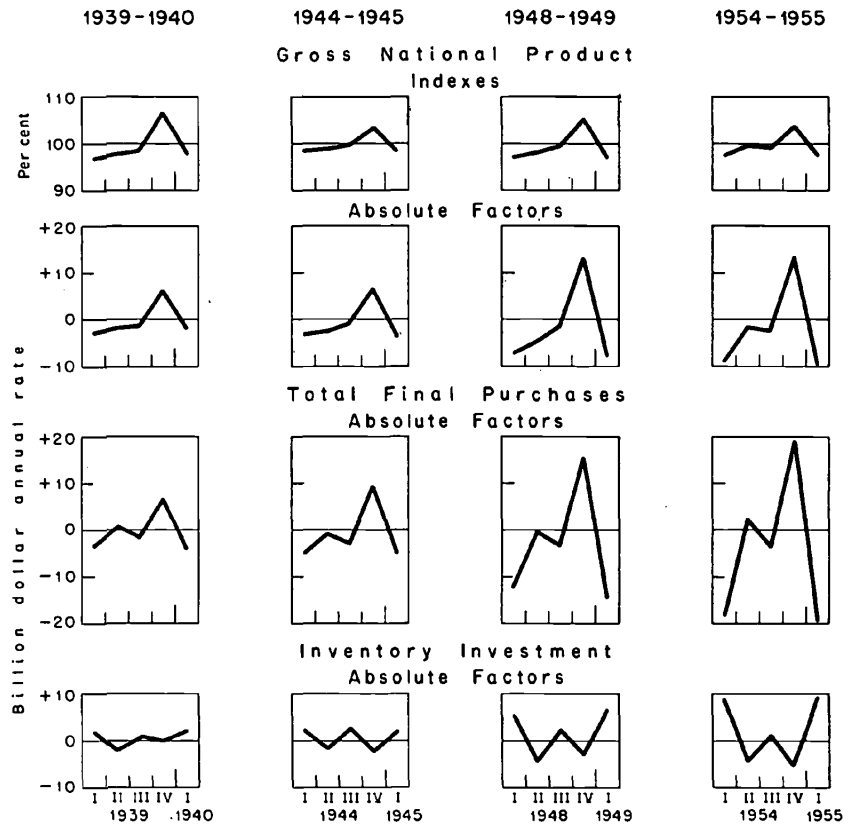
[a] Following year.

year, and indeed rather often, the purely seasonal changes exceed the corresponding changes in the seasonally adjusted data, especially between the third and fourth quarters and the fourth and first quarters (compare sections 3 and 4 of Table 1). Sometimes the seasonal change is many times larger than the nonseasonal.

When this happens at a crucial turn in the business situation, the precise magnitude of the seasonal adjustment is of very great importance. For example, between the third and fourth quarters of 1948 seasonally adjusted GNP rose by $2 billion, then in the next quarter it fell $4 billion, marking the beginning of the 1949 recession. But the seasonal adjustment had eliminated a rise of nearly $15 billion between the third and fourth quarters and a decline of $21 billion be-

Chart 1

Seasonal Factors in Gross National Product, Total Final Purchases, and Inventory Investment, Selected Years, 1939-1955



Source: Table 1 and Table 2.

tween the fourth quarter and the first. The changes that remained after seasonal adjustment were only a fifth or a seventh as large as the changes that had been eliminated by the adjustment. A year later there were equally dramatic changes marking the revival. The seasonally adjusted figures reached their lowest ebb in the fourth quarter of 1949, rose $9 billion in the next quarter. But this sharp upturn, which carried the adjusted figures above their peak 1948 level, became visible only because a decline of $22 billion in the seasonal adjustment factors had more than compensated for a decline of $12 billion in the unadjusted data. One could hardly ask for more impressive evidence of the importance of eliminating the repetitive, seasonal fluctuations that obscure the nonrepetitive cyclical or growth movements in aggregate economic activity, or of the importance of doing this job skillfully.

Table 1 reveals that the dollar magnitude of the seasonal adjustments has been growing, but this growth has been more or less in proportion to the growth in GNP. Hence the implicit relative seasonal factors have remained fairly constant since 1939. The relative amplitude of the adjustment diminished during the war, rose in the immediate postwar years, and has since diminished somewhat. The direction of the adjustment in each of the four quarters has been the same in every year since 1939.[2]

Turning now to the estimate of GNP from the income side (second 4 columns in Table 1), we find substantially smaller seasonal variations than in the product estimate, although the pattern is quite similar. As a result, there is a very prominent seasonal factor in the statistical discrepancy. At first sight this is rather strange, for it would seem possible for the estimators to avoid "errors" that repeat themselves in a regular pattern every year. In fact, however, the unadjusted aggregate is partially adjusted, since some components of the income estimates, notably farm proprietors' income, are used only in seasonally adjusted form (or rather, are estimated in such fashion that no seasonal variations are present). The same thing is true of some components of the product estimates (change in farm inventories), but since the components are not the same as in the income estimates, the adjustments will not, in general, cancel out.[3]

Not only is it anomalous to find a regular seasonal pattern in an

[2] Occasionally in the third quarter there was no appreciable adjustment.

[3] Compare A. J. Gartaganis and A. S. Goldberger, "A Note on the Statistical Discrepancy in the National Accounts," *Econometrica,* April 1955, pp. 170-171. The authors point out that some seasonal adjustment is implicit in some of the estimating procedures, as when payroll data relating to a given week in the month are used to obtain monthly and quarterly totals.

error term, it is also disconcerting to find an apparently unadjusted total partly adjusted. Surely it is desirable to have an estimate of GNP that is entirely free of seasonal adjustment and contains the full seasonal swing that the economy is subject to. Comparisons must sometimes be made with other unadjusted data, such as for a particular industry. Moreover, the absence of a wholly unadjusted aggregate makes it more difficult to judge the validity of the seasonal adjustment of the aggregate, because this judgment, as I shall emphasize later, should rely to an important extent on a comparison of the behavior of adjusted with unadjusted data. In so far as it is feasible to do so, the NID should include only unadjusted data in aggregates that purport to be unadjusted.

The seasonal pattern in GNP is due primarily to the seasonal

TABLE 2

Seasonal Factors in Total Final Purchases and in Inventory Investment

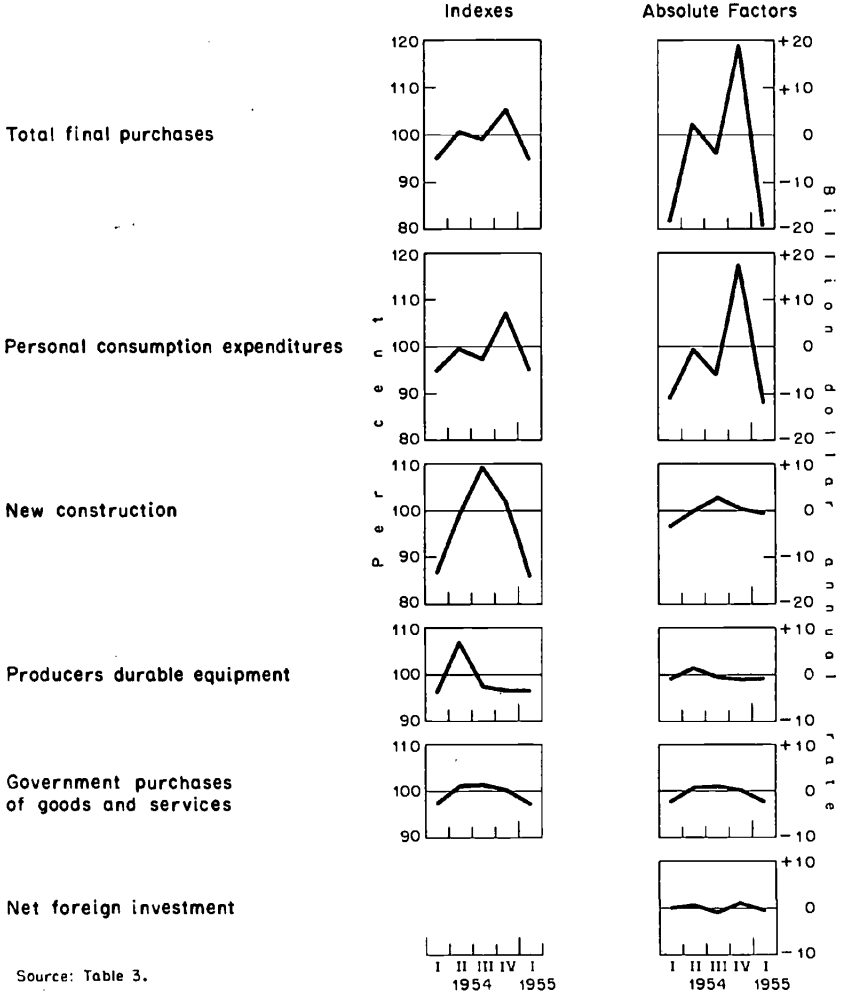
	Total Final Purchases				Changes in Business Inventories			
Quarter	*1939*	*1944*	*1948*	*1954*	*1939*	*1944*	*1948*	*1954*
	1. Absolute Factors (*billion dollar annual rate*): Original Minus Seasonally Adjusted Data							
I	— 3.7	— 2.5	—12.3	—18.4	+1.7	+1.9	+ 5.4	+ 8.8
II	+ 0.4	— 0.7	— 0.1	+ 2.4	—2.3	—1.8	— 4.7	— 4.5
III	— 1.6	— 3.0	— 3.4	— 3.7	+0.6	+2.5	+ 2.4	+ 0.9
IV	+ 6.5	+ 9.3	+15.7	+19.1	0.0	—2.5	— 2.9	— 5.4
I[a]	— 4.3	— 5.2	—14.8	—19.5	+2.1	+2.0	+ 6.5	+ 9.3
	2. Indexes: Original divided by Seasonally Adjusted Data							
I	95.8	97.5	95.0	94.9				
II	100.4	99.7	100.0	100.7				
III	98.2	98.6	98.7	99.0				
IV	107.0	104.2	106.1	105.2				
I[a]	95.5	97.7	94.3	94.8				
	3. Quarter-to-Quarter Change in Absolute Factors (*billion dollar annual rate*)							
I-II	+ 4.1	+ 4.5	+12.2	+20.8	—4.0	—3.7	—10.1	—13.3
II-III	— 2.0	— 2.3	— 3.3	— 6.1	+2.9	+4.3	+ 7.1	+ 5.4
III-IV	+ 8.1	+12.3	+19.1	+22.8	—0.6	—5.0	— 5.3	— 6.3
IV-I[a]	—10.8	—14.5	—30.5	—38.6	+2.1	+4.5	+ 9.4	+14.7
	4. Quarter-to-Quarter Change in Seasonally Adjusted Data (*billion dollar annual rate*)							
I-II	+ 1.9	+ 4.7	+ 6.6	— 1.2	—1.6	—1.1	+ 1.3	+ 0.5
II-III	+ 1.2	+ 5.1	+ 6.1	+ 3.3	+2.3	—0.3	+ 0.1	— 2.2
III-IV	+ 2.3	+ 4.5	+ 1.7	+ 4.0	—1.0	—2.2	+ 0.5	+ 4.3
IV-I[a]	+ 2.0	+ 3.3	— 0.7	+ 6.2	+1.5	+1.5	— 3.4	+ 2.1

