The Impact of Direct Taxes on the Cost of Living

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In this paper we define a cost-of-living index including direct taxes. We show its relationship to the traditional index and demonstrate how nonconsumption costs are properly treated. We then define a fixed-weight approximation, a tax and price index (TPI). Using federal, state, local, and social security tax rates for 1967–85, we construct annual TPI series based on household data. We find that inclusion of direct taxes has sizable impacts on the estimated rate of inflation. Partitioning our household sample, we find that recognition of taxes significantly alters inflation rate differentials estimated using consumption prices alone.

I. Introduction

The U.S. consumer price index (CPI) measures the change over time in the cost of a fixed market basket of goods and services. It can be interpreted as a fixed-weight approximation to a conditional cost-of-living index, where (1) the cost of living is defined as the minimum expenditure necessary to achieve a particular level of satisfaction and (2) the cost is defined to be conditional on all the determinants of the level of satisfaction except current quantities of market goods and services. As a logical consequence of this definition, the CPI is measured gross of indirect taxes, whether imposed at the final or an

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intermediate stage in the production of consumer goods and services, while income and other direct taxes are excluded from the scope of the index.

Despite its consistency with the theory of the cost-of-living index, this asymmetric treatment of taxes creates an anomaly for many of the uses to which the CPI is put, including wage escalation and deflation of income. Most obviously, when the parameters of the income tax system change, escalation of before-tax income by the CPI is unlikely to result in a value aggregate of equivalent real purchasing power. By the same token, if tax structures are shifted away from direct taxes toward indirect taxes (as would occur if a value-added tax were instituted), the CPI will show an increase even if there has been no change in either the overall tax bill or the standard of living. Finally, because of the "bracket creep" resulting from a progressive income tax system, rising consumer prices can lead to more than proportional increases in the income necessary to achieve a base utility level.

In this paper we will define and estimate an index that incorporates direct as well as indirect taxes into a CPI. Following U.K. terminology, we refer to this index as a tax and price index (TPI),[1] although our methodology is very different from that used in the United Kingdom. We emphasize that the TPI is not proposed here as a substitute for or correction of the current CPI framework or measurement techniques. Rather it approximates an alternative measurement objective—the before-tax income necessary to achieve a given level of satisfaction—that may be more appropriate for at least some applications.

Several authors have recognized the need to include direct taxes in an index used to escalate components of before-tax income (see, e.g., Lundberg 1957; Tanzi 1980; Congressional Budget Office 1981, p. 15; Triplett 1983). However, the literature contains no complete or rigorous discussion of how the cost-of-living index framework can be extended to focus on before-tax income rather than total expenditure. In Section II of this paper we attempt to fill this gap, building on a 1972 memorandum by Robert Pollak. We present formulas for what Pollak has called the income cost-of-living index, along with inequalities relating these theoretical indexes to observable fixed-weight bounds.

In Section III we outline the data sources and algorithms used in our index estimation process. Several aspects of the U.S. tax system have the effect of greatly extending the computational requirements

[1] See U.K. Central Statistical Office (1979) or Kay and Morris (1984). Our TPI should not be confused with the total positive income concept used in some Internal Revenue Service tabulations.

of a TPI over those necessary to construct a CPI. First, there is an increased need for information about the covered population of consumer units. Proper determination of filing status and number of exemptions requires knowledge of several household demographic and economic characteristics. Furthermore, in order to compute potential income tax deductions, one must have information on nonconsumption expenditures such as mortgage interest payments and personal business expenses. Second, the usual fixed-weight approximation to an expenditure-based cost-of-living index can be written as a linear function of prices. As a result, the mean CPI for a population can be computed from aggregate consumption data. By contrast, the progressivity of the U.S. tax system implies that TPI series should be computed at the household level, then averaged together. A final complication is that, because marginal tax rates are not continuous functions of income, the before-tax income necessary to yield a specific after-tax income must be obtained by an iterative search process.

Section IV contains our annual index simulations, presented for the period 1967–85. For the population on which we focus—a sample of 7,242 households from the 1972–73 Consumer Expenditure Survey—we present aggregate CPI and TPI series, as well as indexes of the income and social security tax burdens. The indexes demonstrate that, over the 18-year study period, the inclusion of direct taxes has a sizable positive impact on the estimated rate of inflation. However, the federal income tax reductions of 1982, 1983, and 1984 cause the TPI to increase by *less* than the CPI in those years.

As noted above, an important aspect of our approach is that we estimate indexes at the individual household level. The benefits of this approach become apparent in Section V, where we present aggregate indexes for selected population partitionings. In Section VI we summarize our findings and point out several ways in which our methodology will be employed in future research.

II. The Income Cost-of-Living Index and the TPI

The U.S. CPI, as it is currently compiled, measures changes in the *expenditure* necessary to consume a fixed set of goods and services. The CPI is best interpreted within the conditional cost-of-living index framework introduced by Pollak (1975). It approximates a cost-of-living index that focuses on the current consumption of market goods, where market goods are defined as those goods to which a user charge is attached, regardless of the supplier. Within a multiperiod framework, it is conditional on the future consumption of market goods, current and future consumption of public goods and leisure, and current and future environmental conditions. That is to say, in

comparing alternative price vectors for current market goods, its cost-of-living interpretation is restricted to alternatives in which all other variables affecting satisfaction levels are assumed fixed.[2] Regardless of the exact coverage, however, there is an obvious alternative to the expenditure focus of the current CPI that lies clearly within its cost-of-living orientation.

For many of the uses to which the CPI is put, it is perhaps more reasonable to measure changes in the income, before taxes, a consumer must receive to achieve a given level of satisfaction. Pollak (1972) advocates the construction of such a measure, referring to it as an income cost-of-living index (ICOL) as opposed to the usual expenditure cost-of-living index (ECOL). In the remainder of this section we derive the form of an exact ICOL and of the fixed-weight approximations, which we compute in Sections IV and V.

We begin by defining three column vectors of goods, $\mathbf{x}$, $\mathbf{z}$, and $\boldsymbol{\Psi}$. The vector $\mathbf{x}$ corresponds to the usual market basket of consumption goods. Following Pollak (1972), we also include units of "real saving" (i.e., money saving divided by a price index) as an additional element of the market basket. Vector $\mathbf{z}$ represents other, nonconsumption items for which current expenditures are incurred. Many of these can be thought of as investment carrying costs, not properly within the scope of a single-period cost-of-living index but purchased as part of an asset management program. Examples are consumer finance charges, professional memberships, and term life insurance premiums.[3] The vector $\boldsymbol{\Psi}$ includes all other variables on which the one-period cost of living is conditional, such as future consumption, public goods, and environmental variables. To simplify exposition, we suppress $\boldsymbol{\Psi}$ in the remainder of the paper, although it should be kept in mind that the index we desire is conditional on these variables.

