

# **A PLAN FOR ESTIMATING AGE-SPECIFIC MEDICAL PERSONAL CONSUMPTION EXPENDITURE EQUATIONS FOR USE IN THE INFORUM LIFT MODEL**

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## **I. INTRODUCTION**

INFORUM's LIFT, an interindustry-macro model, uses a system of 80 equations to forecast Personal Consumption Expenditures (PCE).<sup>2</sup> The system accounts for different consumption patterns across age groups by estimating age-specific coefficients. These coefficients are estimated under restrictive assumptions that may be invalid. Further, due to difficulties in determining age-specific income distributions, we impose restrictive assumptions concerning the intra-age group and inter-age group distribution of income. These assumptions reduce the LIFT's capability to simulate the effects of income redistributions. This paper reviews the existing PCE system -- cross-section equations, income distribution model, and time-series functions -- and presents several methods of implementing age-specific demand equations into LIFT.

## **II. THE CURRENT LIFT SYSTEM OF PCE EQUATIONS**

The system of PCE equations used by LIFT is based on periodic cross-section and time-series analysis (Devine 1983; Chao 1991; Janoska 1994a). The original theoretical model was designed by Almon (1979). Devine (1983) expanded the model to include cross-section estimations and performed the original empirical analysis. Chao (1991) improved the system's treatment of durable goods. Janoska (1994a) expanded the system and added real interest rate and construction demand variables to the automotive and household durable expenditure categories. In related work, Pollock (1986) significantly improved the system for forecasting income variables used in the PCE system.

A two step approach is used. First, a cross-section analysis using data from the Consumer Expenditure Survey (CEX) estimates the effects of demographic, age, and income variables.

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<sup>2</sup>The INFORUM LIFT (Long-term Interindustry Forecasting Tool) model was developed at the University of Maryland under the guidance of Clopper Almon. McCarthy (1991) presents an overview of LIFT.

Then, the parameters estimated in the cross-section analysis and data from the National Income and Product Accounts (NIPA) are used in a time-series analysis that estimates the effects on consumer spending caused by changes in relative prices, taste trends and business cycles. This two-step approach lets users of LIFT simulate the effects on the U.S. economy of different demographic projections as well as the effects of different distributions of income and relative prices.

We employ a two-step procedure for several reasons. One reason is to correct for definitional differences between the CEX and the NIPA.<sup>3</sup> The primary reason, however, we use the two-step method is the lack of price variation in a single year of cross-section data.

In this section, we review the cross-section analysis with an emphasis on how it accounts for the age structure of the household. Because the income distribution model is a key component of the LIFT PCE system, we also review it. Finally, we review the time-series analysis and equations.

### CROSS-SECTION ANALYSIS

The foundation of the system is the cross-section estimation that uses data from the CEX. The cross-section equation estimated for each expenditure category is of the form:

$$C_i = (a + \sum_{j=1}^K b_j Y_j + \sum_{j=1}^L d_j D_j) * (\sum_{g=1}^G w_g n_g) \quad (1)$$

where:

$C_i$  = household consumption expenditures on good  $i$ .

$Y_j$  = the amount of per capita household "income" within income category  $j$ .

$D_j$  = a zero/one dummy variable used to show membership in the  $j_{th}$  demographic group.

$n_g$  = the number of household members in age category  $g$ .

$K$  = the number of "income" groups.

$L$  = the number of demographic categories.

$G$  = the number of age groups.

$a, b, d, w$  = parameters to be estimated for each commodity.

Conceptually, the above function has two components: consumption expenditure per "adult equivalent" and the "size" of the household in adult equivalents. Household per-capita income and demographic characteristics determine the value of the first component. The size of the household is determined by the second term. For the purposes of the cross-section work, the size

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<sup>3</sup>The CEX only records out-of-pocket spending by households, while the NIPA uses a much broader definition of spending.

of a household does not equal the number of people in the household, but is a function of the ages of the household members and the commodity under examination.

The cross-section estimation defined an "Adult" as an individual between the ages of thirty and thirty nine (30-39) years. By definition, anyone in this age cohort equals one "adult." The effect of being a member of the other seven age cohorts on consumption is determined relative to the effect of this adult cohort. For example, according to our estimates, an additional infant in a household will not significantly increase the expenditures on alcohol by the household, but adding a person in their mid-twenties will increase household alcohol expenditures. Similarly, an additional twenty-year-old in the household will not increase the expenditures by the household on children's clothing, but a newborn will. In terms of adult equivalents, a newborn will count as less than one adult in the equation for alcohol expenditures, but will count as several adults in the equation forecasting children's clothing. Since the size of the weights for each age group are relative to the adult weight, we refer to them as Adult Equivalent Weights (AEW).

There are eight age cohorts, or "gpop," in the system. There are three cohorts of the "young," four cohorts of the "middle aged," and one cohort of the "elderly" (aged 65 or higher). The cohorts are given below:

- **Gpop1:** Age 0-5 years
- **Gpop2:** Age 5-15 years
- **Gpop3:** Age 15-20 years
- **Gpop4:** Age 20-30 years
- **Gpop5:** Age 30-40 years (This cohort is our Adult cohort.)
- **Gpop6:** Age 40-50 years
- **Gpop7:** Age 50-65 years
- **Gpop8:** Above 65 years

Some demographic dummy variables included in the cross-section estimation are:

- **Region:** North East, North Central, South and West.
- **Family Size** : One person, two person, three or four person, and five or more person households.
- **Education:** One if the household head was college educated.
- **Age of Household Head:** Households with heads: under thirty-five; between thirty-five and fifty-five; and over fifty-five.

Besides estimating the effects of the various demographic and age variables on consumption expenditures, the cross-section equations estimate five separate income parameters. A distinct marginal propensity to spend out of income is estimated for each income variable and cross-section commodity. This is known as a piecewise linear Engle curve (PLEC). The PLEC allows the effect of income to vary as per-capita household income rises. For example, a household

in the lowest income bracket might only spend \$0.04 out of every dollar on jewelry, but a household in the highest income bracket might spend \$0.40 of every dollar of disposable income on jewelry. The pattern of expenditures might be reversed for some goods. For example, poorer households might have a higher propensity to consume used automobiles than do richer households.

