Effects of Future Demographic Changes on the U.S. Economy: Evidence from a Long-Term Simulation Model

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December 1996

Work on this project was funded by the Health Care Financing Administration, HCFA Contract 500-93-0007. We gratefully acknowledge HCFA's financial support, as well as the help and guidance provided by John Phelps and Dan Waldo in the Office of the Actuary. Opinions expressed here are the authors', and do not represent the opinions of the Health Care Financing Administration. Parts of this paper were presented at the Fourth INFORUM World Conference in Tokyo, Japan, and at the National Association of Business Economists Conference in Boston, USA, both in September 1996. We wish to thank participants at those conferences, as well as members of the INFORUM staff for several helpful suggestions.

Abstract:

Demographics, especially the size and the age-composition of the population, contribute substantially to the growth and structure of any economy. Over the next 55 years, the age composition of the U.S. population will change dramatically, as the post World War II “baby boom” ages into retirement. In this paper, we use a long-term interindustry model of the U.S. economy to examine how the age composition of U.S. population affects overall economic growth as well as the output/employment structure of the economy. We find that the system of funding government commitments to pension and medical care for the elderly is a primary channel through which demographic effects translate into economic effects.

Keywords:

Demographics, Baby Boom, population, long-term projections, Social Security, Medicare, United States.

Introduction

The size and characteristics of a country's population have long been recognized as key influences on almost all aspects of economic performance. Demographic variables -- total population growth, the age composition of the population, the 'quality' of the population -- influence both the aggregate demand for goods and services as well as the composition of that demand. At the same time, demographics influence the amount of labor available for production and the circumstances under which that labor will be offered.

The present work is motivated by the simple fact that the age composition of the U.S. population will change substantially over the next 50 years. So far the influence of the Baby Boom (those born from 1946 to 1964) has been felt in labor force growth, the structure of jobs and wages, and in the composition of consumer spending.[1] However, the changes in economic structure that have already occurred may pale in comparison to the predictable age-composition effects that will occur when the Baby Boom reaches retirement age, beginning around 2010. In this paper we illustrate the macroeconomic and structural effects of these foreseeable changes in the population structure using a macro-interindustry model of the U.S. economy.[2]

This paper is divided into four sections. In the first section, we give a brief overview of U.S. demographics over the last 150 years and suggest economic areas where age composition may have noticeable effects. We then briefly review how demographic variables influence the macro-interindustry model. Finally, we compare a base scenario for the macro-interindustry model that contains the expected population changes with a scenario in which we hold constant the current age composition of the population.

U.S. Population Trends

Table 1 shows major demographic data series for the U.S. since 1850, with projected population statistics through 2050.[3] In the 60 years prior to 1990, the U.S. population grew 102 percent, compared with a projected increase of 57 percent between 1990 and 2050. Population growth is expected to slow progressively through 2050. Excluding the Great Depression years, by 2030 population growth is likely to be slower than in any other decade since 1850.

[Table 1 about here]

The driving forces behind the projection of slowing population growth are shown in the rest of Table 1. Although birth rates are assumed to be on a slight upward trend from 2000 through 2050, they remain well below any level seen from 1850 through 1970. It is crucial to note that birth rates also remain well below the noticeable surge in birth rates in 1950 and 1960 that created the post World War II Baby Boom cohort. Life expectancies for men and women are assumed -- following Census Bureau Middle Series assumptions -- to increase between 1990 and 2050 by about 10 years and 6 years respectively, somewhat smaller than the 11-year and 13.6-year increases in life expectancies for men and women that occurred between 1940 and 1990. Net immigration is assumed, following the Census Bureau Middle Series assumptions, to be 880,000 each year from 1994 through 2050. The decade sum ending in 2000 of 9.86 million immigrants reflects the surge in immigration in the early 1990s that has already occurred.[4]

The reasons for a relatively slow population growth are fairly obvious. Projected fertility rates are relatively low, at the same time that the projected share of women in child-bearing years falls. Only the relatively high levels of immigration keeps population growth rates from further decline, so the general outlook is for slowing overall population growth, increasingly dominated by net immigration.

The jump in birth rates in the middle decades of the century, coupled with rising life expectancies, led to a large percentage of the population in the age group associated with that birth cohort. Table 2 shows the enormous influence the Baby Boom has had, and will continue to have, on the population age composition (shaded cells indicate population groups that are predominantly in the Baby Boom cohort). In Table 2, this cohort appears in the 1950 entry, and move progressively down the diagonal of that table. The cohort is currently in the 30-39 and 40-49 age brackets, accounting for about 31 percent of the population.

[Table 2 about here]

There are several ways to illustrate the size of the Baby Boom cohort. For example, between 1850 and 1990 the largest ten-year age group is always in one of the groups of age less than 40. However, the dual effects of increased longevity and the Baby Boom drastically change this outcome. Between 1990 and 2050 the largest single age group is the 60+ group, by 2050 as a share of total population this group accounts for 25 percent of the population. Further, in 1950, just after the cohort began to be born, 54 percent of the population was aged between 20 and 60, ages when there is a strong labor force attachment. As the cohort ages, the share of the population in the prime working years at first diminishes, then rises to slightly more than 55 percent of the total population in the year 2000.[5] By 2030, the percentage of the population between 20 and 60 years old has fallen to just above 48.5 percent again, but with less than 27 percent of the population younger than 20. Thus, the dependent population is primarily old, rather than young.[6]

Economic Impacts of the Age Composition

The economic impacts of the aging of the U.S. population has been the subject of much discussion, but little comprehensive empirical work. Cutler *et al* (1990) examine the issues surrounding the aging of the population. Fair and Dominguez (1991)estimate the effects of age composition on consumer spending, labor force participation and savings. Yoo (1994) compares three theoretical growth models looking particularly at the effects of the retiring baby boom on the capital-labor ratio.[7] An enormous literature has developed around the projected effects the aging population has on the Social Security system and proposals to maintain the solvency of the system.[8] However, most of this work is done in the context of a partial equilibrium framework, or examines only the effects on specific sectors. In the present work, we attempt to examine the general equilibrium effects of the aging.[9] There are three main areas of effects: labor force effects, government budget effects, and spending-composition effects.

An aging population tends to reduce labor force growth. As Table 2 shows, after 2000, the working age population progressively shrinks as a percentage of the overall population . Slowing working age population will tend to reduce labor force growth, reducing the economy's potential to produce.[10]

The structure of the federal entitlement programs tends to favor the elderly. Medicare, Social Security, and Medicaid accounted for about 35 percent of the federal budget in 1994. Access to the Medicare program is restricted to the elderly and all but a small portion of Social Security payments go to those older than 62.[11] Surveys of Medicaid recipients suggest that the single largest spending category is related to long-term nursing care for the elderly, even though most of the recipients of the program are not elderly. As a greater share of the population enters the age groups eligible for these entitlements, program outlays will balloon, leading either to rising deficits or taxes or both.[12] For example, the 1996 Trustee's Report of the Health Insurance Trust Fund projects that Medicare outlays will rise from 2.6 percent of GDP in 1995 to 8.1 percent in 2050.

Aside from macroeconomic considerations, the changing age structure is likely to shift consumer spending away from durable and non-durable goods to services, with stronger shifts toward health services. Many investigators have suggested that the elderly tend to consume different goods and services than other age groups.[13] The changing structure of consumer demand should lead to different employment patterns. To the extent that industries have different levels of productivity and compensation, aggregate productivity and demand may be raised or lowered. Thus, while the changing structure of demand may affect industries differently, it may also have macroeconomic effects.

To assess the overall effects on the economy from these three channels of influence, we use the LIFT simulation model. The labor force and federal budget effects are reasonably straightforward in the model. An increase in the labor force in the LIFT model will increase potential GNP growth. Initially, actual GNP is below potential, causing lower inflation and interest rates. Both of these eventually lead to higher real demand. Lower inflation rates tends to raise real income growth, while lower interest rates raise spending on investment goods, exports, and some types of consumer spending.

