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The Baby Boom As It Ages: How Has It Affected Patterns of Consumptions and Savings in the United States?

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Abstract

Using detailed estimates of personal consumption expenditures at the state level for 1900, 1929, 1970, 1977, and 1982 developed by Stanley Lebergott, this paper demonstrates that the passage of the Baby Boom from childhood through the teen years and into family formation would have caused marked swings in patterns of aggregate consumption and savings in the United States during the past 50 years. The effect of age structure on personal consumption expenditures is estimated using population by single year of age from 0 to 85, revealing the expected pattern of life cycle consumption and savings in the adult years. In addition, however, a strong age-related pattern of consumption expenditures for children is demonstrated, with a strong savings component. The pattern which emerges for children in all periods is strongly U-shaped, with the highest levels of expenditure in the earliest years and for teens, and a marked pattern of saving when children are aged about 5 through 12.

1. Introduction

What impact—if any—has the aging of the postwar baby boom had on patterns of consumption and saving in the United States economy? And what impact will it have as it ages further, and moves into retirement? It has been responsible for massive changes in the age structure of the United States population, with the proportion of the population aged 20 to 24, for example, declining by 30 percent between 1940 and 1960, followed by an increase of over 50 percent between 1960 and 1980, and then another decline of 30 percent between 1980 and 1997. Once they have all retired, by the year 2050, there will be three persons aged 85+ for every one year old in the population (whereas the ratio currently is about 1:1—see Figure 1). Economists have identified what appear to be marked age-related fluctuations in the proportions of income consumed and saved by individuals throughout this century. Do these patterns carry through when the data are aggregated over individuals—or are variations due to changes in one age group largely offset by changes in another?

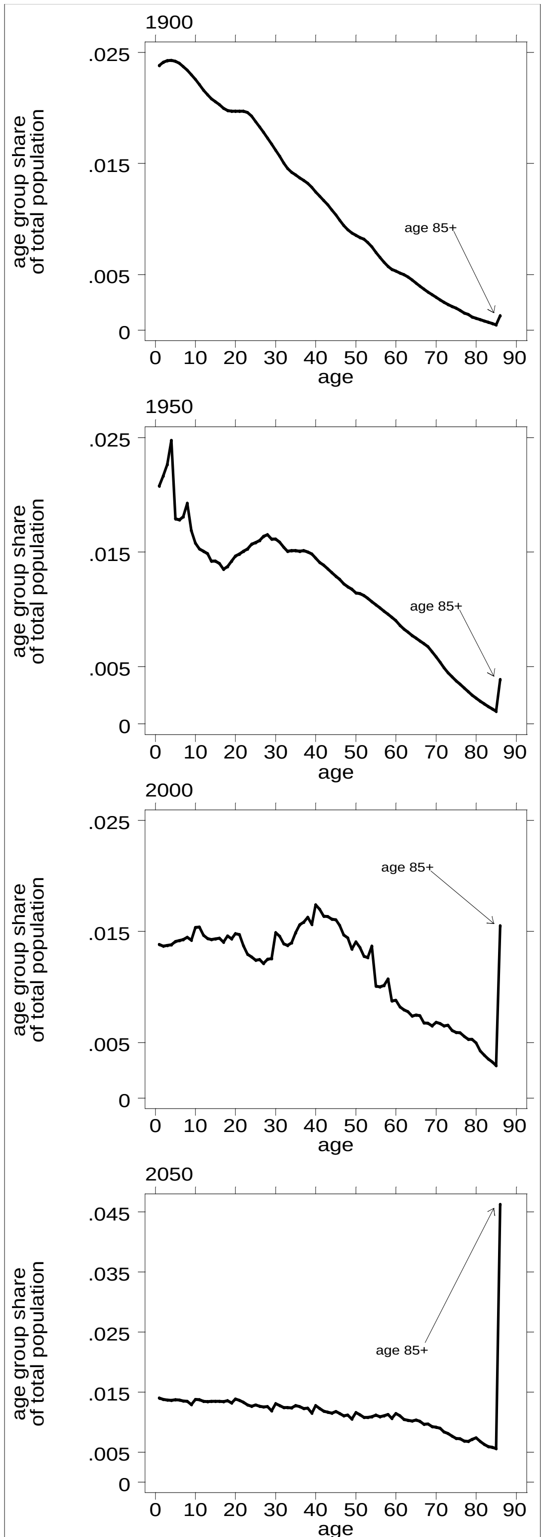

Figure 1: The changing U.S. age structure: proportion of the population in each of 85 single year age groups, and the share aged 85+, in 1900, 1950, 2000 and 2050.

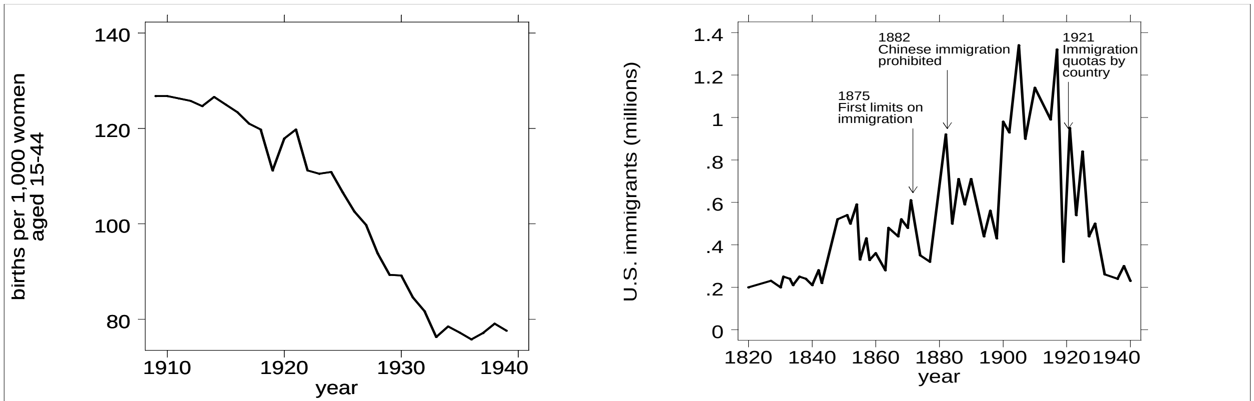

Figure 1: General Fertility Rate (left panel) and numbers of immigrants to the U.S. (In millions, right panel), in the period before 1940. *Source for immigration figure: London Times, August 22, 1993 as reported in Mandel (1995).*

John Maynard Keynes (1937) suggested that the adverse economic conditions of the 1930s were at least in part due to demographic trends. Here in the United States, like the United Kingdom, birth rates had begun falling sharply after 1910 , and immigration—which Kuznets (1958, 1961) has demonstrated had a strong impact on the economy—had fallen sharply following reforms in the 1920s. These trends are depicted in Figure 2. Keynes presented a stagnation thesis in which, as summarized by Espenshade (1975), “population growth stimulates investment in factories and machinery; and with population growing, businessmen are more likely to regard their investment misallocations as less serious than when the growth is slow or nil.” If correct, then the same type of phenomenon would have operated in the 1970s and early 1980s as a result of birth rates which began falling in the late 1950s.

This paper addresses these questions using new and detailed data prepared by Stanley Lebergott (1996) on cross-sections of personal consumption expenditures (PCE) at the state level for five dates during this century—1900, 1929, 1970, 1977 and 1982—as well as the time series of PCE at the national level from 1900-1996, all in combination with detailed age breakdowns of the population at the state and national levels. The approach here is different from that in most previous analyses, in its use of age breakdowns in the *total population* -- including children—rather than just among heads of households or families. Recent research indicates that the ratio of expenditure to income is significantly affected by the age of children in a family, even holding constant the age of adults in that family.

In addition, by avoiding the analysis of individual households in isolation, the study presented here recognizes the possibility of age-related *interhousehold* spending, for example in the form of gift-giving at birth, graduation and marriage, and loans or gifts by prime-age individuals to their financially-strapped young adult children at the household formation stage. If, as suggested by Macunovich (1998a, 1998b, 1999), the incomes of young adults in large birth cohorts are adversely affected by their own cohort size, while at the same time the incomes of their parents are favorably affected, such cross-cohort giving might produce patterns of savings and consumption not predicted by models which deal with households in isolation—patterns related to the age distribution in the total population, rather than to the age of a household's own head.

This type of phenomenon has been explored by Weil (1994), who explains the differences between measured age-patterns of savings at the micro and macro levels as the result of intergenerational responses to the bequest motive. He posits that increased saving by elderly households planning bequests, as measured in micro level surveys, is masked at the macro level because of reduced saving by adult children expecting to receive those bequests. He concludes that

> "if intergenerational relations are important, one cannot use the mean saving of people at different ages (or any other coefficients that come from micro data that do not account for members of other generations) to forecast changes in the aggregate saving rate in response to changes in the age structure of the population. Similarly, if one knew the [coefficients estimated at the macro level], one could forecast changes in the saving rate, even if one did not know the extent to which relations between generations were reflected in these coefficients. (p. 67)"

His findings in support of that hypothesis argue strongly for the use of macro level data to estimate effects of changing population age structure. Another study which can be taken as support for this type of intergenerational effect is Attanasio (1998), in which the savings profile of cohorts born between 1920 and 1939—the parents of the baby boom—is shown to be "shifted down" relative to that of preceding and subsequent cohorts. He argues that this shift can account for "a nonnegligible proportion" of the savings decline in the 1980s. Such a shift might have occurred either as a result of transfers from the parents of the baby boomers to their struggling adult children, or as a result of boomer parents' expectations of bequests from their own parents, as suggested by Weil.

Subsequent sections of this paper present a quick overview of the literature (supplemented in Appendix A), followed by a description of data and methodology (also supplemented, in Appendices B, C and D), and then present results first for total personal consumption expenditures at the state level (in sections 4 and 5 and Appendix E), and then for specific items of expenditure (section 6). Section 5 includes a discussion of results obtained from a differenced model of state-level data: one which looks at effects of *changes* in age shares on *changes* in expenditure between 1900-1929, 1929-1970, 1970-1977 and 1977-1982. Section 7 then brings all of these results together in a time series simulation of estimated demographic effects at the national level.

2. Literature Review

What are the "stylized facts" with regard to the relationship between age structure and patterns of consumption and saving? The literature review in Appendix A presents a more detailed discussion of theses "facts" and their sources. Here we simply touch on the highlights (and cite articles by number to improve the readability of this section):

●**Consumption smoothing occurs over the life cycle**, which given a "humped" lifetime wage profile in turn causes fluctuations in rates of consumption and saving relative to income: the life cycle and permanent income hypotheses (37,85-88). These hypotheses are supported in micro level analyses except for a tendency for the consumption profile to “hump,” paralleling the lifetime earnings profile. This has been explained as an effect of age-related changing marital status and family size (21,36,49,56,96,101,103) and other potentially age-related factors such as retirement patterns (95) and wives’ labor force participation (50,56,96,100,102); and other factors ranging from myopia and uncertainty to Social Security (15,20,22,40,44,90). These hypotheses are supplemented with suggestions of habit persistence (19) and ratcheting due to relative income effects (25).

●There is conflicting evidence at the macro level regarding the **effect of dependency rates** (proportions of young and old relative to the working-age population) on **savings rates**—and through them on economic growth rates. Strong negatives are found by some (39,53,54,62-65), with their methodologies and findings challenged by others (2,12,43,92,93)—but all of these analyses ignore changing *age structure within* the groups of dependents and working-age population. They treat all individuals within each of the three age groups (0-14, 15-64 and 65+) as homogenous.

●Such within-group homogeneity is challenged by researchers using micro data, who find **strong effects of changing age distribution among children** (4,23,59,68,96)—and of course the life cycle hypothesis itself contradicts such assumptions of homogeneity among the working-age population. In general, these researchers suggest that holding income constant, family consumption is about 15 percent greater for older teenagers than for infants, but that children induce a period of strong saving in the pre-college period.

●However, despite findings of strong age patterns in the micro data, usually only **muted effects** are found when economists apply these **micro-level** age structure parameters, in **macro level** analyses. They conclude that the life cycle pattern of savings cannot account for the steep decline of savings rates in the 1980s (6,7,17,55,66). Some have found strong effects on housing demand at the macro level, however (12,81).

●In contrast, **strong age structure effects** accounting for much of the economic phenomena observed in the past forty years, are found by economists using parameters estimated **with macro-level data**. They find effects on inflation (67,84); GDP growth rates (82); expenditures on housing, durable and nondurable goods and services, money demand, and labor force participation (34); real interest rates and unemployment (15,84); per capita income (82,84); savings rates (15,49,67,82); consumption as a proportion of income (46); and labor productivity (15); as well as strong effects of age structure on aggregate demand in the 1800s and early part of this century (1,44,52,53).

What accounts for the strength of these findings in macro level analyses, given the relatively weak showing when micro level results are taken up to the macro level—and in turn what accounts for the latter results, given the strong age effects identified at the micro level? The work of some researchers suggests that the unsuccessful studies have used inappropriate age groupings (59), ignored cross-generational effects (104), used inaccurate data on aggregate economic performance (97), and/or erroneously included lags and leads of the dependent variable which contain information on the relatively slow-moving patterns of demographic factors (99).

A striking pattern emerges from the findings in the literature, of age-correlation among the variables identified as significant in altering patterns of consumption and saving, e.g., income, marital status, family size, wives' labor force participation and retirement patterns. To what extent, then, can an accurately defined age breakdown account for these other differences among families? This is a particularly relevant question if, as suggested by some of the literature, changes in these demographic factors are themselves a function largely of changing age structure in the population (27,30,34,70-72,77). That is, not simply changing proportions in the population as a whole, but actual *age-specific rates of incidence* of these types of demographic behavior might be a function of changing age structure.

3. Data and Methodology

This analysis acknowledges the relevance of Weil's (1994) findings of cross-generational effects on consumption and saving. It is assumed that such effects render inadequate any study which attempts to estimate aggregate age structure effects by simply applying household-specific parameters, to age shares at the macro level. There is, of course, also the problem that elasticities estimated in cross section might reflect short term responses to transient income, while macro level elasticities indicate longer term responses to permanent income levels.

However, the estimation of age effects using aggregate data is plagued by problems of autocorrelation, and Stoker (1986) has demonstrated that the most common method of dealing with such autocorrelation—the inclusion of leads and lags of the dependent variable—produces misleading estimates because the leads and lags include information on the only slowly-changing patterns of age structure, and thus tend to reduce the estimated significance of age structure variables.

Embedded in this issue of autocorrelation is one of feedback effects. Consider, for example, the following potential cycle of effects: a preponderance of young adults in their "high spending" phase of the life cycle causes consumption as a share of disposable income to rise, and this *growth* in consumer demand in the short term spurs investment and economic growth. But savings levels have declined, and this in turn leads to higher interest rates, reduced investment in productivity-enhancing innovations, and ultimately a slow-down in wage growth—all of which tend to *depress* consumer demand. Teasing out the basic effect—the initial increase in consumer demand—becomes virtually impossible with time series data.

In addition, a model which includes a large numbers of age group shares in order to overcome the possibility of erroneous groupings, encounters a problem of severe multicollinearity which calls into question the accuracy of any individual coefficient estimates. This problem can even arise when only a few age groupings are used. And the problems of muticollinearity are compounded by the marked loss of degrees of freedom in estimating those coefficients, as the number of age groups is increased—an important consideration in time series analyses. As observed by David (1962), "Age varies continuously and there are few convenient demarcations between age groups with significantly different behavior patterns." Thus, researchers face a conundrum: construct "artificial" and possibly erroneous age groupings, or face the threat of severe multicollinearity among more finely disaggregated groupings?

This analysis attempts to address the potential problems of autocorrelation, feedback effects, and differences between short- and long- term elasticities by making use of Stanley Lebergott's detailed estimates of personal consumption expenditures (PCE) at the state level at five different points during this century: a panel of cross sections at a semi-aggregated level. Lebergott derived several hundred new series for PCE components annually for the years 1900-1929—and at the state level for the years 1900, 1929, 1970, 1977 and 1982—which are directly comparable with official BEA series as revised in 1993, in both current and constant dollars.

These data prepared by Lebergott are far more comprehensive than data provided by the Consumer Expenditure Survey. As he points out the latter are based on interviews with "less than one-thousandth of one percent of American 'consumer units'" in which "individual members of households try to remember expenditures in the prior year (p. 130)." The 1984 survey, for example, "understated United States food and clothing expenditures by $173 billion. Not to mention $33 billion for house furnishings, $28 billion for alcohol, and $46 billion for entertainment (pp.129-130),” while the census rent sample “was one thousand times greater than that of the BLS (p.131)”

Lebergott’s data began with BEA national income account totals which were then allocated to states. It is important to note that in no case were his allocation methods based on age distributions within the population. Rather, they were derived from census data on production and expenditures, as well as (for 1900) distributions of workers by occupation and service income.

These expenditure data are supplemented with detailed population breakdowns for states in each of these years, provided by the Bureau of the Census. Lebergott’s data, and the census data used in the analyses, are described in detail in Appendix B, and Figure 3 demonstrates the distribution over states in each year, of primary indicators in the data set—four population measures plus per capita income and consumption, and the percent foreign-born.

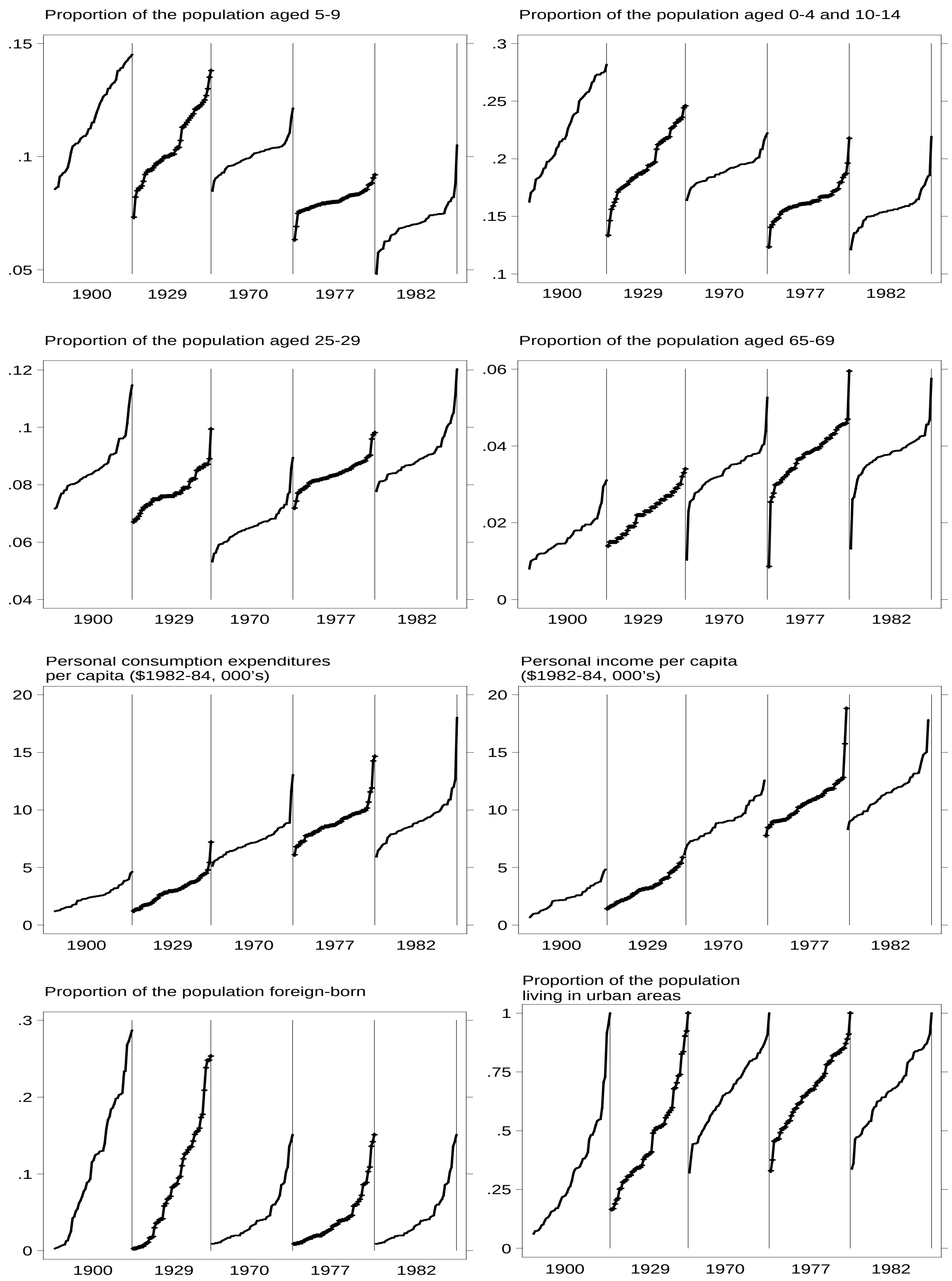

Figure 3: States ranked and presented (lowest to highest) each year on the basis of observed values of variables used in the analysis.