[a] Following year.

variations in total final purchases by consumers, business firms, and government, which are only partly counteracted by the seasonal changes in inventory investment (Table 2 and Chart 1). Total final purchases increase moderately from the first to the second quarter, decline slightly from the second to the third, increase sharply from the third to the fourth, and then decline very sharply from the fourth quarter to the first. The seasonal changes in inventory investment are in exactly the opposite direction, but never completely offset those in

Chart 2

Seasonal Factors in Components of Total Final Purchases, 1954-1955



Source: Table 3.

purchases except between the second and third quarters. Indeed, between the third and fourth quarters, and between the fourth and the first quarter, the seasonal change in the accumulation of inventories offsets only a third or a fourth of the change in purchases; the rest is directly reflected in gross national product.

Just as in the case of total GNP, the seasonal variations in total final purchases and in inventory accumulation are large relative to short-run changes in the seasonally adjusted figures. The quarter-to-quarter changes in inventory investment during 1954 provide a striking example. Between the first and second quarter the seasonal change was a decline of $13.3 billion, the nonseasonal change a rise of $0.5 billion; in the next quarter when the seasonal increase was $5.4 billion,

TABLE 3

Seasonal Factors in Components of Total Final Purchases, 1954

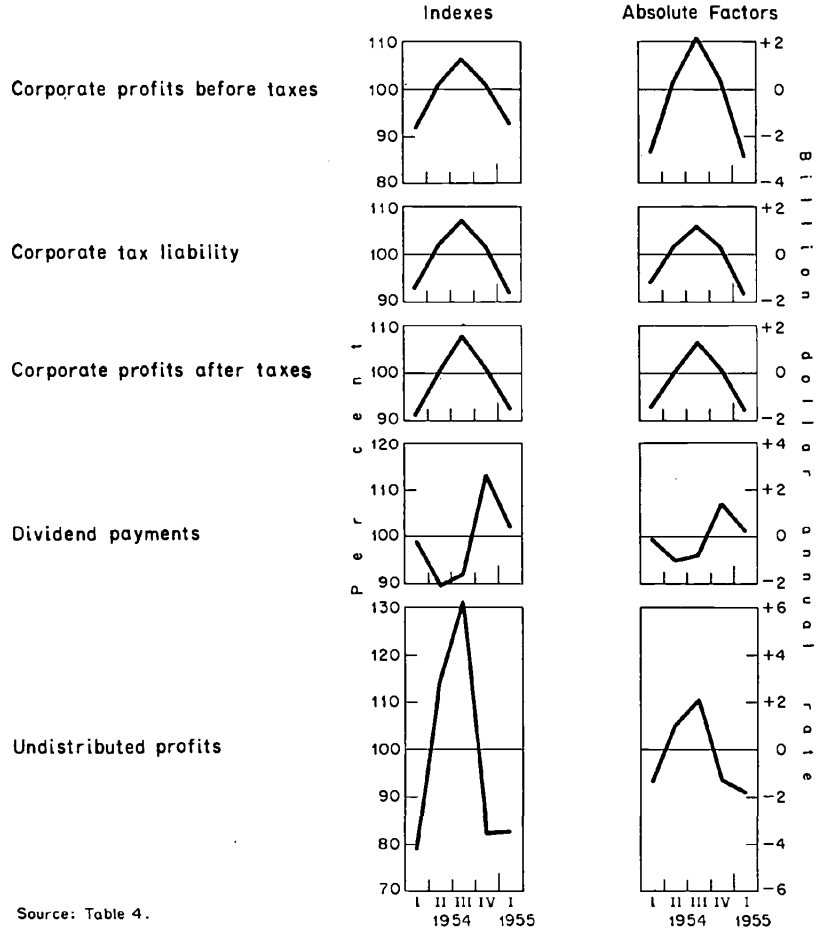
Quarter	Personal Consumption Expenditures	New Construction	Producers Durable Equipment	Government Purchases of Goods and Services	Net Foreign Investment	Total Final Purchases
	1. Absolute Factors: Original minus Seasonally Adjusted Data (*billion dollar annual rate*)					
I	−11.8	−3.5	−0.9	−2.1	−0.1	−18.4
II	− 0.3	−0.1	+1.6	+0.9	+0.3	+ 2.4
III	− 5.9	+2.7	−0.6	+1.0	−0.9	− 3.7
IV	+17.8	+0.6	−0.7	+0.3	+1.1	+19.1
I[a]	−11.8	−4.4	−0.7	−2.2	−0.4	−19.5
	2. Indexes: Original divided by Seasonally Adjusted Data					
I	94.9	86.5	96.1	97.4		94.9
II	99.9	99.6	107.1	101.2		100.7
III	97.5	109.5	97.3	101.3		99.0
IV	107.4	102.0	96.8	100.4		105.2
I[a]	95.2	85.9	96.7	97.1		94.8
	3. Quarter-to-Quarter Change in Absolute Factors (*billion dollar annual rate*)					
I-II	+11.5	+3.4	+2.5	+3.0	+0.4	+20.8
II-III	− 5.6	+2.8	−2.2	+0.1	−1.2	− 6.1
III-IV	+23.7	−2.1	−0.1	−0.7	+2.0	+22.8
IV-I[a]	−29.6	−5.0	0.0	−2.5	−1.5	−38.6
	4. Quarter-to-Quarter Change in Seasonally Adjusted Data (*billion dollar annual rate*)					
I-II	+ 2.9	+1.4	−0.5	−5.8	+0.8	− 1.2
II-III	+ 2.8	+1.2	−0.2	−0.1	−0.4	+ 3.3
III-IV	+ 3.1	+0.9	−0.3	−1.3	+1.6	+ 4.0
IV-I[a]	+ 4.8	+1.8	−0.4	+1.3	−1.3	+ 6.2

[a] 1955.

the adjusted figures declined $2.2 billion; then the seasonal factor declined $6.3 billion, while the adjusted figures rose $4.3 billion. Finally, between the fourth quarter of 1954 and the first of 1955, there was a seasonal rise of $14.7 billion, whereas the adjusted figures rose only $2.1 billion. This case is rather exceptional because, save in the last quarter, the adjusted figures moved in opposite direction to the seasonal factors (suggesting a possible overcorrection, discussed below); but the relative magnitudes of the two sets of figures are not at all unusual.

Our interpretation of Table 2 and Chart 1 is subject to a qualifi-

Chart 3
Seasonal Factors in Corporate Profits, Taxes, and Dividends, 1954-1955



Source: Table 4.

cation noted earlier. The farm inventory component of the unadjusted change in business inventories is, in effect, adjusted for seasonal (that is, a smooth curve is drawn through the annual data to obtain quarterly estimates). Hence the implicit adjustment factors that we have computed do not show the full extent of seasonal variation in inventory accumulation. Unfortunately, without the unadjusted data, we cannot tell in what way our figures and our conclusions should be modified.

From Table 3 and Chart 2 we learn that it is the seasonal variation in personal consumption expenditures that is primarily responsible for the seasonal pattern in total final purchases, and indeed in GNP. The table and chart are limited to the most recent year, but the figures are fairly representative. Seasonal influences in any given quarter