The channels of influence of federal entitlement spending are also straightforward. An increase in non-Medicare entitlement spending raises disposable income, pushing up consumer spending directly. At the same time, the increase in spending (not offset by tax increases) increases the federal deficit, which represents a claim on savings. Interest rates are driven up, which leads to lower domestic spending and lower exports. In LIFT, all else constant, a 1 percentage point increase in the federal deficit as a percent of GDP will raise the 3-month Treasury bill rate by about 30 basis points (0.3 percentage points) and the 10-year Treasury rate by about 45 basis points. Increases in Medicare entitlements work by reducing the price of medical care, and does not directly raise consumer income. In this way, an increase in Medicare is targeted at medical care spending, not at goods and services in general.[14]

A key part of the effect of the changing age distribution is on consumer spending. Before we examine the LIFT simulations, we describe the channels through which sectoral demand is affected by the age structure.

Population Composition and Consumer Spending in the LIFT Model

The system of personal consumption expenditures (PCE) equations used by LIFT is based on work done by Almon (1979), subsequently refined by Devine (1983), Chao (1991) and Janoska (1994a).[15] Devine expanded the Almon model to include cross-section estimations and performed the original empirical analysis for the U.S. Chao (1991) improved the system's treatment of durable goods. Janoska (1994a) building on the work of Monaco (1984), expanded the system and added real interest rate and construction demand variables to the automotive and household durable expenditure categories. In related work, Pollock (1986) significantly improved the system for forecasting income variables used in the PCE system.

The consumer spending equations are estimated in two steps. The first step is a cross-section analysis using data from the Consumer Expenditure Survey (CEX) to estimate the effects of age, other demographic variables, and income on consumer spending.[16] Parameters estimated in the cross-section analysis and data from the National Income and Product Accounts (NIPA) are used in a time-series analysis to estimate the effects on consumer spending caused by changes in relative prices, taste trends and business cycles.

Cross-Section Analysis

The foundation of the system is the cross-section estimation that uses data from the CEX.

The cross-section equation estimated for each expenditure category is:

$$C_i = (a + \sum_{j=1}^{K} b_j Y_j + \sum_{j=1}^{L} d_j D_j) * (\sum_{g=1}^{G} w_g n_g) \qquad \textbf{(2)}$$

where:

C_i	= household consumption expenditures on good i,
Y_j	= the amount of per capita household "income" within income category j,
D_j	= a zero/one dummy variable used to show membership in the j_{th} demographic group,
n_g	= the number of household members in age category g,
K	= the number of "income" groups,
L	= the number of demographic categories,
G	= the number of age groups,
a,b,d,w	= parameters to be estimated for each commodity.

Conceptually, the above function has two components: consumption expenditures per "adult equivalent" and the "size" of the household in adult equivalents. Household per-capita income and demographic characteristics determine the value of the first component. The size of the household is determined by the second term. For each good, the size of a household does not equal the number of people in the household, but is a function of the ages of the household members.

The cross-section estimation defines "Adults" as individuals between 30 and 40 years old. The spending effect of being a member of any other age cohort is determined relative to the effect of this adult cohort. For example, we estimate that an additional infant in a household will not significantly increase the alcohol spending, unlike the effect of adding a 25 year-old person. Similarly, an additional 25-year old in the household will not increase the expenditures by the household on children's clothing, but an additional 0-5-year-old will raise spending on children's clothing.. As an "adult- equivalent", a newborn will count as less than one adult for spending on alcohol, but will count as several adults in the equation for children's clothing. Since the size of the weights for each age group is relative to the adult weight, we refer to them as Adult Equivalent Weights (AEW).[17] The system uses eight age cohorts: 0-5 years; 5-15 years; 15-20 years; 20-30 years; 30-40 years (the Adult cohort); 40-50 years; 50-65 years; above 65 years.

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

- Region: North East, North Central, South and West.
- Family Size: One person, two person, three or four person, and five or more person households.
- Education: One if the household head was college educated.
- Age of Household Head: Households with heads: under 35; between 35 and 55; and over 55.

In general, we forecast these listed variables by simple equations that rely upon the age and gender composition of the population and the total fertility rate.[18]

Besides demographic and age variables, the cross-section equations include five separate income parameters. A distinct marginal propensity to spend out of real income is estimated for each income variable and cross-section commodity. This is known as a piecewise linear Engle curve (PLEC). The PLEC allows the effect of income to vary as per-capita household income rises. For example, a household in the lowest income bracket might spend only $0.04 out of every dollar on jewelry, but a household in the highest income bracket might spend $0.40 of every dollar of disposable income on jewelry. At the same time, poorer households might have a higher propensity to consume used automobiles than richer households.

The amount of real income, Y_j, in each income bracket, J, depends on household income and the range or size of the bracket. As an example, if the bracket borders are set at $ 0, $1000, $2000, $3000, $4000, and infinity, a household with per-capita income of less than $1000 would have all of its income attributed to the first income bracket. A household with a per-capita income of $2500 would have the first $1000 of per-capita income allocated to the first income bracket; the second $1000 of per-capita income allocated to the second income bracket; and the last $500 of per-capita income allocated to the third income bracket. The income in each bracket becomes the Y_j used in equation (3) as the income variables.

Time-Series Analysis

Using the estimated cross-section parameters and the income distribution, we construct a time-series variable, C^*, for each PCE category. C^* for any year equals consumption in that year assuming: no relative price movements, no changes in taste, and perfect complementarity between the cross-section and time series data (Devine 1983). C^* captures the effects of the demographic and income variables across time. C^* is given by:

$$C_i^* = a + \sum_{j=1}^{K} b_j Y_j + \sum_{j=1}^{L} d_j D_j \qquad \textbf{(4)}$$

where :

C^*_i = cross-section variable for commodity I,

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

D_j = percent of US population within demographic group j,

a,b,d,w = parameters from the cross-section estimation.

Similarly, we use AEWs to construct a time-series of the adult equivalent population, WP_t :

$$WP_{i,t} = \sum_{m=1}^{8} w_{i,m} N_{m,t} \qquad \textbf{(5)}$$

where:

WP_{it} = age-weighted population size of commodity i in year t,

$w_{i,m}$ = AEW for cohort m, commodity i,

$N_{m,t}$ = number of individuals in age cohort m, year t.

We then use C^* and WP in the time-series estimation of the consumption expenditure system.

The LIFT consumption system divides 80 categories of PCE into 10 Groups. Parameters are estimated as a system to insure cross-price symmetry and adding up. Each group then is divided into two or more sub-groups. The system is designed so that: (1) weak price effects occur between categories in different groups; (2) moderate price effects occur between categories in different sub-groups within a group; (3) and strong price effects occur between categories within a sub-group. The system imposes price effect symmetry between each group in the system and between each sub-group within a group.

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

M	= the number of groups,
S_L	= the sum of the budget shares of categories in group **L** in the base year, where the budget share is defined as the category's share of total PCE.

The time-series equation is written:

$$\frac{q_{it}}{WP_{it}} = (a_i + b_i C_{it}^* + c_i \Delta C_{it}^*) \prod_{L=1}^{M} \left(\frac{P_{it}}{\bar{E}_{Lt}}\right)^{-S_L \lambda_{IL}} \quad \textbf{(6)}$$

where:

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

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

Estimated Age Effects

This two-step consumption estimation allow the consumer spending equations to respond both to relative price, income, and financial variables from the time series, as well as demographic effects through the cross section. Table 3 shows how real, per capita consumer spending on various goods and services changes as age-composition of the population changes. To construct this table, we calculated the WPs for each commodity. We then formed the index:

$$100*(WP_i/POP)*(POP94/WP_i94)-100,$$

Where WP is defined as above, POP is the total population, and 94 indicates that the values are the 94 values. We then aggregated the 80-sector indexes to the detail shown on Table 3 by using fixed 1995 consumption shares.