The problems of age group definition and multicollinearity among age groups are addressed by making use of a technique suggested by Fair and Dominguez (1991), which is in turn similar to Almon's (1965) distributed lag technique. This methodology is described in more detail in Appendix C, but in general terms it is one which allows the estimation of coefficients on single year population age shares, by constraining them to lie along a polynomial, with the degree of that polynomial determined theoretically and tested empirically. The coefficients φ_j on J population age shares p_j are assumed to enter the consumption equation in the form

$$\sum_{j=1}^{J} \varphi_j p_j \tag{1}$$

which is estimated as a polynomial

$$\sum_{j=1}^{J} \varphi_j p_j = \zeta_1 Z_1 + \zeta_2 Z_2 + \ . \ . \ . + \zeta_n Z_n \tag{2}$$

in which n is the degree of the polynomial and

$$Z_n = \sum_{j=1}^{J} p_j j^{\,n} - \sum_{j=1}^{J} (p_j \sum_{k=1}^{j} k^{\,n}) \tag{3}$$

The consumption equation to be estimated is derived in Appendix D as an aggregation of the following log-linear model describing consumption c as a function of income y for individual i in one of J population groups j, each of which contains individuals with identical intercept α_0 and marginal propensity to consume out of income (*MPC*) α_1:

$$\ln(c_{i_j}) = \alpha_{0_j} + \alpha_{1_j} \ln(y_{i_j}) \qquad i = 1 \ . \ . \ . \ P_j \tag{4}$$

It is assumed that the population can be divided into these J homogeneous groups on the basis of observable characteristics, all of which are assumed to be highly correlated with age, and on that basis the population is divided into 85 single year age groups 0-84 plus an 86th group containing those aged 85+. The aggregated form of the equation is derived as

$$\ln \bar{c} \ = \ \varphi_0 \ + \ \sum_{j=1}^{J} \varphi_{0_j} p_j \ + \ \ln \bar{y} (\varphi_1 \ + \ \sum_{j=1}^{J} \varphi_{1_j} p_j) \tag{5}$$

where $\bar{y}$ and $\bar{c}$ are per capita income and consumption, respectively, at the State level.

The specification of consumption at a per capita level within single year age groups has the decided benefit of addressing implicitly the thorny problem of estimating consumption equivalents within the family, household and/or population: accounting for age differences in consumption requirements which normally bias straight per capita estimates of consumption and income at the family or household level. The use of a full set of age shares permits an agnostic approach to the assessment of weights, and to the identification of appropriate age groupings for establishing weights.

Appendix D derives and discusses the four parameters $\varphi_0, \varphi_1, \varphi_{0_j}, \varphi_{1_j}$ with respect to their relationship with the intercept and *MPC* in equation **(4)** as a result of the aggregation process. φ_1 will be a weighted version of the "true" α_1 in the population, weighted by the ratio of the logged geometric mean income in the total population to its logged arithmetic mean (hereafter referred to as *PID—population income dispersion*) and by the ratio in the total population of the logged arithmetic mean of consumption to its the logged geometric mean (hereafter referred to as *PCD—population consumption dispersion*):

$$\varphi_1 \ = \ (\ln \bar{c} / \ln \omega_C) \, \alpha_1 (\ln \omega_Y / \ln \bar{y}) \tag{6}$$

while φ_0 will be the "true" α_0 weighted by the *PCD*:

$$\varphi_0 \ = \ (\ln \bar{c} / \ln \omega_C) \, \alpha_0 \tag{7}$$

Our estimate of——will be a similarly weighted version of group *j*'s deviation from the population intercept α_0 :

$$\varphi_{0_j} = (\ln\bar{c}/\ln\omega_C)(\alpha_{0_j} - \alpha_0) \quad \textbf{(8)}$$

And our estimate of— — will be group *j*'s deviation from the population *MPC*, α_1, weighted by the *PCD* and by the *PID* for age group j:

$$\varphi_{1_j} = (\ln\bar{c}/\ln\omega_C)(\ln\omega_{Y_j}/\ln\bar{y})(\alpha_{1_j} - \alpha_1) \quad \textbf{(9)}$$

This derivation is consistent with that presented by Hildenbrand (1998), who demonstrates that changes in the aggregate consumption ratio can be accurately estimated without any knowledge of the underlying behavioral relations at the individual level, as long as we have measures of the changing attributes in the population (in this case, the population age shares), mean real income growth and relative price changes (when modeling individual categories of expenditure), and information on changes in income dispersion in the population.

Unfortunately the last of these is missing in our data, so that it will not be possible to retrieve the original α's or α_j's. We can estimate the potential effects of these weights, however, using *PID* measures calculated for 1970, 1977 and 1982 in Current Population Survey data, and a *PCD* based on data in Rogers and Gray (1994). Tables presented in Appendix D show that the magnitude of the PID is roughly 0.95-0.96 in all years, and more importantly, that the ratio of the PID between years is always in the range 0.99-1.0, so the magnitude of the PID in all years is sufficiently close to one, and changes in its magnitude are sufficiently small, that any differential effect between years on the α coefficients will most likely be lost in the general error of estimation.

There is a possibility, however, that the *PID* for group *j*—($\ln\omega_{Y_j}/\ln\bar{y}$, one of the two weights affecting our estimation of α_{1_j})—might show a wider variation than the ratio in the total population—both in the cross section, as we move from one age group to another, and over time.

This is explored as well in Appendix D, where it appears that the effects of variation in this weight will be minimized as long as we work with the logged version of our consumption equation in **(5)**, rather than with the unlogged version **(D.18)** in Appendix D.

4. Estimation Results—Total PCE Using State-Level Data

The model being estimated is presented in equation **(5)**, and will be estimated first in restricted form: that is, assuming that the coefficients φ_{1_j} are all equal to zero. The model is estimated using the state-level personal consumption expenditure data developed by Lebergott (1996), for the years 1900, 1929, 1970, 1977 and 1982. Table 1 and Figure 4 first examine the pattern of age share coefficients (estimated using the methodology detailed in Appendix C) obtained when the population used to explain personal consumption expenditures is restricted to adults: just working age adults on the left (16-64), and then all adults aged 16+ on the right. The patterns estimated are consistent with that hypothesized by the life-

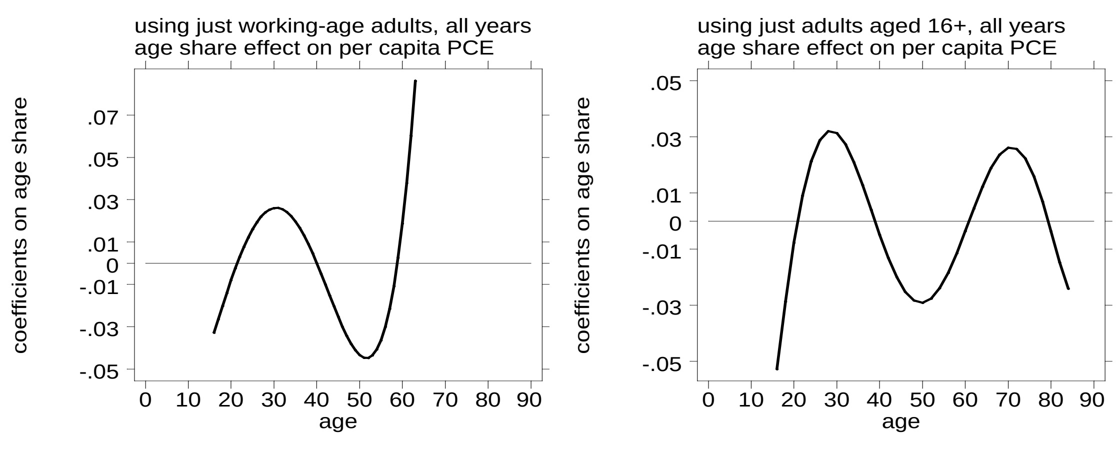

Figure 4: Patterns of age share coefficients estimated using only the adult population (16-64 on the left, and 16+ on the right), all five years pooled, as effects on logged PCE per adult -- as in Table 1.

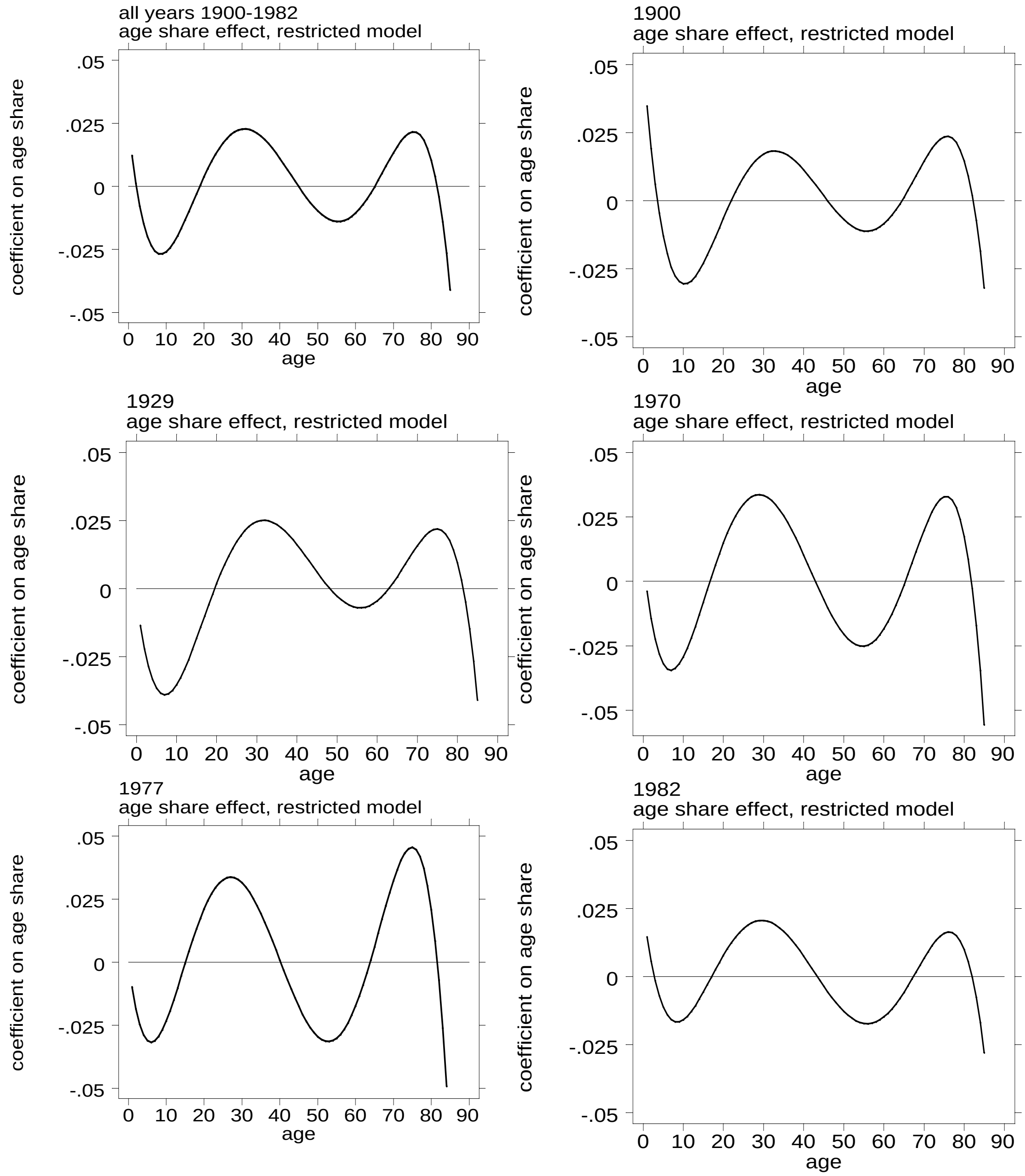

Figure 5: Estimated coefficients on age shares using results in Table 2. (All years, top left, 1900 top right, 1929 and 1970 in middle panel, and 1977 and 1982 in bottom panel.

cycle/ permanent-income models, and the coefficients in each case are highly significant. Figure 5 and Table 2 then estimate the same model using the total population aged 1-85+, for all five years pooled and then separately on the data for each of the five years. The patterns estimated in total and for each of the years are remarkably similar—indeed, a test of the coefficients in each of the single-year regressions shows that they are not significantly different from the coefficients estimated in the pooled sample.

All six panels in Figure 5, and the panel on the right in Figure 4, exhibit the expected "double-humped" pattern of age-related coefficients in the per capita consumption equation, which is consistent with the life cycle hypothesis. Both in the aggregate and in the pattern for each of the five years through this century, individuals are estimated to spend heavily between the ages of about 19 through 45 and 65 through 85, with a marked period of saving between ages 45 and 65.

The major contribution of this analysis is in demonstrating a strong age-related pattern of consumption expenditures for children, with a strong savings component. The pattern which emerges in all of the periods is strongly U-shaped, with the highest levels of expenditure in the earliest years and for teens, and a strong pattern of saving when children are aged about five through twelve. This will be a common pattern in all of the models estimated in this paper. The strong U-shape in expenditures on children may provide an explanation for the conflicting results produced by researchers studying the potential link between dependency and savings rates. Tests using different countries and different time periods have identified a relationship which is sometimes negative and many times inconclusive, and the U-shaped pattern of expenditure identified here suggests that the conflicting results arise because of different age patterns among children in the different countries and time periods examined in these earlier analyses.

Only one of these earlier studies, to my knowledge (Espenshade 1978), has taken account of age structure among children—albeit somewhat crudely—and it is significant that his analysis suggests that only age structure—not numbers of children—has an effect on the savings rates of families. He found that in more developed countries "children have the greatest positive impact on savings when they are nearing completion of high school". The U-shape pattern among children is also consistent with figures presented in Lee and Tuljapurkar (1997), although their estimates suggest net expenditures rather than net savings associated with this group.

However, even Espenshade made no allowance for changing age structure among the working age population. Given the strong hump in expenditures associated in Figures 4 and 5 with the ages 20 to 45—ages which are strongly correlated with childbearing—it seems likely that much of the dependency-savings literature has been attributing expenditure patterns of young adults, to their children. In addition, because much of the literature tends to lump together the populations below and above working ages, these studies might also be attributing to children some of Figure 5's retirement-age spending hump.[1] Only an analysis which controls for shifting age patterns *in the population as a whole*, can be expected to provide an accurate picture of the effect of children on their parents'—indeed, on the entire population's—savings rates.

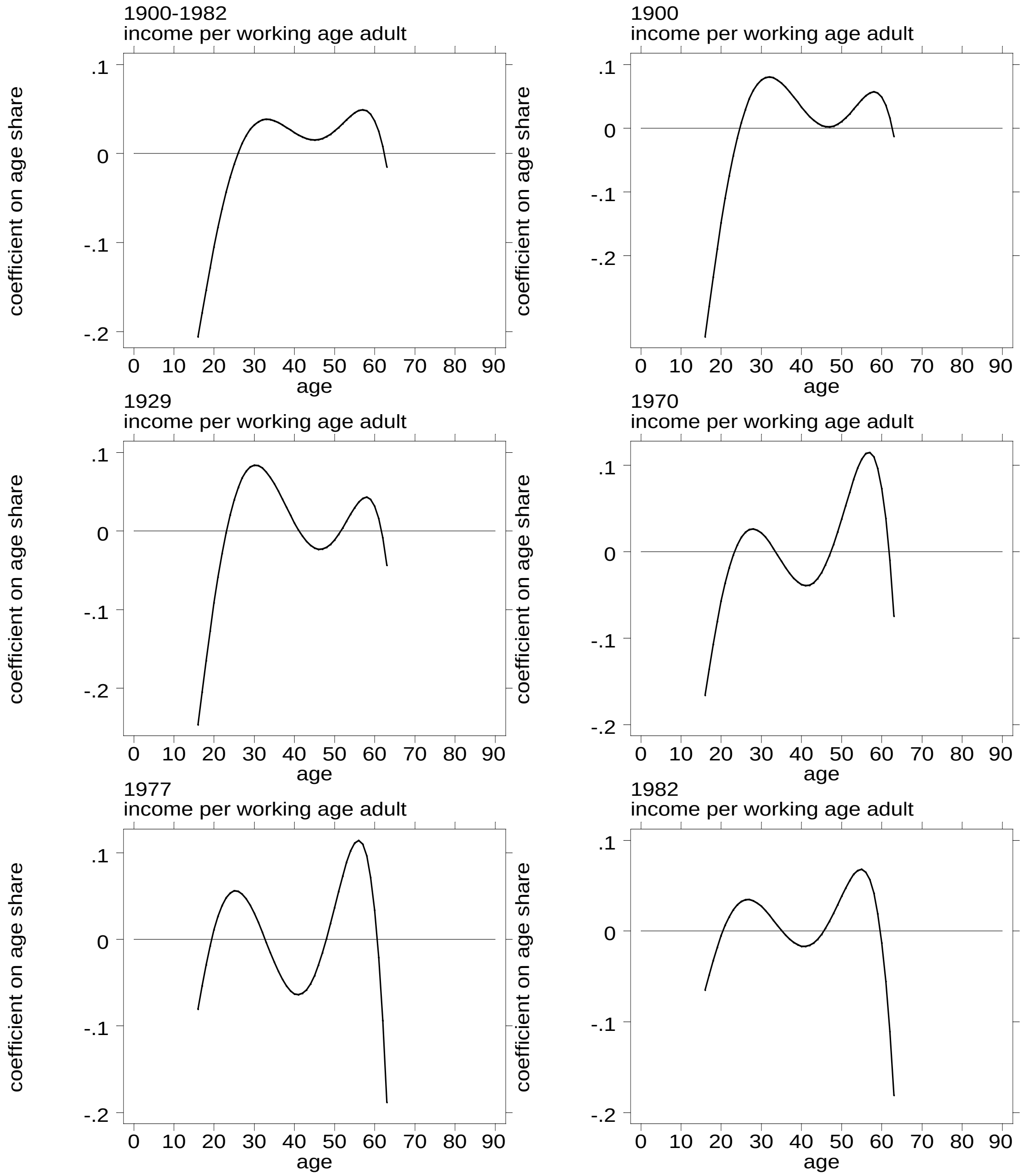

Figure 6: Estimated age share effects on income per working age adult, using just the population aged 16-64, all five years pooled and then individually -- as in Table 3.

5. Finding the Appropriate Form

But thus far we have worked with only the restricted form of the model, and more importantly, have assumed that per capita income used as a regressor in the model is exogenous. However, even average income *per working-age adult* must be considered a function of the age structure among those working-age adults—as indicated by the typical life cycle wage profile. This endogeneity is demonstrated in Figure 6 and Table 3, where the logged income per adult aged 16 to 64 is regressed on the age distribution among those same working-age adults—for all five years pooled, and then separately for each year. The relationship is significant in all years, and displays a double-humped pattern which reflects the experience premium at older ages, and the tendency at younger ages for greater levels of female labor force participation—especially when the wages of young men are depressed by large cohort size relative to those of older workers (Fair and Macunovich 1996; Macunovich 1996a, 1999a). And here again, as in Table 2, we cannot reject the hypothesis that the coefficients estimated on the age shares in each individual year are equal to those estimated in the pooled model.

The effects of this endogeneity are explored in Table 4 and Figure 7, where we examine results using the restricted model and controlling for the endogeneity of income by using—in place of logged income per person—only the residuals from the regression in column (1) of Table 3. This residual income will be referred to hereafter as "age adjusted income," and is used to control for compositional effects of changing age structure among working-age adults on per capita income, which will be collinear with age effects on per capita consumption.

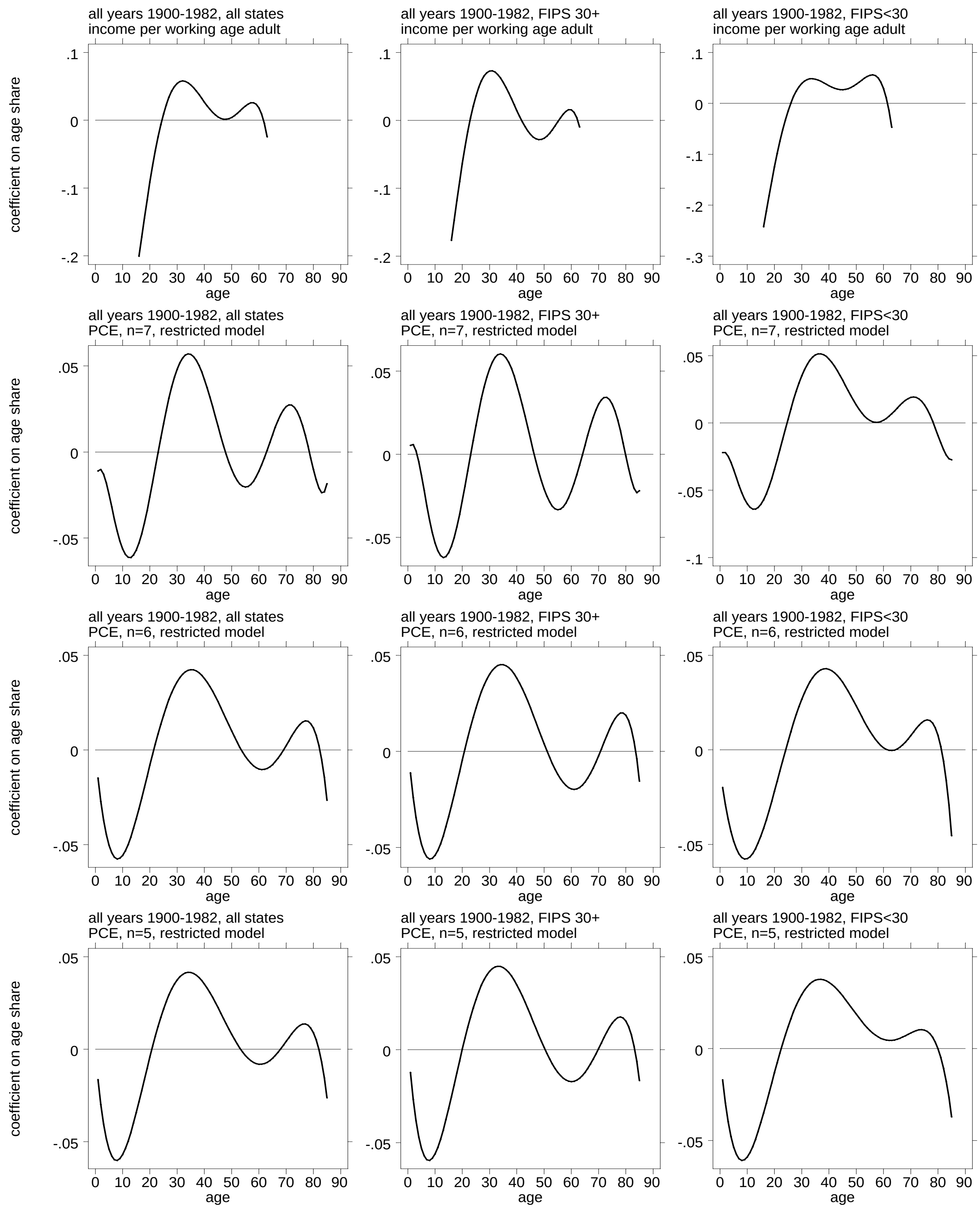

Figure 7: Estimated patterns of age share coefficients when income is treated as endogenous, for all states in all five years and for two subsets of states in all five years. Top panel: estimated effects on income per adult 16-64. Other panels: Estimated effects on per capita personal consumption expenditures, with n = 5, 6 and 7. Left column: all states; middle column: states with FIPS equal to 30 or higher; right column: states with FIPS less than 30. As in Table 4.