We treat the purchase levels of $\mathbf{z}$ as conditioning variables in the function relating consumer utility to consumption of $\mathbf{x}$, as given by

$$U = u(\mathbf{x}; \mathbf{z}). \tag{1}$$

Next we define row price vectors $\mathbf{p_x}$ and $\mathbf{p_z}$ corresponding to the two goods vectors. We will use the term $\mathbf{p}$ to refer to the combination of the two price vectors; that is, $\mathbf{p} = (\mathbf{p_x}, \mathbf{p_z})$. Then the tax system can be represented by a function relating the level of tax to gross income Y, prices $\mathbf{p}$, and consumption levels $\mathbf{x}$ and $\mathbf{z}$, conditional on a variety of

[2] Under restrictive separability conditions, the CPI can also be interpreted as an approximation to a partial subindex that is independent of the levels of all the variables assumed fixed in the conditional subindex (Gillingham 1974; Pollak 1975).

[3] The elements of $\mathbf{z}$ should be distinguished from actual investments, such as purchases of housing assets, the funds for which may come from current savings included in the vector $\mathbf{x}$.

factors such as income source (e.g., wages or transfer payments), filing status, number of household members (i.e., personal exemptions), and geographic location (i.e., state and local filing jurisdiction), which we will represent by the term S:

$$T = t(Y, \mathbf{p}, \mathbf{x}, \mathbf{z}; S). \tag{2}$$

We can now define what we will call the income function Y, equal to the minimum income necessary to cover the taxes incurred, as well as the current purchase cost of $\mathbf{x}$ and $\mathbf{z}$, so as to maintain a base level of utility conditional on $\mathbf{z}$:

$$\begin{aligned} Y(\mathbf{p}, t; U, \mathbf{z}, S) &= \min_{\mathbf{x}} (\mathbf{p}_x\mathbf{x} + \mathbf{p}_z\mathbf{z} + T) \\ &\text{subject to } u(\mathbf{x}; \mathbf{z}) = U, \\ t(\mathbf{p}_x\mathbf{x} + \mathbf{p}_z\mathbf{z} + T, \mathbf{p}, \mathbf{x}, \mathbf{z}; S) &= T. \end{aligned} \tag{3}$$

An index could be constructed as the ratio of income functions under two tax and price regimes, given specified values of S, U, and $\mathbf{z}$. However, our goal is to index the cost of consumption, where that cost includes direct taxes. Investment-related expenses should be excluded, along with other nonconsumption payments, in order to retain a consistency with received cost-of-living measurement theory and also because we have no means of reflecting the offsetting returns to investment.[4] We must recognize the presence of expenditures on $\mathbf{z}$ in order to accurately compute marginal and average tax rates, but we do not wish changes in $\mathbf{p}_z$ to affect the ICOL except insofar as current tax rates are affected. Therefore, we define the "gross consumption cost function" G:

$$G(\mathbf{p}, t; U, \mathbf{z}, S) = Y(\mathbf{p}, t; U, \mathbf{z}, S) - \mathbf{p}_z\mathbf{z}. \tag{4}$$

Using the gross consumption cost function, we define the income cost-of-living index by

$$\text{ICOL}(\mathbf{p}^c, \mathbf{p}^r, t^c, t^r; U, \mathbf{z}, S) = \frac{G(\mathbf{p}^c, t^c; U, \mathbf{z}, S)}{G(\mathbf{p}^r, t^r; U, \mathbf{z}, S)}, \tag{5}$$

where the superscripts c and r indicate price vectors and tax functions in comparison and reference situations, respectively.

Turning to the problem of fixed-weight bounds, let us define a

[4] What we call the income function is similar to what Baye and Black (1984) (in a paper that came to our attention after our own research was completed) call the gross expenditure function. They make no distinction between consumption and nonconsumption expenditures. Consequently, although we find their work interesting, we feel that they have abstracted from a crucial definitional and computational aspect of the problem.

function τ, which yields the tax burden implicitly associated with a given pattern of prices and purchase levels. It is obtained by solving

$$\tau(\mathbf{p}, t; \mathbf{x}, \mathbf{z}, S) = t(\mathbf{p}_x\mathbf{x} + \mathbf{p}_z\mathbf{z} + \tau(\mathbf{p}, t; \mathbf{x}, \mathbf{z}, S), \mathbf{p}, \mathbf{x}, \mathbf{z}; S). \quad (6)$$

Put another way, τ is the amount of tax that would be paid on the minimum income sufficient to pay that tax as well as fund the specified purchases of $\mathbf{x}$ and $\mathbf{z}$. Our fixed-weight index, which we will refer to as the TPI, is then defined by

$$\text{TPI}(\mathbf{p}^c, \mathbf{p}^r, t^c, t^r; \mathbf{x}, \mathbf{z}, S) = \frac{\mathbf{p}_x^c\mathbf{x} + \tau(\mathbf{p}^c, t^c; \mathbf{x}, \mathbf{z}, S)}{\mathbf{p}_x^r\mathbf{x} + \tau(\mathbf{p}^r, t^r; \mathbf{x}, \mathbf{z}, S)}. \quad (7)$$

As in equation (5) we do not include the nonconsumption costs $\mathbf{p}_z^r\mathbf{z}$ and $\mathbf{p}_z^c\mathbf{z}$ in the index.

The usual Laspeyres argument yields the following bounding result. Let $\mathbf{x}^r$ be the value of $\mathbf{x}$ that yields $G(\mathbf{p}^r, t^r; U^r, \mathbf{z}^r, S^r)$; that is, it is the gross cost-minimizing consumption bundle corresponding to the reference situation parameters. Then we have

$$G(\mathbf{p}^r, t^r; U^r, \mathbf{z}^r, S^r) = \mathbf{p}_x^r\mathbf{x}^r + \tau(\mathbf{p}^r, t^r; \mathbf{x}^r, \mathbf{z}^r, S^r) \quad (8)$$

and

$$\text{TPI}(\mathbf{p}^c, \mathbf{p}^r, t^c, t^r; \mathbf{x}^r, \mathbf{z}^r, S^r) \geq \text{ICOL}(\mathbf{p}^c, \mathbf{p}^r, t^c, t^r; U^r, \mathbf{z}^r, S^r). \quad (9)$$

Similarly, if $\mathbf{x}^c$ is the cost-minimizing bundle corresponding to $G(\mathbf{p}^c, t^c; U^c, \mathbf{z}^c, S^c)$, we obtain

$$\text{TPI}(\mathbf{p}^c, \mathbf{p}^r, t^c, t^r; \mathbf{x}^c, \mathbf{z}^c, S^c) \leq \text{ICOL}(\mathbf{p}^c, \mathbf{p}^r, t^c, t^r; U^c, \mathbf{z}^c, S^c). \quad (10)$$

Equation (9) implies that the TPI series we compute in this paper provide an upper bound on a true ICOL, under the assumption that the base period consumption bundle $\mathbf{x}^r$ is "optimal" in the sense of equation (8). Notice, however, that this assumption is fundamentally different from that underlying the usual demand analysis. The consumption vector that minimizes gross consumption cost will not in general minimize $\mathbf{p}_x\mathbf{x}$ at the same level of utility and other parameters. It should be possible to evaluate the alternative assumptions empirically, although we shall not attempt to do so in this paper.