[Table 3 about here]

This index measures the contributions of the age distribution to movements in real, per-capita consumer spending and is identically 0 in 1994. Each entry shows the percent difference from 1994 in real, per-capita consumer spending due to changes in the age distribution of the population. The table shows some interesting patterns. It confirms the observation that the aging population will tend to raise per-capita spending on services while reducing spending on durable goods. Most of the changes due to the aging population occur by 2030, the first year in the table in which all of the Baby Boomer are older than 65. After 2030, the differences from 1994 are little changed.

Compared with 1994, real, per-capita spending on durable goods was 2.4 percent higher in 1960, but is expected to fall to 4.7 percent below 1994 in 2050. The pattern for furniture and household equipment is similar, but more extreme. For nondurable goods the movement from 1960 through 2050 is quite small (a range of -1.2 in 1960 to 0.9 in 2050). The movements for food and alcohol are more exaggerated. Overall, real spending on services rises 4 percent relative to 1994 by 2030, the first entry in the table in which all of the Baby Boomers are over 65. Relative to 1994, real spending on medical services would rise about 11 percent in 2030, with very large gains in the hospital category.

Table 3 suggests that the aging population will have noticeable effects on the pattern of consumer demand. These demographic influences suggest that a feature of any projection that includes baseline demographics should show economic activity skewed toward services and away from goods, especially durable goods. We now turn to simulations that incorporate the labor force, government budget, and consumer spending distribution effects in a single simulation.[19]

Constructing the Simulations

To analyze the full-system effects of the age structure on the economy we compare two scenarios with our base 2050 projection. In the first scenario (AGECON) we held constant the age composition of the population at the 1994 structure, but we allowed overall population to grow as in the Base. Holding the population composition constant at the 1994 structure starkly contrasts with the natural aging that occurs in the Base. In the second scenario, we used the

AGECON population assumptions, but also required that the federal surplus (deficit) maintain its share relative to GNP in the Base. [20] Table 4 shows the percentage differences between AGECON population assumptions and the Base for 10 population groups.

[Table 4 about here]

Holding the population groups constant at their 1994 shares results in large changes in the age structure of the population. The largest differences appear in the 85+ group. In 1995 the AGECON 85+ population is 1.4 percent below the Base, but by 2050 the AGECON 85+ population is almost 70 percent below the Base. The other population groups have mostly offsetting differences; specifically, the AGECON 30-39 group is 36 percent larger than the Base 30-39 group in 2050 .

The bottom panel of Table 4 shows the percentage point differences in the shares of total population accounted for by three groups of the population: young, less than 20; middle, 20-64; and older, greater than 64. Holding the age composition of the population constant at the 1994 structure raises the young share of the population by 1.8 percentage points in 2050, and reduces the older share by 7.1 percentage points. At the same time, the middle share is increased by 5.3 percentage points in 2050. Interestingly the middle share, which largely determines the size of the labor force, is actually 1 percentage point lower through 2010 when the age composition is held constant at the 1994 shares. Table 4 also shows the labor force effect of the AGECON assumptions, that is, it shows that, holding participation rates constant, the civilian labor force would be 7.6 percent higher with constant population shares.

Simulation Results[21]

The AGECON scenario produces a number of remarkable results. Table 5 shows the full simulation effects on consumer spending. While overall consumer spending is little changed in real terms throughout the simulation, the distribution of spending is decidedly different in the AGECON simulation relative to the Base. The contributions of the age distribution alone would have suggested about a 5 percent increase in spending for durable goods.[22] However, spending is about 16 percent higher in the AGECON simulation relative to the Base. About 11 percentage points of the total effect represents indirect effects captured in the full simulation (about a ratio of 2-to-1 indirect to direct effects). A chief reason spending on durable goods increases is a much lower interest rate that results in AGECON. Among nondurable goods, spending on food and alcohol is little affected, showing an increase of slightly more than 2 percent relative to the Base. It is interesting to note that the direct effect taken from Table 3 predicted about a 4 percent drop in food and alcohol spending. This suggests that relative price and income effects overwhelmed the age-distribution effect for these consumer goods. Spending on clothing is up nearly 12 percent by 2050, as the AGECON simulation keeps a larger portion of the population in the clothes-buying ages. The direct effects predicted by Table 3 account for about a third of the overall change.

[Table 5 about here]

Services consumption in the AGECON simulation is nearly 11 percent below the Base, about a third of the decline predicted by the direct effects only. Reductions in spending on medical services are especially significant, with the AGECON simulation predicting a nearly 40 percent drop in spending. However, the income and price effects managed to offset about 3/4 of the direct effects from Table 3, which predicted about a 150 percent reduction in medical services spending. Spending on nursing homes are down about 60 percent, about 3/4 of the ceteris paribus age effects. In sum, changes in relative prices and growing incomes help to ameliorate the age-distribution effects.

Table 6 shows the macroeconomic effects of the AGECON assumption. Keeping more of the population in the working-age years raises the labor force by 7.6 percent in 2050 (Table 4), while potential GNP is raised by about 12 percentage points. The difference between the two is largely made up by a 7 percent increase in labor productivity in the AGECON simulation relative to the Base.[23] Very little of the productivity change is due to higher productivity in individual industries. Instead, most of the increase in productivity is due to the changing distribution of production across LIFT industries. That is, the AGECON simulation tends to shift activity away from low-productivity service sectors into higher-productivity export (up more than 30 percent in total in the AGECON scenario) and capital goods industries (fixed investment up 7.5 percent in 2050).

[Table 6 about here]

The story behind these shifts is straightforward. For the first 25 years of the simulation, little happens to the macroeconomy. However, after 2020, the differences between the Base and AGECON age distributions begin to increase, which begins to be felt in the model. The overall consumption deflator is lowered as activity moves from relatively high-priced medical goods and services to other goods. At the same time, a federal government surplus begins to emerge.

Initially, lower federal spending is due to lower transfer payments, later in the simulation interest payments are also reduced. The emerging federal surplus puts downward pressure on real interest rates, which itself leads to several effects. First, lower real rates tend to lead to greater spending on the interest sensitive consumer goods and on residential building. Second, it tends to reduce the real exchange value of the dollar, promoting exports and reducing imports. Lower real interest rates have offsetting effects on income. Interest payments by the federal government are reduced as the federal debt is actually lowered. This in turn helps to create an even larger federal surplus through standard debt-deficit dynamics. However, lower interest payments reduces consumers' interest income, which helps retard consumption spending. Consumer spending is also lowered because transfer payments for Medicare and Medicaid are much lower in real per capita terms. Overall, lower interest receipts and transfer income actually lead to lower real disposable income, despite a nearly 5 percent increase in real labor income. Lower disposable income ultimately keeps consumer spending in check. Private savings as a share of income (a chief stabilizer in the model) falls as public savings rise. The effect of the accumulation of the federal surplus is to pull activity away from consumer sectors and into export and capital goods sectors.

Table 7 shows the full-simulation effects on the distribution of jobs by industry. The AGECON simulation produces modest job losses and gains through 2020, but as activity shifts by ever larger percentages, the jobs required by each sector begin to change noticeably. In 2050, the AGECON simulation has produced a 5 percent increase in jobs, with a 7 percent increase in private jobs and a 5.5 percent decrease in civilian government jobs. This latter decline reflects the reduction in employment at state and local hospitals which occurs because of the decline in the elderly population share. The distribution of job changes reflects the macro story and the large change in the demand for medical services that arises from the reduction in the elderly population. Medical services jobs are down by 40 percent from the Base, while manufacturing, mining, and transportation jobs are up by the largest percentages.

[Table 7 about here]

Deficit-Neutral Simulation

A number of results from the AGECON simulation depend on the assumption that the federal government will simply allow a large surplus to accumulate. The accumulating surplus puts downward pressure on interest rates, spurs exports and investment, but tends to reduce consumer spending. The assumption that policymakers would simply accumulate the surplus represents one end of a continuum of possible fiscal responses to the economic changes. At the other end of the continuum is the assumption that policymakers act to keep the ratio of the federal deficit to GNP constant at the Base levels. To see the results of this assumption we created another simulation, the AGECON simulation with relative deficit neutrality (DN simulation). Results of this simulation are shown in tables 8, 9, and 10.