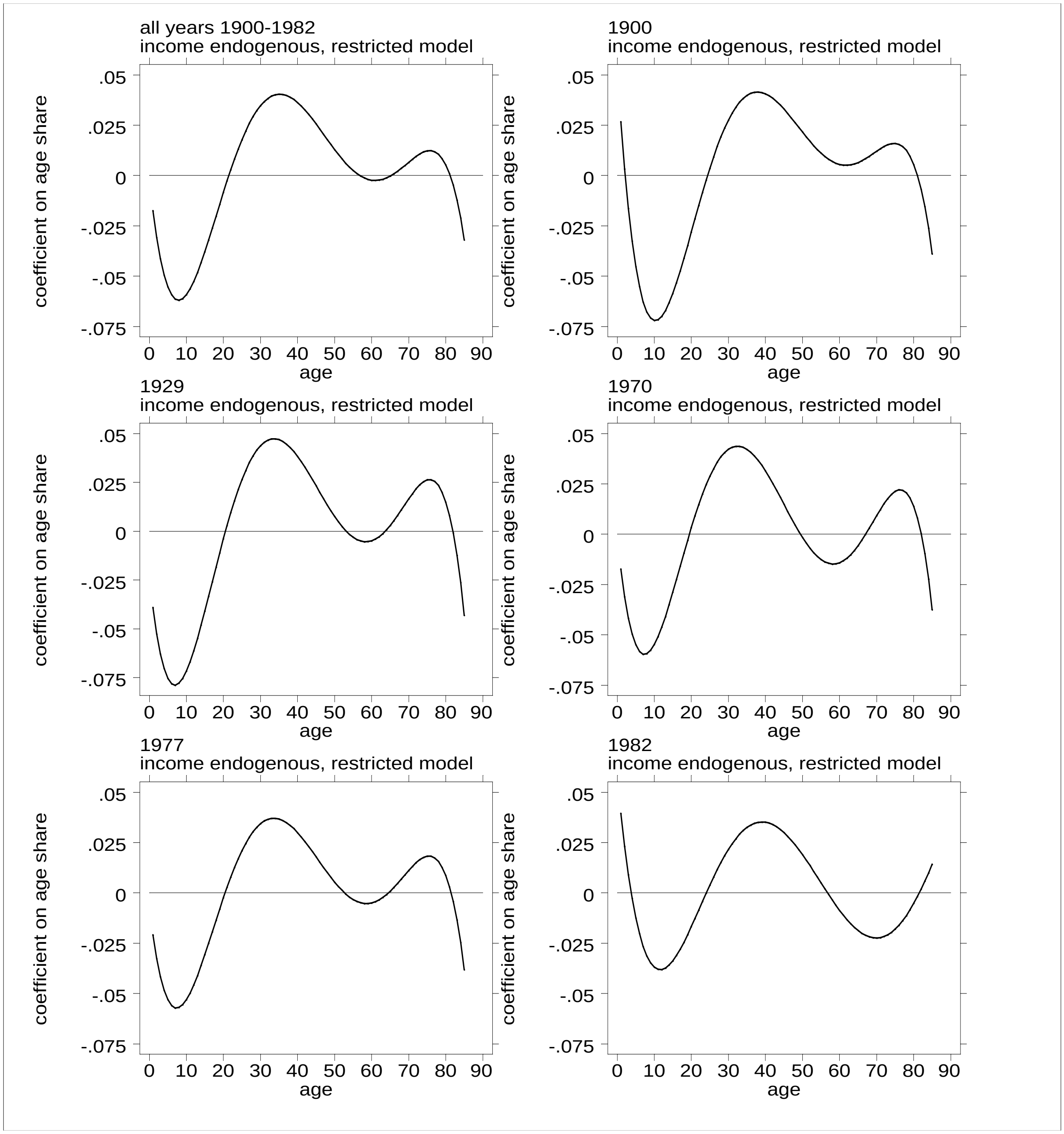

Figure 8: Estimated patterns of age share coefficients in the restricted model, when income is treated as endogenous, with n=5, using age adjusted income from column (1) of Table 3 in the main report. As in Table 5.

Both Table 4 and the following ones focus on the restricted model for per capita Personal Consumption Expenditures (that is, holding all φ_{1_j} in equation **(5)** equal to zero) because F-tests were found to reject the significance of interaction terms between the age shares and income—whether income is used in its original form or age adjusted.[2]

Table 4 presents results testing for the appropriate value of *n* (the degree of the age share coefficients' polynomial), and also testing the model with an out-of-sample-prediction by estimating it on two subsets of states (those with census ID numbers—FIPS—of less than 30 and 30+) and then testing for equality among the coefficients estimated in the full model and in the two subsets. F tests could not in any case reject the hypothesis of equality of coefficients on the age shares. Figure 7 demonstrates the stability of the estimated age share coefficients in the restricted model with income endogenous, both over subsets of the states and with differing values of *n*.

Table 5 and Figure 8 then present counterparts to Table 2 and Figure 5, with income treated as endogenous: estimates for all five years pooled, and then individually for each of the five years.[3] Again we can see in Table 5 that the equality of age share coefficients across years cannot be rejected—although Figure 8 suggests a possible shift in savings patterns in 1982, with the period of saving occurring in older rather than in middle ages, which would be consistent with the discussions in Attanasio (1998) and Weil (1994).

The most notable effects of treating income as endogenous are

- a marked stability in estimates of the effect of the age shares on the intercept term of the consumption function, with the same pattern estimated regardless of the value chosen for *n*; and in all subsets of the data, whether defined geographically or chronologically; and, in results available from the author, in both the restricted and unrestricted models; and

- a more pronounced effect of younger age groups, relative to that of older age groups, on the intercept term (larger positive values for those aged 20-45, and larger negative values for those under age 20).

A final test of the model is in differenced form: that is, examining the effect in each state of *changes* in the shares of each age group on *changes* in per capita expenditures, between 1900 and 1929, 1929 and 1970, 1970 and 1977, and 1977 and 1982 (with income again treated as endogenous). The results of this test are presented in Table 6 and Figure 9, which contain the table of regression results and the estimated patterns of age share effects. Table 6 is similar to Table 4 in that it examines the model with all 51 states in all five years first, and then looks at results with two geographical subsets of states. Results are presented for n=5 as well as for n=7. As with the undifferenced model, the unrestricted form was rejected because coefficients on the interaction terms between age shares and income were not significant in all subsets of the data (although they were

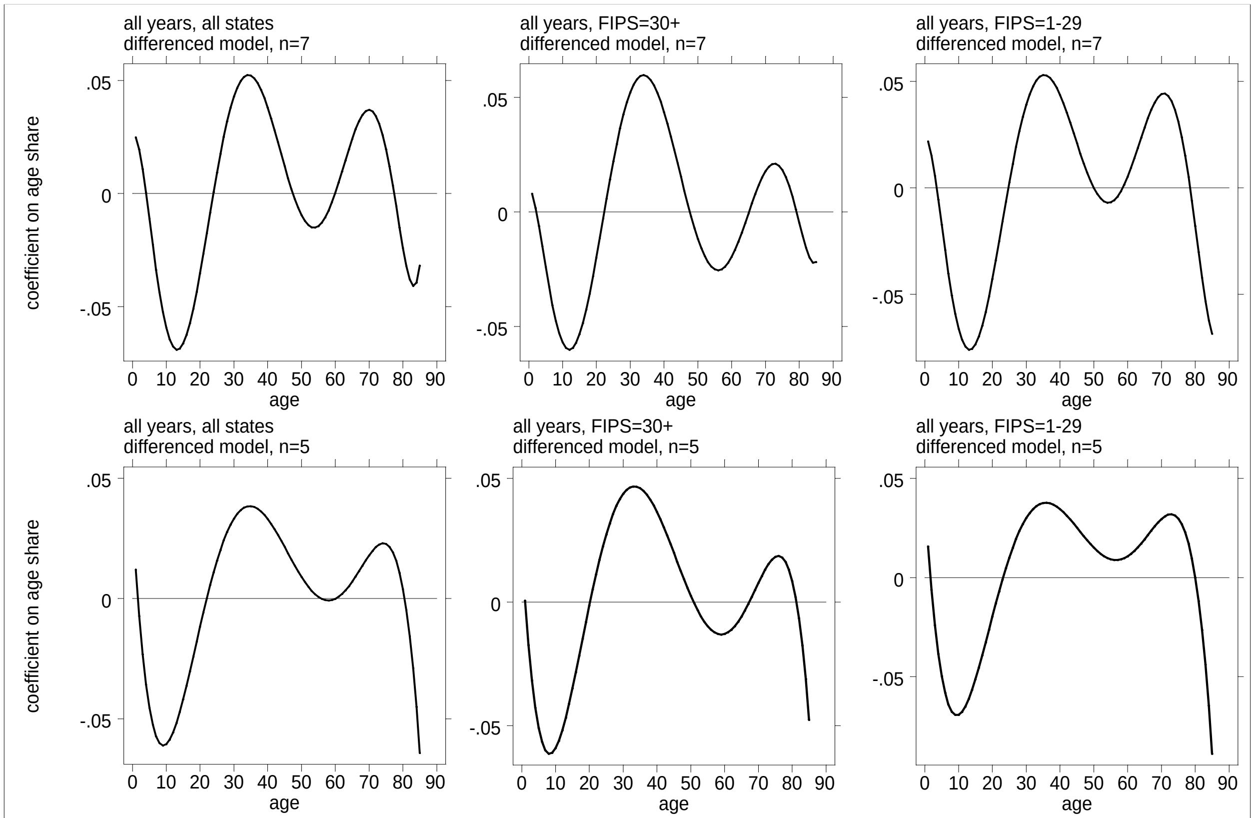

Figure 9: Estimated pattern of effects of changes in age shares on the change in per capita personal consumption expenditures, in the periods 1900-1929, 1929-1970, 1970-1977, 1977-1982. Top panel: using all states and then two subsets of states, with n=7. Bottom panel: using all states and then two subsets with n=5.

significant for the full model with all states and all years). The estimated patterns of effects of age shares on the intercept in Figure 9 are remarkably similar to those presented in Figures 7 and 8 for the undifferenced model with income treated as endogenous.

Appendix E contains several additional figures and tables illustrating the results of other tests of the model, including the use of different formulations of the income and expenditure variables (e.g., consumption per capita versus per adult, versus consumption as a share of income, and income per adult versus income per capita); sequential addition of variables, beginning with just the age shares; and fitting a simple model of per capita consumption with only four age groups, similar to those estimated by other researchers, but basing the age group definitions on patterns of coefficients estimated in the full model (and thus using age groups 5-9; 0-4 and 14-14; 25-29; and 65-69 as in Figure 3).

6. Specific Items of Expenditure: Food, Clothing, Housing, Medical and Transport

Figure 10 and Table 6 demonstrate the strong effects of age distribution in the population, on several sub-categories of expenditure (expressed as shares of total personal consumption expenditure)—again using Lebergott's state-level consumption data for 1900, 1929, 1970, 1977 and 1982, and using age adjusted income. Tests indicated that the simple restricted model was most appropriate in all cases for these subcategories, when the models were tested on subsets of the data as well as on the full data set.

In these models for sub-categories of expenditure, the year dummies have been replaced with a set of "price" variables: the real interest rate, the percent of the population living in urban areas, and the relative price of the commodity—expressed as the ratio of the price index of the good in question relative to the overall price index in that year. Once again, in all cases we see strong age

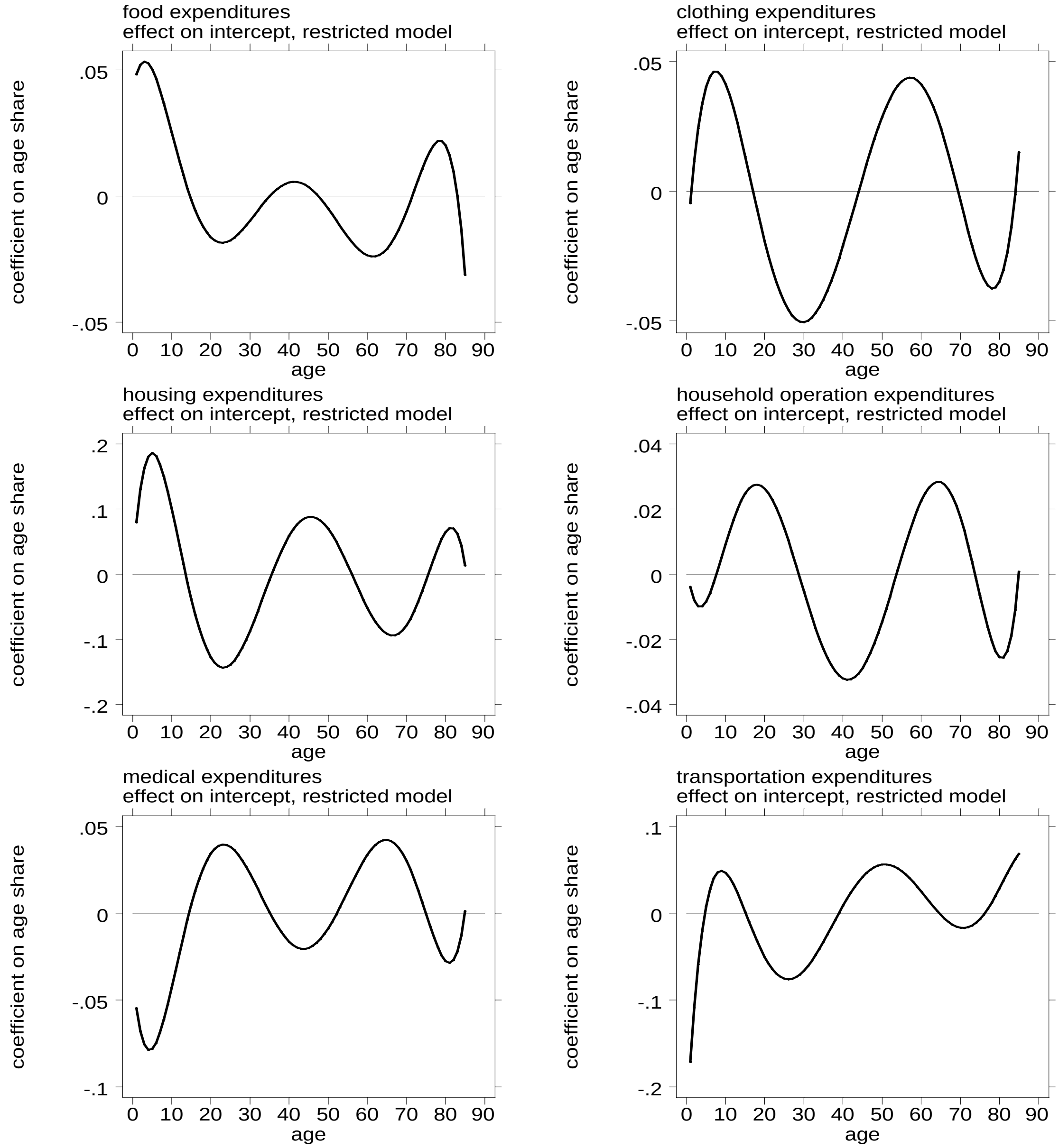

Figure 10: Estimated pattern of effects of age shares on subcategories of expenditure as a share of total Personal Consumption Expenditures -- as in Table 7.

effects on patterns of expenditure. Similar effects have been identified with other sub-categories of expenditure, but space prohibits a full presentation here. The models in which these effects are weakest—both substantially and in terms of statistical significance—are those for food and household operations.

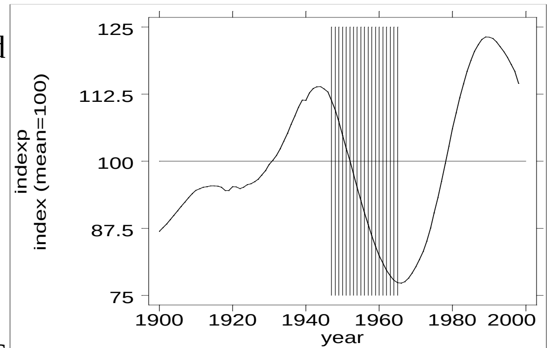

Figure 11: Index of simulated real per capita consumption expenditures in the U.S. as a function of age structure in the population—holding all other factors constant.

7. Simulations

But how *substantially* significant are the results which have been presented here? What is the magnitude of the effect which has been exerted by changing population age structure, on patterns of consumption and saving? We can gain some idea of this effect, by combining the coefficients estimated in the pooled model for 1900, 1929, 1970, 1977 and 1982 in column (3) of Table 4 with the observed age distribution in each year since 1900, to estimate annual per capita consumption levels in the U.S.—but holding age adjusted income and the percent foreign-born constant at their 1900-1998 mean levels.

The pattern of per capita consumption produced by the above procedure is presented in Figure 11, where it can be seen that changes in age structure—holding age-adjusted per capita income constant—would have induced swings of up to ±25 percent around the mean during this century. The “good times” of the 1950s and 1960s can be seen to correspond with a long sharp demographically-induced decline in per capita consumption levels (holding age adjusted income constant). One might surmise that this reduction in per capita consumption increased savings and lowered interest rates, which in turn would have brought about sustained increases in productivity.

This is consistent with the pattern of age adjusted income during this century as presented in Figure 12 (derived by combining the coefficients estimated in the pooled model for 1900, 1929, 1970, 1977 and 1982 in column (1) of Table 3 with the observed age distribution in each year since 1900—but holding constant the percent foreign-born and any year-specific effects). This age adjusted income in Figure 12 is the ratio of observed to predicted real income per working-age adult, controlling for changing age composition among adults, and it experienced its only sustained increase this century, during the same period—the 1950s and 1960s.

But in the 1970s and 1980s we experienced a pronounced demographically-induced *increase* in per capita consumption expenditures (holding age adjusted income constant)—which, given the decline in age adjusted real income experienced during that period as shown in Figure 12, is again consistent with the idea of demographically-induced productivity changes resulting from changes in rates of saving out of income.

The results of this simulation suggest that high birth rates as experienced in the United States in the 1950s and early 1960s do not impose a drag on economic growth in the short term: in fact, they appear to act as a spur to savings and productivity growth rates, with children perhaps providing an incentive for productivity enhancement along the lines identified in Boserup (1965) and discussed in Easterlin (1996), and even as far back as Malthus (1817). A slow-down in productivity growth then occurs when the baby boom reaches its young adult years—but consumption demand increases sharply at that point, so that overall economic growth continues although per capita income growth slows.

The primary harm which occurs in this second phase is experienced by the baby boomers themselves, who suffer a reduction in income relative to the prime-age population, as demonstrated in Macunovich (1999a). Given the rapid increase in per capita incomes experienced in their

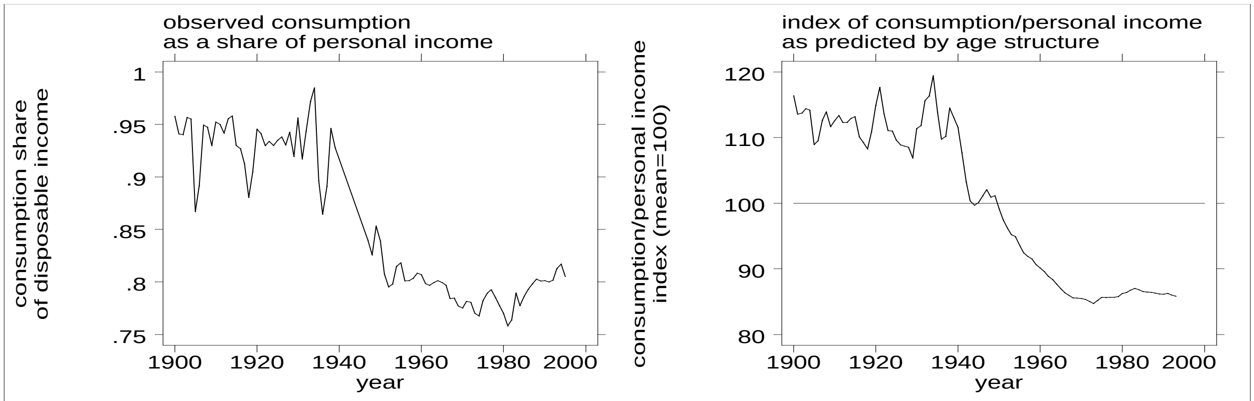

Figure 13: Consumption expenditures as a share of personal disposable income in the U.S.: simulated and actual, 1900-1998. Left panel: index of simulated values as a function of changing age structure in the population —holding all other factors constant. Right panel: observed, 1900-1939 and 1947-1998.

childhood, however, this can only be thought of as harmful in *relative* terms. As demonstrated in Macunovich (1998c,1998d), overall long term wage growth is *increased* given the effects of a baby boom, but the pattern of wage growth is "lumpy", accomplished through an initial acceleration followed by a deceleration This might be thought of as a self-regulating mechanism which prevents runaway population growth over the longer term, since the reduction in relative income in the second phase of growth induces the boomers to reduce their own fertility relative to that of their parents (Macunovich1996a, 1998d).

The effect described in Figure 11 can be better understood in terms of potential impact on savings, by converting the simulated levels of per capita consumption in that figure into consumption as a share of observed personal disposable income, which is presented in Figure 13 along with the actual pattern observed during this century (excluding 1940-1946).

