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3165-03

ECONOMIC ANALYSIS OF EFFECTS OF
BUSINESS CYCLES ON THE ECONOMY OF CITIES

A PROCEDURE TO IMPUTE
QUARTERLY ESTIMATES OF
PERSONAL INCOME IN
COUNTIES CONTAINED IN
MULTI-COUNTY SMSAs

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Cooperative Agreement Number HA-5455
Cooperative Agreement Amount \$134,976
(Competitively Awarded)

Submitted To:

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

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August 1982

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The Problem

The precision available in an analysis of local (county) responses to business cycle fluctuations is seriously limited by the nature of the available data. Although the data available for counties provide detail on the various sources of income (labor earnings, property income, etc.) and considerable industrial detail for wages and salaries and proprietors' income, these data are only available on an annual basis. Since business cycles in post World War II years have experienced recessions of only two to five months' duration, the available data do not have sufficient temporal resolution to permit precise measurement of economic fluctuations, especially for short recessions that are contained entirely within a single year.

The limitations on measurement precision that accompany the use of annual data for the analysis of economic fluctuations can be demonstrated by computing measures of cyclical swing using both quarterly and annual data, and then comparing the measures.¹ In Table 1, these measures have been computed for the six business cycles that occurred between 1948 and 1980 using total wage and salary data for the U.S. from the National Income and Product Accounts.

1. Changes in the level of economic activity in an area can be observed through the use of a variety of measures. One measure that has been used often, and is convenient because of its computational simplicity, is the cyclical swing indicator measure developed and applied by the Bureau of Economic Analysis. This measure computes the mean quarterly percent change (at an annual rate) of nonfarm wages and salaries (or some other income component) during recessions and during periods of expansion. Cyclical swing, the measure of total fluctuation over the entire business cycle, is calculated as the difference between the rate of growth during the expansion and the rate of growth during the recession.

Table 1
 TOTAL U.S. WAGE AND SALARY
 CYCLICAL SWING MEASURES
 1948 TO 1980

	<u>Mean Quarterly Percent Change (at annual rate)</u>		<u>Cyclical Swing</u>
	Expansions	Recessions	Total Business Cycle
1948:III to 1953:II			
Quarterly data	9.99	-3.19	13.18
Annual data	10.24	-0.59	10.83
1953:II to 1957:III			
Quarterly data	6.51	-2.11	8.62
Annual data	6.74	-0.86	7.60
1957:III to 1960:I			
Quarterly data	6.80	-4.33	11.33
Annual data	6.34	0.50	5.84
1960:I to 1969:III			
Quarterly data	7.55	1.29	6.26
Annual data	7.80	2.80	5.00
1969:III to 1973:IV			
Quarterly data	9.22	4.56	4.66
Annual data	9.58	5.98	3.60
1973:IV to 1980:I			
Quarterly data	10.48	5.98	4.50
Annual data	10.76	5.38	5.38

These results show that there are significant deviations between the cyclical swing measures computed using quarterly data and those based on annual data. In general, agreement between the measures for these two series is better for the expansions than it is for the recessions.

The poor agreement shown for the recessions clearly reflects the measurement limitations that accompany a lack of temporal detail in the data for the comparatively short periods of recession. The measures based on annual data also appear to understate the severity of recession, and with the exception of the most recent recession, they suggest significantly less peak to trough fluctuation than is shown by the quarterly data.

Approach

The analytical problems that arise due to the limitations of the annual income data can be partially offset by creating a county data series with imputed quarterly fluctuations. The basis of this approach is to use the quarterly data that are available for individual states as interpolators to impute quarterly fluctuations in the annual county data. To do this, each of the components of income (labor income by major industry group, transfer payments, etc.) is treated separately. For example, quarterly fluctuations at the state level in labor income derived from durable goods manufacturing are used to impute proportionate fluctuations in county durable goods income. As discussed in the section below, not all income components will be adjusted using state indicators. Contributions for social insurance, for example, vary largely with changes in labor income levels. For this reason, county social insurance

contributions will vary proportionately with quarterly fluctuations in county labor income rather than with fluctuations in state social insurance contributions. After each component of income has been imputed on a quarterly basis, total county personal income is computed as the sum of the separate components for that quarter.