[Table 8 about here]

Table 8 shows real consumer spending by aggregated commodity. In contrast to the AGECON simulation, where aggregate consumption was little changed, by 2050 real consumer spending is 8.3 percent above the Base. Compared with AGECON, the distribution of consumer spending has shifted toward goods and services with relatively high income elasticities. Thus, durable goods spending is up nearly 27 percent in the DN scenario, compared with 16 percent in the AGECON scenario. Spending on services overall is 2.3 percent lower in DN than the Base, about half the percentage decline of the AGECON simulation. Spending on medical services is more than 35 percent below the Base, compared with about a 40 percent difference in the AGECON simulation. Both show that the full simulation has about 3 times the impact of the direct effect shown in Table 3.

Table 9 gives a macro picture of the DN scenario. Potential GNP is 6.2 percent higher than the Base in 2050 when the age composition of the population is held fixed and policymakers cut taxes sufficiently to keep the federal deficit at Base levels. This is only slightly more than half the size of the of the percentage increase in potential GNP that occurred in the AGECON simulation. Since the labor force is the same in AGECON and DN, differences in productivity account for most of the difference. In 2050, private labor productivity is 2.4 percent above the Base, in contrast to the AGECON scenario, where productivity is 7 percent above the Base. The differences in productivity in the two alternate scenarios is due to the aggregate spending composition differences.

[Table 9 about here]

In the DN scenario, real interest rates are about 0.7 percent below the Base, compared with the AGECON scenario, in which real interest rates were about 2 percentage points below the Base. Real interest rates are higher in the DN scenario than the AGECON scenario because, by construction, the federal government continues to demand funds. Without the spur to investment and exports from lower real interest rates, the composition of activity in the DN scenario tends to resemble the Base, and gives similar aggregate productivity results.

Table 10 shows the distribution of jobs in the DN simulation. The number of private sector jobs is 6.4 percent above the Base, with Wholesale and Retail Trade (21 percent), Nonmedical services (14.7), Finance, Insurance, and real estate (11.9 percent) and Transportation (11 percent) leading the sectoral increases. The sectors that experienced the largest percentage job increases in the AGECON simulation (manufacturing and mining) had much more modest increases in the DN simulation.

[Table 10 about here]

General Discussion of Results

Our results show that the changing age structure of the population will cause significant changes in the distribution of industrial production and employment. The two simulations shown here attempt to provide endpoints on a continuum of possible federal responses. In either case, the distribution of activity is significantly affected. Macroeconomic differences are larger in the case where the federal government accumulates a surplus, rather than cutting taxes.

Second, it is clear that changing industrial composition has general macro effects as well. For example, measured aggregate private labor productivity is higher when more of the workforce is concentrated in high productivity sectors as opposed to low productivity sectors. Because the medical care sector is, using current measurements, a very low labor productivity growth sector, the movement of activity away from medical sectors when we prevent a significant increase in the elderly population gives a boost to aggregate productivity. The differences in aggregate productivity that result from the changing distribution of industrial activity casts some doubt on long-term forecasts that rely on constant productivity growth over long horizons.

The results in the above tables show how the economy might be different if the population composition were held constant at the 1994 structure. The results suggest that the economy would be larger, with lower inflation and lower interest rates, no matter which fiscal policy choice is made. It is possible however, to reverse the interpretation of the tables, so that holding the age composition constant at the 1994 structure is the Base while the natural aging simulation is used as the alternative. This interpretation would suggest where pressures in the economy will develop as the population ages. Viewing the tables this way, the following observations emerge about the changing structure of the U.S. economy through 2050.

- The percentage of the population accounted for people older than 65 rises dramatically after about 2010.

- Labor force growth slows as the population ages, especially between 2020 and 2030, when the Baby Boom generation is fully retired. The ratio of elderly dependents to people of the working age is 3.1 in 2050, compared with 4.6 in 1995.

- The composition of consumer spending shifts. The aging population raises spending dramatically on medical services. About 1/3 of the overall effect on spending comes from increasing income and the changing distribution of Medicare subsidies.

- Given the structure of entitlement spending, the federal deficit will balloon, causing rising interest rates. The activity shifts arising from higher interest rates and changing consumption patterns leads to slowing productivity growth and lower overall economic activity.

- If the model results are symmetric, the federal tax share of personal income would have to rise about 5 percentage points to keep the federal deficit from rising.

- Even if tax rates are raised, the changing composition of economic activity leads to significant macro effects.

Several aspects of the model merit further development. For example, we have yet to develop reliable equations for labor force participation, or for the fertility or retirement decision. In future work, we intend to investigate these areas, in order to make our simulation results more comprehensive.

Appendix 1

A Framework for Understanding Population Dynamics

Four pieces of information are needed to study the population and age-composition dynamics of any country.

- A base year population for each age (or age group).
- Survival rates from one age (or age group) to the next .
- Net immigration by age (or age group).
- Fertility rates by age (or age group).

From these four pieces of information, a profile of population growth and its age composition can be determined. In the long run, it is clear that overall population can be increased by an rise in the survival rates from one age to the next, an increase in net immigration, or by an increase in fertility. Although total population may be increased by any or all of these means, the age composition of the population depends heavily on which of these factors changes and how they change. For example, across all countries, the lowest survival rates occur among the very young and the very old. Consider two medical breakthroughs; one that increases survival rates for the elderly, or one that increases the chances of survival of a newborn. Each could lead to the same increase in the number of people in the country ten years later, however, the age composition would be very different. Similarly, an increase in immigration or an increase in fertility could lead to the same overall population, but very different age compositions.

The demographic projections model (DPM) used in this study follows this approach to population dynamics, called the the cohort component method of projection. Using this framework, we project the resident population on July 1st of every year. We start with 1994 population for each age and gender. The base year population is aged one year by adding in net immigration for each age and gender group, and applying age and gender specific survival rates to the resulting population. For example, here is the equation used to predict the number of females aged 20 in 1995.

$$Female20_{95} = Female19_{94}*Srtf19_{95} + 0.5*(immf19_{94})+immf20_{95}))*(1+srtf19_{95})*0.5$$

Female20 is the number of women aged 20 in 1995, female19 is the number of women aged 19 in 1994, Srtf19 is the survival rate for 19 year old women in 1994, immf19 is the number of net immigrants aged 19 in 1994, and immf20 is the number of net immigrants aged 20 in 1995.

Although the first term on the right hand side of the equation is straightforward, the second term deserves some explanation. Immigrant entry into the country is assumed to be evenly distributed over the year, and some of the immigrants who enter the country and are listed as age 19 will actually be age 20 on July 1st. Similarly, some of the immigrants who enter and are listed as 20 years old will still be 20 July 1st. So, we take the average of the two years to get effective immigration of 20 year-olds. Furthermore, since immigrants enter the country alive and have lived at least part of the year already, we have to reduce their exposure to mortality for the year. We assume that the typical immigrant has already lived half a year, so their survival rate is the average of 1 and the effective survival rate for 19 year old women.

The survival rates are calculated from the Census Bureau Middle Series life tables. Tables are available for 1995, 2005, and 2050. The life tables are static population tables. They represent the movements of a fictitious population of exactly the same age through all ages instantaneously. In order to get from these tables to effective survival rates we assume that births occur evenly over the year, and that the population dies evenly over the year. Therefore the effective survival rate for any given year in which there is a life table is, say for men aged 20 is:

srtm20 = 1-0.5*(drtm19+drtm20).

Where srtm20 is the effective survival rate for 20 year old males, drtm19 is the morbidity rate, or death rate, for 19 year old males and drtm20 is the morbidity rate for 20 year old males. The effective survival rate is equal to one minus the average of the death rates for 19 and 20 year old men. In order to get survival rates for all years we linearly interpolated the effective survival rates.