The amount of income,  $Y_j$ , in each bracket,  $B_j$ , depends on household income and the range or size of the bracket. Algebraically, this can be represented as:

$$Y_j = \begin{cases} B_j - B_{j-1} & \text{if } B_j \leq Y \\ Y - B_{j-1} & \text{if } B_{j-1} \leq Y < B_j \\ 0 & \text{if } Y \leq B_{j-1} \end{cases}$$

where:

- Y = household per-capita income
- K = the number of income brackets
- $B_0$  is defined as zero and  $B_k$  is defined as infinity.

For example, assume our bracket borders are set at \$ 0, \$1000, \$2000, \$3000, \$4000, and infinity. Then a household with a per-capita income of less than \$1000 would have all of its income attributed to the first income bracket. A household with a per-capita income of \$2500 would have the first \$1000 of per-capita income allocated to the first income bracket; the second \$1000 of per-capita income allocated to the second income bracket; and the last \$500 of per-capita income allocated to the third income bracket. The income in each bracket becomes the  $Y_j$  used in equation (3) as the income variables.

For the boundaries given above,  $B_0=0$ ,  $B_1=1000$ ,  $B_2=2000$ ,  $B_3=3000$ ,  $B_4=4000$ ,  $B_5=$  infinity. Table 1 shows how a set of hypothetical per-capita incomes are allocated to the various income brackets,  $Y_j$ .

**Table 1**

Income	$Y_1$ \$0 - \$1000	$Y_2$ \$1001-\$2000	$Y_3$ \$2001-\$3000	$Y_4$ \$3001-\$4000	$Y_5$ Above \$4000
\$800	\$800	\$0	\$0	\$0	\$0
\$2100	\$1000	\$1000	\$100	\$0	\$0
\$3900	\$1000	\$1000	\$1000	\$900	\$0
\$10000	\$1000	\$1000	\$1000	\$1000	\$6000

The table shows that income is allocated to the first bracket until the upper boundary of the bracket is reached or income is exhausted. If income remains, unallocated income is allocated to the second bracket until income is exhausted or the upper income boundary of the second income bracket is reached. This process continues until either all income has been allocated or we reach the final bracket, where the remaining income is allocated.

One often overlooked feature of the cross-section function is its ability to estimate a set of restricted age-specific income and demographic coefficients. For illustrative purposes, consider a cross-section function with two income categories, or brackets, and three age groups. This can be written:

$$C_i = (a + b_1 Y_1 + b_2 Y_2) * (w_{young} N_{young} + 1 * N_{adult} + w_{elderly} N_{elderly}) \quad (2)$$

where:  $w_{adult}$  Equals 1, by definition

$N_g$  Number of people in age group, g (y=Young; A=Adult; E=Elderly)

$Y_i$  Amount of income in income bracket, i

By expanding the above equation:

$$N_y * \{a w_y + b_1 w_y Y_1 + b_2 w_y Y_2\} + N_A * \{a + b_1 Y_1 + b_2 Y_2\} + N_E * \{a w_E + b_1 w_E Y_1 + b_2 w_E Y_2\}$$

$$C_i = \quad \quad \quad OR$$

$$N_y * \{\alpha_y + \beta_{1,y} Y_1 + \beta_{2,y} Y_2\} + N_A * \{\alpha_A + \beta_{1,A} Y_1 + \beta_{2,A} Y_2\} + N_E * \{\alpha_E + \beta_{1,E} Y_1 + \beta_{2,E} Y_2\}$$

we can see that each set of parentheses can be thought of as the per-capita expenditures by the age group. For example, for each income bracket, each age group has its own marginal propensity to consume (MPC). An adult has an MPC of  $b_1$  or  $\beta_{1,A}$  out of income in the first bracket. Because the MPC for any age group equals the product of  $MPC_{adult}$  and the age group's AEW, the estimated age-specific coefficients are restricted. For example, the  $MPC_{elderly}$  with income in the first bracket equals  $\beta_{1,Elderly}$ , where we have imposed the constraint that this equals  $b_1 * w_{Elderly}$ .<sup>4</sup>

To take full advantage of these age-specific coefficients, one would need to know both the amount of income held by each age group and the distribution of income within the age group. Data on inter-age group and intra-age group distribution of income were unavailable when the earlier work was undertaken (Devine 1982; Chao 1991). To correct for this lack of detailed income distributions by age, previous work assumed that the per-capita incomes of each age group were identical (e.g. per-capita income of the elderly equalled per-capita income of the non-elderly) and that the intra-age income distribution was identical compared to the distribution of aggregate income (see below for further details).

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<sup>4</sup>This analysis holds for the non-age demographic variables as well. For example, the cross-section analysis estimates age-specific coefficients for the region variables. I.e. the effect of an additional person over 65 in the North East.

## THE LIFT INCOME DISTRIBUTION MODEL

Use of a PLEC forces us to forecast the distribution of Disposable Income (DI). The distribution of DI is important because total spending equals the product of total income in the bracket and the Marginal Propensity to Consume (MPC) for the bracket. Table 2 illustrates this point.

**Table 2**  
**Hypothetical MPC for Two Income Groups**

	Income Scenario 1	Spending Scen. 1	Income Scenario 2	Spending Scen. 2
Low (MPC = .05)	\$1000	\$50	\$3000	\$150
High (MPC = .40)	\$6000	\$2400	\$4000	\$1600

Under the first scenario, most of the income belongs to the wealthy households and spending equals \$2450. In the second scenario, the income distribution is more equal (note: total income is unchanged), but spending equals \$1750. Spending is lower because the distribution of income has changed. The PLEC increases the richness of the model, but also means that the complexity of the PCE system is increased because the system relies on both the amount of income and its distribution. Aggregate income is determined by the macroeconomic properties of the model (see McCarthy (1991)), but disposable income (after-tax income) and its distribution are determined by the income distribution model.

The income distribution model must serve two masters. The first is the PCE system that requires data on the distribution of after-tax Personal Income or Disposable Income (DI) by age group. The second is the income tax model that requires forecasts of Adjusted Gross Income (AGI) by six household sizes.<sup>5</sup> Earlier work (Devine 1983; Pollock 1986; Chao 1991) assumed a constant inter-age group distribution of income and identical intra-age group distributions. Consequently, the requirements of the PCE system are satisfied by a forecast of the distribution of aggregate DI.