It should also be noted that we have conditioned our index on those goods and services provided by government and funded through tax revenues. In taking this approach we again follow Pollak (1972), who emphasizes that construction of an ICOL is a conceptually distinct exercise from that of developing a cost-of-living index not conditioned on public or environmental goods. Unconditional recogni-

tion of these factors in a cost-of-living index is independent of the treatment of taxes and is beyond the scope of this paper.[5]

III. Construction of Indexes

The discussion above of the conceptual foundations of a TPI has been intended to demonstrate its relationship to the theoretical ICOL measurement objective. We have abstracted from many operational complexities that result from the multitiered structure of the U.S. tax system. In this section we describe the operational techniques used to incorporate these complexities into our historical TPI series. We also describe the household sample that provides the expenditure data for our analysis.[6]

The before-tax income we measure will be the minimum necessary to yield an after-tax income equal to the expenditure required to purchase the fixed set of consumption goods. We calculated three "tax" components covering federal taxes, state and local taxes, and social security (FICA) contributions, respectively. We treat the latter as a tax because the relationship between changes in real social security contributions and changes in real expected discounted benefits is sufficiently tenuous to make this a reasonable first approximation.

To calculate a CPI, or the expenditure portion of a TPI, one need know nothing about a consumer unit other than its consumption pattern. To calculate the tax components of the TPI, however, it is necessary to know a number of economic and demographic characteristics of the consumer unit and to establish a number of conventions. A household's tax liability depends on the following household-specific factors: (1) household composition, (2) income source, (3) consumption patterns, and (4) other, nonconsumption, expenditures. Much of the impact of these factors is fairly straightforward. For example, household composition affects federal and state tax liability through its impact on, inter alia, filing status, number and type of exemptions, and eligibility for special programs.

The fact that consumer durables provide untaxed income in kind can affect the calculation of a TPI in a much more complex fashion. The most important complexity relates to the treatment of owner-occupied housing. The preferential tax treatment of owner-occu-

[5] Cobb (in press) reports on a recent attempt to unconditionally incorporate levels of nonmarket goods into a cost-of-living index, through the estimation of translation parameters in a system of market good demand equations.

[6] A more detailed review of our procedures is available from the authors on request. Some of this material is also provided in Gillingham and Greenlees (1983), which reports on a preliminary inquiry into the TPI problem.

pants in the U.S. federal and state tax codes stems from the fact that the implicit rent they receive is not taxed. We built this fact into our index by assuming that the amount of in-kind income for homeowners is identical to the value of shelter services consumed. Consequently, in constructing the TPI for homeowners, we computed total money and in-kind income necessary to yield an after-tax income equal to the explicit cost of nonshelter consumption plus the implicit cost of shelter. With the exception of housing, we adopted the convention that current expenditures on the stock of the durable good are a reasonable approximation to the value of the services consumed, and we made no attempt to deal with the implicit income from these goods.

Tax Data

Information on federal income tax brackets, marginal rates, exemptions, deductions, and credits was drawn from *Individual Income Tax Returns*, an annual series produced by the Internal Revenue Service (IRS), and the IRS's guide for individual taxpayers, *Your Federal Income Tax*.

The essential structure of the federal tax system has remained unchanged since 1967, although rule changes have tended to reduce the liability on a given nominal income level. Tax due is computed by applying a system of increasing marginal rates to "taxable income." Tax credits may then be applied to reduce the tax bills of households in certain categories.

The first step in deriving taxable income from gross income is the computation of "adjusted gross income" (AGI). Subtractions from gross income include partial exclusions of specific income categories such as interest, as well as deductions for certain expenditures such as moving costs and contributions to retirement funds. For the purpose of this paper, however, we assume that all money income derives from wages and salaries or from self-employment. This fact, along with our other conventions, implies that, with the important exception of implicit rent, gross income and AGI are equivalent measures. Taxable income equals AGI less the value of exemptions and deductions. We treat explicitly deductible expenses for medical care costs, state and local taxes, interest paid, and charitable contributions. A "standard deduction" is also available for taxpayers who do not choose to itemize or whose deductible expenses are relatively low.

The second major component of the federal direct taxation system consists of contributions to the social security retirement, disability, and health insurance systems. These contributions are a constant proportion of earnings up to a ceiling level. Both the tax rate and the

income ceiling have increased rapidly. In 1967, wage and salary workers contributed 4.4 percent of earnings below $6,600. By 1985 the tax rate and ceiling had reached 7.05 percent and $39,600, respectively. Self-employed individuals are subject to the same ceiling but contribute at a higher percentage rate, which rose from 6.4 in 1967 to 11.8 in 1985.

We obtained data on state and local income taxes from two Commerce Clearing House publications, the *State Tax Handbook* and *State Tax Guide.* The *State Tax Handbook,* published annually, provided the tax brackets and marginal rates for each state and year, as well as the exemptions or credits given for taxpayer, spouse, and dependents. From the *State Tax Guide* we obtained information on current rules for itemized deductions, elderly exemptions or credits, sales taxes, and other details. Since this information is less detailed than our information on federal taxes and since our price series apply to the United States as a whole, however, we do not present index series at the state level.

Of the 50 states and the District of Columbia, we excluded Alaska and Hawaii, on the basis that national price series could not be treated as representative, and two other states, Montana and Wyoming, which were not included in our household sample. The remaining 47 jurisdictions included some that had no tax on earned income; this group contracted from 16 in 1967 to eight in 1985.[7]

For the most part, cities impose a flat percentage rate, which can be thought of as a surcharge on the state schedule. The major exception is New York City, which in 1985 had a schedule with 14 tax brackets. Having no information on the employment location of sample households, we excluded consideration of the commuter taxes imposed by a number of jurisdictions.