The strength of this approach is that it accounts for both the characteristics of the region in which the county is located and the industrial (and other components of income) composition of the county. In counties where certain components of income make up a disproportionate share of total income, the fluctuations in these components will weigh more heavily than they do elsewhere. Thus, to the extent that durable goods manufacturing exhibits high cyclical sensitivity, counties with concentrations of durables manufacturing will show correspondingly high cyclical fluctuations.

Sensitivity to business cycle fluctuations also varies by region. While part of this variation is attributable to industrial composition, other factors, such as secular growth rate and age of capital stock, may also contribute to regional differences. Using states as the basis for imputing quarterly changes in county data helps to capture many of these regional factors. On average, counties in a state will experience business cycle fluctuations more like each other than like some other geographic aggregate, such as the nation as a whole. Finally, since metropolitan counties account for a significant proportion of income in many states, quarterly fluctuations at the state level reflect to that degree county business cycle patterns.

Labor and proprietors' income in this imputation procedure is adjusted on an industry by industry basis to account for variations among

counties in the relative importance of different industries, and the variation by industry in business cycle sensitivity. The importance of accounting for industrial composition can be demonstrated by comparing two counties in the Philadelphia SMSA. In Philadelphia County, the central county of the SMSA, durable goods manufacturing accounts for 8 percent of labor and proprietors' income, and services account for 23 percent. Chester County, also in the SMSA, has a significantly different industrial composition, with 24 percent of income coming from durables manufacturing and only 16 percent from services. To the extent that durable goods manufacturing is cyclically more sensitive than services, taking industrial composition into account can be expected to increase the cyclical sensitivity of imputed quarterly income fluctuations in Chester County by comparison with those in Philadelphia County.

Common to all of the procedures for adjusting the components of income is the principle that imputed quarterly data must conform to the annual data in the original series as a control total. Thus, if the annual data constitute a flow of income for a period of one year, then the sum of the quarterly data for the year after imputation must also equal the original annual total. Secondly, trends which are present in the annual county data series must also be preserved by the process of adjustment so that secular patterns of change are maintained.

BEA has made available papers¹ that describe a procedure for allocating annual data totals to sub-annual periods, such as quarters, using

1. Lewis Bassie, "Interpolation Formulae for the Adjustment of Index Numbers," presented at the Annual Meeting of the American Statistical Association, December 30, 1939 (obtained from Robert Brown, Bureau of Economic Analysis). Also, sample worksheets and instructions for Bassie procedure.

another quarterly data series as an interpolator for the imputation process. This technique simultaneously eliminates spurious discontinuities in the data (such might appear between the last quarter of one year and the first quarter of the next) while holding the sum of the imputed data series for a given year to the original annual total as a control. Since this procedure is well tested and is used by BEA in its work, it is adopted as the basic method for generating quarterly estimates of most personal income components.

This procedure, which we will call the Bassie procedure, sets forth four conditions that the interpolated (quarterly) series must meet, and derives from these conditions a set of correction factors to be applied to the annual data. The procedure operates on a pair of years at a time. Using an exogenous series as an interpolator (state quarterly data), the second year of the pair (annual county data) is converted to quarterly data by extrapolating forward from the first year. This initial step creates a sequence whose quarterly fluctuations follow the pattern of the exogenous interpolator. By doing so, however, the sum of the extrapolated quarters does not equal the original annual total as a control, and a discontinuity is introduced between the last quarter of the first year and the first quarter of the second. To compensate for these problems the quarterly series is adjusted using the derived correction factors. The procedure then moves one year forward (the first year is completed and drops out, the second year is treated like the first, and the next year of annual data is introduced), and the process repeats. (See the papers referenced above for details on the application of this procedure.)

In summary, a quarterly county personal income series is generated by adjusting each of the components of county income using the Bassie proce-

dure, and summing these components to obtain county personal income in a quarter. Since each component is adjusted separately using the state series as an interpolator, both the regional character and industrial composition of the county influence the process of quarterly imputation.

Discussion

This procedure for imputing quarterly fluctuations into annual county personal income data was shaped in part by consultation with experts who are familiar with the limitations of existing data for metropolitan area analysis.¹ In general, opinion from those consulted reflects caution about using any data other than that from a primary source. However, there is also clear recognition of the limits presented by the available data with respect to the study objectives. From that point, opinion from those consulted divides along two lines: those who favor imputing quarterly estimates of county income (Brown, Cartwright, Ledebur, Muller,

1. Persons consulted include:

Robert Brown, supervisory Regional Economist, Regional Economic Measurement Division, Bureau of Economic Analysis. (Responsible for BEA's quarterly data series.)