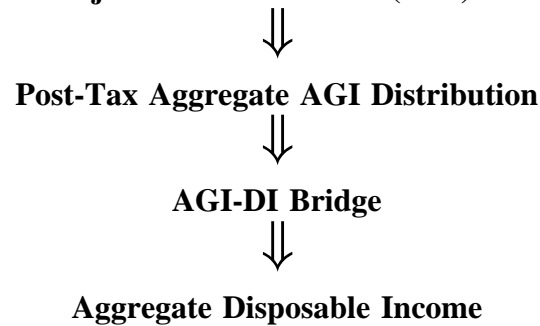
The income tax model requires six separate distributions, one for each of six household sizes. We model the distributions by household size to adjust for the reduction in tax liability that occurs with additional tax exemptions. Personal taxes are subtracted from these six distributions and they are converted to a single distribution of aggregate AGI. Then an AGI-DI bridge is used to add the missing components of DI to the economy-wide distribution of AGI.<sup>6</sup> This forecast of the distribution of DI (or after-tax PI) is then used to construct the five income variables from the cross-section estimation.

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<sup>5</sup>In LIFT, Personal income taxes are levied on the basis of AGI. The PCE equations, however, depend on after-tax Personal Income, or Disposable income. AGI excludes certain non-taxed transfers that are included in Disposable Income.

<sup>6</sup>See Pollock (1986) Chapter 4 for a table showing this AGI-DI bridge.

## 6 Post-Tax Adjusted Gross Income (AGI) Distributions



Because the distribution of DI is constructed from the six detailed distributions of AGI used in the tax model, there is consistency between the distributions used by the tax model and the distributions used by the PCE system. It would be much more difficult to maintain this consistency if we were attempting to model the more detailed distributions from the aggregate distribution.<sup>7</sup>

Historical income distribution data, as reported in the Internal Revenue Service's *Statistics of Income* (SOI), is used by both the tax and PCE models, when available. For years in which historical data is unavailable, a Lorenz curve is forecasted. Pollock uses a functional form described by Kakwani and Podder (1976). Rasche (et al. 1980) show that there are some theoretical constraints this form fails to meet. Further, the data used to estimate the function are no longer available. Work in progress hopes to address these problems (Janoska 1993).

Because of the assumptions made concerning inter-age and intra-age group income distributions, the income distribution model does not provide us with the necessary information to take full advantage of the age-specific income coefficients. For example, LIFT is capable of simulating the effects of a redistribution of income from the wealthy to the poor, but is severely limited in its ability to simulate a redistribution from young to old.

### TIME-SERIES ANALYSIS

Using the cross-section parameters and the income distribution, a time-series variable,  $C^*$ , is constructed for each PCE category.  $C^*$  captures the effects of the demographic and income variables across time. Similarly, the AEWs are used to construct a time-series of the adult equivalent population,  $WP_t$ . These variables are then used as an independent variable in the estimation of the consumption expenditure system.

The LIFT consumption system divides 80 categories of PCE into 10 Groups. Parameters for 78 of these equations are estimated as a system to insure cross-price symmetry. The equations for two categories of PCE, Hospitals and Nursing Homes, are estimated outside the system

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<sup>7</sup>If, for example, we used the aggregate DI distribution to construct age-specific distributions.

(Janoska 1994a). Each group is then divided into two or more sub-groups. The system is designed so that: (1) weak price effects occur between categories in different groups; (2) moderate price effects occur between categories in different sub-groups within a group; (3) and strong price effects occur between categories within a sub-group. The system imposes price effect symmetry between each group in the system and between each sub-group within a group.

We introduce the following notation before providing the general equation used in the time-series estimation:

- $M$ = the number of groups,
- $i \in \mathbf{G}_I$  shows that category  $i$  is in group  $I$ ,
- $S_L$ = the sum of the budget shares of categories in group  $L$  in the base year.

The time-series equation is written:

$$\frac{q_{it}}{WP_{it}} = (a_i + b_i C_{it}^* + c_i \Delta C_{it}^* + d_i t) \prod_{L=1}^M \frac{P_{it}}{\bar{P}_{Lt}}^{-S_L \lambda_{iL}} \quad (3)$$

where:

- $q_{it}$  = expenditures on category  $i$  during year  $t$
- $WP_{it}$  = weighted population size, good  $i$ , in year  $t$
- $C_{it}^*$  = cross-section variable, good  $i$ , in year  $t$
- $P_{it}$  = price good  $i$  in year  $t$
- $\bar{P}_{Lt}$  = average price of group  $L$  in year  $t$
- $S_L$  = share of total consumption, group  $L$ , in base year.
- $a_i, b_i, c_i, d_i, \lambda_{iL}$  = parameters to be estimated.

The variables  $WP$  and  $C^*$  are determined from the parameters estimated in the cross-section work.

$$WP_{i,t} = \sum_{m=1}^8 w_{i,m} N_{m,t} \quad (4)$$

where:

- $WP_{it}$  = Age-Weighted Population Size of commodity  $i$  in year  $t$
- $w_{i,m}$  = Age Group Coefficient on bracket  $m$ , commodity  $i$
- $N_{m,t}$  = Number of Individuals in Age Group  $m$ , year  $t$ .

The equations model per-adult equivalent expenditures ( $Q/WP$ ). This means changes in the age structure leave  $Q/WP$  unchanged. Consequently, any movement in  $Q/WP$  is caused by relative price changes, income distribution effects or taste trends. For example, the baby-boom



caused large increases in the level of expenditures on children's clothing and durable furniture. However, expenditures-per-weighted population on these two commodities remained essentially constant. This implies that the change in spending was due to changes in the age structure and that the increased demand for clothing and furniture would fall as the baby-boomers grew older - which occurred.

Though not done here, one can expand equation (3) to show that the time-series analysis estimates a set of restricted age-specific price coefficients. However, their use in LIFT requires age-specific price data. Since this data does not exist, the price coefficients used in LIFT are weighted averages of the age-specific coefficients.