TABLE 4

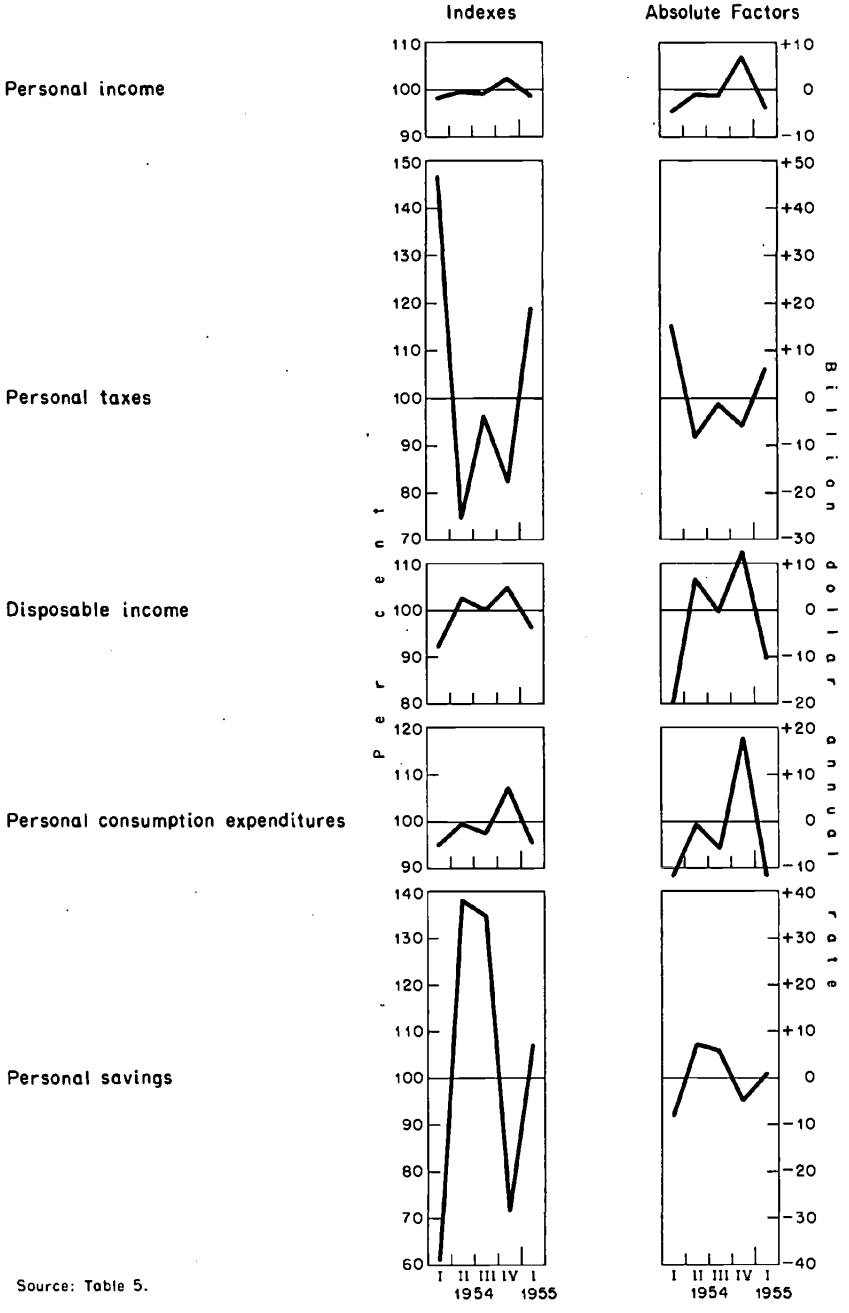
Seasonal Factors in Corporate Profits, in Taxes, and in Dividends, 1954

Quarter	Corporate Profits before Taxes	Corporate Tax Liability	Corporate Profits after Taxes	Dividend Payments	Undistributed Profits
	1. Absolute Factors: Original minus Seasonally Adjusted Data (*billion dollar annual rate*)				
I	−2.7	−1.2	−1.5	−0.1	−1.4
II	+0.3	+0.3	0.0	−1.0	+1.0
III	+2.1	+1.2	+1.3	−0.8	+2.1
IV	+0.4	+0.3	+0.1	+1.4	−1.3
I[a]	−2.9	−1.7	−1.6	+0.2	−1.8
	2. Indexes: Original divided by Seasonally Adjusted Data				
I	91.7	92.7	90.8	99.0	78.8
II	100.9	101.8	100.0	89.8	114.3
III	106.3	107.1	107.8	92.0	131.3
IV	101.1	101.7	100.6	113.2	82.2
I[a]	92.9	91.7	92.2	102.0	82.4
	3. Quarter-to-Quarter Change in Absolute Factors (*billion dollar annual rate*)				
I-II	+3.0	+1.5	+1.5	−0.9	+2.4
II-III	+1.8	+0.9	+1.3	+0.2	+1.1
III-IV	−1.7	−0.9	−1.2	+2.2	−3.4
IV-I[a]	−3.3	−2.0	−1.7	−1.2	−0.5
	4. Quarter-to-Quarter Change in Seasonally Adjusted Data (*billion dollar annual rate*)				
I-II	+1.0	+0.5	+0.5	+0.1	+0.4
II-III	−0.2	−0.1	−0.1	+0.2	−0.3
III-IV	+2.5	+1.3	+1.2	+0.6	+0.6
IV-I[a]	+4.9	+2.4	+2.5	−0.4	+2.9

[a] 1955.

Chart 4

Seasonal Factors in Personal Income, Taxes, Spending, and Savings, 1954-1955



Source: Table 5.

seldom operate either to raise or to reduce all five major categories of purchases (the first quarter of 1954 was exceptional in this respect). Incidentally, whatever one may say about the counter-cyclical behavior of government purchases, they are not counter-seasonal. However, the government sector does provide one exception to the general rule that short-term seasonal changes usually exceed nonseasonal.

Undistributed corporate profits have a marked seasonal pattern—low in the first quarter, high in the second and third (Table 4 and Chart 3). The seasonal swing is distinctly wider, relatively, than in total profits. The difference is not explained by corporate taxes, for the movements in the tax liability are roughly proportional to those

TABLE 5

Seasonal Factors in Personal Income, in Taxes, in Spending, and in Savings, 1954

Quarter	Personal Income	Personal Taxes	Disposable Income	Personal Consumption Expenditures	Personal Savings
	1. Absolute Factors: Original minus Seasonally Adjusted Data (*billion dollar annual rate*)				
I	—4.6	+15.3	—19.9	—11.8	—8.2
II	—1.0	— 8.3	+ 6.9	— 0.3	+7.2
III	—1.3	— 1.2	— 0.1	— 5.9	+ 5.8
IV	+6.8	— 5.9	+12.6	+17.8	—4.8
I[a]	—4.0	+ 6.2	—10.2	—11.8	+1.1
	2. Indexes: Original divided by Seasonally Adjusted Data				
I	98.4	146.8	92.1	94.9	61.0
II	99.7	74.6	102.7	99.9	138.3
III	99.5	96.3	100.0	97.5	134.9
IV	102.3	82.2	104.9	107.4	71.4
I[a]	98.6	119.0	96.1	95.2	107.2
	3. Quarter-to-Quarter Change in Absolute Factors (*billion dollar annual rate*)				
I-II	+ 3.6	—23.6	+26.8	+11.5	+15.4
II-III	— 0.3	+ 7.1	— 7.0	— 5.6	— 1.4
III-IV	+ 8.1	— 4.7	+12.7	+23.7	—10.6
IV-I[a]	—10.8	+12.1	—22.8	—29.6	+ 5.9
	4. Quarter-to-Quarter Change in Seasonally Adjusted Data (*billion dollar annual rate*)				
I-II	+0.8	0.0	+0.8	+2.9	—2.2
II-III	+0.7	+0.1	+0.6	+2.8	—2.2
III-IV	+3.5	+0.3	+3.3	+3.1	+0.2
IV-I[a]	+2.8	—0.5	+3.2	+4.8	—1.5

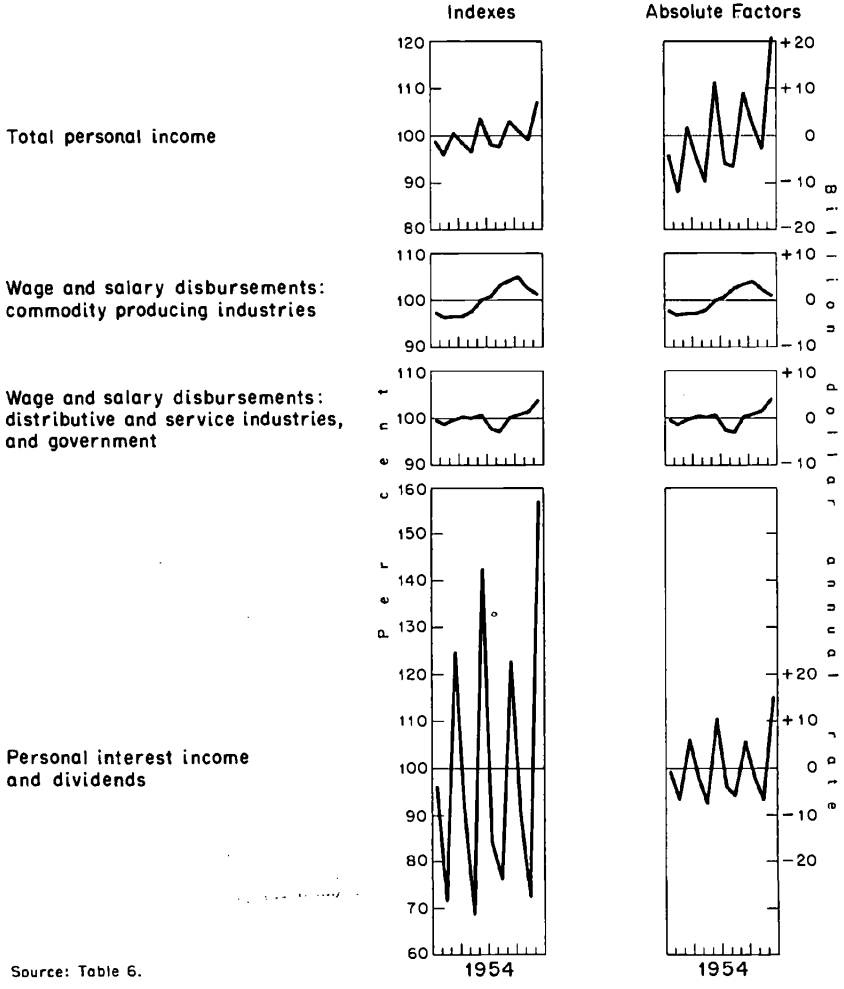
[a] 1955.

in profits: the relative seasonals in taxes and in profits before and after taxes are nearly identical. The large seasonal in undistributed profits is traceable to the seasonal pattern in dividend payments, which is virtually the obverse of that in profits.

Personal income changes little from season to season, but the large seasonal tax payments accentuate the seasonal pattern in disposable income (Table 5 and Chart 4). This seasonal seems to leave its imprint upon consumption expenditures (or vice versa): the quarter-to-quarter seasonal changes in disposable income and consumption are all in the

Chart 5

Seasonal Factors in Sources of Personal Income, 1954



Source: Table 6.

same direction. But the seasonal changes in consumption are by no means proportional to those in income. Nor is there a linear relation. The consumption function clearly shifts with the season of the year. As a result, there is a marked seasonal in personal savings, with a curious resemblance to that in corporate savings—low in the first and fourth quarters, high in the second and third.