Household Data

Our basic household-level data source was the 1972–73 Consumer Expenditure Survey (CES). From the CES we derived annual expenditure series along with information necessary to define filing status, exemptions, deductions, and credits. We began with the CES data base constructed by Hagemann (1982) for his study of household-specific price indexes. We then excluded households that were located in Alaska or Hawaii, that moved or changed tenure status

[7] Most states have progressive marginal tax rate systems similar to that of the federal government. A few states have a single tax rate, while three compute tax liability as a percentage of the federal liability rather than by a rate schedule applied to income. Recently, several states have begun to index their tax brackets to a measure of the inflation rate.

during the survey year, or whose primary earner was retired or unemployed. We also restricted our attention to those households that would use either the single or married filing jointly tax schedules. These and other minor edits resulted in a data base containing 7,242 consumer units.

Hagemann (1982) defined household-level "market baskets" by calculating expenditures in 37 categories of consumption, and he constructed fixed-weight price indexes by linking the base period (1972–73) expenditure weights to the appropriate CPI price series. We followed the identical procedure, differing only in adding several additional budget categories[8] and in extending the price indexes back to 1967 and forward to 1985. We thus implicitly assume that all households in our sample face the same rates of inflation for individual cost items.

Index Computation

The fundamental computational problem in constructing our TPI series is as follows: given a specified value of consumption expenditures, what is the minimum required value of gross income? Because the relationship between income and tax rate is not smooth or even monotonic, there is no closed-form solution to the problem, which is essentially that of determining the value of τ in equation (6) above. We shall use a simplified example to demonstrate the iterative procedure employed for this study.

Let m_F be the marginal federal income tax rate and let C_F be a term incorporating the difference between m_F and the rate applicable in lower income brackets (i.e., C_F reflects the difference between the marginal and average tax rate). Let m_S and C_S be the corresponding state (and local) values and let m_W be the FICA contribution rate. To be consistent with the notation of Section II, define Y as the level of gross before-tax income, and let R indicate implicit rental income (and cost) for owner-occupants. Finally, let D indicate tax-deductible expenditures. Then we have

$$T_S = C_S + m_S(Y - R - D) \tag{11}$$

and

$$T = T_S + C_F + m_F(Y - R - D - T_S) + m_W(Y - R), \tag{12}$$

where T_S and T are, respectively, state tax and total tax. Note that in equation (12) state tax is deductible on the federal return. As in

[8] Household savings were measured directly as the sum of changes in bank accounts, reductions in mortgage loan principal, and various other components. For a discussion of the CES survey design, see Carlson (1974).

Section II, let $\mathbf{p}_x\mathbf{x}$ and $\mathbf{p}_z\mathbf{z}$ equal consumption and nonconsumption expenditures. Since we must have

$$Y = \mathbf{p}_x\mathbf{x} + \mathbf{p}_z\mathbf{z} + T, \tag{13}$$

we obtain, through straightforward algebra,

$$Y = \frac{1}{(1 - m_F)(1 - m_S) - m_W}[\mathbf{p}_x\mathbf{x} + \mathbf{p}_z\mathbf{z} + C_F + (1 - m_F)C_S - (m_F + m_S - m_F m_S)(R + D) - m_W R]. \tag{14}$$

This computed Y value is the solution if (i) $Y - R - D$ falls in the same state and federal tax brackets used to define m_S, m_F, C_S, and C_F; (ii) $Y - R$ does not lie above the ceiling FICA income value, in which case the marginal FICA rate would be zero rather than m_W; and (iii) D exceeds the value of the standard deduction. If these conditions do not hold, new parameters corresponding to Y are inserted into (14) and another solution is attempted.

The procedure we followed is basically an elaboration of this process to allow for personal exemptions, tax credits, percentage and flat standard deductions, states with unusual tax formulas, and other complications. We experienced little difficulty in solving for Y. In no attempts out of 137,598 cases (7,242 households for each of 19 years) did the solution process require as many as seven iterations. The median number of iterations required was three.

The solution values of Y for each household and year provided us with the information necessary to compute our tax and price index series. The TPI itself is an index of $Y - \mathbf{p}_z\mathbf{z}$, as indicated by equations (4) and (7). We can also compute indexes of direct consumption cost $\mathbf{p}_x\mathbf{x}$, or of the separate tax components, to examine the influences of each on the inflation experience of our sample households. The results of these computations are discussed in the next section.

IV. Estimated Tax and Price Indexes

Table 1 presents our simulated annual cost series for consumption and tax, based on our sample of 7,242 CES households. In computing sample means, we weighted household expenditures by their CES sampling weights. This follows the official CPI methodology for estimating population expenditure totals.

The figures in the table highlight the expanding share of taxes in our simulated household budgets. In 1967, the sample consumer units required an average of $11,793 in gross income in order to retain after-tax funds sufficient for their 1972–73 observed purchases. When we subtract the $1,253 cost of nonconsumption expen-

TABLE 1

ANNUAL CONSUMPTION COSTS AND TAX LIABILITIES, 1967–85

	SAMPLE MEAN VALUES					
YEAR	Direct Consumption Cost	Federal Tax	State Tax	FICA Contribution	Gross Consumption Cost	Total Required Income
1967	8,702	1,404	168	266	10,540	11,793
1968	9,019	1,690	202	305	11,216	12,521
1969	9,400	1,912	243	338	11,893	13,267
1970	9,840	1,818	254	341	12,253	13,720
1971	10,267	1,773	291	373	12,703	14,259
1972	10,579	1,742	329	419	13,068	14,715
1973	11,253	1,992	372	547	14,164	15,914
1974	12,429	2,436	448	650	15,963	17,854
1975	13,440	2,634	519	696	17,288	19,339
1976	14,220	2,840	588	747	18,394	20,580
1977	15,133	3,132	657	801	19,722	22,061
1978	16,190	3,604	752	892	21,439	23,953
1979	17,833	4,042	839	1,098	23,812	26,539
1980	19,876	5,081	1,001	1,247	27,205	30,274
1981	21,771	6,102	1,171	1,543	30,587	34,035
1982	23,045	5,962	1,243	1,667	31,917	35,717
1983	23,965	5,635	1,372	1,779	32,751	36,836
1984	24,967	5,638	1,415	1,896	33,916	38,288
1985	25,806	5,813	1,439	2,076	35,134	39,762

ditures, we obtain $10,540 as the gross consumption cost of the 1972–73 bundle in 1967. Of this latter total, approximately $1,404, or 13.3 percent, is allocated to federal income tax. Another 1.6 percent and 2.5 percent are required for state and local income taxes and social security contributions, respectively, leaving 82.6 percent for consumption goods (and saving).