### III. AGE-SPECIFIC COEFFICIENTS IN THE SHORT-RUN

This section lays out a framework for quickly introducing age-specific coefficients into LIFT. It is intended as a short-run solution to the goal of introducing age-specific coefficients into LIFT.<sup>8</sup> In the first subsection, we describe the revised system and in the second subsection, we state the data requirements.

#### THE MODEL

The primary reasons LIFT lacks age-specific coefficients are the difficulties in forecasting intra-age group income distributions and age-specific per-capita incomes that are consistent with the income distribution model. We can side-step this problem and make use of the age-specific coefficients by allowing the inter-age group income distribution to vary. The intra-age group distributions would still be identical to the aggregate distributions, but the amount of income held by each age group would be allowed to vary.

First, using historical data, equations would be developed to forecast the share of total income held by each age group. Variables used in these equations might include:

- **Relative sizes of the age groups:** As the number of elderly grows, their share of total income should grow.
- **Proportion of aggregate income received as pension (public and private), dividend and interest income:** As these increase, the elderly share should increase (Schulz 1992).
- **Inflation:** Fixed incomes (nominal) will fall as a share of total income as inflation increases.

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<sup>8</sup>Later sections of the paper present long-run modifications.

The specific form of these equations and their independent variables will be determined after careful investigation and review.

Second, we assume that each of the intra-age group income distributions are identical to the distribution of aggregate income. This step, combined with the first, gives us the information we need to use the age-specific income coefficients -- the amount of income held by an age group and its distribution. We can construct the age-specific income distributions that generate the information we need in order to construct our income variables. We can do this only because we have assumed that the age-specific income distributions are all identical. While restrictive, this is less so than the current system. Unlike the current system, that does not use the age-specific income coefficients, the proposed modifications would allow the amount of income held by each age group to vary and allows us to use the age-specific coefficients. Thus, the model would better simulate the effects of the changing age structure in the U.S.

Third, the PCE equations would need to be re-estimated. In particular, one would need to reconstruct the time-series variable,  $C^*$ .

Fourth, LIFT would be modified to account for the new age-specific income variables and equations.

#### NECESSARY DATA

For INFORUM to incorporate age-specific income coefficients into LIFT, we require data on the amount of disposable income (NIPA convention) held by the two groups.<sup>9</sup> Unfortunately, this data does not exist. The data that most closely approximates the unavailable disposable income data is the Census Bureau's *Current Population Reports: Consumer Income: Money Income of Households, Families and Persons in the United States* (CPS).

One possible problem with using CPS data instead of disposable income data is that the two data sources use different definitions of income. The CPS contains information on household **money** income, which excludes many of the items included in the NIPA definition of disposable income. Items included in disposable income but excluded from money income include: non-cash government transfers to persons (Medicare, Medicaid, Food stamps and similar items); employment benefits (pension contributions, health insurance benefits); and imputed income (the value of owner-occupied housing). We acknowledge that the share of money income held by an age group may differ from the share of disposable income it holds, but we have no data to investigate or correct for these differences. Many of these problems are addressed in the sections discussing longer-term modifications to the model.

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<sup>9</sup>Ideally, one would also want the distribution of this income within the age group.

## **IV. AGE-SPECIFIC COEFFICIENTS IN THE MIDDLE-RUN**

Given additional time, more significant changes could be implemented as well.<sup>10</sup> In particular, LIFT's treatment of PCE financed by third parties could be revised. First, we discuss why a revision is needed. In the following subsections we discuss employer-provided insurance benefits, individual insurance benefits and government programs. In the last subsection, we turn our attention to our data needs.

### IMPORTANCE OF THIRD-PARTY FINANCING

Unlike other forms of PCE, medical PCE is often financed by third-parties. In 1991, only 22 percent of personal health care expenditures, as measured by the National Health Accounts (NHA), were directly financed by consumers. Private health insurance paid for over 31 percent of personal health care expenditures. Governments paid for 43 percent of these expenditures with Medicare and Medicaid, the two largest government transfer programs, accounting for 34 percent of total personal health care expenditures (Letsch et al. 1992). In 1991, private health insurance and government programs financed 65 percent of personal health expenditures.

Obviously, the method we choose to model the effects of these programs will significantly influence our forecasts of medical PCE. Each of these programs can be modelled in one of the following ways: as a pure income transfer, as an in-kind transfer, as a price subsidy, or as a combination of these three items. As shown by Janoska (1994b), the effect on demand for the subsidized good differs for each of these options. For example, modelling a program as a price subsidy will almost always generate more demand for the subsidized good than will modelling the program as an income or in-kind transfer.

The two types of third-party financing are private insurance benefits and government programs. Private insurance can be broken into employer-provided insurance and individual insurance. Government programs can be further divided into Medicare benefits, Medicaid benefits, and All Other benefits. In the following subsections, we discuss the various ways one can model the effects of these programs and make our recommendations on a course of action.

### EMPLOYER-PROVIDED HEALTH INSURANCE BENEFITS

Insurance is typically thought of as a reimbursement to the insured for "bad events." For example, collision insurance pays the auto owner the amount required to repair his vehicle, regardless of whether or not he repairs the vehicle. Health insurance payments, unlike other forms of insurance, are reimbursements for specific expenditures. This is because benefits are received only when medical expenditures occur. For example, an sick individual does not have

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<sup>10</sup>This section assumes that the short-term modifications have either been implemented or will be implemented along with the middle-run proposals.

the option of refusing treatment but receiving instead a cash payment for the cost of the foregone treatment. Owners of stolen cars, however, do receive such checks and are not required to purchase a replacement automobile. Thus, unlike other types of insurance benefits, health insurance payments to persons are linked to PCE.<sup>11</sup> To be more specific, these payments are linked to one type of PCE, medical expenditures.

The consensus of the economics literature is that health insurance increases medical care demand because it directly subsidizes the cost of medical care (Feldstein 1973; Newhouse and Phelps 1974; Phelps and Newhouse 1974). The insurance operates through a system of deductibles, coinsurance and spending caps. Deductibles, a fixed amount that must be paid before insurance covers any costs, lowers the marginal price of care and affects the decision of when to purchase care (Keeler et al. 1977; Newhouse et al. 1978).<sup>12</sup> Coinsurance, the percent of expenditures that are paid by the consumer, lowers the marginal price of care and increases the demand for medical PCE (Feldstein 1973; Newhouse and Phelps 1974; Phelps and Newhouse 1974).<sup>13</sup> Spending caps, a limit on the maximum payment for which the insurance company is liable, may affect the timing of medical expenditures (Keeler et al. 1977; Newhouse et al. 1978).<sup>14</sup>

This suggests that health insurance benefits should be modelled as a price subsidy and that these benefits should be linked in some manner to medical PCE. Currently in LIFT, these benefits are treated as pure income that may be saved or spent on any form of PCE (Pollock, 1986). Recent work (Janoska 1994b) has shown that treating a price subsidy as an income transfer can lead to inaccurate forecasts of spending on the subsidized good or goods.