The seasonals in certain sources of personal income for which monthly data are available (Table 6 and Chart 5) indicate that the sharp month-to-month changes in aggregate income are traceable to dividend and interest payments. But these monthly fluctuations, which take the form of sharp peaks in March, June, September, and Decem-

TABLE 6

Seasonal Factors in Sources of Personal Income, 1954

Month	Total Personal Income	Wage and Salary Disbursements		Personal Interest Income and Dividends
		Commodity-Producing Industries	Distributive and Service Industries and Government	
1. Absolute Factors: Original minus Seasonally Adjusted Rate (*billion dollar annual rate*)				
January	— 3.8	—2.3	—0.2	— 0.9
February	—12.1	—3.2	—1.4	— 6.9
March	+ 1.8	—2.9	—0.2	+ 6.0
April	— 4.9	—2.9	+0.3	— 2.3
May	— 9.9	—2.1	0.0	— 7.7
June	+11.3	0.0	+0.7	+10.4
July	— 5.9	+0.6	—2.8	— 3.9
August	— 6.3	+2.6	—3.1	— 5.9
September	+ 9.0	+3.3	+0.1	+ 5.6
October	+ 2.5	+4.0	+0.8	— 2.5
November	— 2.8	+2.0	+1.5	— 6.9
December	+20.9	+0.9	+4.2	+15.1
2. Indexes: Original divided by Seasonally Adjusted Data				
January	98.7	97.3	99.8	96.3
February	95.8	96.2	98.7	71.6
March	100.6	96.6	99.8	124.7
April	98.3	96.6	100.3	90.6
May	96.5	97.5	100.0	68.6
June	103.9	100.0	100.6	142.3
July	97.9	100.7	97.5	84.1
August	97.8	103.1	97.2	76.1
September	103.1	104.0	100.1	122.7
October	100.9	104.8	100.7	90.0
November	99.0	102.3	101.3	72.3
December	107.1	101.1	103.7	157.0

ber with troughs in the immediately preceding months, largely cancel out when summed by quarters, leaving wage and salary disbursements in commodity producing industries as the principal determinant of the *quarterly* seasonal pattern in total personal income. All these findings are, however, subject to the qualification that one source, farm proprietors' income, enters into the aggregate only in seasonally adjusted form, and its seasonal pattern therefore is not reflected in the estimated adjustment factors for total personal income. Farmers' income, of course, has a large seasonal element, but how far this might influence the seasonal pattern in total income is not possible to say with the data at hand.

The Quality of the Seasonal Adjustment in Major Income and Product Series

The NID has not published a description of its seasonal adjustment procedures, although I understand the preparation of such a document is on its agenda. My appraisal is based mainly on what I have been able to deduce from an examination of the published data and is confined to the major items in the accounts, which we have just described. This has the disadvantage of concentrating on the implicit adjustments derived by adding together adjusted components, while ignoring the direct adjustments actually made by the compilers. A full appraisal should do both; the kind of limitation my procedure imposes will become apparent from what follows.

There is no professional consensus on precisely what it is that a seasonal adjustment should eliminate, and it is difficult therefore to lay down ground rules for an appraisal. A number of criteria are used in the trade, and it is not only practically not feasible but also mathematically impossible to satisfy them all. For example, if the seasonal indexes for twelve months are to sum precisely to 1,200, a common requirement, it is not possible as a rule to have the sum of a year's adjusted data equal precisely the sum of the unadjusted data, which also seems to be a reasonable requirement.[4] There is really an amazing variety of difficulties one can run into in making what one would like to call a simple adjustment for seasonal variations.

In the end an appraiser must judge for himself whether too much has been eliminated by the seasonal adjustment, or not enough. I have found some examples of both kinds of inadequacy, by my stand-

[4] Nevertheless, the condition that the indexes sum to 1,200 is necessary if, under certain reasonable assumptions, the *expected value* of the sum of a year's adjusted data is to equal the sum of original data (see Arthur F. Burns and Wesley C. Mitchell, *Measuring Business Cycles*, National Bureau of Economic Research, 1946, p. 51).

ards, but on the whole the adjustment of the national accounts series seems to me to be quite satisfactory. I do not want to produce a different impression in the following discussion, which necessarily concentrates on the problem areas and deals with some rather fine points.

ADJUSTMENT OF COMPONENTS VERSUS ADJUSTMENT OF TOTALS

If we start, as before, with the seasonal adjustment of total GNP, we are concerned immediately with an issue that seldom if ever gets treated in textbook discussions of seasonals, namely, whether the adjustment of an aggregate should be made directly, or indirectly by adjusting the components and adding them up. Indeed, the problem is a more general one, for it comes up also when the series in question can be derived by taking the difference between two other series, and again when the series is a ratio or product of two other series. The general practice is to adjust the components, and it has a great deal of logic to recommend it. But I have had enough sad experience to know that this procedure can produce untoward results, especially when ratios or products are involved. Consequently I would like to explore some of the implications of the indirect adjustment—not with much hope of convincing anyone that direct adjustment is to be preferred, but rather to provoke discussion.

As remarked at the outset, the indirect adjustment does not produce a strictly repetitive seasonal, but rather one that may vary cyclically, secularly, and erratically. The implicit seasonal pattern for a given year will depend on (1) the seasonal pattern in each component and (2) the relative weight of the component. Since the relative weights may vary erratically, or cyclically, or secularly, the implicit pattern will also vary from year to year in this manner. In addition, the patterns used in adjusting the components may be altered from time to time.[5] As a result, it is difficult to describe what it is that is being eliminated from the aggregate. The ordinary statement—that the figures are adjusted for the *usual* seasonal change—does not mean what it seems to say, for the adjustment in one year is almost never the same as in the year before. For example, the adjustment in GNP for the fourth quarter during 1948 to 1954 varied from 12.9 to 14.2 billion dollars

[5] The implicit pattern depends, therefore, on the particular set of components selected for adjustment. Differences in the level of detail, or in the nature of the classification, will produce differences in the implicit adjustment. This is no doubt partly responsible for the differences between the seasonal factors in the income and in the product estimates of GNP (Table 1). Moreover, the results may vary depending on the order of the procedure. For example, should corporate profits before taxes be adjusted by summing adjusted figures for taxes, dividends, and undistributed profits, or should undistributed profits be adjusted by subtracting adjusted taxes and dividends from adjusted profits before taxes?

(annual rate), or from 3.6 to 5.2 per cent. These are certainly not large variations, but that fact makes it even more difficult to explain to the layman why there should be any variation at all. Since GNP in the fourth quarter is usually about 4 per cent above the average for the year, why not adjust it downward by 4 per cent every year?

Of course, there are good reasons for expecting seasonal factors to change, and among these reasons are the changing importance in an aggregate of components that have different seasonal factors. But unless the evidence for the change is obtrusive, so that failure to recognize it would produce prominent defects in the adjustment, there is much to be said, on grounds of simplicity, for using constant adjustment factors. It is very difficult to judge the adequacy of an indirect adjustment of an aggregate. Reviewing the adjustment of each of several hundred component series is a tremendous task. Yet there is nothing else one can do if one wishes to trace to its source any supposed or apparent inadequacy of the adjustment of the aggregate. And this is as true for the compiling agency as it is for the outside user.[6]

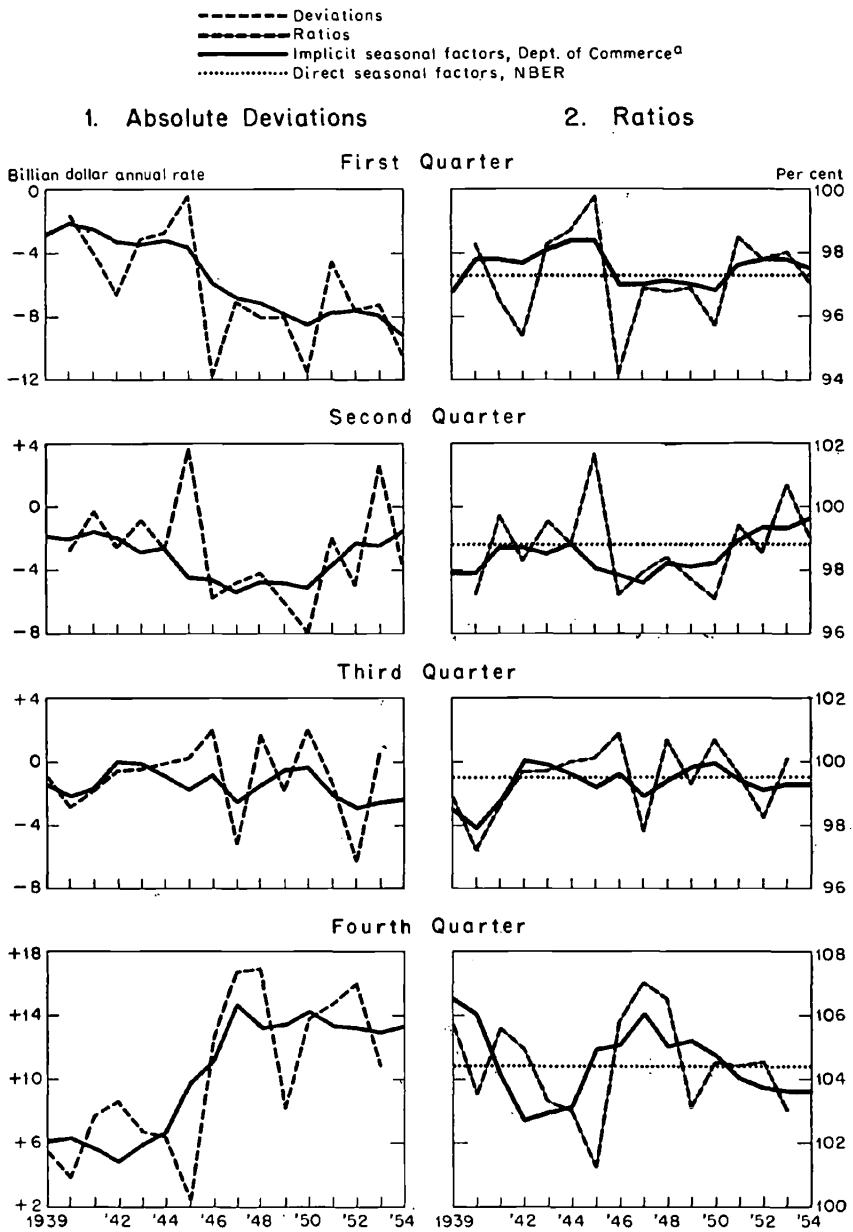
Moreover, inadequacy of the indirect adjustment of an aggregate may not be apparent from an examination of the aggregate itself. If some residual repetitive movement has not been eliminated, this may be observable; but if the fault is on the other side, and too much *nonrepetitive* movement has been eliminated, how can that possibility be tested? The implicit adjustment factors will not be strictly repetitive, but do they deviate too far from the repetitive path, or not? And do they deviate in the right direction? There is really no way to answer these questions properly without examining the component adjustments. Perhaps this is why it is so seldom done.