By 1985, the mean direct consumption cost of $25,806 was only 73.5 percent of the gross cost of that level of consumption expenditure. Federal, state and local, and FICA burdens all rose more rapidly than the prices of market goods. These three tax components totaled, respectively, 16.5, 4.1, and 5.9 percent of gross consumption cost.

Table 2 presents index series derived from the value series in table 1. As expected given its method of calculation, our estimated CPI closely approximates the published CPI-U X1 series with the same rental equivalence definition of homeowner shelter costs (Gillingham and Lane 1982). Again, we see that all three tax series rose much more rapidly than prices of goods and services over the study period. In 1985 the TPI index, based on gross consumption cost, stood at 333.3, 37 index points above the direct consumption cost index. This indicates that, had the before-tax earnings of sample households been

TABLE 2

TAX AND PRICE INDEXES, 1967–85

	INDEX					PERCENTAGE CHANGE				
		Tax Component					Tax Component			
YEAR	CPI	Federal	State	FICA	TPI	CPI	Federal	State	FICA	TPI
1967	100.0	100.0	100.0	100.0	100.0	...	...	...	...	...
1968	103.6	120.4	120.0	114.6	106.4	3.6	20.4	20.0	14.6	6.4
1969	108.0	136.2	144.2	126.9	112.8	4.2	13.1	20.2	10.7	6.0
1970	113.1	129.5	150.9	128.2	116.2	4.7	−4.9	4.6	1.0	3.0
1971	118.0	126.3	172.7	140.0	120.5	4.3	−2.5	14.5	9.2	3.7
1972	121.6	124.1	195.4	157.1	124.0	3.0	−1.7	13.1	12.2	2.9
1973	129.3	141.9	221.1	205.4	134.4	6.4	14.4	13.1	30.8	8.4
1974	142.8	173.5	266.2	244.0	151.4	10.5	22.3	20.4	18.8	12.7
1975	154.4	187.6	308.5	261.1	164.0	8.1	8.1	15.9	7.0	8.3
1976	163.4	202.3	349.3	280.4	174.5	5.8	7.8	13.2	7.4	6.4
1977	173.9	223.1	390.5	300.5	187.1	6.4	10.3	11.8	7.2	7.2
1978	186.1	256.8	446.9	334.7	203.4	7.0	15.1	14.5	11.4	8.7
1979	204.9	287.9	498.7	412.0	225.9	10.1	12.1	11.6	23.1	11.1
1980	228.4	362.0	594.9	468.0	258.1	11.5	25.7	19.3	13.6	14.2
1981	250.2	434.7	695.7	579.3	290.2	9.5	20.1	16.9	23.8	12.4
1982	264.8	424.7	738.7	625.6	302.8	5.9	−2.3	6.2	8.0	4.3
1983	275.4	401.4	815.4	667.7	310.7	4.0	−5.5	10.4	6.7	2.6
1984	286.9	401.7	840.5	711.5	321.8	4.2	.1	3.1	6.6	3.6
1985	296.6	414.1	855.0	779.3	333.3	3.4	3.1	1.7	9.5	3.6
Average annual rate (%)						6.2	8.2	12.7	12.1	6.9

indexed by the CPI, these households on average would have fallen far short of retaining the same purchasing power in 1985 that they had in 1967.

Year-to-year percentage changes in the TPI and component indexes are also shown in table 2. The table shows again that the TPI rose faster than the CPI by an average 0.7 percent per year. The major reason for this divergence appears to be the inflation-induced "bracket creep." The years of greatest inflation in goods prices were 1974, 1979, 1980, and 1981. These are also the four years in which our TPI increased at a double-digit rate. All three of the component tax indexes can be seen to be highly sensitive to the goods inflation rate. However, each tax series also reflects changes in statutory rates and other system parameters. For example, the imposition of a 10 percent surtax for 9 months in 1968 and the full year 1969 contributed to sharp increases in the federal tax index in those years. That surtax was phased out in 1970, and the Tax Reform Act of 1969 introduced a lower rate schedule for single taxpayers beginning in 1971. These and other IRS changes resulted in three consecutive years of declining federal tax liabilities. The introduction of several

tax credit provisions in 1975 and 1976 helped make those years of relatively low index change. Finally, our federal tax index rose more slowly in 1979 than in 1978, despite the accelerating price inflation, because of a lower marginal rate structure imposed under the Revenue Act of 1978.

Of course, the Economic Recovery Tax Act of 1981 had the most obvious legislative impact on the TPI. The year 1982 is the first since 1972 in which recognition of direct taxes served to lower our inflation estimate. Again in 1983 and 1984 the TPI rose less rapidly than the CPI, its 2.6 percent rate of increase in 1983 being the lowest in the 18-year period of study.

Although, because of their greater weight, federal taxes have the largest upward impact on the TPI, it should be noted that they represent the slowest rising of the three tax index series. The state tax index increased at the greatest annual rate, 12.7 percent over the period 1967–85. It is also notable that this rapid growth relative to the other series tends to be concentrated in the early years, when several states were imposing income taxes for the first time. As shown in table 2, the state tax liability rose 95.4 percent between 1967 and 1972, while consumption costs and federal taxes each rose by less than 25 percent. By contrast, in most of the years after 1972 the federal tax index rose more rapidly than the state index.

Only one sample year, 1970, saw no change in either the FICA tax rates or the earnings ceiling. Correspondingly, our FICA contributions index rose only 1.0 percent in 1970, as compared with its 18-year average annual increase of 12.1 percent. The years of sharpest FICA index change are 1973, when the wage and salary contributions rate was raised by 12.5 percent, the self-employed rate by 6.7 percent, and the ceiling by 20 percent, and 1981, when the rate increases were 8.5 percent and 14.8 percent, respectively, and the ceiling rose by 14.7 percent.

Another way in which we can represent these changes in the tax burden is by expressing federal, state, and FICA liabilities as a percentage of their associated direct consumption cost. For example, the FICA cost of $266 in 1967 can be thought of as a 3.1 percent "premium" on the $8,702 cost of consumption goods and services. This "premium" rose to 5.3 percent in 1976 and 8.0 percent in 1985. In figure 1 we chart the growth of the component and total tax premiums over our study period. The figure highlights the dominant role of the federal income tax, in terms of both trend and volatility. Whereas the state and FICA premiums displayed steady growth, the total premium reached peaks of 26.5 percent in 1969 and 40.5 percent in 1981, as a result of the federal policy changes noted above.