We calculate life expectancy conditional on reaching a given age, life expectancy at birth or at retirement for instance, by recreating the life tables for each year and calculating the total number of years an individual would live if he/she were to age instantaneously through the life table. This is consistent with standard demographic techniques.

A further complication is that we have to make projections of the resident population. For the most part, most U.S. citizens continuously residing overseas are in the military. We deal with this by subtracting out the male and female armed forces overseas from the current year and adding them back in the following year.

To calculate the number of births, we apply age-specific fertility rates to each female age group. Thus, total births is the sum of the product of age-specific fertility rates and populations:

$$Births = fert_{15}*female_{15}+...+fert_{49}*female_{49}.$$

Where fert(j) is the fertility rate for j year old women, and female(j) is the population of j year old women. The fertility rates are from the Census Bureau Middle series.

Because DPM splits the population into males and females, we need to split total births in to male and female. We do this by using the ratio of 105 males to 100 females, which is the ratio typically used by demographers in population projections.

The resulting set of equations comprises a recursive model that can be used to forecast population and the age/gender composition out as far as the assumptions about fertility, survival rates, and net immigration are made. The INFORUM DPM includes equations that rely on the age/gender composition of the population, as well as fertility rates, as independent variables.

Appendix 2

An Overview of the LIFT Model

LIFT is an interindustry-macro model of the U.S. economy that includes information for 85 producing sectors, including output, employment, prices, and interindustry sales. Factor cost information (value-added) is forecasted for 51 industries, including labor compensation, profits, depreciation, and net interest payments. In addition to the industry components, LIFT is a complete macro model, determining GDP, interest rates, inflation rates, the overall unemployment rate, etc. The model allows feedback from the industry detail to the macroeconomic aggregates. It achieves industrial consistency through its input-output structure. Most of its estimated equations are based on econometrics analysis of time-series data from about 1955 through 1993, and the simulation horizon extends up through 2050.

Final Demand, Output, and Jobs

LIFT takes into account the relationships among producing sectors to determine output, employment, and prices. Output for any product is the sum of all of the final demands and intermediate use. Intermediate use comes from an input-output table that tracks how much each sector buys from all other sectors to make its product. For example, an increase in auto production leads to increases in the output of steel, plastics, and business services.

The model uses the basic input-output equation to determine output:

$$q = Aq + f$$

where q is a column vector of outputs, A is the technology matrix, and f is a column vector of final demands. The technology matrix shows how much of each product is needed to produce another product. The interindustry structure changes over time. The time-series of A-matrices are derived from a 1982 matrix. Matrix coefficients are forecasted with time trend equations to capture technology changes. Trends are applied across the row.

Final demand equations are estimated econometrically at detailed levels. There are equations for consumer spending (80 types), equipment investment spending (57 industries), construction (31 types), exports and imports (85 products each). Both sectoral and macroeconomic variables are used in these equations. For example, business investment spending by the motor vehicles industry depends on motor vehicles output (sectoral demand), interest rates, and tax rates (macro factors). Consumer spending on new automobiles depends on their relative price (sectoral factor) and the cost of financing, represented by the interest rate (macro factor).

We use "bridge" matrices to translate consumer spending by category, equipment investment by industry, and structures purchases by type of structure into goods and services defined in terms of producing sectors. For example, the equipment-by-industry bridge translates investment by agriculture into farm machinery, trucks, computers, along with several other categories of capital goods.

Output forecasts are combined with industry-level equations for productivity and average hours per job forecasts to arrive at forecasts of jobs required by industry. Productivity by industry depends on terms that capture business cycle effects on productivity as well as time trends. Hours equations generally depend on time trends and movements in the unemployment rate.

Prices and Income

Prices for any product are the weighted sum of unit costs. These costs are the cost of intermediate goods and direct factor costs (labor compensation, indirect taxes, capital income, i.e. value-added). Labor compensation is divided into wages and salaries and employer contributions for pensions, for health insurance, for social insurance, and for other benefits. The 8 components of capital income are model separately. Among the components are corporate profits, proprietor income, net interest payments, capital consumption allowances.

Intermediate costs come from the input-output structure. For example, an increase in profits in the steel industry raises steel prices (all else constant), which raises costs for auto makers, and, in turn, raises prices in autos and all other products using steel. Prices by industry are calculated using the dual of the input-output equation:

$$p = pA + v$$

where p is a row vector of prices, A is the technology matrix, and v is a row vector of value-added per unit of output.

Equations for labor compensation, profits, etc. (value-added) are estimated at the 51 industry level and depend both on sector specific and macroeconomic factors. Example: Equations to predict corporate profits by industry depend on real output growth (sectoral demand), and the GNP gap (economy-wide excess demand).

The following tables show the sectors and categories of variables in the LIFT model, along with the variables that influence them in the model.

LIFT Product Side

Component	Sectors	Influences
Output by product sector	85	q = Aq + f
Personal Consumption by NIPA expenditure category	80	Disposable income Size distribution of income Change in disposable income Interest rates, Relative prices Age structure of population Other demographic variables
Equipment Investment by investing industry	55	Change in product outputs Change in relative prices of user cost of capital, labor, and energy Stock of equipment by industry
Construction by type	31	Output, Income, or Expenditure Interest rates, Stocks, Demographics
Inventory Change by product sector	85	Product output, Inventory stocks Interest rates and inflation
Imports by product sector	85	Domestic demand by product Domestic/foreign product prices Exchange rates
Exports by product sector	85	Foreign demand by product Foreign/domestic product prices Exchange rates
Labor Productivity by product sector	85	Output cycles by sector Time trends
Length of Work Week by product sector	85	Change in output, Unemployment rate Labor force participation
Employment	85	Labor productivity, output, work year
Consumption, Equipment, & Construction by product	85	Final demands by category are bridged to producing sectors
Government Purchases by product sector	85	Exogenous

LIFT Price-Income Side

Component	Sectors	Influences	
Prices by product sector	85	$p = pA + v$	
Value added by product sector	85	Value added by industry distributed to products based on product-to-industry bridge	
Value added by industry:			
Labor Compensation	51	Hourly compensation * hours	
Aggregate wage (hourly compensation)	1	Labor productivity Excess money growth GNP Gap Price shocks (oil,agric)	
Relative wages industry/aggregate	51	Unemployment, inflation Labor force participation	
Return to capital by industry	51	Corporate profits Proprietor income Net interest Depreciation allowances Inventory value adjustment Business transfer payments	+ + + + +
Rental income for 1 industry	1	Average share of nominal GNP Inflation Transitory nominal GNP	
Indirect business taxes total of all industries	1	Lagged IBT as share of GNP Growth in real GNP	
by industry	51	Share of total IBT Exogenous	
Government subsidies (largely Agricultural subsidies)	51	Exogenous	

LIFT Return to Capital by Industry

Component	Sectors	Influences
Corporate Profits by industry	51	Mark-up over labor costs Input costs Demand (output, unemployment, interest rates)
Proprietor Income "large" industries	9	Mark-up over labor costs Capital stock to output Demand
all other proprietor income by industry	42	Change in labor compensation (three-year average)
Net Interest Payments total domestic payments	1	Current AAA-bond rate Smoothed average rate Business debt
by industry	50	Share of total domestic payments
Rest of World payments	1	Change in net factor income
Capital Consumption Allowances Corporate and Noncorporate totals determined by same specification, but with different equations	51	Depreciation of equipment Depreciation of structures
Inventory Valuation Adjustment Corporate & Noncorporate determined by same specification, but with different equations	1	Inflation
by industry	51	Share of total IVA
Business Transfer Payments total	1	Share of nominal GNP Lagged real interest rate Unemployment rate
by industry	51	Share of total Business Transfers