These observations can be illustrated. Chart 6 shows the implicit seasonal adjustment factors for GNP for each quarter, annually since 1939, in both absolute and relative form. Superimposed on these are the factors usually used to derive a direct seasonal adjustment, the deviations of the quarterly data from a centered four-quarter moving average, and (in the second panel) the corresponding ratios to the moving average. Although there is a general correspondence between the deviations and ratios on the one hand, and the implicit factors on the other, it is difficult to find much justification for the year-to-year

[6] This can operate in reverse, too. The compiler may hesitate to make or publish a needed revision in the seasonal adjustment of a component since it involves changing the adjusted figures for the aggregate. The solution adopted by the Board of Governors of the Federal Reserve System in adjusting only the major components of its industrial production index has much to recommend it *(Federal Reserve Bulletin,* December 1953, pp. 1263-1264).

Chart 6

Gross National Product: Implicit and Direct Seasonal Factors, and Deviations of Original Data from and Ratios to Four-Quarter Moving Averages, 1939-1954



[a] In col. 1 the implicit seasonal factors are the differences between original and seasonally adjusted data. In col. 2 the implicit seasonal factors are the ratios of original to seasonally adjusted data.

fluctuations in the implicit factors from those in the ratios. The ratios to moving average admittedly contain all manner of randon fluctuations; so, apparently, do the implicit factors, but they are of a different sort. If a moving seasonal were to be derived from the ratios it would broadly resemble the movements in the implicit seasonal, but it would differ considerably in detail (especially in the fourth quarter). In my judgment the ratios support the use of a constant relative seasonal for the entire period.

Chart 7 shows the result of applying a constant relative seasonal to GNP. The "quality" of the adjustment seems to me to be about as good as that of the implicit seasonal; in some respects it is better.[7] If the implicit method effects an improvement at all, is such a refinement warranted in view of the intrinsic errors in all seasonal adjustments as well as in the data themselves?

One or two other considerations support my heretical view. In many aggregates, one can expect the seasonals in the several components to offset one another. This is much more true of seasonal variations than it is of cyclical variations or even secular trends.[8] Indeed, the seasonal variations in different components may be inversely related, for example, total final purchases and inventory investment (Chart 1). Since 1939 the absolute amplitude of the seasonal in final purchases (first to fourth quarter) has increased from $10 billion to $37 billion, or about three and a half times. But there has been an

[7] The principle deficiencies of the constant seasonal are that the fourth-to-first quarter decline is over-corrected in 1943-1944 and 1944-1945 and under-corrected in 1946-1947 and 1947-1948. Its principal merits are that it eliminates a slight residual seasonal attributable to inventory investment and that it improves the adjustment in 1939-1940. The constant seasonal factors, derived by the ratio to moving average method, are almost identical with the implicit Department of Commerce seasonal averaged over the same period (III 1939–II 1954).

Quarter	NBER Index (*direct*)	Commerce Index (*implicit*)	Difference
I	97.3	97.6	+0.3
II	98.8	98.5	−0.3
III	99.5	99.3	−0.2
IV	104.4	104.5	+0.1

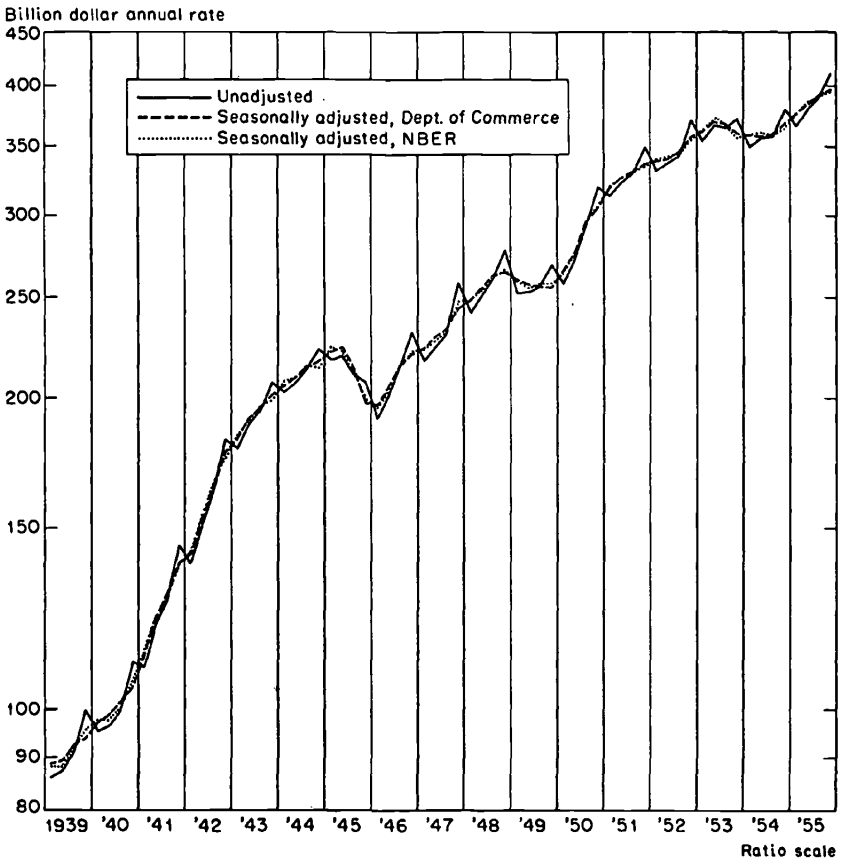
[8] In a calculation made some years ago for Wesley C. Mitchell, we found that the cyclical amplitude (rise and fall) of the FRB index of industrial production during 1919-1938 was 30.2 per cent, the range of the implicit seasonal adjustment factors for the total index, 8.6 per cent. The average cyclical amplitude of the 18 major industry components of the total index was 37.7 per cent and the average range of their seasonal indexes, 18.8 per cent. Hence 80 per cent (30.2/37.7) of the average cyclical amplitude of the components was preserved in the total index while only 46 per cent 8.6/18.8) of the average seasonal amplitude was to be found in the total index.

even greater relative increase in the seasonal amplitude of inventory investment, from $—2 billion to $—14 billion. Hence the seasonal amplitude of GNP has increased only two and a half times, from $9 billion to $22 billion. At all times, the seasonal in GNP has a much smaller relative amplitude than in final purchases, due to the offsetting seasonal in inventory investment: in 1954 it was 6.1 per cent as against 10.3 per cent, or less than two-thirds as large. Similarly the seasonal in final purchases has a smaller relative amplitude than in most of *its* components.

It follows that the seasonal in the aggregate may even be less subject to pronounced systematic change than those in the components. Although the former will change with the changing patterns and rela-

Chart 7

Gross National Product: Two Seasonal Adjustments, 1939-1955



tive weights of the components, these may offset one another to such an extent and vary in such an erratic way that only a relatively constant seasonal emerges—one that can be eliminated readily by simple, direct means, as shown in Chart 7. Of course, if all of the components are to be seasonally adjusted anyway, the direct adjustment of the aggregate is an extra step. But it might be possible for the compiler to avoid adjusting some of the less important components were their adjustment not required simply to obtain an adjusted aggregate.

I realize that direct adjustment of aggregates and subaggregates carries with it the implication that the compiling agencies commit a cardinal sin, one that may cause them and the users of the data much anguish. The adjusted components will not add up to the adjusted total. I do not think the discrepancies are likely to be large, however (see the direct and indirect adjustments in Chart 7). Indeed, if they do turn out to be large, it is a sign of trouble with one adjustment or the other. The failure of adjusted components to add precisely to the adjusted total could be covered by a footnote paraphrasing the usual one about rounding errors: "Because of seasonal adjustment, adjusted detail may not add to adjusted totals." That, at least, ought to make the reader sit up and take notice, thus achieving my main objective. The direct adjustment puts the user on his guard. He can if he wishes readily check the calculation provided he is told that it was done by some standard method. The indirect adjustment leads to indifference for the user cannot possibly check the calculation.

Since my campaign for direct adjustments is not likely to be immediately successful, let me fall back to a second line of defense in anticipation, and recommend that direct adjustment be used by the compilers at least as a check upon the indirect adjustment. It can help them to recognize defects in the latter and hence lead to revision and improvement. One instance of this nature is noted below.

FURTHER TESTS OF THE ADJUSTMENTS

As already mentioned, the matter of direct versus indirect adjustment also comes up when one is dealing with a ratio between two series. In my experience the derivation of an adjusted ratio by taking the ratio of two adjusted series frequently produces an inadequate adjustment—so frequently, in fact, that I have been led to think of this as a rather stringent test for the adequacy of the adjustment of the two component series. It is a particularly difficult test to pass if the adjustment of the two series has been done independently. For example, we have computed an index of labor cost per unit of output in manufacturing by dividing the Bureau of Labor Statistics index of

factory payrolls by the Federal Reserve Board index of manufacturing production. In this case the seasonal adjustment of both series was done by the same agency, the Board of Governors of the Federal Reserve System, but the ratio of the adjusted series contains a noticeable seasonal pattern. This suggests an inadequate adjustment of either the numerator or denominator, or of both.