David Cartwright, Chief, Regional Economic Information Systems Branch, Regional Economic Measurement Division, BEA.

Ray Grimes, Chief, Regional Economic Analysis Division, BEA.

John Kort, Economist, Regional Economic Analysis Division, BEA.

Larry Ledebur, Senior Research Associate, The Urban Institute.

Tom Muller, Principal Research Associate, The Urban Institute.

Monroe Newman, Head, Department of Economics, Pennsylvania State University.

and Newman), and those who feel that research would be better served by using existing BEA data supplemented with data from other sources (Grimes and Kort).

We have sought to reconcile these two sets of opinions by restricting our use of imputed quarterly data largely to descriptive purposes. That is, the quarterly imputations will be used primarily to illustrate the pattern and severity of local cyclical fluctuations, to make comparisons across metropolitan areas, and between central counties and rest-of-SMSA. For some analytical purposes the quarterly data will not be employed. For example, in testing the hypothesis that local economic fluctuations are aligned more closely with state economic fluctuations than with national economic cycles, it would be manifestly inappropriate to use for the test quarterly data whose imputation assumed a close relationship between local and state cycles. Consequently, this test must be made with unadjusted annual data.

For descriptive purposes, there is no satisfactory substitute for imputed quarterly income totals. BLS monthly employment data, which are not seasonally adjusted, have been suggested as a substitute for the imputed quarterly income data. Unfortunately, we find that this source is inadequate for a number of reasons. Most important, perhaps, is that the definition of employment covered by this series is not consistent over an acceptably long period of time. Additionally, until quite recently, differences among state unemployment laws have produced different levels of coverage among states. Over the study period, there have been a number of changes in the types of employment covered by this source. Of particular concern are the changes that have occurred in the coverage of public sector workers. At various times different groups of public

employees have been added to those covered by the BLS source. These changes have included the addition of state government employees, county hospital workers, and local government employees. Since an important dimension of this study concerns the stabilizing effect of state and local government employment on the local effects of business cycles, this presents a serious limitation. Additionally, employment is recorded by place of work and no adjustment is provided to convert this series to employment by place of residence. Since some central cities have heavy incommuting of workers, this place of work perspective is not well suited to an analysis of the effect of cycles on area residents.

The limitations inherent in the imputation procedure need to be kept in mind. One of these limitations is that the timing (though not the magnitude) of local business cycles, if established by analysis of the imputed quarterly income data, will be determined to a considerable extent by the timing of cycles in the state quarterly data, especially for shorter cycles. Since each component (industry group) of county income is adjusted using state quarterly fluctuations as an interpolator, the timing of state fluctuations will be transmitted to the counties through this linkage. Some local timing effects may also be present in total county personal income, however, through the effect of maintaining control totals and accounting for industrial composition. Thus, there are limitations on the analyses that can be performed to compare the timing of local cycles with those in other geographic aggregates.

There are limitations, too, on analyses aimed at identifying the stabilizing effect of the different components of income. Both income derived from locally oriented industries and transfer payments are of interest for their stabilizing influence, but the imputation procedure may

attenuate the true quarterly variance in each of these components. This occurs because local industry income is adjusted based on the corresponding fluctuations in the state income component rather than local economic conditions, and because unemployment insurance payments are not separately identified as an element of county transfer payments.¹

Procedure

The steps that are followed in the process of adjusting annual county income data to impute quarterly fluctuations are described in detail below.

1. Adjust Wage and Salary and Proprietors' Income by Industry.

Procedure: Use state quarterly income fluctuations in each industry group to impute quarterly fluctuations for each industry group in the county.

Justification: Within a given industry, fluctuations in the level of activity at the state level will be a good indication of fluctuations for that industry in the county. Using the state as the basis for adjusting industry income in a county accounts for regional variations in economic activity which would not be included if a national basis was used. For example, in the mining sector fluctuations in coal mining may not necessarily follow the fluctuations in ore mining. To the extent that these different mining activities are concentrated in different states, using state data will account for regional variations in mining activity.

1. We are investigating the possibility of requiring separately county data on unemployment insurance payments, welfare transfers and other major counter-cyclical government transfers.