LIFT Macroeconomic and "Other" Variables

Component	Influences
Population	Exogenous: INFORUM DPM
Labor Force	Exogenous: INFORUM DPM
Tax policy	Exogenous: 1986 Tax Law, 1993 changes
Monetary policy	Exogenous: INFORUM (M2 or monetary base. St. Louis)
Government expenditures	
Purchases	Exogenous: INFORUM assumptions
Transfer payments	Exogenous: INFORUM assumptions
Old age	constant in real terms per recipient
Medicare	constant fraction of health spending
Unemployment	constant in real terms per recipient
Other	nominal level assumed
Interest payments	Endogenous: depends on Debt and Interest rates
Price of crude oil	Exogenous: INFORUM assumption
Savings rate	GNP Gap
	3-month Treasury bill rate
	Consumer installment debt ratio
Interest rates	
3-month Treasury bill	Inflation
	Real monetary base, St. Louis
	GNP Gap
	Credit demand (including Federal deficit)
10-year Treasury note	3-month Treasury bill rate
	Inflation
	Credit demand (including Federal deficit)
Commercial paper	3-month Treasury bill rate
Mortgage rate	10-year Treasury note rate
Aaa bond rate	10-year Treasury note rate
	Profits + Depreciation as share of GNP
Bridge tables:	
Intermediate coefficients	Across-the-row trends
Construction materials	Across-the-row trends
Personal consumption	Trends
Equipment investment	Investment cycle, Trends

Endnotes

1. Many authors have examined particular economic aspects of the Baby Boom generation. See for example, Easterlin (1991), Fair and Dominquez (1991) and Yoo (1994).

2. The macro-interindustry model we use to assess the effects of the aging U.S. population is the LIFT model, built and maintained at the INFORUM group of the University of Maryland. For a quick overview of the model, see Appendix 1. Other useful references include McCarthy (1991), Monaco and Phelps (1995), and Monaco and Phelps (1996).

3. Projections are from INFORUM's Demographic Projections Model (DPM). In this case, the projections are extremely close to the Census Bureau's recently released population projections. See Appendix 1 for more information about DPM.

4. The surge in immigration reflects the changes in the 1986 Immigration and Reform and Control Act (IRCA). The act legalized many illegal immigrants and allowed for family members of the formerly illegal immigrants to enter the country.

5. These large cohort changes led Easterlin (1991) to hypothesize that the large cohorts entering the labor force in the 1970's would lead to lower wages and an increase in female labor force participation rates, delayed marriages and lower fertility rates.

6. As late as 1950 and 1960, the population profile was pyramidic, that is, as a percent of the population, the largest cohort appeared in the youngest age group and the smallest cohort appeared in the oldest group. The movement of the Baby Boomers through the age distribution tends to invert the pyramid.

7. See also Cutler *et. al.* (1990) for a theoretical model incorporating dependency ratios and age dependent structure of labor productivity.

8. Recent volumes include Moon and Mulvey (1995), Marmor (1988), Steurle and Bakija (1994), and Weaver (1990).

9. Fair and Dominguez attempt to estimate the labor force and consumption effects, but do not explicitly consider the effects on the federal budget.

10. In this paper we assume fixed labor force participation rates. Obviously, another avenue to consider is changing participation rates dependent on the economy and the age structure of the population. Fair and Dominguez (1991) test the Easterlin hypothesis of relative wages, and find mixed results.

11. The exceptions for Medicare include those with end-stage renal disease. The disability insurance payments from Social Security account for a small percentage of total outlays.

12. Assuming no change in the structure of entitlements.

13. It was common in the popular demographics literature of the 1970s and early 1980s that the fastest growing consumer goods industries were those related to people in their mid-twenties.

14. See Janoska (1994b) for a discussion of this treatment of Medicare.

15. For a comprehensive review of competing demand systems see Guayacq (1985).

16. We used the 1972 CEX to estimate the cross-section regressions used in this study.

17. In some cases, namely for most parts of medical services spending, we substituted weights we calculated from other sources in place of our estimated weights. Weights were crafted to conform to Waldo et. al. (1989).

18. For details of these equations, see Dowd (1996).

19. Demographic variables appear in several other LIFT equations. For example, the number of school-age children is a key explanatory variable in the equations predicting construction of educational buildings, both public and private. The equation for single family residential structures depends on the share of the population in the traditional new-home-buying population (ages 25-40).

20. There are number of ways to achieve deficit neutrality; we chose to reduce the amount of taxes as a share of personal income.

21. Several other major assumptions were made in these scenarios. First, we assumed that monetary policy (M2 and the St. Louis monetary base) accommodated the increases in potential GDP that arose from a larger workforce. Second, we assumed that the number of multiple job holders in the labor force were a constant share of the number of jobs in the economy.

22. Table 3 shows the effect of the aging population on the pattern of consumer spending, holding constant real income, prices, and other demographic/economic variables in the PCE equations. Entries in Table 3 show the effect of aging, entries in Table 5 show the effects of not aging. Because both Table 5 and Table 3 are essentially percentage deviations from 1994, and because we kept the total population the same between the Base and the AGECON scenario, we can compare the effects directly.

23. Potential GNP is a function of participation rates (held constant across simulations), productivity growth, labor force growth, and the percentage change in average weekly hours. The LIFT hours equations respond to economic conditions; higher unemployment rates lead to lower weekly hours.

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TABLE 1
Demographic Assumptions and Projections, DPM

	Population		Births per 1000 women aged 14-44	Life Expectancy at Birth, years		Immigration	
	Millions	Annual growth, decade ending	Total	Male	Female	Decade sum (millions)	Percent of Pop. increase
1850	23.2		197.6			1.71	
1860	31.4	3.0	187.6			2.60	31.7%
1870	38.6	2.0	170.6			2.32	32.2%
1880	50.2	2.6	158.6			2.81	24.2%
1890	62.5	2.2	140.6			5.25	42.7%
1900	75.8	1.9	133.6	46.3	48.3	3.69	27.7%
1910	92.4	2.0	126.8	48.4	51.8	8.80	53.0%
1920	106.5	1.4	117.9	53.6	54.6	5.74	40.7%
1930	123.1	1.5	89.2	58.1	61.6	4.11	24.7%
1940	132.1	0.7	79.9	60.8	65.2	0.53	5.9%
1950	152.3	1.4	106.2	65.6	71.1	1.04	5.1%
1960	180.7	1.7	118.0	66.6	73.1	2.52	8.9%
1970	205.2	1.3	87.9	67.1	74.8	3.32	13.6%
1980	226.5	1.0	68.4	70.0	77.4	4.49	21.1%
1990	248.7	0.9	70.9	71.8	78.8	7.34	33.1%
2000	275.2	1.0	63.8	73.0	79.8	9.86	37.2%
2010	298.4	0.8	68.3	74.1	80.7	8.80	37.9%
2020	322.5	0.8	70.1	75.4	81.6	8.80	36.5%
2030	345.8	0.7	70.0	76.7	82.5	8.80	37.7%
2040	367.8	0.6	71.9	78.2	83.5	8.80	40.0%
2050	390.5	0.6	72.9	79.8	84.7	8.80	38.7%

Source: *Historical Statistics: Colonial Times to 1970*, *Statistical Abstract of the United States*, various issues, authors' calculations

TABLE 2
Age Composition of the Population 1850-2050

	Percent of Population in Age Groups *									
	0-9	10-19	20-29	30-39	40-49	50-59	60+	75+	85+	20-60
1850	28.9	23.3	18.4	12.1	7.9	4.8	4.1	na	na	43.2
1900	23.8	20.6	18.3	13.9	10.2	6.8	6.4	na	na	49.2
1920	21.7	19.0	17.4	15.0	11.5	7.9	7.5	1.4	0.0	51.8
1940	16.1	18.2	17.3	15.1	13.0	10.0	10.5	2.1	0.2	55.4
1950	19.5	14.4	15.8	15.1	12.8	10.2	12.1	2.5	0.4	53.9
1960	21.7	16.8	12.2	13.6	12.5	10.0	13.2	3.1	0.5	48.3
1970	18.1	19.6	15.1	11.1	11.8	10.3	14.0	3.7	0.7	48.3
1980	14.6	17.4	18.0	13.9	10.0	10.3	15.7	6.4	1.0	52.2
1990	14.8	14.0	16.3	16.8	12.6	8.8	16.8	7.2	1.2	54.5
2000	14.4	14.1	13.5	15.1	15.4	11.1	16.4	6.0	1.5	55.1
2010	13.6	13.8	13.6	12.9	13.8	13.8	18.5	6.1	1.9	54.1
2020	13.7	13.0	13.3	13.0	11.9	12.5	22.6	6.6	1.9	50.7
2030	13.5	13.2	12.7	12.8	12.1	10.9	24.8	9.0	2.3	48.5
2040	13.6	13.1	12.9	12.3	12.0	11.2	24.9	11.0	3.5	48.4
2050	13.8	13.2	12.8	12.5	11.6	11.2	25.0	10.9	4.4	48.1

Source: *Historical Statistics: Colonial Times to 1970*, authors' calculations. * Shares of population in the group relative to total population.