Finally, figure 2 displays marginal tax rates for each tax compo-

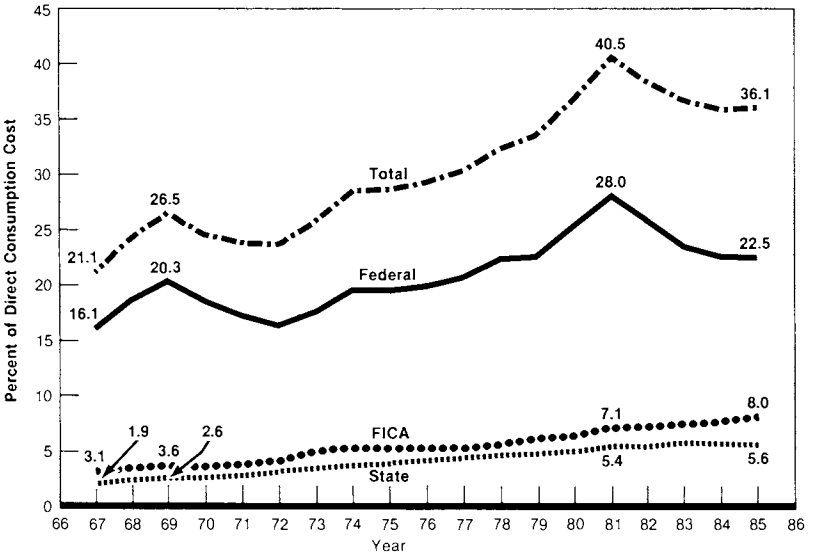

FIG. 1.—Tax premiums

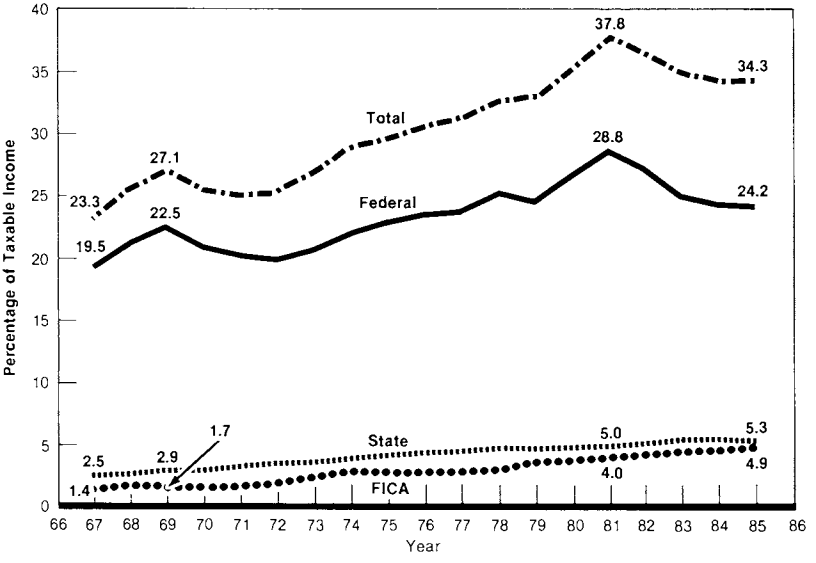

FIG. 2.—Marginal tax rates

nent, as well as the total of the federal, state, and local rates. These values are one by-product of our computational algorithm and represent the marginal rates that would be faced in each year by a household with earned income sufficient to achieve a constant real consumption level. (As usual, the rates in the figure are weighted mean values for our consumer unit sample.) The behavior of the overall series is similar to the premium graphed in figure 1, with the total marginal rate peaking in 1981 and then returning in 1985 to approximately the 1979–80 level. One interesting contrast between the figures is that, while the FICA liability in each year is greater than that for state and local income taxes, the mean FICA marginal rate is always lower since a large proportion of the sample is beyond the ceiling earnings level and hence faces a zero payroll tax rate at the margin.

V. Indexes for Population Subgroups

As noted in Section I, the fact that our indexes were computed at the consumer unit level means that it is a relatively simple matter to produce indexes for selected subpopulations as well as for the U.S. aggregate. Some suggestive estimates are displayed in tables 3 and 4 and figures 3 and 4. In presenting these results, we recognize that a full evaluation of the effects of inflation on different groups of households must also take into account such factors as income sources, asset portfolios, and geographical distribution (cf. Hurd and Shoven 1982). Here we consider only the relative impacts of rising purchase prices and tax rates.

Table 3 presents selected results for several population subgroups. We first classified sample households into "real" consumption quartiles on the basis of the 1973 value of their base year (1972 or 1973) consumption bundle. We also divided the sample according to filing status, source of earned income, and tenure. The table displays, for each subgroup, their 1967 and 1985 mean consumption costs and tax payments, along with the estimated tax and price index levels at the end of the 18-year period.

It should be emphasized that differences between subgroup TPIs do not simply reflect the statutory progressivity in the tax structure or distinctions between the individual and joint filing schedules. The extent to which, for example, wealthier households design their consumption and investment patterns so as to reduce their tax liability is reflected in lower base period tax shares for those households. On the other hand, intertemporal *changes* in tax avoidance behavior will not be reflected in the indexes, in keeping with their fixed-weight definition.

TABLE 3

ANNUAL CONSUMPTION COSTS AND TAX LIABILITIES BY HOUSEHOLD CHARACTERISTICS

		Direct Consumption Cost	Federal Tax	State Tax	FICA Contribution	Gross Consumption Cost
1973 consumption level:						
Quartile I	1967	3,594	320	32	182	4,127
	1985	10,821	966	328	969	13,083
	Index	301.1	301.7	1,034.0	533.6	317.0
Quartile II	1967	6,500	705	80	287	7,572
	1985	19,363	2,660	796	1,824	24,643
	Index	297.9	377.0	1,001.2	635.4	325.5
Quartile III	1967	9,153	1,158	135	297	10,742
	1985	27,160	4,854	1,312	2,586	35,912
	Index	296.7	419.2	974.2	871.0	334.3
Quartile IV	1967	15,560	3,431	427	300	19,719
	1985	45,878	14,770	3,320	2,926	66,894
	Index	294.8	430.5	777.0	974.8	339.2
Filing status:						
Single	1967	4,738	988	129	206	6,060
	1985	13,885	3,187	855	1,283	19,210
	Index	293.1	322.6	663.9	623.0	317.0
Joint	1967	9,323	1,469	175	276	11,243
	1985	27,675	6,225	1,531	2,201	37,631
	Index	296.8	423.8	877.1	797.6	334.7
Income source:						
Wage and salary	1967	8,571	1,356	162	260	10,350
	1985	25,415	5,570	1,395	1,989	34,369
	Index	296.5	410.7	859.7	764.8	332.1
Self-employed	1967	11,297	2,340	288	393	14,319
	1985	33,559	10,618	2,314	3,810	50,301
	Index	297.1	453.7	803.1	968.8	351.3
Tenure:						
Owner	1967	9,715	1,518	168	275	11,676
	1985	28,827	6,521	1,488	2,249	39,085
	Index	296.7	429.5	888.0	817.4	334.7
Renter	1967	6,063	1,106	170	244	7,583
	1985	17,943	3,970	1,312	1,625	24,850
	Index	295.9	359.0	770.7	667.3	327.7