It seems apparent from the similarities in Figure 13 that the annual pattern of consumption predicted on the basis of our model—which was fitted on state-level data for 1900,1929, 1970,1977 and 1982—is very similar to that actually experienced during this century in the United States as a whole. As a test of this observation, the actual patterns of consumption as a share of income in the

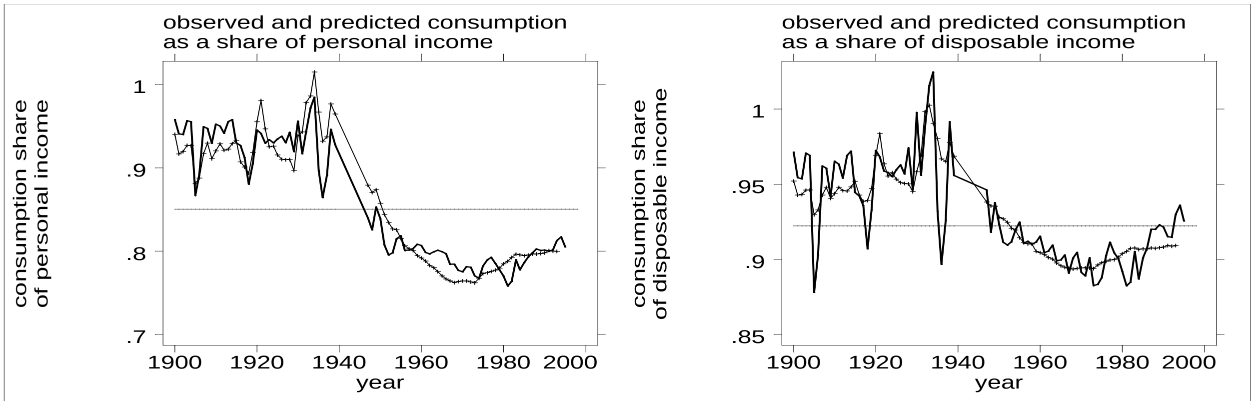

Figure 14: Observed and predicted levels of personal consumption expenditures as a share of income. Left panel: total personal income. Right panel: disposable personal income.

periods 1900-1939 and 1947-1994—both total personal and disposable—were regressed on the index presented in Figure 13. The results (with t-statistics in parentheses) are presented below:

PCE/personal income = -0.092 + 0.065***index** - 0.001* **time** (**ρ**=0.82) R^2 = 0.69, N = 86, DW = 1.89
(-1.0) (11.4) (3.2) (13.1)

PCE/disposable income = 0.06 + .019***index** +.001* **time** (**ρ**=0.34) R^2 = .56, N = 86, DW = 1.87
(0.5) (7.2) (3.0) (3.3)

Figure 14 compares observed with predicted values using these models and it can be seen that the model fits the patterns quite well. Given this fairly close fit, what impact does the model suggest that the baby boom will have as it ages further, during the first half of the next century? A projection of the future path of per capita personal consumption expenditures—holding real age-adjusted per capita income constant—based on the Census Bureau's medium population projection is presented in Figure 15.

If indeed the declines in this measure correspond with "good times", then we can expect a continuation of current healthy economic conditions through most of the first half of the next century. This projected pattern is probably misleading, however, since it assumes no feedback between economic conditions and fertility rates between now and 2050!

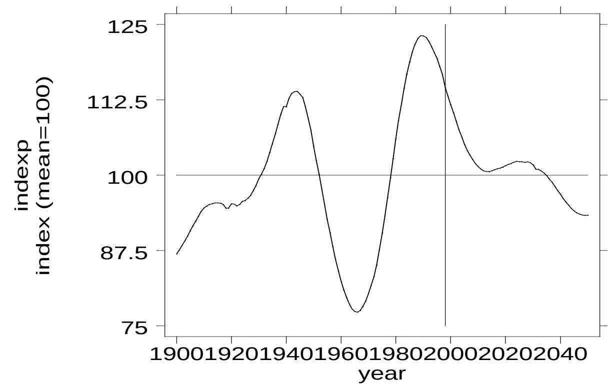

Figure 15: A projection through the year 2050 of demographically-induced changes in per capita consumption expenditures.

Endnotes

[*]The author gratefully acknowledges the help she has received from the people at the Maxwell School, financial assistance through an NIA Fellowship, and Richard Easterlin's inspiration and support.

1. Indeed, some of the researchers (e.g., Adams 1971; Bilsborrow 1980) who have challenged the results in Leff's (1969, 1971, 1980, 1984) widely-cited articles on dependency and savings rates, have pointed out that Leff's coefficient on the proportion of the population aged 0-14 loses its significance in the absence of a control for the share of population aged 65+.

2. It should be noted that F tests did not reject the significance of interaction terms in an unrestricted model using all 51 states in all five years, with n=7, but this significance disappeared in subsets of the data, suggesting that the unrestricted model had "over-fit" the data.

3. Table 5 presents results with n=5, while Table E-3 in Appendix E presents results with n=7.

	working-age adults only	*all adults aged 16+*
Z_1	**-.015**	**-.045**
	(-3.4)	*(-4.9)*
Z_2	**.001**	**.006**
	(4.6)	*(5.0)*
Z_3	**-.00004**	**-.0002**
	(-5.2)	*(-5.0)*
Z_4	**3.35e-07**	**4.42e-06**
	(5.6)	*(4.8)*
Z_5		**-4.00e-08**
		(-4.6)
Z_6		**1.38e-10**
		(5.3)
ln(income per adult)	**.640**	**.653**
	(17.9)	*(17.3)*
ln(% foreign-born)	**.061**	**.059**
	(9.1)	*(7.8)*
Year=1929?	**.050**	**.040**
	(2.3)	*(1.8)*
Year=1970?	**.402**	**.319**
	(6.0)	*(5.3)*
Year=1977?	**.352**	**.357**
	(5.2)	*(4.2)*
Year=1982?	**.200**	**.242**
	(3.1)	*(2.7)*
Intercept	**5.625**	**4.366**
	(2.5)	*(4.3)*
Number of obs	**249**	**249**
F Statistic	**2156.34**	**1257.41**
Prob > F	**0.0000**	**0.0000**

Notes: Dependent variable is ln(PCE per adult).
t-statistics in parentheses.
Estimated using STATA "robust regression" which first eliminates outliers and then iterates to identify appropriate weightings.

Table 1: Regression results using only the population of adults, all five years pooled — as in Figure 4.

Years included:	***All***	***1900***	***1929***	***1970***	***1977***	***1982***
Z_1	**-.015**	**-.025**	**-.011**	**-.015**	**-.013**	**-.012**
	(-6.9)	*(-3.5)*	*(-1.7)*	*(-2.3)*	*(-2.5)*	*(-2.8)*
Z_2	**.001**	**.002**	**.001**	**.002**	**.002**	**.001**
	(7.6)	*(3.3)*	*(2.4)*	*(3.4)*	*(4.4)*	*(3.1)*
Z_3	**-.00004**	**-.0001**	**-.00004**	**-.0001**	**-.0001**	**-.00003**
	(-7.7)	*(-3.0)*	*(-2.6)*	*(-4.1)*	*(-5.4)*	*(-2.6)*
Z_4	**5.75e-07**	**7.51e-07**	**5.81e-07**	**7.18e-07**	**7.98e-07**	**4.03e-07**
	(7.6)	*(2.9)*	*(2.6)*	*(4.6)*	*(5.8)*	*(2.3)*
Z_5	**-2.70e-09**	**-3.40e-09**	**-2.79e-09**	**-3.45e-09**	**-3.97e-09**	**-1.85e-09**
	(-7.5)	*(-2.8)*	*(-2.6)*	*(-4.9)*	*(-5.8)*	*(-2.0)*
ln(income per person)	**.683**	**.606**	**.654**	**.544**	**.795**	**.761**
	(16.1)	*(4.9)*	*(9.5)*	*(4.5)*	*(6.2)*	*(4.4)*
ln(% foreign-born)	**.034**	**-.017**	**.042**	**.051**	**.032**	**.032**
	(5.0)	*(-0.8)*	*(2.9)*	*(3.5)*	*(2.4)*	*(1.8)*
State=Oklahoma?		**.347**				
		(2.2)				
Year=1929?	**-.025**					
	(-1.1)					
Year=1970?	**.263**					
	(4.1)					
Year=1977?	**.227**					
	(3.7)					
Year=1982?	**-.074**					
	(-1.2)					
Intercept	**-1.849**	**- 7.217**	**5.844**	**2.599**	**1.664**	**-4.949**
	(-1.2)	*(-1.3)*	*(1.1)*	*(0.5)*	*(0.4)*	*(-1.1)*
Number of obs	**249**	**48**	**48**	**51**	**51**	**51**
F Statistic	**1569.58**	**171.49**	**603.72**	**85.86**	**53.24**	**50.85**
Adj R-square	*0.9858*	*0.9667*	*0.9890*	*0.9224*	*0.8797*	*0.8747*
Root MSE	**.05752**	**.06606**	**.04444**	**.03949**	**.04375**	**.05146**
F (joint test of Z's)	**16.97**	**3.61**	**7.11**	**8.21**	**8.67**	**2.58**
Prob > F	**0.0000**	**0.0135**	**0.0002**	**0.0001**	**0.0000**	**0.0506**
Prob > F (H_0: n_{n_t} ' $n_{n_{allyears}}$)						
Z_1		*0.1573*	*0.5779*	*0.9754*	*0.6880*	*0.5803*
Z_2		*0.2834*	*0.8410*	*0.6858*	*0.6374*	*0.3245*
Z_3		*0.4081*	*0.9625*	*0.4797*	*0.2438*	*0.3180*
Z_4		*0.5039*	*0.9783*	*0.3662*	*0.1154*	*0.3407*
Z_5		*0.5699*	*0.9367*	*0.2988*	*0.0716*	*0.3650*
ln(income per person)		*0.5393*	*0.6803*	*0.2558*	*0.3880*	*0.6505*
ln(% foreign-born)		*0.0208*	*0.5851*	*0.2482*	*0.8642*	*0.9209*

Notes: Dependent variable is ln(personal consumption expenditures per person)
All regressions run with STATA, using state populations as weights. Similar results obtained when using STATA "robust regression" technique (which first eliminates outliers and then iterates to identify appropriate weightings), and when using state total real income as weights. Results available from author.
t-statistics in parentheses

Table 2: Results for basic model using population-weighted regression, for all years pooled and individually — illustrated in Figure 5.

	All years pooled	1900	1929	1970	1977	1982
Z_1	**-.091**	**-.129**	**-.157**	**-.114**	**-.126**	**-.104**
	(-3.7)	*(-2.2)*	*(-2.2)*	*(-2.9)*	*(-2.8)*	*(-2.6)*
Z_2	**.009**	**.015**	**.016**	**.013**	**.014**	**.011**
	(3.5)	*(2.3)*	*(2.0)*	*(3.2)*	*(2.9)*	*(2.3)*
Z_3	**-.0003**	**-.001**	**-.001**	**-.001**	**-.001**	**-.0004**
	(-3.2)	*(-2.2)*	*(-1.7)*	*(-3.2)*	*(-3.1)*	*(-2.3)*
Z_4	**1.00e-05**	**1.00e-05**	**1.00e-05**	**1.00e-05**	**1.00e-05**	**1.00e-05**
	(3.0)	*(2.0)*	*(1.6)*	*(3.2)*	*(3.2)*	*(2.3)*
Z_5	**-2.96e-08**	**-4.78e-08**	**-5.27e-08**	**-5.40e-08**	**-6.45e-08**	**-4.28e-08**
	(-2.8)	*(-1.8)*	*(-1.4)*	*(-3.2)*	*(-3.3)*	*(-2.3)*
ln(% foreign-born)	**.101**	**.105**	**.155**	**.093**	**.065**	**.093**
	(12.2)	*(3.9)*	*(4.8)*	*(8.7)*	*(4.7)*	*(6.7)*
year=1929?	**.264**					
	(8.1)					
year=1970?	**1.544**					
	(34.2)					
year=1977?	**1.593**					
	(28.8)					
year=1982?	**1.506**					
	(25.1)					
Intercept	**19.337**	**40.360**	**11.956**	**20.014**	**4.347**	**-6.712**
	(4.7)	*(3.0)*	*(0.7)*	*(2.1)*	*(0.5)*	*(-0.5)*
Number of obs	**249**	**48**	**48**	**51**	**51**	**51**
F statistic	**1087.69**	**130.56**	**82.44**	**57.59**	**18.99**	**22.10**
Adj R-square	*0.9777*	*0.9430*	*0.9123*	*0.8716*	*0.6834*	*0.7169*
Root MSE	**.08951**	**.09573**	**.10441**	**.05018**	**.06145**	**.06195**
F(joint test of Z's)	**33.09**	**13.96**	**5.96**	**6.90**	**6.53**	**2.77**
Prob > F	*0.0000*	*0.0000*	*0.0007*	*0.0002*	*0.0003*	*0.0386*
Prob > F (H_0: n_{n_t} ' $n_{n_{allyears}}$)						
Z_1		*0.5094*	*0.3627*	*0.5593*	*0.4349*	*0.7452*
Z_2		*0.4031*	*0.4152*	*0.3761*	*0.3130*	*0.8154*
Z_3		*0.4188*	*0.4597*	*0.2627*	*0.1937*	*0.7006*
Z_4		*0.4528*	*0.5008*	*0.1932*	*0.1204*	*0.5786*
Z_5		*0.4892*	*0.5380*	*0.1500*	*0.0774*	*0.4745*
ln(% foreign-born)		*0.8726*	*0.1025*	*0.4412*	*0.0128*	*0.5865*

Notes: Dependent variable is ln(personal income per adult aged 16-64).t-statistics in parentheses.
The Z's have been calculated based not on total population shares but on the share of total adults aged 16-64 in each single year age group from 16-64.
Regressions estimated using STATA "robust regression" weighted by total population.

Table 3: Estimating age share effects on per capita personal income: results from regressing logged personal income per adult aged 16-64 on the age distribution of adults aged 16-64 -- illustrated in Figure 6.

States Included:	*All States*			*FIPS=30+*	*FIPS=1-29*
Z_1	**.009**	**-.016**	**-.018**	**-.02**	**-.017**
	(1.8)	*(-5.0)*	*(-7.9)*	*(-5.3)*	*(-6.2)*
Z_2	**-.003**	**.001**	**.002**	**.002**	**.002**
	(-3.8)	*(3.3)*	*(9.0)*	*(6.2)*	*(6.4)*
Z_3	**.0003**	**-.00004**	**-.0001**	**-.0001**	**-.00004**
	(4.9)	*(-1.7)*	*(-8.7)*	*(-6.3)*	*(-5.7)*
Z_4	**-1.00e-05**	**2.98e-07**	**6.58e-07**	**7.32e-07**	**5.52e-07**
	(-5.3)	(0.6)	(8.3)	(6.1)	(5.1)
Z_5	**1.87e-07**	**7.88e-10**	**-2.94e-09**	**-3.27e-09**	**-2.44e-09**
	(5.4)	*(0.2)*	*(-7.9)*	*(-5.9)*	*(-4.7)*
Z_6	**-1.60e-09**	**-1.44e-11**			
	(-5.4)	*(-0.8)*			
Z_7	**5.30e-12**				
	(5.2)				
age adjusted income	**.614**	**.549**	**.547**	**.638**	**.458**
	(16.1)	*(13.1)*	*(13.1)*	*(10.6)*	*(8.3)*
ln(p% foreign-born)	**.129**	**.123**	**.124**	**.129**	**.107**
	(21.8)	*(19.0)*	*(19.7)*	*(15.2)*	*(11.9)*
Year=1929?	**.227**	**.193**	**.195**	**.236**	**.155**
	(11.9)	*(9.4)*	*(9.6)*	*(8.2)*	*(5.3)*
Year=1970?	**1.353**	**1.266**	**1.265**	**1.263**	**1.231**
	(48.0)	*(45.0)*	*(45.2)*	*(28.4)*	*(33.0)*
Year=1977?	**1.3**	**1.26**	**1.242**	**1.244**	**1.214**
	(38.4)	(37.5)	(50.1)	(32.8)	(38.3)
Year=1982?	**1.104**	**1.104**	**1.093**	**1.063**	**1.101**
	(31.4)	*(30.6)*	*(32.0)*	*(21.1)*	*(24.8)*
Intercept	**12.543**	**9.548**	**9.534**	**8.412**	**9.935**
	(9.0)	*(6.3)*	*(6.3)*	*(3.5)*	*(5.5)*
Number of obs	**248**	**249**	**249**	**125**	**124**
F Statistic	**1478.99**	**1260.08**	**1377.34**	**660.52**	**855.33**
Prob > F	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

Prob > F:	**H_0:** $n_{n_{group}} = n_{n_{allstates}}$		**H_0:** $n_{n_{FIPS<30}} = n_{n_{FIPS\geq30}}$
Z1	*0.6657*	*0.6699*	*0.3095*
Z2	*0.5867*	*0.4302*	*0.1407*
Z3	*0.5470*	*0.3461*	*0.0994*
Z4	*0.5385*	*0.3287*	*0.0985*
Z5	*0.5503*	*0.3390*	*0.1143*
age adjusted income	*0.1355*	*0.1093*	*0.0015*
ln(% foreign-born)	*0.5391*	*0.0602*	*0.0147*
Year=1929?	*0.1592*	*0.1737*	*0.0069*
Year=1970?	*0.9552*	*0.3621*	*0.3984*
Year=1977?	*0.9633*	*0.3832*	*0.3540*
Year=1982?	*0.5485*	*0.8622*	*0.3939*

Notes: Dependent variable is ln(personal consumption expenditures per person). t-statistics in parentheses. Regressions estimated using STATA "robust regression" which eliminates gross outliers and then iterates to identify appropriate weightings.

Table 4: Estimates when income is treated as endogenous in regressions for all years pooled, first for all states with n=5, 6 and 7, and then for two subsets of states, with n=7. Illustrated in Figure 7.

Years included:	*All*	*1900*	*1929*	*1970*	*1977*	*1982*
Z_1	**-.018**	**-.03**	**-.019**	**-.019**	**-.016**	**-.02**
	(-8.0)	*(-4.1)*	*(-2.9)*	*(-2.6)*	*(-3.2)*	*(-4.5)*
Z_2	**.002**	**.002**	**.002**	**.002**	**.002**	**.001**
	(9.0)	*(4.0)*	*(3.9)*	*(3.7)*	*(4.5)*	*(3.6)*
Z_3	**-.0001**	**-.0001**	**-.0001**	**-.0001**	**-.00005**	**-.00003**
	(-8.5)	*(-3.5)*	*(-3.9)*	*(-4.1)*	*(-4.8)*	*(-2.5)*
Z_4	**6.27e-07**	**7.70e-07**	**8.06e-07**	**7.77e-07**	**6.44e-07**	**3.55e-07**
	(7.9)	*(3.1)*	*(3.7)*	*(4.3)*	*(4.7)*	*(1.8)*
Z_5	**-2.79e-09**	**-3.34e-09**	**-3.69e-09**	**-3.56e-09**	**-2.94e-09**	**-1.30e-09**
	(-7.3)	*(-2.8)*	*(-3.5)*	*(-4.3)*	*(-4.5)*	*(-1.3)*
age adjusted income	**.647**	**.704**	**.669**	**.404**	**.61**	**.454**
	(14.4)	*(5.9)*	*(9.5)*	*(2.4)*	*(5.8)*	*(3.1)*
ln(% foreign-born)	**.111**	**.057**	**.117**	**.114**	**.107**	**.106**
	(20.0)	*(3.7)*	*(10.5)*	*(12.4)*	*(9.9)*	*(7.9)*
Year=1929?	**.162**					
	(7.3)					
Year=1970?	**1.184**					
	(34.6)					
Year=1977?	**1.156**					
	(38.7)					
Year=1982?	**1.018**					
	(27.5)					
Intercept	**9.858**	**0.145**	**14.530**	**10.629**	**11.818**	**-1.086**
	(6.7)	*(0.0)*	*(2.8)*	*(1.8)*	*(2.3)*	*(-0.2)*
Number of obs	**249**	**48**	**48**	**51**	**51**	**51**
F Statistic	**1404.94**	**176.06**	**603.13**	**64.61**	**49.86**	**41.73**
Adj R-square	*0.9842*	*0.9631*	*0.9890*	*0.8990*	*0.8725*	*0.8508*
Root MSE	**.06075**	**.06957**	**.04446**	**.04503**	**.04506**	**.05615**
F (joint test of Z's)	**97.37**	**28.72**	**58.53**	**10.86**	**9.08**	**8.11**
Prob > F	***0.0000***	***0.0000***	***0.0000***	***0.0000***	***0.0000***	***0.0001***
Prob > F (H_0: n_{n_t} ' $n_{n_{allyears}}$)						
Z_1		*0.1114*	*0.8776*	*0.8996*	*0.7151*	*0.6196*
Z_2		*0.2767*	*0.5663*	*0.6800*	*0.8248*	*0.4734*
Z_3		*0.4512*	*0.4607*	*0.5158*	*0.9711*	*0.2529*
Z_4		*0.5705*	*0.4171*	*0.4118*	*0.9035*	*0.1824*
Z_5		*0.6469*	*0.3992*	*0.3538*	*0.8173*	*0.1470*
age adjusted income		*0.6395*	*0.7555*	*0.1593*	*0.7258*	*0.1959*
ln(% foreign-born)		*0.0011*	*0.6024*	*0.7137*	*0.7341*	*0.7013*

Notes: Dependent variable is ln(personal consumption expenditures per person)
All regressions run with STATA "robust regression" with state total population as weights.
t-statistics in parentheses

Table 5: As in Table 2 (pooled and single year regressions of PCE using the restricted model) but with income treated as endogenous, with n=5.(See Appendix E fpr a comparable table with n=7) As in Figure 8.