TABLE 3
Real Per Capita Consumer Spending Changes due to Age Composition Shifts
Percentage Change relative to 1994

	Percentage change relative to 1994, 1994 = 0							
	1960	1980	2005	2010	2020	2030	2040	2050
Durable Goods	2.4	1.4	-1.5	-2.3	-3.7	-4.6	-4.8	-4.7
Motor Vehicles and Parts	-0.3	1.8	-1.6	-1.9	-2.5	-3.2	-3.3	-3.2
Furniture & Household Eqpt.	4.3	1.2	-1.4	-2.3	-4.0	-5.1	-5.3	-5.2
Non-Durable Goods	-1.2	-0.9	0.5	0.6	0.8	0.9	1.0	0.9
Food and Alcohol	-3.3	-2.5	1.4	1.9	3.1	4.3	4.5	4.2
Clothing	2.8	1.3	-0.8	-1.3	-2.4	-3.3	-3.4	-3.3
Services	-7.3	-3.4	4.0	6.6	9.4	14.5	26.4	35.9
Housing & Hshld. Operation	-0.5	-1.8	0.3	0.4	0.8	1.1	1.2	1.1
Transportation	-4.5	0.4	0.8	1.1	0.8	0.3	0.3	0.1
Medical Services	-26.5	-14.0	14.7	24.3	35.3	57.3	109.7	152.4
Education	-10.1	14.3	-0.8	-0.7	-3.7	-4.9	-4.9	-5.3
Personal & Recreation	-1.9	-2.0	1.0	1.9	4.8	7.5	7.8	7.7
Financial & Legal	-0.1	1.1	3.7	5.2	4.1	1.1	1.0	1.1

Source: Authors' calculations. Holding income and prices constant, a value of 1 indicates that real per capita spending is up 1 percent relative to spending in 1994 due to the composition of the population.

Table 4
Population Age Composition
Population Shares Constant Simulation

	Percentage Deviations from Base *						
	1995	2005	2010	2020	2030	2040	2050
Total Population	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0-4 years	1.2	9.8	10.0	9.5	11.3	10.2	8.5
5-14 years	-0.2	2.7	6.6	8.2	8.1	8.7	7.2
15-19 years	-0.2	-2.5	-2.6	4.8	3.7	3.8	4.0
20-29 years	2.3	7.6	6.4	9.0	14.1	12.4	13.1
30-39 years	1.2	25.7	31.5	30.3	32.6	37.7	35.7
40-49 years	-3.0	-8.9	0.8	17.1	15.1	16.2	20.4
50-64 years	-0.9	-24.1	-31.6	-30.1	-18.7	-18.7	-19.8
65-74 years	0.4	13.3	2.6	-25.8	-32.2	-19.8	-19.5
75-84 years	-1.0	-7.4	-1.4	-10.5	-37.2	-44.1	-35.7
85-100 years	-1.4	-20.2	-28.3	-30.4	-42.1	-61.8	-69.1
Civilian Labor Force	-0.1	-1.7	-1.8	1.7	6.1	7.0	7.6
	Deviations from Base Values **						
% Population < 20	0.1	0.9	1.4	2.1	2.1	2.1	1.8
% Population 20-64	0.0	-1.0	-1.0	1.5	4.8	5.2	5.3
% Population 65+	0.0	0.2	-0.4	-3.6	-6.9	-7.3	-7.1

Source: Authors' calculations. * A value of 1 indicates the population group is 1percent larger than the base. ** A value of 1 indicates that the population group as a share is 1 percentage point larger than the base.

Table 5
Personal Consumption Expenditures
Population Shares Constant Simulation

Percentage Deviation from base							
	1995	2005	2010	2020	2030	2040	2050
Total PCE	0.0	-0.2	-0.8	-0.5	0.5	0.6	-0.4
Durable Goods	0.2	3.9	5.0	7.7	11.4	15.3	15.8
Motor Vehicles & Parts	0.2	5.2	6.0	9.0	12.9	16.5	16.4
Non-Durable Goods	0.0	0.3	0.3	0.9	2.7	5.3	6.4
Food and Alcohol	-0.1	-1.0	-1.4	-1.6	-0.9	1.1	2.2
Clothing	0.1	2.3	2.8	4.6	7.7	11.1	11.7
Services	-0.1	-2.1	-3.7	-4.6	-5.2	-7.9	-10.6
Housing & Hhld Oper.	-0.1	0.0	-0.3	-0.7	0.3	2.7	3.7
Transportation	-0.2	0.0	-0.4	0.5	2.8	5.2	5.8
Medical Services	-0.4	-8.5	-12.9	-15.5	-21.0	-32.9	-39.3
Physicians	0.2	0.7	0.0	-1.0	1.7	6.2	8.3
Dentists & Other Prof.	0.1	1.9	2.3	2.3	4.1	8.9	12.3
Priv. & Gov. Hospitals	-1.0	-18.1	-26.0	-29.5	-37.3	-51.1	-57.1
Nursing Homes	-1.2	-20.1	-27.6	-27.8	-34.7	-50.8	-57.3
Other Services	0.0	-0.3	-1.4	-2.2	-0.1	3.9	4.8

Source: Authors' calculations. A value of 1 indicates that consumption is up 1 percent relative to the base.

Table 6
Macroeconomic Summary
Population Shares Constant Simulation

Percentage Deviations from Base						
	2005	2010	2020	2030	2040	2050
Gross Domestic Product	-0.6	-1.0	0.5	3.1	6.4	10.5
Potential GNP	-0.9	-1.0	1.1	5.0	8.7	11.6
Personal Consumption	-0.2	-0.8	-0.5	0.5	0.6	-0.4
Sum Fixed investment	-1.5	-1.4	0.8	2.5	4.8	7.5
Residential Structures	-4.2	-2.9	0.6	0.8	3.1	4.9
Non-resid. Struct.& Equip.	-0.8	-1.1	0.8	2.9	5.1	7.8
Exports	-0.1	-0.1	1.8	7.0	16.8	31.9
Imports	0.5	0.1	-1.0	-3.5	-6.6	-10.1
PCE Deflator (77=100)	-0.6	-1.1	-3.8	-10.8	-20.7	-27.6
Avg. Hourly Comp. Nom.	0.9	1.5	-0.6	-7.3	-15.3	-22.0
Exchange Rate, ($/For Cu)	0.7	1.4	2.3	2.7	4.1	9.0
Private Labor Productivity	0.4	0.8	1.3	2.4	4.7	7.0
Real Disposable Income	0.4	-0.5	-1.1	-1.7	-2.0	-2.1
Deviations from Base Values						
	2005	2010	2020	2030	2040	2050
Three month T-bills, %	0.2	-0.1	-1.0	-2.3	-2.9	-2.9
Savings rate, %	0.3	0.0	-0.9	-2.4	-3.0	-2.2
Ratio Surplus to GNP %★	-0.1	0.4	1.7	3.2	5.0	6.6
Deviations from Base Growth Rates						
	1995-05	2005-20	2020-30	2030-40	2040-50	
Gross Domestic Product	-0.1	0.1	0.3	0.3	0.4	
Potential GNP	-0.1	0.1	0.4	0.3	0.3	
M2	-0.1	0.1	0.4	0.3	0.3	
PCE deflator (77=100)	-0.1	-0.2	-0.8	-1.2	-0.9	
Private Labor Productivity	0.0	0.1	0.1	0.2	0.2	
Total jobs, mil	-0.1	0.1	0.3	0.1	0.1	
Labor force, mil	-0.2	0.2	0.4	0.1	0.1	

Source: Authors' calculations. ★ Base value is deficit alternative is surplus. *A value of 1 indicates that the variable is up 1% relative to the base. ** A value of 1 indicates that the variable is 1percentage point higher than the value in the base. *** A value of 0.1 indicates that the variable is growing one-tenth of a percentage point faster.