As described in Janoska (1994b), there are four suggested remedies to this problem:

■ **Maintain Status Quo:** As always, one option is to do nothing. Health insurance benefits would continue to be modelled as a pure income transfer and in the absence of user intervention, we would continue to under-forecast the effects of increased health insurance benefits. Since this proposal requires that no changes be made in LIFT, the marginal cost and marginal benefit are both zero.

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<sup>11</sup>Health insurance is not really **health** insurance but is actually **medical expenditures** insurance.

<sup>12</sup>I.e. the marginal price the consumer perceives is below the actual marginal price **even if the deductible has not been met** (Keeler et al. 1977).

<sup>13</sup>The price subsidy equals one less the coinsurance rate. Thus, the higher the coinsurance rate, the lower the subsidy.

<sup>14</sup>If the cap is a yearly cap, I might defer treatment until the start of the next year. However, if the cap is a lifetime cap, then the spending cap does not influence my choice of whether or not to seek care.

■ **Direct One-to-One Link Between Benefits and Medical Services PCE:** This solution would directly link benefits to medical PCE on a dollar per dollar basis. Disposable income would be redefined as "Discretionary" income or NIPA Disposable Income less benefits. A new spending rate would be calculated based on spending from Discretionary income. Equations would be estimated to forecast private demand for medical services (NIPA Medical services PCE net health insurance financed services). Total medical services would equal the sum of Out-of-Pocket, Private and Government.<sup>15</sup>

This approach, however, incorrectly models the effects of changes in health insurance benefits (Janoska 1994b). It has one principal advantage over the status quo approach -- it links benefits to expenditures. We believe this approach is little better than maintaining the status-quo, since we would still incorrectly model the demand effects of health insurance benefits. The proposal is appealing on a certain level, but we believe there are better ways to implement this link.

■ **Ad-hoc or "Back of the Envelope" Linking:** This approach is very similar to the Direct One-to-one Link approach. However, instead of imposing a one-to-one link, we would develop estimates of the change in medical PCE caused by an increased dollar of benefits. For example, we could impose a one-to-two link -- \$1 of benefits would generate \$2 of medical services PCE. Implementing this approach in the model would be no more difficult than the Direct One-to-One Link proposed above and would move us closer to modelling Medicare benefits as price subsidies.

The size of the link could be based on the estimates or assumptions of LIFT users. This approach is both a strength and a weakness. The benefit is flexibility, since it allows a much wider range of simulations. The weakness is the arbitrary manner in which we chose the size of the link. Estimates of the displacement effect could be made, but proper estimates would require adjusting income and price to treat health insurance benefits as a price subsidy. Since this work would be required if we modelled the program as a price subsidy, we believe that the extra effort should be invested in modelling the benefits as a price subsidy.

■ **Price Subsidy Approach:** This alternative has INFORUM modelling health insurance benefits as a price subsidy with a link between payments and medical PCE. Each medical PCE category would have its own subsidy amount. The size of insurance payments could be expressed as either a percent of producer price or as a dollar amount. If expressed as a percent of price, LIFT would determine the consumer price based on the producer price and this "wedge" between producer and consumer price. LIFT would then forecast medical PCE and determine the total dollar size of the Medicare program. Alternatively, if expressed as a total program size, LIFT would calculate the wedge and determine the subsidy as a percent of price.<sup>16</sup>

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<sup>15</sup>See below for a definition of Government.

<sup>16</sup>For a detailed description of this process, see Janoska (1994b).

We outline the estimation procedure below:

- Step 1. Redefinition of income variable used by PCE system as follows:

$$LIFT\ DI = NIPA\ Disposable\ Income - Insurance\ Benefits - Government$$

- Step 2. Redefine price deflators used by PCE system as follows:

$$DEFL'_i = C_i * DEFL_i$$

where  $C_i$ , the coinsurance rate, is given by:

$$C_i = 1 - \text{subsidy rate}_i = 1 - \frac{Nominal\ PCE_i - Insurance_i - Government_i}{Nominal\ PCE_i}$$

$DEFL'_i$  = LIFT PCE Deflator, category i  
 $DEFL_i$  = NIPA PCE Deflator, category i  
 Nominal  $PCE_i$  = Nominal PCE in Category as Defined by NIPA  
 Insurance Benefits $_i$  = Medicare Spending, category i

- Step 3. Estimate parameters for the current system of PCE equations, but use the newly defined disposable income and deflators as independent variables.

This approach assumes that the average coinsurance rate equals the marginal insurance rate across all individuals. This assumption leads to a bias (Newhouse et al. 1979) because coinsurance rates vary across individuals and average coinsurance rates do not equal marginal rates. Because we cannot measure the true marginal coinsurance rate, we assume that the average rate equals the marginal rate.

Our price parameters will be biased for another reason as well -- deductibles. Keeler et al. (1977) show how deductibles will bias our price parameters in an unknown direction. Keeler et al. (1977) and Newhouse et al. (1979) show that by either eliminating individuals with deductibles from the data set or lumping individuals together who have the same deductible, the bias is eliminated. These solutions cannot be implemented here because our data does not provide information on who has a deductible in their insurance policy or the size of the deductible. We acknowledge that our estimated parameters may be biased, but feel that the size of the bias is small relative to the improvement gained through modelling insurance benefits as a price subsidy.