States Included:	All	FIPS=30+	FIPS=1-29	All	FIPS=30+	FIPS=1-29
$^{a}Z_1$	**.002**	**-.002**	**-.0002**	**-.025**	**-.024**	**-.028**
	(0.4)	*(-0.2)*	*(0.0)*	*(-9.9)*	*(-7.4)*	*(-7.1)*
$^{a}Z_2$	**-.003**	**-.002**	**-.003**	**.002**	**.002**	**.002**
	(-3.5)	*(-1.7)*	*(-1.8)*	*(10.0)*	*(7.8)*	*(6.9)*
$^{a}Z_3$	**.0003**	**.0002**	**.0003**	**-.0001**	**-.0001**	**-.0001**
	(5.2)	*(2.8)*	*(2.7)*	*(-9.2)*	*(-7.2)*	*(-6.3)*
$^{a}Z_4$	**-1.00e-05**	**-1.00e-05**	**-1.00e-05**	**8.18e-07**	**8.54e-07**	**8.85e-07**
	(-6.2)	*(-3.4)*	*(-3.1)*	*(8.5)*	*(6.6)*	*(5.8)*
$^{a}Z_5$	**2.05e-07**	**1.51e-07**	**1.82e-07**	**-3.72e-09**	**-3.87e-09**	**-4.05e-09**
	(6.7)	*(3.7)*	*(3.2)*	*(-7.9)*	*(-6.1)*	*(-5.5)*
$^{a}Z_6$	**-1.78e-09**	**-1.30e-09**	**-1.56e-09**			
	(-7.0)	*(-3.9)*	*(-3.2)*			
$^{a}Z_7$	**6.00e-12**	**4.30e-12**	**5.14e-12**			
	(7.1)	*(3.9)*	*(3.1)*			
age-adjusted ^{a}income	**.529**	**.686**	**.365**	**.458**	**.618**	**.286**
	(12.9)	*(14.1)*	*(5.1)*	*(9.9)*	*(10.9)*	*(3.7)*
^{a}ln(% foreign-born)	**.098**	**.13**	**.064**	**.107**	**.125**	**.097**
	(7.4)	*(8.2)*	*(2.7)*	*(7.0)*	*(6.9)*	*(3.7)*
Year=1970?	**.842**	**.788**	**.937**	**.859**	**.839**	**.938**
	(30.1)	*(23.4)*	*(20.2)*	*(26.9)*	*(21.9)*	*(18.4)*
Year=1977?	**-.311**	**-.411**	**-.258**	**-.271**	**-.351**	**-.26**
	(-7.7)	*(-8.4)*	*(-3.5)*	*(-7.5)*	*(-7.6)*	*(-4.6)*
Year=1982?	**-.473**	**-.579**	**-.431**	**-.414**	**-.483**	**-.379**
	(-14.0)	*(-12.9)*	*(-8.4)*	*(-11.5)*	*(-10.2)*	*(-7.0)*
Intercept	**.267**	**.355**	**.226**	**.252**	**.31**	**.217**
	(12.8)	*(14.1)*	*(6.3)*	*(10.9)*	*(10.8)*	*(5.9)*
Number of obs	198	100	98	197	99	98
F Statistic	395.77	275.73	172.04	356.57	245.37	167.34
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Test of Z's	74.36	55.97	27.62	66.77	48.62	34.67
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Prob > F (H_0: $n_{n_{group}}$ ' $n_{n_{allstates}}$)						
$^{a}Z_1$		*0.5932*	*0.8036*		*0.6613*	*0.4546*
$^{a}Z_2$		*0.3225*	*0.8156*		*0.9406*	*0.5677*
$^{a}Z_3$		*0.2535*	*0.7826*		*0.8017*	*0.6404*
$^{a}Z_4$		*0.2219*	*0.7474*		*0.7849*	*0.6599*
$^{a}Z_5$		*0.1810*	*0.6891*		*0.8161*	*0.6497*
$^{a}Z_6$		*0.1550*	*0.6512*			
age-adjusted ^{a}income		*0.0018*	*0.0243*		*0.0058*	*0.0265*
^{a}ln(% foreign-born)		*0.0463*	*0.1622*		*0.3276*	*0.7212*
Year=1970?		*0.1113*	*0.0439*		*0.5912*	*0.1264*
Year=1977?		*0.0440*	*0.4750*		*0.0881*	*0.8458*
Year=1982?		*0.0199*	*0.4138*		*0.1511*	*0.5175*

Notes: Dependent variable is the change in the ln(personal consumption expenditures per capita).
t-statistics in parentheses.
The change in personal income per adult aged 16-64 was treated as endogenous: only residuals were used, from a regression on the change in age shares among adults aged 16-64.
Regressions estimated using STATA "robust regression" which eliminates gross outliers and then iterates to identify appropriate weightings.

Table 6: Estimates using differenced data for the periods 1900-1929, 1929-1970, 1970-1977 and 1977-1982, for all states together and then separately for states with FIPS equal to 30 or higher, and states with FIPS equal to less than 30. Illustrated in Figure 9.

Dependent variable:	*food*	*clothing*	*housing*	*household operations*	*medical*	*transport*
Z_1	**.009**	**.022**	**.083**	**-.009**	**-.023**	**.086**
	(2.8)	*(9.1)*	*(12.1)*	*(-1.8)*	*(-4.6)*	*(13.5)*
Z_2	**-.002**	**-.002**	**-.012**	**.002**	**.004**	**-.008**
	(-4.2)	*(-14.0)*	*(-13.0)*	*(2.7)*	*(5.7)*	*(-9.9)*
Z_3	**.0001**	**.0001**	**.001**	**-.0001**	**-.0002**	**.0003**
	(4.2)	*(15.4)*	*(11.5)*	*(-2.9)*	*(-5.3)*	*(7.3)*
Z_4	**-2.31e-06**	**-9.74e-07**	**-1.00e-05**	**2.43e-06**	**4.23e-06**	**-1.00e-05**
	(-4.1)	*(-15.2)*	*(-10.3)*	*(2.9)*	*(4.9)*	*(-5.7)*
Z_5	**2.49e-08**	**4.51e-09**	**1.28e-07**	**-2.65e-08**	**-4.34e-08**	**5.76e-08**
	(4.0)	*(14.4)*	*(9.5)*	*(-2.9)*	*(-4.7)*	*(4.7)*
Z_6	**-1.00e-10**		**-4.83e-10**	**1.06e-10**	**1.67e-10**	**-1.97e-10**
	(-3.9)		*(-8.8)*	*(2.9)*	*(4.4)*	*(-4.0)*
age adjusted income	**-.263**	**-.121**	**.096**	**-.069**	**.219**	**-.29**
	(-4.8)	*(-1.8)*	*(0.7)*	*(-0.8)*	*(2.3)*	*(-2.3)*
ln(% foreign-born)	**.013**	**-.022**	**.087**	**-.017**	**-.05**	**-.109**
	(1.5)	*(-2.3)*	*(4.1)*	*(-1.2)*	*(-3.5)*	*(-5.8)*
ln(% urban)	**-.161**	**-.405**	**35.129**	**.969**	**-1.606**	**20.244**
	(-7.6)	*(-0.8)*	*(27.7)*	*(1.2)*	*(-1.9)*	*(17.6)*
relative price	**-.239**	**-.459**	**1.31**	**.016**	**1.344**	**.663**
	(-6.1)	*(-13.5)*	*(11.9)*	*(0.3)*	*(15.5)*	*(7.1)*
real interest rate	**-1.849**	**.165**	**.341**	**.105**	**-.092**	**.274**
	(-3.5)	*(6.1)*	*(6.3)*	*(3.0)*	*(-2.6)*	*(5.8)*
Intercept	**-7.925**	**2.638**	**-41.811**	**-4.074**	**5.895**	**24.686**
	(-4.2)	*(1.2)*	*(-9.0)*	*(-1.3)*	*(1.9)*	*(6.0)*
Number of obs	**246**	**247**	**247**	**247**	**247**	**247**
F-statistic	**223.96**	**137.53**	**282.65**	**6.40**	**340.80**	**217.19**
Prob > F	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**	**0.0000**

Notes: Dependent variables are specified at the top of each column, and were expressed as logged shares of total Personal Consumption Expenditures. t-statistics in parentheses.
Regressions were estimated using STATA "robust regression" which eliminates gross outliers and then iterates to identify appropriate weightings.
Personal income per adult aged 16-64 was treated as endogenous: only residuals were used, from a regression on age shares among adults aged 16-64.
Relative price is the price index of the specified commodity relative to the overall consumer price index in each year.

Table 7: Regression results for subcategories of expenditure as a share of total Personal Consumption Expenditures -- illustrated in Figure 10.

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APPENDIX

Appendices to:
The Baby Boom as It Ages:
How Has It Affected Patterns of Consumption and Saving in The U.S.?

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APPENDIX A: DETAILED LITERATURE REVIEW

The expectation of age-related patterns of consumption and saving in aggregate data arise from the observation of such patterns in micro data. Presented here is a somewhat cursory review of literature dealing with the life cycle and permanent income hypotheses, and demographic factors other than age in micro data, followed by a more detailed discussion of studies dealing specifically with age of children -- and then a discussion of analyses of age patterns in aggregate data.

A.1 Analyses of Micro Data

Economists have long been aware of an apparently age-related empirical phenomenon in patterns of consumption and saving at the micro level, although the ”true” model explaining this micro relationship has proved somewhat elusive. The life-cycle (Modigliani, 1949, 1954, 1960, 1986) and permanent income (Friedman, 1957) hypotheses (LCH and PIH, respectively) are the most widely accepted explanations for this age-related pattern, but they have been questioned on a number of grounds. Most importantly, although these models predict a relatively flat lifetime consumption profile, the observed profile tends to be somewhat “hump-shaped” ― paralleling to some extent the lifetime income profile.

Some researchers such as Watts (1958), Forsyth (1960), David (1962), Tobin (1967), Houthakker and Taylor (1970), Schmitz (1979) and Ketkar and Cho (1982) suggested changes in family size which tend to be age-correlated, as an explanation for the age-humping, with other explanations ranging from health-related restrictions on consumption at older ages (Börsch-Supan and Stahl, 1991) to myopia (Carroll and Summers, 1991), buffering in the face of uncertainty (Nagatani, 1972; Deaton, 1992), the substitution of goods for leisure with rising wages (Ghez and Becker, 1975; Heckman, 1974), and liquidity constraints which make it necessary to analyze separately the typical consumer and the typical saver (Carroll and Summers, 1991). In addition, other models have been suggested which are alternatives to the LCH and PIH, such as the habit persistence model put forward by Brown (1952) and the relative income hypothesis of Duesenberry (1949).

Still others have suggested additional factors as age-correlates or complements to explain the age-humping and the secular decline in savings observed during the 1980s, such as wives’ labor force participation (Strober, 1977; Vickery, 1979; Schmitz, 1979; Ketkar and Cho, 1982; Jacobs et al., 1989; Soberon-Ferrer and Dardis, 1991), retirement status (Rubin and Nieswiadomy, 1997), and Social Security (Gultekin and Logue, 1979; Wilcox, 1989).

Pollak and Wales (1981) suggest and test various theoretically plausible methods of incorporating such demographic heterogeneity in complete demand systems, and then test the methods using British micro data with number of children in the family (1, 2 and 3+) as the demographic variable. They find that family size significantly affects consumption patterns. These tests are carried further by Barnes and Gillingham (1984), who successively test the significance of tenure, family type and then number of children using U.S. Consumer Expenditure Survey (CES) data for 1972-73. They, too, find that demographic variables play a significant role, and suggest that the unpooled specification (in which all parameters are allowed to vary by demographic group) is the superior method of estimation.

Although it has been most common in micro level analyses to focus on number of children without regard to their age distribution, a few researchers have examined the effects of children by age group. Schmitz (1979), for example, formulated a variable using the number of children in a household under eighteen multiplied by the average age of those children, and found that the variable has a large but statistically insignificant effect on consumption. Deaton et al. (1989) incorporated the numbers of persons in a household within each of seven different age groups (0-4, 5-8, 9-13, 14-17, 18-23, 24-60 and >60), and found significant effects of changes in the age composition of households both on total per capita expenditures and on individual sub-categories of expenditure. They estimated that an additional baby is equivalent to 21 percent of an adult, an additional 5-8-year-old 22 percent of an adult, and an additional 9-13-year-old 31 percent of an adult.

Attanasio (1994) found significant negative effects of children by age group on the ratio of savings to consumption, with the measured negative effect increasing significantly from infants through children aged 3-15 to children aged 16-17. He found savings depleted 2 to 6 times as much by children aged 16-17 as by infants. Similarly, Friedman (1957) Muellbauer (1977) and Barton (1964) have attempted to develop household equivalence scales incorporating the effects of size and age composition of household members on costs and expenditures.[1]

Perhaps the most detailed analyses of the effect of changing age distributions of children, however, have been conducted in recent years by Lazear and Michael (1988) and Lino (1998). Lino estimated, on average, an increase of about 15% in parents' expenditure as a share of income, as children age from 0-2 to 15-17, as shown in Table A-1.

	Before-tax income, husband-wife families			Single parent families	
	< $35,500	$35,500-59,700	> $59,700	< $35,500	$35,500+
Age of child					
0-2	5,820	8,060	11,990	4,900	11,210
3-5	5,920	8,270	12,230	5,510	12,030
6-8	6,070	8,350	12,180	6,230	12,800
9-11	6,090	8,320	12,090	5,820	12,380
12-14	6,880	9,050	12,930	6,270	13,120
15-17	6,790	9,170	13,260	6,970	13,580

Table A-1: Estimated expenditures per child by age group in 1997, by type of family and income. (*Source: Lino,1998, pp.15 and 21)*

Lazear and Michael demonstrated both that patterns of expenditure shift radically depending on the age of the child (more on clothing and food and less on housing or transportation, for example) -- and also that parents *increase their total consumption as a proportion of income*, as their children age. The amounts can be substantial as indicated in Tables A-2 and A-3, taken from their book.

These two tables require and merit close attention. The first seven rows in Panel A of Table A-2 present what Lazear and Michael call the "partial effect" of an only child as s/he ages; that is, the redistribution of expenditure which occurs as the child ages *relative to expenditure when the child was 0-5,* but holding total expenditure constant. Thus, for example, even if I were not allowed to spend any more in total when my child was aged 15-17, relative to total spending when s/he was 0-5, I would still shift my

[1]It should be noted, however, that in a comment on Friedman's paper "A Method of Comparing Incomes of Families Differing in Composition" which appeared in that volume, Jean Mann Due presented an analysis of Portland families in 1945 which did not appear to show any effect of changing age composition among children (pp.21-24).

Expenditure Item	Male	Employment: Part time	Employment: Full time	Age: 6-11	Age: 12-17	Age: 18-24	Age: 25+
Panel A: Partial Effect (Rows 1-7 hold consumption and income constant, and row 8 holds income constant)							
Redistribution of expenditure, holding Total Consumption constant:							
1. Food	$ 95	$ -104	$ - 20	$ 577	$ 567	$ 291	$ 338
2. Housing	10	- 53	-178	-232	-401	-269	-331
3. Clothing	- 44	- 44	- 12	- 24	49	- 4	- 50
4. Nondurables	53	62	100	105	52	36	- 21
5. Durables	- 53	39	289	-165	- 32	-136	46
6. Transportation	30	21	51	- 39	- 23	125	51
7. Services	- 91	78	-231	-222	-211	- 42	- 34
8. Change in Total Consumption, for a given change in this characteristic:	$ 82	$ 979	$ 882	$ 558	$ 484	$ 1505	$ - 96
Panel B: Total Effect (Sum in each column adds to figure in row 8.)							
Food	$ 122*	$ 43	$ 112	$ 660	$ 639	$ 516	$ 324
Housing	38	98	- 42	- 146	-326	- 37	-346
Clothing	- 32	24	50	15	82	101	- 56
Nondurables	63	114	147	135	77	115	- 26
Durables	5	352	571	13	123	345	15
Transportation	39	71	96	- 11	1	200	47
Services	- 53	278	- 52	- 108	-112	265	- 53

Table A-2: The Relation of Family Spending Patterns to Child's Characteristics: Husband-Wife Families with *One* Child *(Source: Table is adapted from Table 3.2 in Lazear and Michael (1988).*

Expenditure Item	Male	Employment: Part time	Employment: Full time	Age: 6-11	Age: 12-17	Age: 18-24	Age: 25+
Panel A: Partial Effect -- Older Child (Rows 1-7 hold consumption and income constant, and row 8 holds income constant)							
Redistribution of expenditure, holding Total Consumption constant:							
1. Food	$ 81	$ -181	$ -179	$ 382	$ 405	$ 363	$ 567
2. Housing	- 51	4	-286	-339	-501	- 441	-374
3. Clothing	- 60	- 29	43	- 18	66	- 11	-100
4. Nondurables	18	27	- 9	89	59	127	-123
5. Durables	78	110	591	-164	19	- 67	-318
6. Transportation	28	- 9	36	68	67	179	95
7. Services	- 94	79	-195	- 19	-115	-150	7
8. Change in Total Consumption, for a given change in this characteristic:	$ 53	$ 871	$ -224	$ 630	$ 1044	$1505	$2597
Panel B: Partial Effect -- Younger Child (Rows 1-7 hold consumption and income constant, and row 8 holds income constant)							
Redistribution of expenditure, holding Total Consumption constant:							
1. Food	$ 29	$ -109	$ -207	$ 179	$ 238	$- 45	$ 990
2. Housing	1	- 39	-184	1	- 68	163	217
3. Clothing	- 42	4	- 48	44	102	49	-115
4. Nondurables	5	13	227	- 19	- 55	14	27
5. Durables	112	- 36	502	-162	-263	-474	-1483
6. Transportation	2	68	58	- 35	1	71	- 19
7. Services	- 107	100	-348	- 8	45	222	383
8. Change in Total Consumption, for a given change in this characteristic:	$ 5	$ 876	$1225	$ 621	$ 9	$2053	$ - 45

Table A-3: The Relation of Family Spending Patterns to Child's Characteristics: Husband-Wife Families with *Two* Children *(Source: Table is adapted from Table 3.3 in Lazear and Michael (1988).*

patterns of expenditure, taking $401 away from housing, spending an additional $567 on food (as any parent of a teenager knows!), and so on. (For those who wish to assess these changes in current dollars, multiplying by a factor of four gives a rough translation from 1972 to 1997 dollars.)

The bottom row in Panel A of Table A-2, however, indicates the change in total consumption expenditure which will also occur as the child ages, given an unchanged level of family income. My 15-17 year old, for example, will induce me to spend an additional $484 (about $1,950 in 1997 dollars, or close to 5% of my total consumption expenditures on average) more than I did when s/he was under 6, even with no increase in my total income -- and I will distribute this new expenditure as indicated in Panel B of Table A-2, with once again the largest share ($639 in 1972/3 dollars) going to food. The impact of an 18-24 year old is more than three times as large, inducing me to spend close to 15% more out of the same income than I otherwise would have.

Table A-3 presents the same type of information, but now for a two-child family since expenditure patterns on first and second children can vary considerably. Panels A and B in this table both present only "partial effects" -- redistributional effects holding total expenditure constant -- but once again the last row in each Panel indicates the change in total expenditure which would be induced by a child of that age, even with no increase in family income.

A.2 Analyses Using Aggregate Data

The significance of compositional effects -- including those caused by changing age structure -- on aggregate demand was stressed by Abramovitz (1961), and early age structure effects were demonstrated by Hall (1963) using Australian data from 1861-1961 and by Kelley (1968) using Australian data from 1861-1911, and (1969) cross-national data for fourteen countries including the U.S. both nationally and sectionally in the period from 1846 to 1920. A number of more recent analyses using macro level data have also demonstrated strong effects of age composition. The motivation of researchers in these analyses derives from the fairly conclusive evidence at the micro level, as set out in the previous section, and is expressed well by Schmitz, (1979:359):

“If the consumption and saving of individual families are significantly affected by their size, age, and labor force participation and by changes in relative prices over their lifetimes then measured aggregate consumption and saving functions may drift over time if they ignore changes in characteristics of the population”.

Heien (1972), focusing just on adults aged 24+, found significant effects of his age-distribution parameters on current consumption as a proportion of lifetime income using annual U.S. data for the period 1948-1965.

McMillan and Baesel (1990) used quarterly U.S. data from 1949-1986 to estimate models of real interest rates, income, inflation and unemployment. Their model featured three demographic variables, one representing the ratio of adult savers to borrowers (age 35-64/age 15-34, 65+) another the adult population growth rate (age 16+) and the third the total population growth rate: they found the savers to borrowers ratio significant in all equations.

Fair and Dominguez (1991) also used quarterly U.S. data, for the period 1954-1988, to estimate the effect at the macro level of age structure variables in equations for per capita consumption (services, nondurables and durables), housing investment, money demand and labor force participation. They focused just on age structure changes among adults aged 16+, and used an Almon-lag technique to estimate coefficients for population by single year of age 16-69 and 70+, all of which were significant[2] and conformed to expected patterns based on life cycle models of expenditure and saving.

Also focusing on adults, Lindh and Malmberg (1998) used data for twenty OECD countries between 1960-1994 to test the effect of age structure on inflation rates, under the assumption that differential rates of savings by age group would differentially affect inflation. The age groups they used were 15-29, 30-49, 50-64, 65-74 and 75+. They consistently found significant (positive) effects of young retirees (65-74) and significant negative effects of those aged 30-49 and older retirees, in pooled time series cross section specifications both with and without controls for country and year fixed effects. Signs and significance levels of the other age groups varied depending on the specification used: in the absence of year dummies there was a significant positive effect of young adults (15-29) and a negative effect of those aged 50-64. The effects of changing age structure were shown to be substantially significant, with inflation rates increased by two percentage points in the 1960s and early 1970s, and then reduced by three percentage points in the 1990s.