The appropriateness of this approach obviously can vary considerably by industry. Many industries (e.g., durable good manufacturing) sell primarily to national markets and the level of their activity will be strongly affected by conditions in those markets. Other industries (e.g., retail trade) serve more locally oriented markets, and conditions in these markets would be linked more closely with local economic conditions.¹ Although it would be desirable to treat local and nonlocal industries separately to capture these differences, doing so would significantly increase the complexity of the adjustment procedure. Since the experts that we consulted overwhelmingly felt that any improvements achieved would be insignificant, local and nonlocal industries will be treated alike.

2. Aggregate Income.

Procedure: Sum the income of all industries in the county to obtain total labor and proprietor's income by place of work on a quarterly basis.

1. For example, local industries in Allegheny County, Pennsylvania (Pittsburgh SMSA) may respond differently to business cycle fluctuations than their counterparts in Philadelphia County because of differences in their industrial composition. Allegheny County depends on highly cyclical durables manufacturing for 27 percent of its income, whereas this sector accounts for only 8 percent of income in Philadelphia County. During sharp downturns, especially those in which durables manufacturers are hit hard, personal income may be more depressed in counties like Allegheny than those like Philadelphia. To the extent that activity levels in local industries, such as retail trade, are influenced by county personal income levels, local industries in counties like Allegheny may decline more than would be predicted by the activity of the retail component at the state level.

3. Adjust Contributions for Social Insurance.

Procedure: Impute quarterly fluctuations in social insurance contributions on the basis of fluctuations in total labor and proprietors' income in the county.

Justification: This closely approximates the procedure used by the Bureau of Economic Analysis to allocate total state Social Insurance contributions to counties. (See BEA, Local Area Personal Income, 1974-1979, Volume 1, "Summary," page xxii.)

4. Compute Place of Work/Place of Residence Adjustment.

Procedure: Use straight line interpolation to estimate residence adjustments on a quarterly basis.

Justification: The Bureau of Economic Analysis uses a complex procedure based on commuting patterns by industry to estimate the residence adjustments. Since these patterns are not readily accessible and because of the complexity of their procedure, the straight line method is used. Moreover, commuting patterns are based on 1970 census data and it is questionable if a more elaborate adjustment procedure would significantly improve the quality of the imputed data.

5. Adjust Dividends, Interest, and Rent.

Procedure: Impute county quarterly fluctuations on the basis of state quarterly fluctuations in dividends, interest, and rent.

Justification: Capital markets are assumed to have generally uniform rates of return among places so that fluctuations in local rates of return will follow those for the state. Since income from dividends, interest, and rent is the product of capital investment levels and the rate of

return, this procedure further assumes that the pattern of quarterly fluctuation in the level of investment held by county residents follows the pattern for the state.

6. Adjust Transfer Payments.

Procedure: Impute quarterly fluctuations for transfer payments in the county based on state quarterly fluctuations.

Justification: Over three-fourths of these funds, on a national basis, go to individuals for retirement, health insurance, and disability payments. Payments of this type can be expected to vary primarily with fluctuations in benefit levels and the size of the recipient population. Changes in benefit levels will be captured by quarterly fluctuations at the state level, and changes in the size of the recipient population will be accounted for through the trend component of the adjustment.

Other types of transfer payments, such as those for income maintenance and unemployment insurance, can be expected to vary somewhat with local economic conditions. Although state fluctuations in this component may not be totally representative of local change, these payments account for only 8 percent of total transfers (at the national level), and therefore this procedure should produce acceptable results.

The possibility of isolating the counter-cyclical components of transfer payments through an independent data set is under investigation.

7. Adjust Population.

Procedure: Impute quarterly population estimates using straight line interpolation between annual estimates.

Justification: Population changes are assumed to occur smoothly throughout the year. Although seasonal population fluctuations may occur in some rural counties, such population changes are unlikely to be an important component of change in most metropolitan counties.

8. Compute Derived Quarterly County Income Estimates.

Procedure: From total labor and proprietor's income by place of work subtract contributions for social insurance to obtain net labor and proprietors' income by place of work; add residence adjustment to obtain net labor and proprietor's income by place of residence; add dividends, interest, and rent, and transfer payments to obtain personal income by place of residence; divide by population to get per capita personal income.