For these equations to generate forecasts, forecasts of either the subsidy rate or total insurance benefits would have to be provided.<sup>17</sup> LIFT would be modified so that either the subsidy rate or the amount of insurance would be given to the model. Once either value is known, the other can be determined as follows:

We know that the dollar size of insurance benefits equals:

$$\text{Insurance Benefits}_i = \text{sib}_i * \text{Nominal PCE}_i = \text{sib}_i \text{ DEFL}_i \text{ Real PCE}_i \quad (6)$$

where:

$$s_i = \text{sib}_i + \text{sig}_i$$

(or, total subsidy (s) equals insurance subsidy (sib) plus government subsidy (sig) ) and

$$\text{Real PCE} = G(\text{DEFL}_i, s_i, \text{Income}, \text{DEFL}_{\text{other}})$$

thus:

$$\text{Insurance Benefits}_i = \text{sib}_i \text{ DEFL}_i G(\text{DEFL}_i, s_i, \text{Income}, \text{DEFL}_{\text{other}}) \quad (7)$$

We can solve equation (9) for whichever of the two, subsidy rate (s) or insurance benefits<sub>i</sub>, is unknown. Once we determine total benefits, we make the employer-provided/individual-purchased health insurance split. This split can either be specified exogenously or equations can be developed to forecast it.

This approach requires a considerable amount of start-up cost in terms of data work, revamping the estimation routines and modifying LIFT. Most of these costs would be incurred under the "ad-hoc" approach described above. The only additional cost would be modifying LIFT so that it could handle wedges between producer and consumer prices (consumer price subsidies). We believe that the amount of effort required to implement this proposal -- treatment as a price subsidy -- compared to implementing any of the other alternatives is a cost that is far below the expected benefit.

One advantage of treating employer-provided health in this manner is that it makes our disposable income variable look more like CPS money income. As mentioned in the short-run

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<sup>17</sup>These values could either be specified exogenously or equations could be developed.

modification section, we intend to use CPS data to forecast age-specific disposable income shares.<sup>18</sup>

### INDIVIDUAL HEALTH INSURANCE BENEFITS

Employer-provided insurance benefits are a subsidy from one economic actor (business) to another actor (persons). Consequently, increases in the subsidy leave the income available for discretionary spending unaffected. Individual health insurance benefits, however, are entirely financed within a single class. If individual benefits were modelled as a subsidy, changes in the size of the subsidy would change personal income because money being used to finance the subsidy is no longer considered "income." If we treat these benefits as an income transfer, as is currently done, then there is no effect on personal income since the transfer takes place between individuals in the same class.

While we believe that the correct approach is to model both types of benefits as price subsidies, we are afraid that this will not be possible for individual insurance benefits. Private insurance is financed by persons so changes in the subsidy rate or expenditures on the subsidized goods will affect personal income on a dollar-for-dollar basis. This means that we would need to solve for the level of income, PCE and the size of the subsidy simultaneously. Unfortunately, each is determined by the other two.

For example, given any level of income and subsidy rate, we can solve for PCE. We then calculate the size of the subsidy (rate \* PCE) and subtract this from income. Since income has now changed because the size of the subsidy has changed, we must again solve for PCE. In turn, this new level of PCE affects the size of the subsidy which in turn affects income. Thus, modelling individual benefits as a subsidy means we must solve PCE iteratively.

We reject this solution and instead propose maintaining the status quo for individual insurance. Individual insurance benefits accounted for approximately six percent of medical PCE (Monaco 1994) so the cost of maintaining the status quo should be small.

### GOVERNMENT MEDICAL TRANSFERS

Government transfers that finance medical PCE can be divided into three programs -- Medicare, Medicaid, and Other. Medicare and Medicaid are easily defined and the size of the programs are found readily in the NIPA. Other, however, is a catch-all category for all other types of government transfers (as defined by the NIPA) that finance medical PCE and are neither easily defined nor found in the NIPA. Below, we define these government programs and describe alternatives for modelling their effects on medical PCE.

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<sup>18</sup>The treatment we propose for Government programs (see below) also has this effect.



■ **Medicare:** The Hospital and Supplemental Medical Insurance program is often referred to by its more common name, Medicare. The program provides national health insurance to the elderly, disabled persons receiving Social Security payments for at least 24 months, and most persons with end stage renal disease (Petrie 1993). The program covers inpatient hospital care, some inpatient nursing home care, home health care, hospice care, physician and supplier services, and outpatient services. The program does not cover expenditures on Drugs.

We believe that Medicare should be modelled in the same manner as private health insurance.<sup>19</sup> The four alternatives given above are applicable here.

■ **Medicaid:** The Medicaid program provides medical care for certain groups of the poor (De Lew et al. 1992; Gurny et al. 1993a). Each State and the District of Columbia is free to administer and establish its own Medicaid program as long as the plan meets certain Federally-determined mandates (Gurny et al. 1993c). The program is partially funded through Federal grants to States.

While often considered a government-run health insurance program for the indigent (Phelps 1992), the program functions more like an in-kind transfer than as a price subsidy (Smeeding and Moon 1980). Eligible individuals receive a virtually free gift of medical care. States are allowed to charge recipients nominal deductibles, coinsurance and copayments, but may do so under only restrictive conditions (Gurny et al. 1993b). In practice, this has meant that recipients pay little, if anything, for their medical care (Phelps 1992). We interpret this to mean that the program is an in-kind transfer of medical services to persons.

We believe that there are two appropriate methods of modelling in-kind transfers: the Direct One-to-One Link and the Ad-hoc methods presented above. We are unsure which method is the most appropriate in terms of economic theory and forecasting performance. Regardless of which approach we choose, our treatment of Medicaid-financed PCE when estimating the age-specific demand equations is unaffected. An in-kind transfer approach requires that we remove Medicaid-financed care from our sample prior to estimating our functions.

■ **Other Government:** Since we have only a vague notion of what government programs belong in this category, it is difficult to formulate a plan for its treatment. We can broadly define this category as all government transfers except Medicare and Medicaid that appear in NIPA Table 3.11 - "Government Transfer Payments to Persons" that may only be used to purchase medical care. These transfers include: Federal Military medical insurance (payments for medical services for dependents of active duty military personnel at nonmilitary facilities); the portion of Federal transfers that are payments for medical services for retired military

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<sup>19</sup>The reasoning behind this decision follows that given for private insurance. A more detailed discussion of Medicare can be found in "A Suggested Approach to Modelling Medicare Benefits," a report submitted to the Health Care Financing Administration in completion of tasks 6 and 7 of contract #500-93-0007.

personnel and their dependents at nonmilitary facilities; the portion of State and local Other that consists of medical insurance premiums paid on behalf of indigents. In 1989, the sum of these items was less than \$15.7 billion. Total medical PCE in 1989 equalled \$483.5 billion. Thus, the programs in this category financed less than 4 percent of medical PCE.<sup>20</sup>

Based on their titles, these three programs appear to function as price subsidies. Currently, LIFT treats these programs as pure income transfers, which is inappropriate if they actually are subsidies. However, given that all of these programs are extremely small relative to total medical PCE, we believe that little would be gained by implementing any approach other than the Status-Quo method described above.