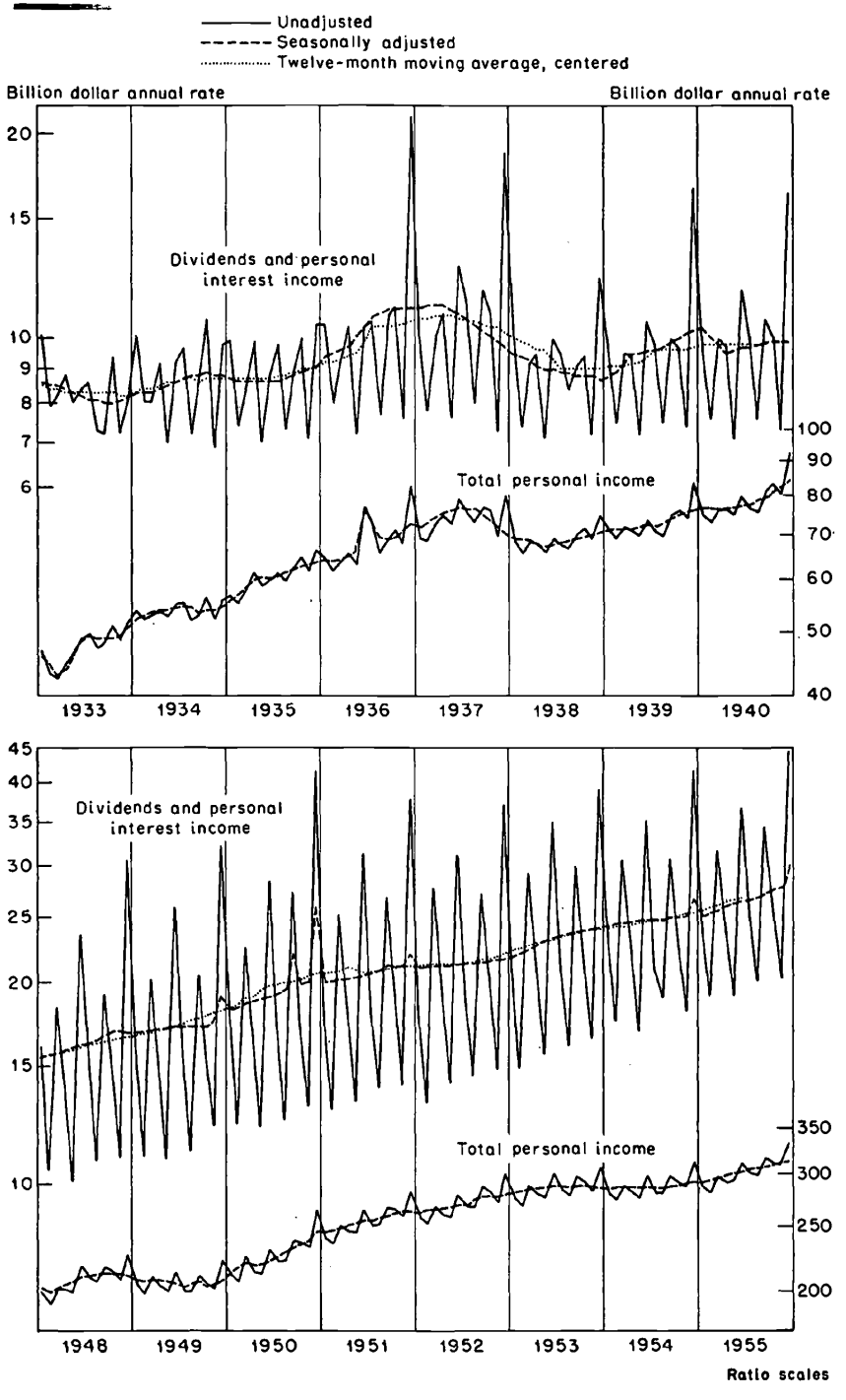
I have applied this test to three ratios of seasonally adjusted national accounts series: (1) the ratio of the statistical discrepancy to total GNP, (2) the ratio of personal savings to disposable income, and (3) the ratio of wage and salary disbursements to total personal income (monthly). So far as I can tell, there is no residual seasonal in any of these ratios. They pass the test with distinction. The test has one limitation, however: it is not sensitive to what might be called an overelimination of seasonal. If the adjustment is made so that each series closely approximates, let us say, a twelve-month moving average, part of the erratic, cyclical, or trend movements may be eliminated. And my test will not detect this. But it is not easy to detect this by any sort of test, especially if the series in question is an aggregate adjusted by the indirect method. Yet I have an idea that such overadjustment does characterize some of the national accounts series.

A series that shows some evidence of such smoothing is the monthly series on dividend and personal interest income (Chart 8). Note, for example, the adjustment of the December figures. In 1933 the adjusted figure is slightly above the unadjusted; then in 1934 and 1935 the adjusted figure is considerably below the unadjusted; in 1936 and 1937 there is another sharp increase in the amount of the adjustment; in 1938 the adjustment is cut in half; then in 1939 and 1940 it is increased again. These shifts in the adjustment factors were evidently introduced in order to produce a smooth adjusted series, or were incorporated in the process of smoothing the adjusted series. They contribute to the smoothness of the adjusted total personal income series, as the lower panel of the chart shows. Some liberties also appear to have been taken with the adjusted data in the second half of 1936 and first half of 1937: the adjusted data seem to be too high relative to the unadjusted. This may also have been produced by the application of some smoothing technique.

In the later part of the series a different kind of defect in the adjustment appears. There are sharp isolated peaks in the adjusted data in December 1949, 1950, 1951, and 1954, and in September 1950. I am at a loss to account for them, though they are apparently due to dividends rather than interest income, for they appear also in the quarterly dividend series. The application of a constant or slowly changing

Chart 8

Dividends and Personal Interest Income, and Total Personal Income, 1933-1940 and 1948-1955



seasonal would, I am sure, produce erratic movements throughout the series, not simply in these isolated months.

Inventory investment is another series that appears to have been overadjusted for seasonal changes. The implicit adjustment factors (Chart 1) trace a zig-zag movement from quarter to quarter: high in the first quarter, low in the second, high in the third, and low in the fourth. The seasonally adjusted data trace the opposite zig-zag fairly

TABLE 7

Inventory Investment: Distribution of Peaks and Troughs by Quarters and Quarterly Directions of Change, 1939–1954

	Number of Times Data Reach				Number of Times Data		
Quarter	Peak[a]	Trough[a]	No Turn[a]	Quarter	Rise	Fall	Do Not Change
			Unadjusted Data				
I	15			IV to I	15		
II		15	1	I to II		16	
III	12		4	II to III	15	1	
IV		12	3	III to IV	3	13	
			Seasonally Adjusted Data				
I	1	4	10	IV to I	7	8	
II	8	4	4	I to II	10	6	
III	3	6	7	II to III	6	10	
IV	6	5	4	III to IV	9	7	
			Deviations of Adjusted Data from Moving Average[b]				
I	3.5	5	6.5	IV to I	8	7	
II	8	4	2	I to II	9	5	1
III	3	6.5	4.5	II to III	4	9	1
IV	6	6	3	III to IV	8	7	

[a] A peak (trough) is reached when the figure is higher (lower) than in the preceding and the succeeding quarter. Entries of one-half are made when figures in adjacent quarters are tied.

[b] The moving average is a centered four-quarter moving average of the unadjusted data. Because of centering, the period covered is III 1939 to II 1954.

often, as Chart 9 and Table 7 show. When the quarters are arrayed according to the magnitude of the adjustment factors, as in the following tabulation, it seems clear that both the upward and the downward adjustments have been too large, on the whole.

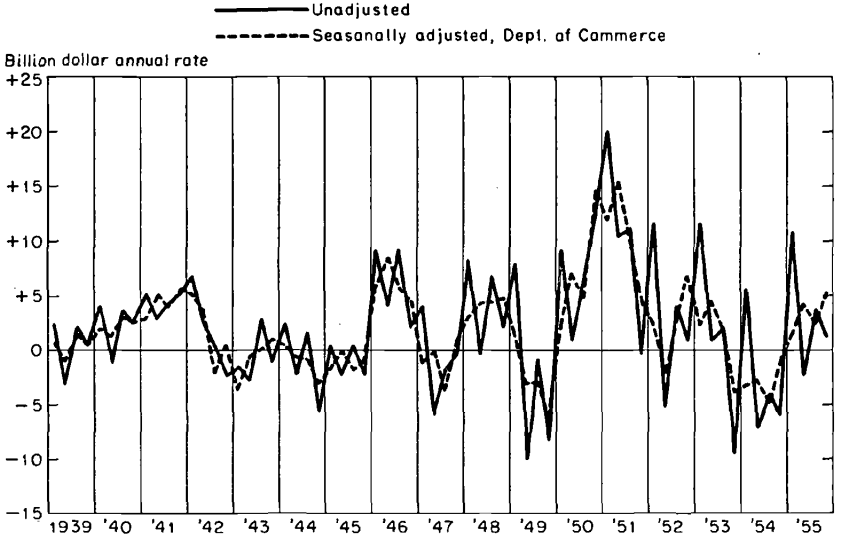
	Frequency, in Seasonally Adjusted Data, of	
Seasonal Factor	Peaks	Troughs
Large upward adjustment (II)	8	4
Small upward adjustment (IV)	6	5
Small downward adjustment (III)	3	6
Large downward adjustment (I)	1	4

That is to say, the seasonal factors that were applied must have had too large an amplitude, resulting in an overcorrection.[9] This is not true of every year, however. In 1939 and 1940, and in 1944 and 1949 to a lesser extent, the series appears to be undercorrected.

Because of the volatility of inventory investment one might expect a defect in its seasonal adjustment to show up in GNP (when GNP is adjusted by summing adjusted components). The defect is not large relative to the cyclical and secular changes in GNP; but it does show itself when these changes are attenuated by means of a four-quarter moving average (Table 8). Because the seasonal pattern in inventory investment is inversely related to that in GNP (and final purchases), the overcorrection of inventory investment shows up as an undercorrection of GNP. Moreover, in the two years when inventory investment is notably undercorrected, 1939 and 1940, GNP appears slightly overcorrected (see Chart 7).