On the other hand Malmberg (1994) included an age breakdown for the entire population in his analysis of Swedish data from 1950-1989, using eight age groups: <20, 20-24, 25-29, 30-39, 40-49, 50-64, 65-74 and 75+. He found very strong effects of his age structure variables on GDP growth rates, savings rates and per capita income growth. It should be noted, however, that he treated all individuals under age 20 as homogeneous.

With annual Japanese data for the period 1955-1993, Horioka (1997) found statistically significant age structure effects on the savings rate, using two age structure variables: the ratio of minors (aged <20) and the ratio of elderly (aged 65+) to the working-age population.

Stoker(1986) presented a convincing demonstration of the effect of distributional measures when he tested for effects of changing income dispersion on average family expenditure using aggregate U.S. data from 1951-1978. He showed that “the inclusion of the four proportion variables (and a constant) in each equation suffices to account for virtually all of the simple (first-order) autocorrelation. . .(p.786)” He emphasized the need to control for distributional effects in modeling aggregate consumption: “When nonlinearities or other effects of individual heterogeneity are known to exist at the individual level, macroeconomic equations must be subject to distributional effects. . .Failure to find statistically significant distributional effects in such a situation means that the macroeconomic data display too little variation to identify effects, not that they are absent. (P.789)”

And finally, Blomquist and Wijkander (1994) conducted simulations for Sweden in the postwar period which demonstrated “that demographic changes of the baby boom type experienced in many countries can give rise to changes in [labor productivity, real wage rates, the rate of interest and the household savings ratio] of the form actually observed. (p.46)”

[2] However, the age structure variables lost their significance in the durable goods specifications which included lags and leads. In addition, their estimated coefficients in an equation for personal savings, while significant, were of the “wrong” signs — a result which they thought might reflect inadequate controls for cyclical fluctuations. Once again, however, their model specification included lagged values of the dependent variable. These result will be addressed in the next section.

A.3 Applying Micro Level Results at the Aggregate Level

There have been two fairly recent studies which were successful in applying at the macro level, age-related demand elasticities estimated using micro data. In 1989 Mankiw and Weil published their analysis of the U.S. housing market, predicting a decline of 47% in house prices by 2007, based on age structure effects estimated at the micro level using 1970 and 1980 cross-sectional data. Their results stimulated a host of responses, such as Hendershott (1991), who did not question that there was a relationship with age structure, but suggested that the parameters in Mankiw-Weil's model really fit only the 1960s and 1970s data -- that a more realistic projection was a decline of ten to fifteen percent. In a later study, Bergantino (1997) found significant effects of age-related elasticities estimated using 1992 and 1995 Survey of Consumer Finance data, when applied in macro level equations for housing demand and stock prices in the U.S. postwar period.

Similarly, estimates of savings rates made using parameters from micro data, such as Auerbach and Kotlikoff (1989) and Auerbach et al. (1990), have identified significant fluctuations over the next several decades as a result of shifts in the age structure. They conclude, however, that the decline of the savings rate in the 1980s cannot be explained by age composition. This conclusion might be questioned, however, in light of Weil's (1994) findings on intergenerational effects not captured by coefficients estimated using micro level data, as discussed in section 1 of the main paper.

Despite the fairly convincing evidence of age-related patterns of expenditures, outlined thus far in this and previous sections, researchers have often found that the patterns seem to disappear when taken up to the aggregate level. This was the case for Lieberman and Wachtel (1979), who used micro data to estimate savings rates in households with heads of different ages, and then applied these rates to observed age distributions over time at the macro level. They estimated a significant effect of changes in the distribution of ages of household head on patterns of savings (an estimated decline of 3% in the 1950s, 8% in the 1960s and 5% in the 1970s), but suggested that in the aggregate this effect would be almost totally offset by age-related changes in income distribution. "Relatively rapid growth in the number of households in some age groups seems to reduce their income relative to the incomes of slow-moving groups, and this has tended to mitigate the age effect on the aggregate level of saving" (p.350). A similar result was found by Kennickell (1990), using parameters estimated in the 1983-86 Consumer Expenditure Survey.

This result might once again reflect the absence of controls for *cross-household effects* on expenditures when micro level estimates are taken up to the macro level, as discussed by Weil (1994). Such effects can offset the patterns of expenditure estimated in isolation for single households by age of head. (As, for example, when more affluent members of smaller cohorts increase their expenditures during their prime age in order to help out struggling adult children in larger cohorts, who already head their own households. This inter-cohort expenditure pattern would produce lower savings rates for the prime aged adults, than expected simply on the basis of their own age.)

In addition, Lazear and Michael (1988) demonstrated that it is important to focus on *appropriate demographic groupings* when looking for patterns in the aggregate data. Table A-4 below, taken from their book, presents some of the results of their analyses of expenditure patterns of husband-wife families by presence and number of children -- results which are, effectively, averaged over age groups -- and they make the following comments with regard to it:

> ". . .one notes very few interesting differences in their demographic descriptions. The

> income and expenditure levels do rise somewhat with family size, although the average proportion of before-tax income spent on total consumption remains relatively stable: 68 percent, 76 percent, 69 percent, and 70 percent, respectively. Likewise the spending pattern, as reflected in the proportion of total consumption spent on each of seven major components, changes very little on average from families of one size to families of another size. 1988:27)"

This is certainly true: the stability of proportions spent on various categories of consumption across these family sizes is truly remarkable. Even their average income levels vary only minimally. (Note that these figures from their study were based on the 1972-73 *Consumer Expenditure Survey* and are thus expressed in 1972/3 dollars.) But Lazear and Michael then go on to observe:

> "The variation *within a family size* dominates between-group differences. For example, the variation in the proportion spent on food between groups is about 5 percentage points while the variation within a group is 8 or 9 percentage points (1988:25, italics added)."

That is, the spending patterns of families when aggregated like this across age groups show little variation among families by size -- but the differences *by age group within each family size*, and especially by age of child, can be much more substantial. A family with a teenager will tend to spend more, and on different items, than the family of a new-born, even holding family income constant.

Another source of problems in taking micro level estimates to the macro level, was suggested by Slesnick (1992). He demonstrated the sensitivity of estimates of the time path of savings rates in the U.S., to choice of data: ". . .the NIPA [National Income and Product Accounts] personal savings rate peaks at 19.5% in 1973 and subsequently decreases by about one-third over the remainder of the sample period. The average saving rate computed using the CEX [Consumer Expenditure] surveys increases through 1973, falls until 1980 and then increases [by approximately one-third between 1981 and 1987]. The reversal in downward trend runs counter to the stylized facts as they are usually presented. (P.596)"

A.4 Inconclusive Results Using Time Series Analyses
One significant set of failures was already alluded to in footnote 2: Fair and Dominguez' (1991) failure to obtain significant age coefficient estimates in the presence of lags and leads, in their durable goods model — and the estimation of age group coefficients with the "wrong" sign in their savings rate model, again in the presence of a lagged dependent variable.

Espenshade (1978) examined the effect of changing age composition among dependents, using alternative measures including the proportion of the population under 5, under 10, under 15, and 65+. He found statistically significant effects of age structure on aggregate expenditures in the U.S. between 1929-1970, excluding 1942-45. However, when he ran simulations he found a "tendency for the direct and indirect effects of population change to offset one another. A trend toward zero population growth. . .means a relative rise in the levels of living, and the goods and services which an older society would acquire relatively more of are largely those of which a wealthier society would purchase relatively less, and vice versa. (P.158)" His study, however, was concerned more with the *distribution* of total expenditures, and the effect of an ageing population, rather than with the effect of fluctuations in age structure on expenditure as a share of income. And here again, Espenshade's model included a lagged value of the dependent variable.

Another occurred when Blinder (1975) tested for the effect of changes in the distribution of income at

Characteristic	Husband-Wife Families of Size*: 2	3	4	5
Panel A: Demographic Characteristics				
EDUC: Husband	11.9 years	12.1 years	12.6 years	12.4 years
Wife	12.0	12.2	12.3	12.1
AGE: Husband	46.4 years	40.5 years	38.3 years	39.4 years
Wife	44.4	37.9	35.5	36.6
RACE: Black (%)	5%	7%	5%	6%
RENTER (%)	31%	32%	22%	18%
Panel B: Income and Consumption				
Income (before tax)	$14,163	$14,026	$16,910	$17,443
Income (after taxes)	$11,160	$11,107	$13,544	$14,096
Total Consumption	$ 9,666	$10,611	$11,737	$12,151
Panel C: The Spending Pattern				
Food (%)	19%	19%	21%	23%
Housing (%)	29	27	26	24
Clothing (%)	5	6	6	7
Nondurables (%)	7	7	7	7
Durables (%)	16	18	17	17
Transportation (%)	6	6	5	5
Services (%)	18	17	17	18
Number of obs.	2,461	2,196	1,851	1,078

* Families of size 3, 4, and 5 have 1, 2, and 3 children of any age, respectively, and no other family members.

Table A-4: Husband-Wife Families of Size 2 through 5*, Characteristics and Spending Patterns *(Source: Table is adapted from Table 3.1 in Lazear and Michael (1988).*

the aggregate level, hypothesizing MPCs which vary by income level and therefore would lead to increased consumption with a more equal distribution of income. His results failed to support that hypothesis, however, suggesting instead a slight tendency for such a redistribution to lead to a decline in consumption — a result which he felt was consistent with Duesenberry's (1949) model.

Stoker (1986) provided a possible explanation for these occurrences when he suggested that Blinder's failure to find significant effects arose from his inclusion of lagged consumption, which in turn would tend to mask distributional effects:

> ". . .ignoring the presence of distributional effects may lead one to overemphasize evidence of dynamic effects in aggregate data. Because of limited distribution movements, distributional effects may tend to persist in aggregate data over many time periods and *give rise to statistically significant effects of lagged variables on current variables*. . .The effects of individual heterogeneity may be just as important to understanding macroeconomic relationships as dynamic behavioral effects. (p.791, italics added)"

This same criticism might be thought to apply to the work of Denton and Spencer (1976), who found no statistically significant effect of changing age structure or household size on aggregate consumption in Canada between 1928-1971, excluding 1940-1946, or on an international cross-section. They included lagged values of both income and consumption in their equations — and in addition imposed the constraint that the age pattern of effects would "increase linearly from birth, reach a maximum of 1 at age 18, and remain constant for all subsequent ages. (p.89)"

A.5 The Literature on Dependency and Savings Rates

There is a long and controversial literature focused on the effect of dependency rates on savings rates, which is of course related to the issues discussed here. The literature is, however, aimed primarily at comparisons of DC's and LDC's, and attempts to explain lower rates of growth in LDC's as a function of their higher fertility rates.

One of the most consistent elements in this literature is its focus on *number* of children (and sometimes the number of the elderly), rather than on their age distributions (Leff, 1969, 1971, 1980, 1984; Kelley, 1973; Fry and Mason, 1982; Kelley and Schmidt (1996) -- all of whom find a significant negative effect of dependency on savings; and Adams, 1971; Gupta, 1971; Bilsborrow, 1980; Ram, 1982, 1984 — all of whom contest Leff's methodology and results) In addition, the literature universally fails to include considerations of changing age structure *among the working age population*: the variables used are the ratio of the dependent to the working age population. These same shortcomings appear in the work of, Brander and Dowrick (1994), who found a negative relationship between contemporaneous fertility and dependency rates (the share of the population aged 15-64), and the growth rate of real per capita product, in data for 107 countries from 1960-1985. They found this negative relationship even using IV controls for the potential endogeneity of birth rates.

But Espenshade (1978), in addressing work by Kelley (1973) which suggested a negative effect of dependency on savings rates, demonstrates that "In contrast to Kelley's finding, however, the family size variable has no significant effect on savings either in its linear or in it squared form. . .although family size has no effect on household saving, the age of children does. . .children have the greatest positive impact on savings when they are nearing completion of high school. . .the importance of family size per se as a determinant of household saving behaviour diminishes as a society reaches higher stages of economic and social development."

Espenshade's conclusions were based on an analysis of the 1960-61 U.S. Consumer Expenditure Survey, in which he included an "average age of children" variable along with a family size variable. That average age variable is somewhat crude, however, scaled so that 0 = no children ,1 = oldest child under six, 2 = oldest child 6-11 and youngest under six, 3 = all children 6-11 or oldest 12-17 and youngest under six, 4 = oldest child 12-17 and youngest 6-11, and 5 = all children 12-17. And again in this analysis, no controls were used for the age structure of the working age population (other than a restriction that the household head be under 45). However, his finding of a strong sensitivity to the age distribution of children suggests this as a possible reason for the wide discrepancies in the literature.

Another "atypical" analysis was conducted by Lewis (1983): a simulation of saving rate sensitivity to fertility decine in the U.S. in the period 1830-1900, based on annual child-rearing costs by age of child (0-17) which were derived from a number of micro surveys. His estimates were based on a large number of assumptions, including unchanged adult levels of consumption when a child is added to a household. His conclusions were that the presence of children affected only the *lifetime pattern* of savings, not the overall level, so that higher rates of fertility in the nineteenth century would have depressed savings among younger cohorts but increased those among older cohorts. On balance, however, because the age distribution was weighted toward younger cohorts, aggregate savings would have fallen: he estimates that the observed decline in the dependency rate 1830-1900 "explains between 21 and 24 percent of the 6-percentage-point rise in the aggregate savings rate. (p.837)"

APPENDIX B: DATA SOURCES

The data on consumption expenditures which were used in the analysis were prepared by Stanley Lebergott (1997), in a painstaking and well-documented effort which produced personal consumption expenditures at the state level, broken down into the 100+ sub-categories itemized in the national income accounts, for the years 1900, 1929, 1970, 1977 and 1982, as well as annual data at the national level for the years 1900-1993. The same source provides personal income figures at the state and national levels, for the same dates.

As Lebergott describes, his data were developed chiefly from "the Censuses of Retail Trade, Services, Housing, Government and Population. Each Census drew on an enormous sample of knowledgeable respondents. For the most part the reports rest on detailed and original records rather than fleeting and vagrant consumer memories. Thus the 1977 Census of Retail Trade collected data from firms with over 85% of all retail sales. The 1977 Census of Services relied on direct reports for about 70% of all services in scope. The 1980 Census of Housing collected rent and value data from over 95% of the population. (p.71)" His state estimates "uniformly began with estimates, by specific item, for the United States as a whole. . .Each U.S. total was distributed among the states by an allocator, and usually checked against another allocator. Had estimates been directly made for each state, they would not necessarily add to an adequate U.S. total. More important, comparisons against the per capita average for the U.S. as well as nearby states, permit some judgment as to whether a state estimate falls outside reasonable limits.

It is important to note that in no case were the allocators used by Lebergott based on age distributions within the population. Rather, they were derived from various census data on production and expenditures, as well as distributions of workers by occupation and service income. The following passages, taken from his documentation for 1900, illustrate the methodologies employed by Lebergott in allocating expenditures at the state level.

"For such major items as food, clothing, furniture, and lighting we utilize the 1901 expenditure survey of 25,440 families by the U.S. Commissioner of Labor. Our individual state averages for these individual items were checked by regressing them against relevant occupation counts times average nonagricultural service income. (p.92)" For food off-premise the result was then checked against "the Population Census count of persons engaged in food retailing: merchants and dealers (excl. wholesale) in groceries and produce, hucksters and peddlers, butchers, bakers, and confectioners. (p.93)" A U.S. total of meals and beverages "was allocated by the number of persons in specified occupations (hotel keepers, bartenders, restaurant keepers, saloon keepers, and waiters) times the average service income per worker in the state. (p.93)" Food furnished employees was allocated using two series: "One was the aggregate expenditures on farm labor reported by farmers. The other was (a) average monthly wages without board, minus average wages with board, divided by (b) farm wages without board. (p.94)"

"The value of dairy products consumed on farms was used to allocate the U.S. total for food produced and consumed on farms by farm operators. (p.94)"

"Clothing expenditures per capita in thirty-three states can be derived from the survey by the Commissioner of Labor. The intra-regional variation shown by these figures seemed unreasonably great, and was probably a reflection of sampling variability. We therefore averaged the per capita figures within each of eight regions. These averages were then tested by correlating them with per capita expenditures given by multiplying the occupation count for two groups of merchants and dealers (clothing and men's furnishings plus dry goods, fancy goods, and notions) times the service income per worker. . .(p.95)"

Population Data
The population data were taken from hard copy and electronic files provided by the Bureau of the Census. These data were on occasion available only by five year age group: in such cases, single years of age were estimated as one-fifth of each corresponding five year age group.

1900.
Data at the state level on total population and population by five year age group through age 34, and ten year age group 35-64, were taken from the 1900 Census of Population, Volume 1, Part 1, Table 3, pp.110-111.

These data were supplemented by percentage distributions of state populations by five year age group through age 84, provided for 1900 in the 1930 Census of Population, Volume II: General Report, Statistics by Subject, Table 25, pp.660-668.

1929.
Data for the year 1930, as provided in the 1930 Census of Population, were used for 1929. Data at the state level on total population and population by five year age group through age 84 were taken from the 1930 Census of Population, Volume II, General Report, Statistics by Subject, Table 24, pp.610-658.

1970.
Data at the state level on population aged 0-2, 3-4, 5-13, by single year of age from 14-24, and for age groups 25-29, 30-34, 35-44, 45-54, 55-59 and 65+ were available in electronic form for the year 1970 in file e7080sta.txt from the Bureau of the Census Website http://www.census.gov/population/estimates/state.

The 1970 estimates in this file are consistent with those published in Current Population Reports Series P-25, No. 998. These electronic data were supplemented using total population and population by five year age group through age 84 taken from the 1970 Census of Population, General Population Characteristics, Volume I, Section I, Part 1, Table 62, pp.1-297 - 1-309.

1977.
Two alternative methods were used to prepare population by single year of age for 1977:

1) Data for 1980 are available at the state level by single year of age to 84 (based on the 1980 Census), and there are significant discrepancies between the Census Bureau's population estimates for the late 1970s, and the 1980 census. These discrepancies, taken together with the fact that the 1977 data are too aggregated in certain age ranges (see point 2 following), led to an effort to "backdate" the 1980 data by three years, to use in place of the questionable 1977 figures. These backdated 1980 population figures were assumed to be preferable for calculating population age shares.

2) Data at the state level on population aged 0-2, 3-4, 5-13, by single year of age from 14-24, and for age groups 25-29, 30-34, 35-44, 45-54, 55-59 and 65+ were available in electronic form for the year 1977 in file e7080sta.txt from the Bureau of the Census Website http://www.census.gov/population/estimates/state. The 1977 estimates in this file are consistent with those published in Current Population Reports Series P-25, No. 998. Because there is no additional source of data for 1977, as there is for 1970, to break down the larger age aggregates, (35-39 from 35-44, 45-49 from 45-54, 5-9 from 5-13, and five year groups above 64), national patterns for the year 1977 were used within these age groups. These estimated

1977 figures were used as a check on the backdated 1980 figures: it was found that there is a close correspondence.

1982.

Data at the state level on total population and population by single year of age through age 84 on July 1, 1982 were taken from computer files downloaded from the Bureau of the Census Website http://www.census.gov/population/www/estimates/st_stiag.html.

1900-1979 US data:

These data were taken from Lotus files of population by single year of age, provided on diskette by the Bureau of the Census (Kevin Deardorff, Population Division, at (301) 763-7950. Coverage in each decade is as follows:

	1900-1929:	1930-39:	1940-49:	1950-59:	1960-79:
age	0-75+	0-75+	0-85+	0-85+	0-85+
resident population	yes	yes	yes	yes	yes
AK & HI?	excluded	excluded	excluded	included	included
AF overseas?	excluded	excluded	included	included	included
reference CPR P-25:	#311	#311	#311	#311	#519 & #917

1980-89 US data:

(resident population plus AF overseas, incl. AK and HI, age 0-100+ and total, as of July in each year): Files e8081pqi.txt through e8990pqi.txt from Bureau of the Census Website http://www.census.gov/population/www/estimates/nat_80s_detail.html

1990-98 US data:

(resident population plus AF overseas, incl. AK & HI, age 0-100+ and total, as of July in each year): Files e9090pmp.txt through e9898pmp.txt from Bureau of the Census Website http://www.census.gov/population/www/estimates/nat_90s_2.html

APPENDIX C: METHOD USED TO ESTIMATE COEFFICIENTS ON POPULATION AGE SHARES

In an unconstrained model, population age shares — if assumed to affect the intercept of the consumption equation — would enter the equation for Personal Consumption Expenditures as

$$\sum_{j=1}^{J} \varphi_j \, p_j \tag{1}$$

where p_j is the share of total population represented by age group j and φ_j is the coefficient to be estimated. Since our population data are available in single years of age 0-84 and 85+, J — the total number of age groups — is 86 in this analysis. Because there is already an intercept term in the model, and the p_j by definition sum to one, the φ_j must be constrained to sum to zero in order to estimate the model.

However, it would be impractical to attempt to estimate 86 separate coefficients. As an alternative this analysis has adopted a method suggested by Fair and Dominguez (1991), which is in turn similar to Almon's (1965) distributed lag technique. The φ_j are constrained to sum to zero in order to preserve the intercept term, and constrained to lie on a polynomial of degree n (where n is to be determined in fitting the model) such that

$$\varphi_j = \zeta_0 + \zeta_1 j + \zeta_2 j^2 + \zeta_3 j^3 + \, . \, . \, . \, + \zeta_n j^n \qquad j = 1 \, . \, . \, . \, J \tag{2}$$

and we have imposed the constraint:

$$\sum_{j=1}^{J} \varphi_j = 0 \tag{3}$$

Substituting equation (3) into equation (2) we can derive

$$\zeta_0 = -\zeta_1 (1/J) \sum_{j=1}^{J} j - \zeta_2 (1/J) \sum_{j=1}^{J} j^2 - \, . \, . \, . \, - \zeta_n (1/J) \sum_{j=1}^{J} j^n \tag{4}$$

and thus

$$\sum_{j=1}^{J} \varphi_j \, p_j = \zeta_1 Z_1 + \zeta_2 Z_2 + \, . \, . \, . \, + \zeta_n Z_n \tag{5}$$

where

$$Z_n = \sum_{j=1}^{J} p_j j^n - \sum_{j=1}^{J} (p_j \sum_{k=1}^{j} k^n) \tag{6}$$

APPENDIX D: MODEL DERIVATION

We will begin by assuming that one of the following simple models -- linear or log-linear -- describes the observed pattern of consumption relative to income for individual *i* in the population.

$$c_i = \beta_{0_i} + \beta_{1_i} y_i \qquad i = 1 \ldots P \tag{7}$$

$$\ln(c_i) = \alpha_{0_i} + \alpha_{1_i} \ln(y_i) \qquad i = 1 \ldots P \tag{8}$$

Let's also assume that we can identify *J* groups in the entire population, on the basis of some observed characteristic, such that all of the individuals *i* in each group *j* share a common consumption function. That is, $\beta_{0_i} = \beta_{0_k}$ and $\beta_{1_i} = \beta_{1_k}$ for all *i* and *k* in group *j*, in equation **(7)**, but these coefficients may differ across groups. What happens when we attempt to estimate an aggregate consumption equation for the entire population *P*, that is for all *J* groups taken together: how are the coefficients we estimate related to the "true" coefficients in equations **(7)** and **(8)**? This section explores that question, first for equation **(7)** and then for equation **(8)**.