## DATA REQUIREMENTS

LIFT operates within the framework of the NIPA. Consequently, almost all the variables used in LIFT are defined using NIPA conventions. For example, personal income and disposable income in LIFT are constructed in virtually the same manner as is done in NIPA table 2.1 "Personal Income and Its Disposition" (See McCarthy (1991) for more details). Thus, when we refer to medical PCE, we mean, as it is defined by the NIPA. For example, the NIPA do not include the medical treatment of military personnel at military facilities in PCE, but instead, consider this treatment a government purchase.

So that INFORUM can revise its treatment of third-party financed medical PCE, we need time-series data that provides NIPA-compatible data on the amount spent by funding source in each medical PCE category. Unfortunately, the NIPA do not provide data at this level of detail. For example, NIPA reports total Medicare transfers but fails to report any detailed spending by the program. Similarly, NIPA reports the size of employer-provided health insurance benefits, but fails to report the categories in which the spending occurs nor does it report any data on the size of individual-purchased health insurance benefits.

The National Health Accounts (NHA) provide us with data at the required level of detail, but the data is not directly compatible with the NIPA. For example, the NHA report total Medicare spending, as well as the PCE categories where the spending occurs, but report a different value for total Medicare spending than the NIPA. This is because the NHA, designed as a set of health accounts, often contains information that the NIPA, designed as a system of national income accounts, lacks.<sup>21</sup> For example, where the NIPA only report employer-provided health insurance

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<sup>20</sup>This value is calculated using the NIPA value for the three items. However, the two "other" programs include non-medical related transfers. For example, the Federal Other program includes aid to students and payments to nonprofit organizations. If we excluded these non-medical transfers from the programs, the size of All other government would be less than the \$15.7 billion listed here.

<sup>21</sup>These expenditures are recorded by NIPA, but are included in aggregate spending categories. Consequently, we can not isolate the information we need.

benefits, the NHA report employer-provided and individual-purchased health insurance benefits.<sup>22</sup>

It is likely that these discrepancies are created by the conflicting views of personal health spending used by the two sets of accounts. The NHA uses a much broader definition of medical PCE than does the NIPA. Below are some examples of how INFORUM believes the two data sets differ:

- Treatment of Veterans at Military or Veterans hospitals:  
NIPA:Government purchase  
NHA :Personal Health Care purchases
- Treatment of Veterans at Non-Military hospitals:  
NIPA:Transfer payment (purchase recorded as PCE)  
NHA :Personal Health Care Purchase
- Treatment of Military Personal and their Dependents at Military Hospitals:  
NIPA:Federal Defense Purchase  
NHA :Personal Health Care Purchase

One area in particular that the NHA and NIPA differ is the size of government-financed medical PCE. In the NIPA, only the medical purchases funded by the programs reported in "Table 3.11-Government Transfers to Persons" are recorded as PCE. These programs include: Medicare, Workers' Compensation, Military Medical Insurance (payment for medical services for dependents of active duty military personal at non-military facilities), and Other.<sup>23</sup> In the NHA these programs, and a range of programs the NIPA consider government purchases are defined as personal health care purchases. These programs include: "Medicare, Worker's Compensation, Medicaid, Department of Defense, Maternal and Child Health, Vocational Rehabilitation, Alcohol, Drug Abuse, and Mental Health Administration, Indian Health Service, and miscellaneous general hospital and medical programs," (Lazenby et al. 1992).

Before NHA data can be used to calculate the size of third-party financed PCE by category, the NIPA and NHA data must be reconciled in some manner. One solution is for INFORUM to have access, or be given, a data set or documentation that clearly reconciles the differences between NIPA and NHA conventions so that INFORUM can construct a set of detailed medical accounts that follow NIPA conventions.<sup>24</sup> A second solution is for INFORUM to use the NHA

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<sup>22</sup>Though the number reported by the NHA differs from the NIPA value.

<sup>23</sup>Other consists largely of payments to nonprofit organizations, aid to students, and payments for medical services for retired military personnel and their dependents at nonmilitary facilities. Only the latter should be included in medical PCE.

<sup>24</sup>While we have a fairly clear idea on how to undertake such a reconciliation, our preference is for an exact reconciliation - even if this includes a category titled "statistical discrepancy."

data after first removing items that we already know do not belong in a NIPA-style accounting framework. We believe that once we have corrected for these major differences, the remaining discrepancies will be small. This procedure will not give us the actual data, but should provide us with data that closely approximates the actual data.

## V. LONG-RUN IMPROVEMENTS: THE CROSS-SECTION DATA

The current cross-section equations rely on data from the Consumer Expenditure Survey. Use of this data leads to biased time-series parameters (Janoska 1993). Any long-run solution must include a reestimation of the medical PCE cross-section functions with different data.

The bias arises because the CEX records household expenditures but excludes any expenditures for which the household is reimbursed (Bureau of Labor Statistics 1992). Consequently, the CEX ignores all insurance benefits and government in-kind transfer payments. If the distribution of these third-party payments is skewed towards one age group, then the CEX will lead to biased parameters (Janoska 1993). The bias arises in the current system because we use cross-section coefficients that explain out-of-pocket spending in a time-series equation that explains **total** spending.

For example, a large portion of the medical spending by the elderly (GPOP8) is financed by third-parties (e.g. Medicare and Medicaid). The CEX data ignores this spending and consequently, the CEX-based Adult Equivalent Weight (AEW) for the elderly is too small.