Chart 9

Inventory Investment: Unadjusted and Seasonally Adjusted, 1939-1955



[9] Since this was written data through the second quarter of 1957 have become available, and the results continue to suggest that the seasonal in inventory investment is over-corrected. In eight out of the ten quarter-to-quarter changes between IV 1954 and II 1957 the seasonally adjusted data move in opposite direction to the original data. As before, increases in the seasonally adjusted figures are much more frequent than decreases between the first and second and between the third and fourth quarters (there are four increases and only one decrease since 1954), while decreases outnumber increases between the fourth and first and between the second and third quarters (here there are four decreases and only one increase).

These results are supported by a comparison of the published seasonal adjustment with the constant seasonal that we computed directly from the GNP aggregate. The figures adjusted by the constant seasonal, when taken as deviations from a four-quarter moving average, do not show the same alternation of peaks and troughs in successive quarters as does the adjusted series of the Department of Commerce. And when our adjusted data are subtracted from the Commerce adjusted series, the undercorrection in the latter reappears. The difference between the constant seasonal index and the average implicit index derived from the Commerce series (see note 7) is also reasonably consistent with this evidence.

It is worth noting that GNP adjusted by the constant seasonal does

TABLE 8

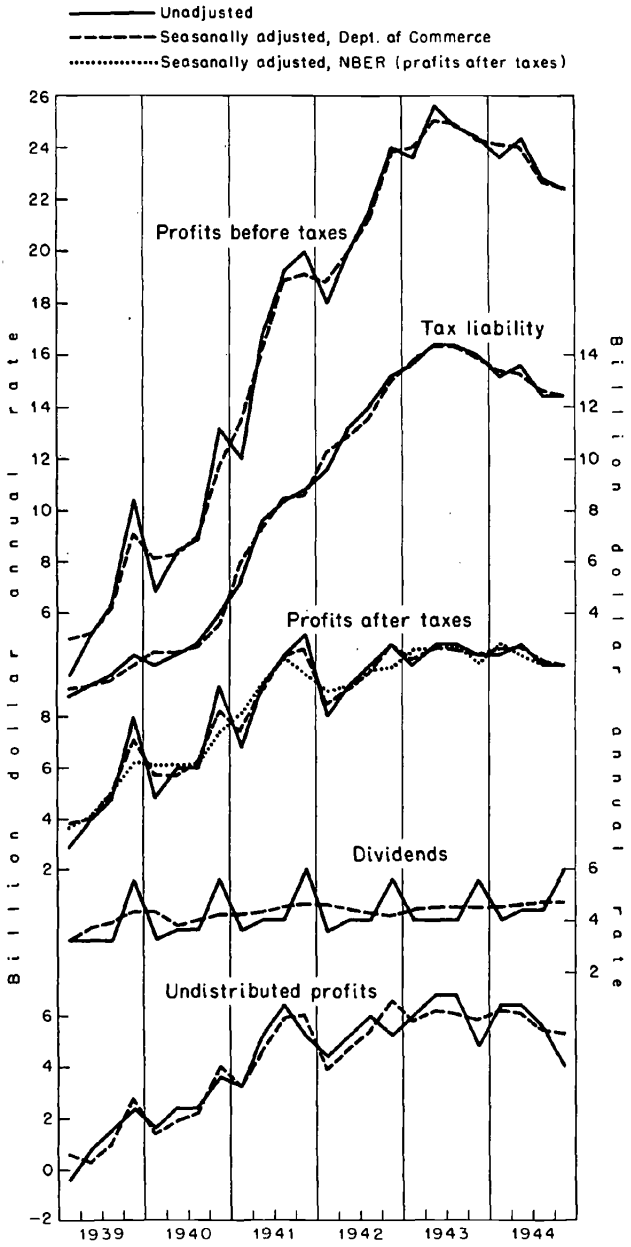
Gross National Product: Distribution of Peaks and Troughs by Quarters, and Quarterly Directions of Change, 1939-54

	Number of Times Data Reach				Number of Times Data		
Quarter	Peak[a]	Trough	No Turn[a]	Quarter	Rise	Fall	Do Not Change
			Deviations of Original Data from Moving Average[b]				
I		14	1	IV to I		15	
II	5		9	I to II	14	1	
III		6	8	II to III	8	6	
IV	15			III to IV	15		
			Deviations of Commerce Adjusted Data from Moving Average[b]				
I	3.5	5	6.5	IV to I	7	8	
II	5	1.5	7.5	I to II	8	6	1
III	3	5	6	II to III	5	9	
IV	7	7	1	III to IV	7	8	
			Deviations of NBER Adjusted Data from Moving Average[b]				
I	4	3.5	7.5	IV to I	7	7	1
II	3	3	8	I to II	7	8	
III	4	4	6	II to III	6	8	
IV	4.5	5	5.5	III to IV	7	8	
			Deviations of Commerce Adjusted Data from NBER Adjusted Data				
I		5	10	IV to I	7	8	
II	9	3	4	I to II	13	3	
III	3	4	9	II to III	7	9	
IV	7	7	1	III to IV	8	8	

[a] A peak (trough) is reached when the figure is higher (lower) than in the preceding and the succeeding quarter. Entries of one-half are made when figures in adjacent quarters are tied.

[b] The moving average is a centered four-quarter moving average of the adjusted data. Because of centering, the period covered is III 1939 to II 1954.

Chart 10
Seasonal Adjustment of Corporate Profits and Related Series, 1939-1944



not show the same overcorrection in 1939-1940 as the published series, and that as a result the acceleration in output in the last half of 1939 and the retardation in the first half of 1940 is prominent in the figures adjusted by the constant seasonal but virtually obliterated in the published series. I believe that a great variety of other evidence testifies to the fact that such an acceleration and retardation actually occurred in 1939-1940, so that this is a point in favor of the constant seasonal adjustment. Whether it is wholly attributable to the Commerce Department's undercorrection of inventory investment in 1939-1940 or partly to a too vigorous smoothing of other items in the national accounts I do not know. For anyone wishing to trace the course of this particular fluctuation in the economy, the question would be worth pursuing.

Another example of what seems to be an undercorrection for a seasonal appeared in my review of the series. In corporate profits after taxes there are sharp peaks in the fourth quarter and troughs in the first quarter in both seasonally adjusted and unadjusted data in 1939, 1940, 1941, 1942, and 1943 (Chart 10). When we called this to the attention of the National Income Division and showed them an alternative direct adjustment of the series (see the chart), George Jaszi explained that they regarded tax rate changes as "outside the scope of seasonal adjustments" and that "rate increases in the 1939-1943 period tended to produce downward fourth-to-first quarter movements in the unadjusted data which we left in the adjusted series." This point of view has force, although I think it would be possible also to argue that, if rate changes ordinarily took effect at the beginning of the calendar year (or some other regular date), one type of seasonal pattern might be applied when the change was an increase, and another when it was a decrease.[10] However, variations in the size of the rate changes might cause difficulties with such a scheme.[11]

[10] We have used an analogous procedure in seasonally adjusting bituminous coal production. Because much of the industry operated on a two-year labor contract, strikes occurred every other year with some regularity, at least during 1904-1914. Hence we derived and applied one seasonal pattern for odd (peace) years and another for even (strike) years (see Burns and Mitchell, *op. cit.*, pp. 61-62).

[11] A similar problem arises in a monthly series on railway tax accruals (Interstate Commerce Commission). Tax accruals usually have increased moderately through the year but declined sharply at the end. The year-end declines vary considerably in magnitude, presumably reflecting corrections for changes in tax rates or ratables that occurred during the year. As a result, the seasonally adjusted series is marked by occasional sharp peaks or troughs in December, giving the appearance of undercorrection or overcorrection. The unadjusted December figures, in other words, not only differ from the other months in level but also show far greater variability. Perhaps some new method of adjustment can be devised to deal with seasonal patterns in variability.

Yet I am not altogether satisfied with the explanation of the fourth-to-first quarter declines. These appear also, though less prominently, in unadjusted corporate profits *before* taxes. And the unadjusted figures for corporate tax liability do not show exceptionally large fourth-to-first quarter increases. Indeed, it appears to be the seasonal adjustment of the tax liability that put large fourth-to-first quarter increases into the adjusted tax figures, thus accentuating the declines in the after-tax series. The adjustment of the before-tax figures also contributed to the result: the fourth-to-first quarter declines seem to be slightly undercorrected in the 1939-1943 period. In short, an undercorrection of the before-tax figures combined with an overcorrection of taxes, produced an undercorrection of the after-tax figures. If this was the procedure used by the NID in deriving the adjusted after-tax data (I understand the adjustment is actually done separately for each industry), we have a case where indirect adjustment by differencing two adjusted series creates a more prominent defect than appears in the two directly adjusted series. The effect can be traced through to undistributed profits, which are clearly overcorrected in the 1939-1942 period (Chart 10), presumably because the adjustment was obtained by subtracting adjusted dividends from adjusted after-tax profits.

CAUSAL ANALYSIS IN SEASONAL ADJUSTMENT

The corporate tax liability case raises the question how far causal analysis should be used in adjusting data for seasonal variations. In general it would seem wise to fortify such adjustments with all possible knowledge of the factors underlying seasonal variations. But it is important that such analysis be made in quantitative terms; that it be restricted to the regular, repetitive, intra-annual fluctuations that are commonly known as seasonal variations; and that it be made known to the public. Otherwise the compilers may succumb to the temptations of adjusting the data according to their preconceptions and rationalizing the results, while the user of the data will be unaware of what is going on.

A striking example of the need for causal analysis is provided by the personal income series (Chart 8). In June and December 1936 there were unusually large increases in the unadjusted figures, in each case an increase of 22 per cent above the preceding month. In the adjusted data the June increase is retained almost completely but the December increase is virtually wiped out (the June increase is reduced to 16 per cent, the December increase to 2 per cent). The June increase was due to the veterans' bonus payment; the December increase to a

change in the seasonal pattern of the dividend and interest component of personal income. Although large December increases had not occurred previously, they continued to occur subsequently. Since I do not know the cause of this shift, I do not know whether it could have been discovered at the time. But it is obvious that knowledge of the causes of both extraordinary fluctuations would have been essential to the proper seasonal adjustment of the current data.