Table 7
Aggregate Sector Employment
Population Shares Constant Simulation

Percentage Deviations from Base						
	2005	2010	2020	2030	2040	2050
Civilian jobs	-1.4	-2.1	0.1	3.0	3.9	5.0
Private sector jobs	-1.5	-2.1	0.3	3.8	5.4	7.0
Ag., forestry, fishery	-1.2	-1.5	-0.4	1.5	3.9	6.6
Mining	-1.1	-1.4	1.1	5.7	12.0	19.6
Construction	-1.5	-1.5	0.7	2.9	4.6	6.2
Non-Durables Mfg.	-0.4	-0.7	1.0	5.0	10.7	17.8
Durables Mfg.	0.0	0.4	3.9	9.5	17.5	26.5
Transportation	-1.0	-1.4	1.5	6.6	12.2	18.4
Utilities	-0.7	-1.2	-0.3	2.1	5.8	10.3
Trade	0.3	0.6	4.1	9.5	13.8	16.2
Finance, Ins, Real Est	-1.4	-2.2	-0.1	4.7	9.2	13.1
Non-Medical Services	-0.7	-0.9	1.7	6.4	10.6	13.6
Medical services	-10.4	-14.8	-15.8	-20.1	-32.9	-39.7
Civilian Government	-1.2	-1.8	-0.6	-1.4	-3.8	-5.5

Source: Authors' calculations. A value of 1 indicates that there are 1 percent more jobs in the sector in the population constant than in the base.

Table 8
Personal Consumption Expenditures
Deficit Neutral Simulation

Percentage Deviations from Base							
	1995	2005	2010	2020	2030	2040	2050
Total PCE	0.0	-0.3	-0.2	1.9	5.2	7.8	8.3
Durable Goods	0.2	3.8	6.0	10.9	17.4	24.5	26.8
Motor Vehicles & Parts	0.2	5.2	7.4	12.4	19.1	25.9	27.5
Non-Durable Goods	0.0	0.3	0.8	3.1	6.9	11.8	14.2
Food and Alcohol	-0.1	-1.0	-0.9	0.0	2.2	6.0	8.1
Clothing	0.1	2.2	3.6	7.7	13.7	20.4	22.9
Services	-0.1	-2.2	-3.2	-2.3	-0.8	-1.2	-2.3
Housing & Hhld. Oper.	-0.1	-0.1	0.0	0.5	2.5	6.3	8.1
Transportation	-0.2	-0.1	0.4	3.0	7.6	12.5	14.5
Medical Services	-0.4	-8.6	-12.5	-13.8	-18.2	-29.4	-35.4
Physicians	0.2	0.6	0.3	0.8	5.2	11.5	14.4
Dentists & other Prof.	0.1	1.9	2.5	3.0	5.3	10.7	14.1
Private & Gov. Hosp.	-1.0	-18.2	-25.5	-27.6	-34.4	-47.8	-53.5
Nursing Homes	-1.2	-20.2	-27.1	-25.7	-31.5	-47.2	-53.4
Other Services	0.0	-0.4	-0.4	1.6	7.0	15.0	18.5

Source: Authors' calculations. A value of 1 indicates that consumption is up 1 percent relative to the base.

Table 9
Macroeconomic Summary
Deficit Neutral Simulation

Percentage Deviations from the Base *						
	2005	2010	2020	2030	2040	2050
Gross Domestic Product	-0.6	-0.6	0.7	2.7	4.1	4.1
Potential GNP	-0.9	-1.0	0.7	3.7	5.7	6.2
Personal consumption	-0.3	-0.2	1.9	5.2	7.8	8.3
Fixed investment	-1.5	-1.0	0.5	1.9	2.7	2.4
Residential Structures	-4.1	-2.1	-0.9	-1.4	-1.2	-1.3
Non-resid. Struct. & Equip.	-0.8	-0.8	0.8	2.6	3.3	2.9
Exports	-0.1	-0.1	-0.2	0.1	0.9	1.3
Imports	0.4	0.9	2.8	4.6	6.9	7.9
PCE deflator (77=100)	-0.6	-1.2	-3.1	-9.2	-18.5	-26.4
Avg Hourly compensation	0.8	1.5	0.7	-4.2	-10.7	-17.9
Exchange Rate, ($/For Cu)	0.7	1.3	0.2	-3.8	-10.0	-17.1
Private Labor Productivity	0.4	0.7	0.6	0.8	1.8	2.4
Real disposable income	0.3	0.5	2.3	4.4	6.5	6.6
Deviations from Base Values **						
	2005	2010	2020	2030	2040	2050
Three month T-bills, %	0.1	0.1	-0.2	-1.1	-1.3	-1.7
Savings rate, pct	0.3	0.3	-0.1	-1.2	-1.8	-2.3
Surplus relative to GNP, %	0.0	0.0	0.0	0.0	0.0	-0.1
Ratio pers.taxes to income	0.0	-0.5	-1.7	-3.0	-4.3	-4.8
Deviations from Base Growth Rates ***						
	1995-05	2005-20	2020-30	2030-40	2040-50	
Gross Domestic Product	-0.1	0.1	0.2	0.1	0.0	
Potential GNP	-0.1	0.1	0.3	0.2	0.0	
M2	-0.1	0.1	0.3	0.2	0.0	
PCE deflator (77=100)	-0.1	-0.2	-0.6	-1.1	-1.0	
Private Labor Productivity	0.0	0.0	0.0	0.1	0.1	
Total jobs	-0.1	0.2	0.3	0.1	0.0	
Labor force	-0.2	0.2	0.4	0.1	0.1	

Source: Authors' calculations. *A value of 1 indicates that the variable is up 1% relative to the base. ** A value of 1 indicates that the variable is 1percentage point higher than the value in the base. *** A value of 0.1 indicates that the variable is growing one-tenth of a percentage point faster.

Table 10
Aggregate Sector Employment
Deficit Neutral Simulation

Percentage Deviations from Base	2005	2010	2020	2030	2040	2050
Civilian jobs	-1.5	-1.7	0.9	4.0	4.8	4.5
Private sector jobs	-1.5	-1.7	1.1	5.0	6.4	6.4
Ag., Forestry, Fishery	-1.2	-1.3	-0.2	1.5	3.3	4.4
Mining	-1.1	-1.0	0.7	3.4	5.8	6.6
Construction	-1.5	-1.3	0.2	1.7	2.2	2.0
Non-Durables Mfg.	-0.5	-0.4	0.8	3.1	5.3	6.3
Durables Mfg.	0.0	0.6	2.2	4.4	6.6	7.1
Transportation	-1.0	-1.0	2.0	6.4	9.7	11.0
Utilities	-0.8	-0.9	0.0	1.7	3.3	3.9
Trade	0.2	1.2	5.9	13.0	18.7	21.0
Finance,Ins.,Real Est.	-1.4	-1.7	1.2	6.6	10.7	11.9
Non-Medical Sevices	-0.7	-0.5	2.9	8.2	12.7	14.7
Medical services	-10.4	-14.5	-14.3	-17.6	-29.6	-35.7
Civilian Government	-1.2	-1.8	-0.5	-1.1	-3.4	-5.0

Source: Authors' calculations. A value of 1 indicates that there are 1 percent more jobs in the sector in the population constant than in the base.