On the basis of the estimated direct consumption cost indexes in the first column of table 3, it appears that inflation rates have been slightly lower for the types of goods and services purchased by high-consumption quartiles. By contrast, when we include taxes in total costs, we observe a strong positive cross-sectional correlation between this broader measure of inflation and real consumption level.

Tax inflation has had a greater effect on high-consumption households, in large part because of the greater weight of taxes in their budget. For example, federal and state and local income taxes added "premiums" of 22.1 and 2.7 percent, respectively, to the 1967 gross costs of households in quartile IV, the highest-consumption quartile. By contrast, in 1967 federal and state and local income taxes combined for only a 9.8 percent premium on quartile I consumption costs. (Since the FICA schedule is characterized by a flat rate and a ceiling, the FICA premium declines in the higher quartiles.) Table 3 also demonstrates that the rates of federal and FICA tax inflation had a strongly positive relationship with consumption level. The 1985 federal tax indexes for quartiles I–IV correspond to annual rates of change of 6.3, 7.7, 8.3, and 8.4 percent, respectively. Comparable results for FICA are 9.7, 10.8, 12.8, and 13.5 percent per year. Although the state tax index rises more slowly in the high-consumption quartiles, the absolute growth in the state tax liability is much greater for those households.

Further elaboration on the growth of tax premiums in the TPI, by consumption quartile, is provided in figure 3. Each quartile series displays the rising trend, with peaks in 1969 and 1981, familiar from figure 1. Of equal interest is the increasing degree of tax progressivity, as indicated by the manner in which the four series diverge. The percentage premiums for the three lower quartiles are relatively similar in the early years. However, between 1974 and 1977, quartiles I and II move lower, while the series for quartile III continues to rise roughly in proportion to the quartile IV series. This can be explained by several federal programs introduced during the middle 1970s that had special advantages for lower-income households, including the General Tax Credit (1975), the Earned Income Credit (1975), and the Credit for the Elderly (1976). The value of the standard deduction was also increased several times during this period.

Table 4 and figure 4 compare the behavior of marginal tax rates, by consumption quartile. The figure shows a pattern of rising and diverging total marginal rates, with the rate for the lowest quartile rising much less rapidly than the others. Perhaps surprisingly, the marginal rate for the third quartile lies below the quartile II rate over much of our period of study. This results from the regressivity of the FICA tax, as demonstrated in table 4. In 1973, the FICA earnings

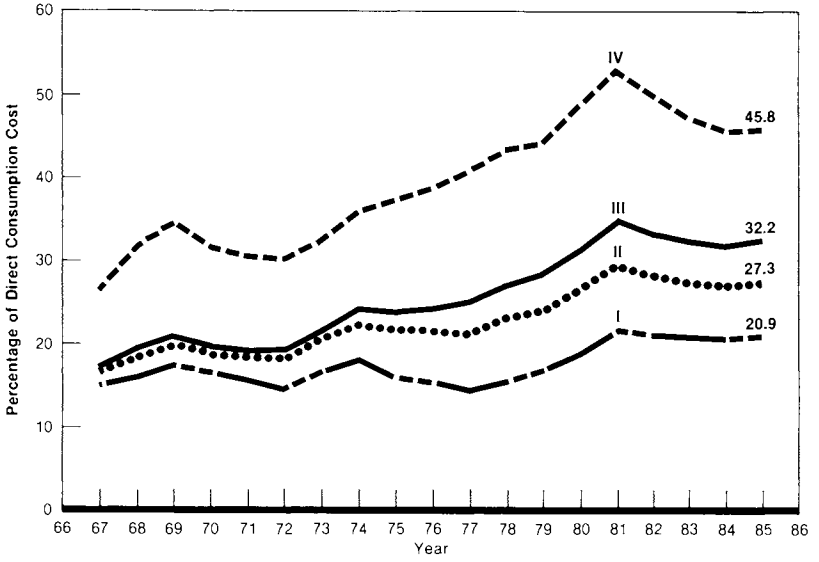

FIG. 3.—Tax premiums by quartile

TABLE 4

TOTAL MARGINAL TAX RATES BY QUARTILE

Quartile and Tax Component	1967	1973	1979	1985
I:				
Federal	14.3	14.1	14.1	14.2
State	1.7	2.4	3.3	3.9
FICA	4.3	5.9	6.2	7.2
Total	20.3	22.4	23.5	25.4
II:				
Federal	18.1	19.1	21.0	20.2
State	2.3	3.4	4.5	5.3
FICA	1.2	4.0	6.0	7.1
Total	21.6	26.4	31.5	32.6
III:				
Federal	19.9	21.4	25.9	26.1
State	2.6	4.0	5.1	5.7
FICA	.0	.2	2.3	4.9
Total	22.5	25.6	33.3	36.7
IV:				
Federal	25.5	28.9	37.7	36.0
State	3.4	5.2	6.1	6.4
FICA	.0	.0	.0	.2
Total	28.9	34.1	43.8	42.6