Because of the bias caused by third-party payers, we must re-estimate our cross-section functions with data that records expenditures regardless of source of payment. Ideally, one would like to have data that contains information on all three types of health care expenditures (out-of-pocket, insurance benefits, and government in-kind transfer payments) by the individual since the cross-section analysis could then incorporate this information in some manner. The 1987 National Medical Expenditure Survey (NMES) is such a data source (Public Use Tape Information, 1992).

Two other data sources are similar to the NMES - the National Medicare Care Expenditure Survey (NMCES) done in 1977 and the National Medical Care Utilization and Expenditure Survey (NMCUES) gathered in 1980. The three surveys are not directly comparable and several years separate the data. Consequently, we have decided against attempting any type of "time-series" estimation using cross-sectional data from these three sources. Since the NMES is the most recent of the three surveys, we believe that it is the appropriate data source to use. Thus, we intend to use the NMES for our cross-section analysis.

The form of the cross-section equations would remain unchanged, only the data used to estimate the medical PCE categories would be revised.

## **VI. LONG-RUN IMPROVEMENTS: TREATMENT OF IMPUTED INCOME<sup>25</sup>**

Both NIPA and LIFT include "imputed" income in their definitions of disposable income. In the NIPA, imputed income is calculated as the value of goods and services received by persons for which they are not charged. For example, the value of owner-occupied housing is included in NIPA and LIFT disposable income.

In theory, the imputed income received from owner-occupied housing equals the amount that home owners would have to pay in order to rent their homes, but, because its true value can never be observed, data are derived from a formula. Again, in theory, the imputed income received can only be spent in the PCE category owner-occupied housing. In the NIPA, this is always the case because it is identically true. This is not the case in LIFT, however. Because LIFT treats this imputed income exactly as it does other forms of income, an increase in income received through owner-occupied rent can be spent on any of the PCE categories.

By including this imputed income in our time-series income variables, we allow it to be spent in PCE categories other than owner-occupied housing. Thus, when running simulations, some imputed income is spent on medical PCE. Because a higher percentage of the elderly live in their own home than the non-elderly (Census 1990) and, because the elderly tend to have higher equity in their homes than the non-elderly (Schulz 1990), receipt of this imputed income is skewed towards the elderly. Because we let this imputed income be spent in any PCE category, we give the elderly "too much" income.

We propose solving this problem by removing imputed income from the income variables we use when forecasting PCE. The various types of imputed income and the PCE categories associated with them would be linked by identities that would be based on the formulas used when the NIPA calculates these items.

## **VII. LONG-RUN IMPROVEMENTS: INCREASED NUMBER OF AGE GROUPS**

It is generally accepted that one's preferences change as one ages. The INFORUM PCE system acknowledges this by estimating the set of Adult Equivalent Weights. The system is restrictive, however, in that it allows for only eight AEWs. One long-run improvement we suggest is increasing the number of age groups.

Ideally, one would estimate age-specific demand equations for every age. This is because each cohort's tastes may differ from the tastes of those younger or older than themselves (Schulz

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<sup>25</sup>The focus in this section is not directly on medical spending, but is instead on the process of constructing the variables we use to forecast medical spending.

1992). If we assume that a cohort's preferences change as it ages, than a-priori, we cannot reject the assumption that preferences change every year. We refer to the system of equations that allow preferences to change every year as the "completely comprehensive" PCE system.

This completely comprehensive system would give us approximately 100 age-specific demand equations per PCE category. From a practical standpoint, however, such a system is unwieldy. The completely comprehensive PCE system would have over 8000 equations that would need to be estimated and incorporated into LIFT. One would need to review a large number of age-specific forecasts to ensure a sensible forecast of PCE. The costs associated with such a comprehensive system are prohibitive. Thus, we believe that some simplifying assumptions are in order. We plan on estimating three age-specific demand equations: non-elderly (under 65 years of age); young-old (65 to 75 years of age); and old-old (over 75 years of age).

Casual empiricism as well as economic studies have shown that the elderly have higher expenditures on medical care than do the non-elderly (Devine 1983; Harrison 1986; Waldo et al. 1989; Chao 1991). Following Schulz (1992), we believe that the elderly (age 65 and over) should be split into two age cohorts. We assume that the elderly fall in one of two categories: 65 to 75 years (young-old) and 75 years and over (old-old).<sup>26</sup>

We split the elderly into two cohorts because there is considerable evidence that spending on medical care increases dramatically for individuals over the age of 75 (Harrison 1986; Waldo et al. 1989). This may indicate less income-price responsiveness or it may be a case where a separate AEW is required. One objective of the proposed research is identifying which alternative (AEW versus Own income-price coefficients) is the most appropriate for use in LIFT. Even in the case that we reject the hypothesis of separate income-price parameters, it is our belief that the empirical evidence strongly suggest that the elderly should not be considered one large homogeneous group.

## **VIII. LONG-RUN IMPROVEMENTS: A RICHER INCOME DISTRIBUTION MODEL**

Recent work has pointed out the shortcomings of the current functional form used by LIFT to forecast the Lorenz curve (Rasche et al. 1980; Ortega et al. 1991; Janoska 1993). Any long-term solutions would involve scrapping the current functional form and the adoption of either the Rasche or Ortega functions.

The short-run modifications rely on the assumption that each if the age-specific income distributions were identical to the distribution of aggregate income. Having a set of age-specific income distributions that maintained consistency with, but differed from the aggregate distribution

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<sup>26</sup>We use Schulz' nomenclature.

would greatly enrich the simulation capabilities of the model. At this time, we are unsure as to how one would implement such a system, but believe that such a system could be created.

## **IX. SUMMARY**

The current LIFT PCE system can be modified to allow for age-specific demand equations in a number of ways. In the short-run, age-specific equations can be added by relaxing some of the restrictive assumptions used by the system. Longer-run proposals require more substantial revisions to the system -- ranging from scrapping the current treatment of third-party payments to increasing the number of age groups in the model. As the baby-boom begins to retire, the importance of the elderly in determining aggregate PCE can only increase. Increasing the richness of the impact age has on the PCE system should greatly improve any long-run forecasts using LIFT.

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## WORKING PAPERS

INFORUM WORKING PAPER 94-011

A Plan for Estimating Age-Specific Medical  
Personal Consumption Expenditure Equations  
for Use in the INFORUM LIFT Model

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INTERINDUSTRY FORECASTING PROJECT  
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