Thus we will define for each group *j*

$$c_{i_j} = \beta_{0_j} + \beta_{1_j} y_{i_j} \qquad i = 1 \ldots P_j \tag{9}$$

and aggregating over all P_j individuals in group *j* we derive:

$$\sum_{i=1}^{P_j} c_{i_j} = C_j = \beta_{0_j} P_j + \beta_{1_j} \sum_{i=1}^{P_j} y_{i_j} \tag{10}$$

which can also be expressed as:

$$C_j = \beta_{0_j} P_j + \beta_{1_j} Y_j \tag{11}$$

where Y_j is the total income in group *j*. Then, aggregating over all *J* groups:

$$C = \sum_{j=1}^{J} C_j = \sum_{j=1}^{J} \beta_{0_j} P_j + \sum_{j=1}^{J} \beta_{1_j} Y_j \tag{12}$$

Now, with *Y* defined as total income in the total population *P* (all *J* groups taken together), β_0 and β_1 defined as the true coefficients for the total population *P* and $\bar{y}_j$ and $\bar{y}$ defined as the mean income in group *j* and in *P*, respectively, define:

$$\tilde{\beta}_{0_j} = \beta_{0_j} - \beta_0 \tag{13}$$

$$\tilde{\beta}_{1_j} = \beta_{1_j} - \beta_1 \tag{14}$$

$$\tilde{\beta}^*_{1_j} = (\bar{y}_j / \bar{y})\ \tilde{\beta}_{1_j} \tag{15}$$

Substituting **(13)** and **(14)** into **(12)** gives

$$C = \sum_{j=1}^{J} (\tilde{\beta}_{0_j} + \beta_0) P_j + \sum_{j=1}^{J} (\tilde{\beta}_{1_j} + \beta_1) Y_j \tag{16}$$

which simplifies to

$$C = \beta_0 P + \sum_{j=1}^{J} \tilde{\beta}_{0_j} P_j + \beta_1 Y + \sum_{j=1}^{J} \tilde{\beta}_{1_j} Y_j \tag{17}$$

Then, with $p_j = P_j / P$ and $\bar{y}_j P_j = Y_j$, substituting **(15)** into **(17)** and dividing through by total population *P* gives

$$\bar{c} = C/P = \beta_0 + \sum_{j=1}^{J} \tilde{\beta}_{0_j} p_j + \bar{y} (\beta_1 + \sum_{j=1}^{J} \tilde{\beta}^*_{1_j} p_j) \tag{18}$$

and if the *J* groups are defined on the basis of age structure, we can estimate the coefficients in the two summations using the Fair-Dominguez technique described in section .

Thus $\tilde{\beta}_{0_j}$ is a measure of group *j*'s deviation from the total population intercept β_0, and $\tilde{\beta}^*_{1_j}$ is group *j*'s deviation from the marginal propensity to consume (*MPC*) in the total population, β_1, weighted by group *j*'s relative income. Because we have no measures of income dispersion among the age groups in the population in the data assembled here, we cannot recover the unweighted *MPC* for group *j*, β_{1_j}, so that any estimate of the effect of changing population age structure on aggregate Personal Consumption Expenditures will be confounded with the effect of changing relative incomes among the various age groups in the population. However, Macunovich (1998a, 1998b and 1999 forthcoming) suggests that changing relative incomes are highly endogenous, with virtually all of the changes in relative income observed among age groups in the population over the past thirty-five years resulting from changes in the population age structure. If this is the case, then estimates of the weighted *MPC*s of the age groups $\tilde{\beta}^*_{1_j}$ can be used to give us good approximations of the true effect of changing population age structure on aggregate Personal Consumption Expenditures. In this case, simulations of consumption in one year *t* using another year *t+k* population base must also use the coefficients estimated for year *t+k* to see the full effect of a change in population age structure.

If instead of equation **(7)** — the linear form — equation **(8)** — the log-linear form — is assumed to hold in our population, we can complete a similar exercise in order to identify the relationship between the coefficients we can estimate econometrically and the "true" coefficients in equation **(8)**. Once again we divide the population into j groups containing P_j individuals, each with its own potentially unique consumption function:

$$\ln(c_{i_j}) = \alpha_{0_j} + \alpha_{1_j}\ln(y_{i_j}) \qquad i = 1 \ldots P_j \tag{19}$$

and aggregating over all P_j individuals in group j we derive:

$$\sum_{i=1}^{P_j} \ln(c_{i_j}) = \alpha_{0_j}P_j + \alpha_{1_j}\sum_{i=1}^{P_j} \ln(y_{i_j}) \tag{20}$$

and then in turn aggregating over all J groups taken together we obtain:

$$\sum_{j=1}^{J}\sum_{i=1}^{P_j} \ln(c_{i_j}) = \sum_{j=1}^{J} \alpha_{0_j}P_j + \sum_{j=1}^{J} \alpha_{1_j}\sum_{i=1}^{P_j} \ln(y_{i_j}) \tag{21}$$

And given that

$$\sum_{j=1}^{J} \alpha_{1_j}\sum_{i=1}^{P_j} \ln(y_{i_j}) = \sum_{j=1}^{J} \alpha_{1_j}\ln(\prod_{i=1}^{P_j} y_{i_j}) \tag{22}$$

$$\sum_{j=1}^{J}\sum_{i=1}^{P_j} \ln(c_{i_j}) = \ln(\prod_{j=1}^{J}\prod_{i=1}^{P_j} c_{i_j}) \equiv \ln(\prod_{i=1}^{P} c_i) \tag{23}$$

we can define α_0 and α_1 as the true coefficients for the total population P, with:

$$\tilde{\alpha}_{1_j} = \alpha_{1_j} - \alpha_1 \tag{24}$$

$$\tilde{\alpha}_{0_j} = \alpha_{0_j} - \alpha_0 \tag{25}$$

to obtain

$$\ln(\prod_{i=1}^{P} c_i) = \sum_{j=1}^{J} (\tilde{\alpha}_{0_j}+\alpha_0)P_j + \sum_{j=1}^{J} (\tilde{\alpha}_{1_j}+\alpha_1)\ln(\prod_{i=1}^{P_j} y_{i_j}) \tag{26}$$

Rearranging equation **(26)** and dividing through by P we obtain:

$$\ln(\prod_{i=1}^{P} c_i)/P = \alpha_0P/P + \sum_{j=1}^{J} \tilde{\alpha}_{0_j}P_j/P + \alpha_1\ln(\prod_{i=1}^{P} y_i)/P + \sum_{j=1}^{J} \tilde{\alpha}_{1_j}\ln(\prod_{j=1}^{J} y_j)/P \tag{27}$$

Defining ω_C as the geometric mean of consumption C in the population P, and ω_Y and ω_{Y_j} as the geometric means of income in the populations P and P_j, respectively, equation **(27)** is equivalent to

$$\ln\omega_C \ = \ \alpha_0 \ + \ \sum_{j=1}^{J} \tilde{\alpha}_{0_j} P_j/P \ + \ \alpha_1 \ln\omega_Y \ + \ \sum_{j=1}^{J} \tilde{\alpha}_{1_j} \ln\omega_{Y_j} P_j/P \tag{28}$$

Now, with $\bar{y}$ as the arithmetic mean per capita income and $\bar{c}$ as the arithmetic mean per capita consumption in population *P*, and $p_j = P_j / P$, if we define:

$$\tilde{\alpha}_1 \ = \ \alpha_1 (\ln\omega_Y / \ln\bar{y}) \tag{29}$$

$$\tilde{\alpha}^*_{1_j} \ = \ \tilde{\alpha}_{1_j} (\ln\omega_{Y_j} / \ln\bar{y}) \tag{30}$$

and then multiply equation **(28)** through by $\gamma \ = \ \ln\bar{c}/\ln\omega_C$ we obtain:

$$\ln\bar{c} \ = \ \gamma\alpha_0 \ + \ \sum_{j=1}^{J} \gamma\tilde{\alpha}_{0_j} p_j \ + \ \ln\bar{y}(\gamma\tilde{\alpha}_1 \ + \ \sum_{j=1}^{J} \gamma\tilde{\alpha}^*_{1_j} p_j) \tag{31}$$

which is now in a form equivalent to a logged version of equation **(18)***:*

$$\bar{c} \ = \ C/P \ = \ \beta_0 + \sum_{j=1}^{J} \tilde{\beta}_{0_j} p_j \ + \ \bar{y}(\beta_1 \ + \ \sum_{j=1}^{J} \tilde{\beta}^*_{1_j} p_j) \tag{18}$$

But whereas in equation **(18)** the estimated coefficients $\tilde{\beta}_{0_j}$ and $\tilde{\beta}^*_{1_j}$ will measure group *j*'s deviation from the "true" coefficients β_0 and β_1, with the latter deviation weighted by group *j*'s relative income, as derived earlier:

$$\tilde{\beta}_{0_j} \ = \ \beta_{0_j} \ - \ \beta_0 \tag{13}$$

$$\tilde{\beta}^*_{1_j} \ = \ (\bar{y}_j / \bar{y}) \ \tilde{\beta}_{1_j} \ = \ (\bar{y}_j / \bar{y}) \ (\beta_{1_j} \ - \ \beta_1) \tag{32}$$

in this logged version of the equation the estimated coefficients will bear a more complicated relationship to the "true" coefficients. In this case, even our estimate of α_1 will be biased, since we can retrieve only a weighted estimate of it, namely $\gamma\tilde{\alpha}_1$, which is weighted by the ratio of the logged geometric mean income in the total population to its logged arithmetic mean *and by the ratio in the total population of the logged arithmetic mean of consumption to its the logged geometric mean:*

$$\gamma\tilde{\alpha}_1 \ = \ (\ln\bar{c} / \ln\omega_C) \alpha_1 (\ln\omega_Y / \ln\bar{y}) \tag{33}$$

while our closest estimate of the "true" α_0 will be *weighted by the ratio in the total population of the logged arithmetic mean of consumption to its logged geometric mean*:

$$\gamma\alpha_0 \ = \ (\ln\bar{c} / \ln\omega_C) \alpha_0 \tag{34}$$

Our estimate of $\alpha_{0_j} - \ \gamma\tilde{\alpha}_{0_j} -$ will be a similarly weighted version of group *j*'s deviation from the population intercept α_0 :

$$\gamma\tilde{\alpha}_{0_j} = (\ln\bar{c}/\ln\omega_C)(\alpha_{0_j} - \alpha_0) \tag{35}$$

And our estimate of α_{1_j} — $\gamma\tilde{\alpha}^*_{1_j}$ — will be group *j*'s deviation from the population *MPC*, α_1, weighted by the ratio in the total population of the logged arithmetic mean consumption to its logged geometric mean and by the ratio of the logged geometric mean of income in group *j* to the logged arithmetic mean of income in the total population:

$$\gamma\tilde{\alpha}^*_{1_j} = (\ln\bar{c}/\ln\omega_C)(\ln\omega_{Y_j}/\ln\bar{y})(\alpha_{1_j} - \alpha_1) \tag{36}$$

These consumption and income weights could pose a potential problem in that they comprise the ratio of two logs, rather than the log of a ratio[3], and are thus sensitive to scaling changes. However, in practice the degree of sensitivity in the income measure is slight — especially with regard to potential bias introduced in the estimation of the α's — as can be seen in the table below:

	1970	1977	1982	ratios 1977/1970	ratios 1982/1970
Estimated values of $(\ln\omega_Y/\ln\bar{y})$:					
using 1982-84 constant $	.95954	.96454	.95853	.9948	1.0011
using 1996 constant $	.96100	.96594	.96014	.9936	0.9984
using current dollars	.95685	.96299	.95839	.9949	1.0009
using 1982-84 $ *10,000	.97501	.97947	.97571	.9955	0.9993
using 1982-84 $ / 100	.92711	.93412	.92371	.9925	1.0037

Table D-1: Demonstrating the sensitivity of the relative income and consumption weights to scaling changes. A comparison of values of $(\ln\omega_Y/\ln\bar{y})$ ***in the years 1970, 1977 and 1982 calculated by the author from CPS micro data using per capita income in the total population, with a range of scales applied to per capita income. The index ranges from zero to one, with one representing total income equality. Thus all measures can be seen to indicate a rise in equality between 1970 and 1977, followed by a fall between 1977 and 1982.***

The magnitude of the consumption weight has been estimated using quintile data for 1992 presented in Rogers and Gray (1994). Using their data, the consumption weight in that year — which affects our estimate of all parameters — was about 0.979, while the income weight was about .966. Our estimate of the "true" α_1 will be weighted by the ratio of these two weights, which is 0.986. Thus it can be seen that both the magnitude and the variation from year to year in these weights probably renders their effects negligible.

There is a possibility, however, that the ratio of logged geometric mean income *in group j* to the logged

[3]If the relative income weight were the log of the income ratio, rather than the ratio of the logs, it would be equivalent to a special case of Atkinson's index of inequality, which arises when the marginal utility of income is inversely proportional to income, as in Bernoulli's hypothesis.

arithmetic mean *in the total population* (one of the two weights affecting our estimation of α_{1_j}), if it were available, might show a wider variation than the ratio in the total population — both in the cross section, as we move from one age group to another, and over time. Once again, CPS income data — this time by age group — for 1970,1977 and 1982 were used to assess the magnitude of these group weights, and their variation over time. The results of this analysis are presented in Figure D-1, using two different methods of calculating per capita income for persons by age group. The sets of weights in the left panel were prepared using per capita income calculated simply by dividing each person's total household income by the (unweighted) number of persons in the household, while the weights in the right panel were prepared by dividing each person's total household income by the number of *adult equivalents* in the household. Adult equivalents were calculated using a weight of 0.4 for each child under age twelve, 0.7 for those aged 12-17 and 1.0 for all persons eighteen and over.

Here again, as with the population income dispersion measures, the magnitude of these weights combined with the relatively small variation over age groups and time (between about 0.9 and 1.0 in the left panel, and 0.95 and 1.0 in the right) indicates that they will have only a minimal effect on the estimated α_{1_j} coefficients.

This is not the case for the age group income dispersion measures in equation **(32)**, however — the weights which would apply in an unlogged version of the model. As indicated in Figure D-2, the variation in these weights by age group is very large (from nearly 0.5 to 1.5 in the left panel, and 0.75 to 1.25 in the right). Thus the estimated effects of age structure using an unlogged version of the consumption model would be subject to serious bias. This will be demonstrated in the estimation phase.

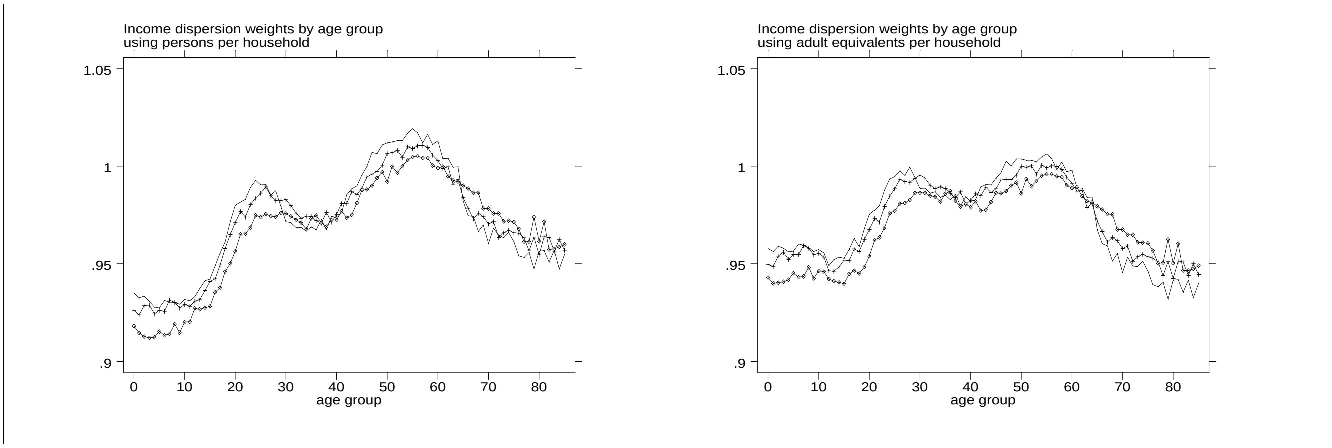

Figure D-1: Income dispersion measures by age group — $(\ln \omega_{Y_j} / \ln \bar{y})$ ***— for 1970, 1977 and 1982, calculated using CPS data.*** *Left panel based on per capita income calculated as total household income divided by number of persons. Right panel based on per capita income calculated as total household income divided by number of adult equivalents (children <12 weighted 0.4, 12-17 weighted 0.7, all others weighted 1.0).*

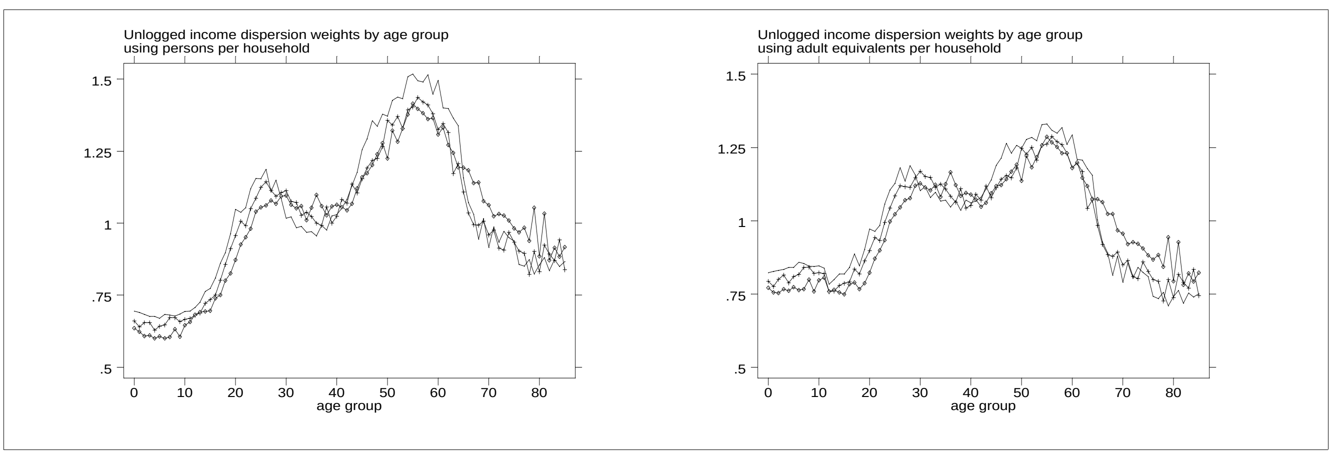

Figure D-2: Unlogged Income dispersion measures by age group — $(\bar{y}_j / \bar{y})$ ***— for 1970, 1977 and 1982, calculated using CPS data.*** *Left panel based on per capita income calculated as total household income divided by number of persons. Right panel based on per capita income calculated as total household income divided by number of adult equivalents (children <12 weighted 0.4, 12-17 weighted 0.7, all others weighted 1.0).*

APPENDIX E: SENSITIVITY ANALYSES

Several additional analyses were undertaken in order to check the results presented in the main paper. Table E-1 and Figure E-1 examine the effects of changing the formulation of the income and consumption measures used, in order to determine if the estimated age share effects were sensitive to the choice of variables. The results presented there indicate little if any sensitivity.

Table E-2 and Figure E-2 then examine the effect on the estimated age share coefficients, of differing model specifications. The basic "double-humped" pattern of age share effects is apparent in all specifications, although the relative magnitude of effects at younger ages is intensified when the age shares are used on their own, without controlling for income, and in the unrestricted model. We see this same type of effect in the main report, when income is treated as endogenous.

Table E-3 and Figure E-3 are counterparts to Table 4 and Figure 7 in the main report, in that they present results of estimating the restricted model for per capita personal consumption expenditures with the pooled data and also for single years individually, with income treated as endogenous. But the models in Table E-3 are estimated with n=7, rather than with n=5, as in Table 7.

Table E-4 presents the results of an analysis using just four age groupings (5-9; 0-4 and 10-14; 25-29; and 65-69) instead of the 86 single-year-of-age shares used in the rest of the report. In all of the pooled estimates in Table E-4 (1900-1982, 1929-1982, 1970-1982 and 1977-1982) the estimated effects of the four age groups are consistent both internally and with the age share effects estimated in the more comprehensive models in the main report, and consistently significant, with children aged 5-9 exerting a negative influence on per capita personal consumption expenditures and all other groups exerting a positive effect. The estimated effect of the 25-29 years olds is approximately double that of the 65-69 year olds.