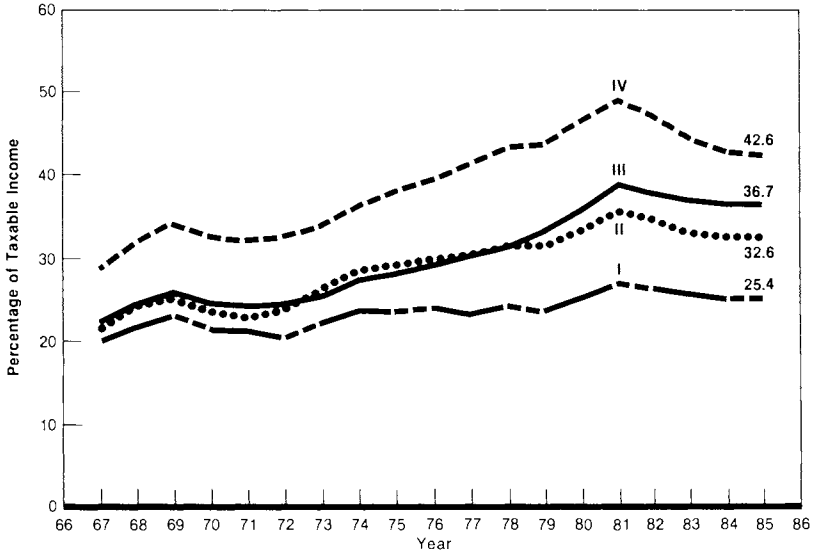

FIG. 4.—Marginal tax rates by quartile

ceiling for wage earners was $10,800, a level that implies that most households in quartiles III and IV would face a zero payroll tax rate at the margin. The average marginal FICA rate in quartile II was 4.0 percent (the statutory wage and salary rate was 5.85 percent in 1973), enough to counteract the other two tax components and yield a higher total marginal rate than in quartile III. This effect became less important after 1979, when the earnings ceiling was raised from $17,700 to $22,900, beginning a series of upward increments toward its 1985 level of $39,600.

Returning to table 3, we see that household classifications other than consumption quartile also demonstrate the importance of direct taxes on cost-of-living measures. Again, 1967–85 price inflation rates are relatively similar across groups, while the gross cost index is higher for joint filers and self-employed workers and slightly higher for homeowners. It should be recognized that, to some extent, these differences reflect the relative income effects discussed above; married couples, homeowners, and the self-employed tend to have relatively high consumption levels and so are more seriously affected by increases in the tax indexes.

In order to abstract from income effects, we stratified the sample by consumption quartile and computed indexes by filing status within each quartile. We then edited single individuals from the sample and constructed indexes for joint filers within each quartile, broken down

by tenure status and income source. This stratification process revealed sharply lower base period tax liabilities in each quartile for joint filers and FICA wage earners (because of their lower rate schedules) and for homeowners (because of the untaxed nature of their implicit rental income). However, in general, the intertemporal variations described in the last paragraph continued to hold when consumption level was held constant.

VI. Summary and Directions for Future Research

The purpose of this paper has been to define and estimate a "tax and price" index that incorporates direct as well as indirect taxes. Current U.S. CPI methodology measures changes in the minimum expenditure necessary to consume a fixed set of consumption goods and services and consequently approximates an expenditure-based cost-of-living index. The indexes we define and compute in this paper measure changes in the total cost, including direct taxes, of the same fixed set of goods and services. They approximate, in an analogous fashion, an income-based cost-of-living index.

Our tax and price indexes were calculated at the individual household level and used detailed procedures to add federal taxes, state and local taxes, and social security contributions to an expenditure-based "CPI." All these components increased substantially faster over the sample period than the estimated CPI, with state and local taxes increasing at the fastest rate. Although "bracket creep" is the primary explanation for divergence between the TPI and CPI, changes in tax policy were also shown to have important effects. Most obviously, as a result of the Economic Recovery Tax Act cuts, the rate of inflation as measured by the TPI fell from 12.4 percent in 1981 to 2.6 percent in 1983, while our CPI for the same population shows a decrease only from 9.5 to 4.0 percent. Partitioning our household sample by several demographic economic characteristics, we found that recognition of taxes tended to alter significantly the inflation rate differentials estimated on the basis of consumption prices alone.

While our indexes are important and interesting in their own right, the data bases and computational techniques used for their construction will also facilitate useful analyses of changes in the structure of the U.S. tax system. For example, federal income tax rate brackets, along with the personal exemption and standard deduction levels, have been indexed to the CPI beginning with the 1985 tax year. By simulating such a policy over the 1967–85 period, one can determine how different the TPI estimate of inflation would have been under this policy. It is also a straightforward matter, within the TPI framework, to demonstrate how different population groups have been or

would be affected by other hypothetical changes in tax policy. Finally, the concept of gross consumption cost and the use of a fixed expenditure pattern make the TPI a valuable tool for the measurement of intertemporal changes in the progressivity of the tax system and its components.

References

Baye, Michael R., and Black, Dan A. "The Gross Cost of Living Index." Manuscript. Lexington: Univ. Kentucky, 1984.

Carlson, Michael D. "The 1972–73 Consumer Expenditure Survey." *Monthly Labor Rev.* 97 (December 1974): 16–23.

Cobb, Steven A. "Interarea Cost of Living Measurement with Nonmarket Goods: A Demand System Approach." *J. Urban Econ.* (in press).

Congressional Budget Office. *Indexing with the Consumer Price Index: Problems and Alternatives.* Washington: Government Printing Office, 1981.

Gillingham, Robert. "A Conceptual Framework for the Consumer Price Index." In *Proceedings of the Business and Economic Statistics Section.* Washington: American Statis. Assoc., 1974.

Gillingham, Robert, and Greenlees, John S. "The Incorporation of Direct Taxes into a Consumer Price Index." In *Price Level Measurement,* edited by W. Erwin Diewert and Claude Montmarquette. Ottawa: Statistics Canada, 1983.

Gillingham, Robert, and Lane, Walter. "Changing the Treatment of Shelter Costs for Homeowners in the CPI." *Monthly Labor Rev.* 105 (June 1982): 9–14.

Hagemann, Robert P. "The Variability of Inflation Rates across Household Types." *J. Money, Credit and Banking* 14, no. 4, pt. 1 (November 1982): 494–510.

Hurd, Michael, and Shoven, John B. "Real Income and Wealth of the Elderly." *A.E.R. Papers and Proc.* 72 (May 1982): 314–18.

Kay, J. A., and Morris, C. N. "The Gross Earnings Deflator." *Econ. J.* 94 (June 1984): 357–69.

Lundberg, Erik. *Business Cycles and Economic Policy.* Translated by J. Potter. London: Allen and Unwin, 1957.

Pollak, Robert A. "The Treatment of Taxes in the Consumer Price Index." Manuscript. Washington: Bur. Labor Statis., 1972.

———. "Subindexes in the Cost of Living Index." *Internat. Econ. Rev.* 16 (February 1975): 135–50.

Tanzi, Vito. *Inflation and the Personal Income Tax: An International Perspective.* Cambridge: Cambridge Univ. Press, 1980.

Triplett, Jack E. "Escalation Measures: What Is the Answer? What Is the Question?" In *Price Level Measurement,* edited by W. Erwin Diewert and Claude Montmarquette. Ottawa: Statistics Canada, 1983.

U.K. Central Statistical Office. "The Tax and Price Index—Sources and Methods." *Econ. Trends,* no. 310 (August 1979), pp. 81–89.