Seasonal movements in the various components of gross national product are of such magnitude, and their proper adjustment of such significance in facilitating current appraisals of cyclical and secular change, that greater public awareness of the meaning of such adjustments, of the problems they create, and of the methods used, analytical or mechanical, to derive the adjustments is highly desirable. One of the necessary ingredients in this educational process would be an official description and appraisal of the seasonal adjustment of the national accounts.[12] I hope that the NID, in addition to its many other tasks, will soon produce such a document.

COMMENT

ERNEST W. GROVE, Department of Agriculture

We in the Farm Income Branch of the Department of Agriculture have had our occasional differences of opinion with the National Income Division, and I must confess to certain feelings of satisfaction tinged with amusement in seeing some of our concepts and practices cited here as good examples which the NID should follow.

As an estimator myself, on the other hand, I find myself generally in sympathy with the defendant in these proceedings. V Lewis Bassie and Stanley Lebergott are notable exceptions, but some of the critics have seemed to belabor the NID simply for refusing to extend the estimates beyond their reasonable foundation in factual source material.

The NID is fully capable of defending itself, however, and I wish merely to throw a little cold water on two proposals for expansion of the estimates in the agricultural field. The first of these, suggested by Morris Cohen and Martin R. Gainsbrugh and supported by Raymond W. Goldsmith, concerns the measurement of agricultural saving. The

[12] A minor point in this connection: comparison of unadjusted and adjusted data, which is necessary to the appraisal of the latter, would be facilitated if the unadjusted data in the *National Income Supplement* were published on an annual rate basis instead of quarterly totals, to correspond with the annual rate basis used for the seasonally adjusted data. Multiplying the published quarterly totals by four is not only an inconvenience to the user; it also magnifies the rounding errors.

second, emphasized by Geoffrey H. Moore, but also mentioned by Raymond Goldsmith, has to do with the provision of quarterly estimates of farm operators' net income on a seasonally unadjusted basis.

Goldsmith has made some useful estimates of agricultural saving,[1] so my objection here is not that nothing whatever can be done in this field but rather that what can be done is not the whole story. "Perpetual inventory" calculations and the differencing of successive balance sheet items provide a measure of agricultural saving in a sense, but this measure seems to fall substantially and consistently short of representing the total personal saving of the farm population.

When estimates of farm saving derived in this manner are subtracted from estimates of the net disposable income of the farm population, the residual estimates of farm consumption expenditures are unreasonably high. Of course, this might arise from the farm income estimates being too high, but I prefer to believe that it arises from the estimates of saving being too low. I am also convinced that the latter is the case.

Lack of information on farm holdings of certain types of assets is one obvious reason for the understatement of farm saving, but I think there is another and a more important explanation arising from the movement of people to and from farms. If saving is derived as the difference between successive balance sheet items, there are two types of population movement which would result in an understatement of saving: (1) the movement of persons with liquid assets *from* farms, and (2) the movement of persons with debt *to* farms. Both of these movements typically occur when farms change hands, with the result that increases in total farm debt and decreases in liquid farm assets may not truly represent dissaving by farm people.

If this interpretation is correct, I think it constitutes a serious obstacle to the determination of total personal saving and total consumption expenditures of the farm population by any method other than the expensive one of interview surveys.

As to the seasonal "disadjustment" of farm income, Moore and Goldsmith give some good reasons for wishing to see the quarterly totals of income and saving on a wholly unadjusted basis. But wishing will not make it so, and I do not hesitate to use the word "impossible" in this connection. Of course, arbitrary figures are always possible. But truly unadjusted quarterly estimates of net farm income are *not* possible with the information presently available.

When a series is available on a seasonally adjusted basis, but one is

[1] Raymond W. Goldsmith, *A Study of Saving in the United States,* Princeton University Press, 1955.

told that it is not available and cannot be made available in the original unadjusted form, there is only one possible explanation: the seasonally adjusted series itself must not be quite what it purports to be.

This is certainly true in the case of seasonally adjusted farm income. Farmers' gross cash receipts are available in unadjusted form, and are adjusted for seasonal variation in the usual manner. But there is hardly any information available on the quarterly distribution of farm production expenses, the inventory change, or other components of gross farm income. These items are simply interpolated from annual data, with the result that farm operators' net income on a seasonally adjusted basis is something of a hybrid calculation.

We undertook the publication of seasonally adjusted farm income estimates, despite their weaknesses, because of the obvious need for them, and because of considerable pressure from various sources for their development. The pressures that now seem to be starting for the seasonal "disadjustment" of farm income we hope firmly to resist. The information needed to provide what Moore and Goldsmith want could probably be collected—but only, I think, at prohibitive cost.

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UNADJUSTED SERIES

I concur in Goeffrey H. Moore's proposition (page 553) that a set of truly unadjusted data would be desirable. But I would state the point somewhat differently. For several of the income and product categories we do not really have sufficient data to provide estimates that reflect all actual changes that take place within a particular quarter or month. In spite of these limitations, we think that we can provide quarterly or monthly rates that are representative of the broader changes that occur in such items under the impact of general business conditions. It is in these instances that we do not provide "unadjusted" series that differ from the "adjusted" ones. In the typical case in which we have no truly unadjusted series we are thus unable to construct a truly "seasonally adjusted" series either. Generally, the series we show in such cases have built into them an element of smoothness which reflects the absence of complete monthly or quarterly information. Progress towards genuinely unadjusted data (and genuinely seasonally adjusted data as well) depends on our obtaining more nearly adequate primary statistical information. This is a condition largely beyond our control.

Although the problem of estimating actual quarterly or monthly changes is mainly one of data collection, its intractability may in some

instances reflect more fundamental, analytical difficulties which emerge in applying the concept of income to progressively shorter periods. A searching examination of the problems involved in the presentation of truly unadjusted (as well as truly seasonally adjusted, rather than merely smoothed) estimates would have to cover this possibility also.

GLOBAL ADJUSTMENT

Moore has not convinced me that an over-all seasonal adjustment of aggregates is preferable to a separate seasonal adjustment of components. I believe that the latter procedure is clearly indicated, in particular, if the weights of the components in the aggregate vary over time. He observes (page 567) that the seasonal pattern in the total is likely to be less than in the components, due to offsets. It does not follow, however, that these offsets will result in a simple pattern easy to eliminate. Given the fact that the weights of the components change, the pattern in the total is likely to be blurred, and detailed adjustment will, in general, give superior results. The other considerations which he adduces—greater simplicity and greater amenability to simple mechanical verification—I find attractive but not very weighty.

I want to make it clear, however, that I find simple tests in terms of aggregates (as well as differences, ratios, and products) very useful for detecting readily the possible presence of residual seasonal movements in "adjusted" components. For instance, as Moore notes, one can often spot a faulty adjustment in either of two series by examining the movement of their ratio. But the use of such a test does not imply any belief that the seasonal pattern is basically resident in the ratio rather than in the components and hence could best be eliminated by direct adjustment of the ratio.

The subject of seasonals is a very intricate one, and what I have said with regard to the advisability of detailed adjustment is intended only as a general proposition which will cover most practical instances. I can think of certain cases in which judicious grouping, based upon a causal analysis of the seasonals, will give better results than a rigid pursuit of detailed methods. Such a case is referred to on page 563, note 5, of Moore's paper: we adjust profits before taxes and dividends; treat taxes in any given year as a constant fraction of adjusted profits before tax; and obtain undistributed profits as a residual.

ANALYSIS OF PARTICULAR COMPONENTS

I shall comment briefly on the specific analysis of selected components of our series which Moore undertakes in the concluding section of his paper (pages 568 ff.).

With reference to the personal interest and dividend series, it should be noted that the interest component is smoothed, in the absence of adequate information on a monthly or quarterly basis. The estimation of dividends gives rise to different problems, since in this case monthly information is available. The unadjusted quarterly figures show a rather clear-cut seasonal pattern except for parts of the prewar period, for which the seasonal adjustment problem was complicated by the distinctly lesser adequacy of the basic data. However, after considerable experimentation, we rated as unsatisfactory our attempts to construct a monthly series based on seasonal adjustment of the conventional type. Such a series was found to be quite erratic, because of large random shifts in payment dates, bookkeeping lags, and so forth. Therefore, we adopted the general procedure of computing seasonally adjusted totals on a quarterly basis and then deriving the monthly values by a smoothed interpolation.

We feel that this element of smoothing in the dividend series is required because the very notion of income becomes tenuous when applied to progressively shorter time periods. It would not be meaningful from the standpoint of my personal finances if I recorded income on the day on which my salary check happens to be deposited in the bank; it is sensible to say that I receive income at a uniform rate. Similarly, we believe that it would not be meaningful to record in the national accounts the common garden variety of erratic movements in monthly dividend payments.

We have, however, modified the general method summarized above in order to preserve in the seasonally adjusted estimates those analytically significant movements representing large fluctuations in payments of "extra" or "special" dividends. These account for the "isolated peaks" noted by Moore as appearing in the published estimates for September 1950 and a number of Decembers. Perhaps it would also have been desirable to preserve the irregular movements in dividends occurring in response to changes in tax laws. Had we done so, the monthly estimates for December 1936 and January 1954, *inter alia*, would be higher, and those for proximate months would be somewhat lower.

With respect to inventory investment, it appears to us that we may have neglected a seasonal in the inventory valuation adjustment stemming from seasonal tendencies in the wholesale price series. This may upon further research prove responsible for the anomalies Moore notes.

I see less substance in his comments on our corporate profit series. He agrees that my point regarding the treatment of tax rate changes

"has force," and I think that his evidence against the before-tax series is not too strong. However, quarterly profits represent a most troublesome area, and I would not wish to create the impression that the estimates are of a high degree of precision. Perhaps it is not worthwhile to argue the matter further.