Dependent Variable:	ln(PCE/adult)			ln(PCE per person)		ln(PCE/Income)		
	aged 15+	aged 15-64						
Z_1	-.005	-.008	-.008	-.009	-.012	-.009	-.008	-.008
	(-2.1)	*(-3.5)*	*(-3.8)*	*(-4.2)*	*(-5.6)*	*(-4.2)*	*(-3.5)*	*(-3.8)*
Z_2	.001	.001	.001	.001	.001	.001	.001	.001
	(3.5)	*(4.8)*	*(5.1)*	*(5.5)*	*(7.0)*	*(5.5)*	*(4.8)*	*(5.1)*
Z_3	-.00002	-.00003	-.00003	-.00003	-.00004	-.00003	-.00003	-.00003
	(-4.2)	*(-5.4)*	*(-5.7)*	*(-6.1)*	*(-7.3)*	*(-6.1)*	*(-5.4)*	*(-5.7)*
Z_4	3.56e-07	4.27e-07	4.49e-07	4.76e-07	5.52e-07	4.76e-07	4.27e-07	4.49e-07
	(4.7)	*(5.8)*	*(6.0)*	*(6.3)*	*(7.4)*	*(6.3)*	*(5.8)*	*(6.0)*
Z_5	-1.77e-09	-2.06e-09	-2.17e-09	-2.26e-09	-2.58e-09	-2.26e-09	-2.06e-09	-2.17e-09
	(-5.0)	*(-6.0)*	*(-6.2)*	*(-6.5)*	*(-7.4)*	*(-6.5)*	*(-6.0)*	*(-6.2)*
ln(income per person)	.608			.61		-.39		
	(15.9)			*(16.0)*		*(-10.2)*		
ln(income per adult 15+)		.611			.61		-.389	
		(15.9)			*(15.8)*		*(-10.1)*	
ln(income/adult 15-64)			.61					-.39
			(16.2)					(-10.3)
ln(% foreign-born)	.06	.057	.057	.056	.053	.056	.057	.057
	(8.4)	*(7.9)*	*(7.9)*	*(7.8)*	*(7.3)*	*(7.8)*	*(7.9)*	*(7.9)*
Year=1929?	.011	.009	.011	.01	.009	.01	.009	.011
	(0.5)	*(0.4)*	*(0.5)*	*(0.5)*	*(0.4)*	*(0.5)*	*(0.4)*	*(0.5)*
Year=1970?	.415	.414	.424	.42	.427	.42	.414	.424
	(6.0)	*(6.1)*	*(6.2)*	*(6.1)*	*(6.2)*	*(6.1)*	*(6.1)*	*(6.2)*
Year=1977?	.357	.375	.328	.391	.416	.391	.375	.328
	(5.5)	*(5.8)*	*(5.5)*	*(6.0)*	*(6.4)*	*(6.0)*	*(5.8)*	*(5.5)*
Year=1982?	.253	.249	.261	.252	.255	.252	.249	.261
	(3.8)	*(3.8)*	*(4.0)*	*(3.8)*	*(3.9)*	*(3.8)*	*(3.8)*	*(4.0)*
Intercept	-1.821	-1.702	-2.233	-1.63	-1.545	-1.63	-1.702	-2.233
	(-1.3)	*(-1.2)*	*(-1.6)*	*(-1.2)*	*(-1.1)*	*(-1.2)*	*(-1.2)*	*(-1.6)*
Number of obs	249	249	249	249	249	249	249	249
F Statistic	1642.14	1652.38	1740.43	2019.19	1999.79	68.21	68.37	68.88
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Notes: All regressions run with STATA robust regression, which eliminates gross outliers and then iterates to estimate weights
t-statistics in parentheses

Table E-1: Demonstrating the effect of changing definitions of income and consumption variables used in the basic model estimated with STATA robust regression, for all years pooled — illustrated in Figure E-1

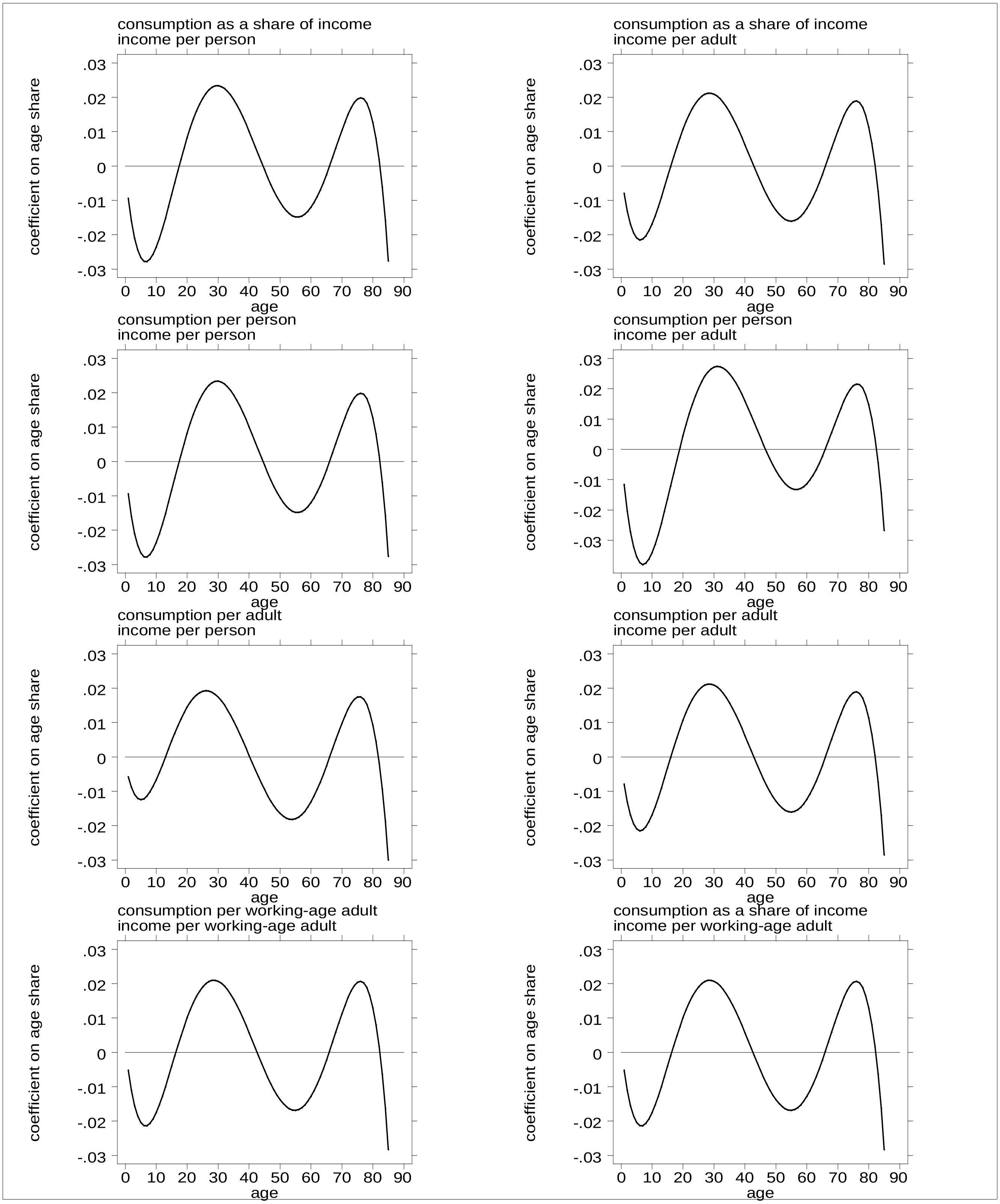

Figure E-1: Illustrating the effect on estimated age share coefficients, of using different formulations of the income measure and the dependent variable, as in Table E-1.

[illegible]	(-8.8)	(-8.1)	(-7.7)	(-1.8)		
[illegible]	(7.5)	(8.0)	(7.6)	(2.2)		
[illegible]	(-6.6)	(-7.8)	(-7.5)	(-2.4)		
[illegible]				(23.8)	(16.1)	(7.2)
[illegible]	(-0.8)	(-4.5)	(-1.6)	(-2.6)		
[illegible]	(19.3)	(1.6)	(4.4)	(2.4)		
[illegible]	(20.8)	(0.8)	(4.0)	(1.3)		(2.7)
[illegible]	(12.6)	(-2.7)	(1.6)	(-0.8)		
[illegible]		0.9570	0.9872	0.9884	0.9912	
[illegible]			(-3.2)	(-5.2)	(-4.5)	(6.3)

Notes: Dependent variable is ln(personal consumption expenditures per person)
All regressions run with STATA "robust regression", using state populations as weights
t-statistics in parentheses

Table E-2: Demonstrating the effect of sequentially adding variables to the basic model, for all years pooled -- illustrated in Figure E-2.

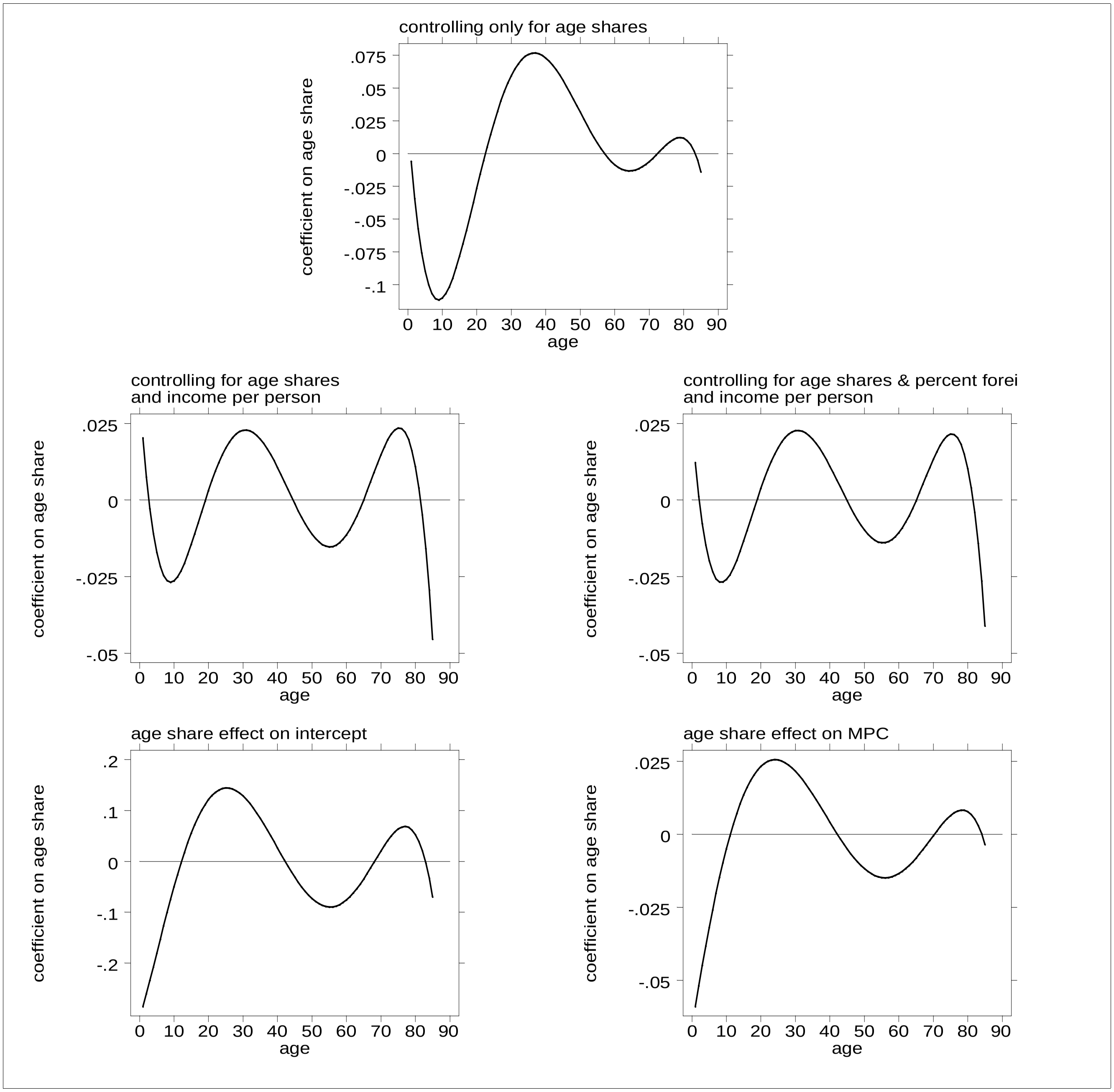

Figure E-2: Illustrating the effect of sequentially adding variables to the model, as in Table E-2.

Years included:		All	1900	1929	1970	1977	1982
(2.5)	(-0.4)	(0.8)	(1.7)	(0.4)	(0.9)		
(-4.6)	(-0.3)	(-1.6)	(-2.6)	(-1.1)	(-1.9)		
(5.8)	(0.5)	(2.2)	(3.0)	(1.5)	(2.4)		
(-6.4)	(-0.5)	(-2.7)	(-3.1)	(-1.8)	(-2.6)		
(6.6)[1]	(0.5)	(3.0)	(3.1)	(1.9)	(2.7)		
(-6.6)[2]	(-0.4)	(-3.1)	(-3.0)	(-2.0)	(-2.7)		
(6.6)[3]	(0.4)	(3.2)	(2.8)	(2.1)	(2.8)		
(16.3)[4]	(5.9)	(9.9)	(2.8)	(5.1)	(3.5)		
(20.8)[5]	(2.2)	(8.5)	(9.6)	(10.0)	(8.0)		
(8.3)[6]							
(36.5)							
(28.3)[7]							
(25.4)							
(8.0)	(0.4)	(4.1)	(2.3)	(2.6)	(1.2)		
1407.12	136.16	586.51	63.43	41.49	37.58		
0.9866	0.9628	0.9912	0.9183	0.8793	0.8682		
0.3543	0.9695	0.3962	0.6196	0.8790			
0.4021	0.9317	0.4085	0.5401	0.7624			
71.77	15.52	43.10	13.05	8.80	8.87		
0.3374	0.9497	0.4655	0.5676	0.7367			
0.2633	0.8169	0.5473	0.6206	0.7270			
0.2067	0.7045	0.6386	0.6877	0.7133			
0.1627	0.6334	0.7450	0.7465	0.7071			
0.6567	0.6290	0.1183	0.8507	0.7957			
	0.0009	0.5562	0.4892	0.8406	0.6418		

)

0 $\varphi_{n_t} = \varphi_{n_{allyears}}$

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Notes: Dependent variable is ln(personal consumption expenditures per person)
All regressions run with STATA “robust regression” with state total population as weights.
t-statistics in parentheses

Table E-3: As in Table 2 (pooled and single year regressions of PCE using the restricted model) but with income treated as endogenous, and with n=7 (see Table 5 for a comparable table with n=5). Illustrated in Figure E-3.

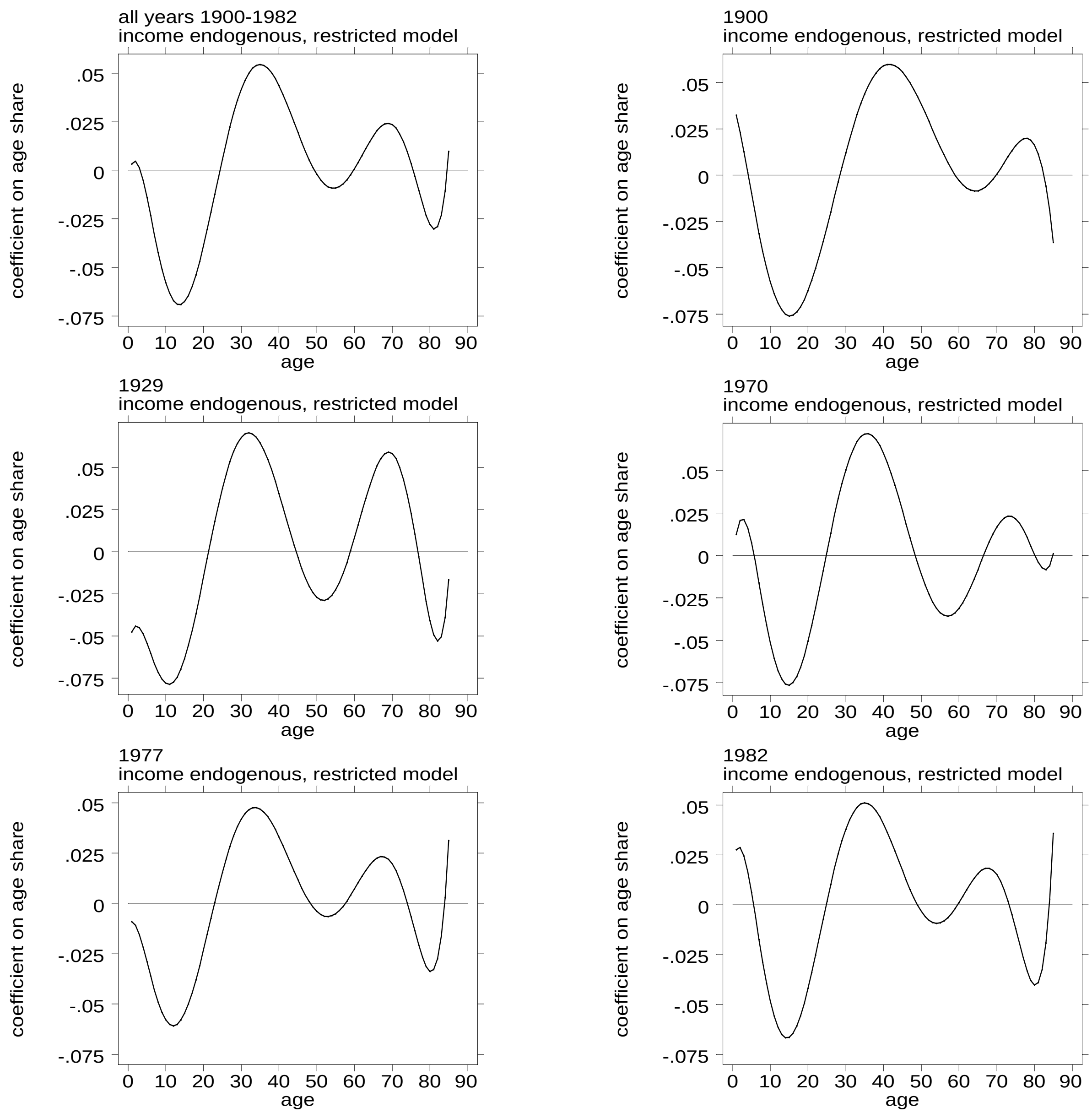

Figure E-3: Estimated pattern of age share coefficients when income is treated as endogenous, for all five years pooled (upper left), and individually for each year —as in Table E-3 .

Years included:	1900-1982	1929-1982	1970-1982	1977-1982	1982	1977	1970	1929	1900
children aged 5-9	-.422	-.497	-.488	-.432	-1.23	-.907	.083	-.166	.629
	(-2.9)	(-3.6)	(-3.9)	(-2.9)	(-2.6)	(-3.3)	(0.3)	(-0.3)	(0.9)
children 0-4 & 10-14	.382	.49	.502	.456	1.666	.487	.147	-.067	-1.16
	(2.5)	(3.4)	(3.5)	(2.7)	(3.0)	(2.4)	(0.4)	(-0.1)	(-2.1)
adults aged 25-29	.395	.554	.403	.428	.429	.5	.715	.536	-.397
	(4.8)	(7.1)	(5.4)	(4.2)	(2.5)	(3.0)	(6.2)	(1.9)	(-1.1)
adults aged 65-69	.116	.178	.097	.088	.272	-.008	.267	.132	-.055
	(3.3)	(5.2)	(2.6)	(1.8)	(3.0)	(-0.1)	(4.3)	(1.0)	(-0.4)
ln(income per person)	-.389	-.331	-.479	-.448	-.313	-.392	-.646	-.361	-.374
	(-11.2)	(-8.7)	(-8.9)	(-6.5)	(-3.3)	(-3.9)	(-7.0)	(-4.6)	(-4.4)
ln(% foreign-born)	.059	.057	.069	.077	.038	.072	.074	.066	.005
	(8.1)	(8.0)	(9.2)	(7.9)	(2.7)	(5.2)	(6.6)	(3.4)	(0.2)
Year=1929?	.037								
	(1.7)								
Year=1970?	.386	.292							
	(6.0)	(5.6)							
Year=1977?	.326	.175	-.043						
	(5.6)	(3.5)	(-1.9)						
Year=1982?	.218	.048	-.146	-.101					
	(3.5)	(0.9)	(-4.7)	(-5.7)					
Intercept	-1.084	-.066	-1.086	-.869	.239	-1.908	.303	-.606	-3.794
	(-2.2)	(-0.1)	(-2.1)	(-1.3)	(0.2)	(-1.5)	(0.4)	(-0.4)	(-1.6)
Number of obs	249	201	153	102	50	50	51	48	48
F Statistic	74.93	37.76	28.67	23.66	7.35	8.85	18.54	4.83	23.17
Prob > F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000
F tests that each coefficient is equal to the value estimated for pooled 1900-1982, Prob > F:									
children aged 5-9		0.5872	0.6067	0.9496	0.0913	0.0852	0.1238	0.6738	0.1239
children 0-4 & 10-14		0.4607	0.4106	0.6619	0.0272	0.6094	0.5341	0.4470	0.0087
adults aged 25-29		0.0420	0.9170	0.7442	0.8423	0.5340	0.0081	0.6203	0.0416
adults aged 65-69		0.0747	0.6085	0.5595	0.0957	0.1198	0.0204	0.9074	0.2516
ln(income per person)		0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ln(% foreign-born)		0.7841	0.2020	0.0737	0.1291	0.3600	0.1933	0.7482	0.0165

Notes: Models estimated using STATA "robust regression" which first eliminates outliers and then iterates to identify weights. Dependent variables is ln(personal consumption expenditures as a share of personal income). t-statistics in parentheses The first four variables are each calculated as the log of the share of total population in each age group.

Table E-4: Regression results from models using only four age groups, rather than 86 single-year-of-age shares.

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