NBER WORKING PAPER SERIES

GENERATIONAL ACCOUNTING AND IMMIGRATION IN THE UNITED STATES

Alan J. Auerbach
Philip Oreopoulos

Working Paper 7041
http://www.nber.org/papers/w7041

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
March 1999

We gratefully thank Jagadeesh Gokhale, Tim Miller, and, especially, Barry Edmonston for their provision of data and projections necessary for the computations presented in this paper. We thank Jagadeesh Gokhale, Ron Lee and Jan Walliser for comments on an earlier draft, and the Burch Center for Tax Policy and Public Finance, the Social Sciences and Humanities Research Council of Canada, and the Center for the Economics and Demography of Aging (through NIA grant P20 AG12839) for financial support. The views expressed in this paper are those of the authors and do not reflect those of the National Bureau of Economic Research.

Generational Accounting and Immigration
in the United States
Alan J. Auerbach and Philip Oreopoulos
NBER Working Paper No. 7041
March 1999
JEL No. H6, J1

ABSTRACT

In recent years, the renewed strength of immigration to the United States has sparked a debate about the economic effects of immigration. A central issue in this debate has been the fiscal impact of immigrants. Most research in this area has adopted a static, cross-section approach in assessing the net impact of immigrants on the economy's fiscal position. However, a dynamic approach is important because of the age dependency of many government tax and expenditure programs, and necessary to take the descendents of immigrants into account.

This paper reconsiders the fiscal impact of immigrants over time, using the technique of generational accounting. We may summarize our results with three findings:

1. Because *new* immigrants represent a larger fraction of future generations than of present ones, shifting the burden onto future generations also shifts it, relatively, onto new immigrants. Thus, if the entire fiscal imbalance currently estimated for the United States is placed on future generations, then the presence of new immigrants reduces the burden borne by natives.

2. When a policy of "fiscal responsibility" is followed, whether there is a fiscal gain from immigration depends on the extent to which government purchases rise with the immigrant population.

3. The impact of immigration on fiscal balance is extremely small relative to the size of the overall imbalance itself. Thus, immigration should be viewed neither as a major source of the existing imbalance, nor as a potential solution to it.

Alan J. Auerbach
Department of Economics
University of California
549 Evans Hall
Berkeley, CA 94720-3880
auerbach@econ.berkeley.edu

Philip Oreopoulos
Department of Economics
University of California
549 Evans Hall
Berkeley, CA 94720-3880
oreo@econ.berkeley.edu

Introduction

In recent years, the renewed strength of immigration to the United States has sparked a debate about the economic effects of immigration. A central issue in this debate has been the fiscal impact of immigrants. Most research in this area has adopted a static, cross-section approach in assessing the net impact of immigrants on the economy's fiscal position.[1] However, recent work has extended this perspective to consider the impact of immigrants over time. A dynamic approach is important because of the age dependency of tax and expenditure programs, and the necessity to take the descendents of immigrants into account. For example, a large working-age immigrant population might appear from cross-section analysis to lessen the fiscal burden of a pay-as-you-go social security pension system, even if these immigrants will eventually receive benefits from the system that exceed the taxes they pay, in present value. On the other hand, a large population of school-age immigrants might appear to add fiscal pressure via added expenditures, even if the subsequent income taxes paid by them in their adulthood and by their native offspring more than compensate for the increased spending.

A key contribution adopting such a dynamic approach (National Research Council, 1997, Chapter 7, based largely on Lee and Miller, 1997) reached the conclusion that U.S. immigrants provide a net fiscal benefit in present value, when account is taken of their own impact on tax receipts, transfers and government purchases, as well as the impact of their descendents. However, this finding hinged on the assumption that government would shift its fiscal policy to a sustainable path by stabilizing its national debt-GDP ratio and thereby raising the net tax burdens on all individuals, including immigrants. Under the assumption of no change in policy (an

[1] This line of research is surveyed in National Research Council (1997), Chapter 6.

unsustainable situation), immigrants' contributions were projected to be slightly negative, indicating that whether immigration is "part of the problem" or "part of the solution" depends on whether there is a solution, or just a problem.

This paper reconsiders the fiscal impact of immigrants over time, using the technique of generational accounting introduced by Auerbach, Gokhale and Kotlikoff (1991) and applied subsequently by a number of others.[2] In stressing the impact of policy on the relative burdens of different age cohorts, generational accounting produces a measure of fiscal imbalance that is independent of the accounting conventions used to measure national debt. Of particular value in the present context is that it permits us to consider not only the net contribution of immigrants to fiscal balance, but also the size of this impact relative to the overall imbalance. Generational accounting also allows us to compare changes in immigration policy to other policies in terms of their impact on fiscal balance and the welfare of different generations.

In performing this analysis, another of the paper's contributions is its adaptation of the generational accounting methodology to accommodate the presence of immigrants and immigration. In the past, generational accounts have typically ignored immigration, treating population changes resulting from immigration as if they resulted from a decline in mortality among natives in the immigrant's generation. That is, all members of a given generation at each age were treated as survivors among the original U.S. residents of that generation. Thus, each generation's account included the projected taxes and transfers of subsequent immigrants of the same cohort, and therefore did not reflect the net fiscal burdens of current residents of that generation. For example, if immigrants were primarily aged, and received certain old-age benefits, these benefits would have been treated as additional transfer payments to current

[2] For a recent compilation, see Auerbach, Kotlikoff and Leibfritz (1999).

residents, leading to an understatement of the typical resident's lifetime fiscal burden. For countries with significant immigrant populations, such a procedure could provide a distorted picture of the fiscal burdens of current generations and hence of the relative gap between current and future generations implied by a given fiscal policy.

Because of the importance of this change in methodology, we begin our presentation in the next section with a description of the new approach to generational accounting and a comparison of this approach with the previous one. After discussing our data sources, we turn then to an analysis of the impact of immigration to the United States on fiscal balance and generational burdens.

Generational Accounting: Existing Methodology

We begin with a brief review of the standard generational accounting methodology. For further discussion, the reader is referred to Auerbach, Gokhale and Kotlikoff (1991) or Auerbach and Kotlikoff (1999).

Generational accounting is based on the government's intertemporal budget constraint. This constraint, written as equation (1), requires that the present value of all future net tax payments made by current and future generations must be sufficient to cover the present value of future government consumption as well as service the government's initial net indebtedness.[3]

(1) $$\sum_{s=0}^{D} N_{t,t-s} + \sum_{s=1}^{\infty} N_{t,t+s}(1+r)^{-(s-t)} = \sum_{s=t}^{\infty} G_s (1+r)^{-(s-t)} - W_t^g$$

[3] The constraint does not assume that government debt is ever fully paid off, merely that the debt grows less quickly than the rate of discount, i.e., it does not explode. Thus, it is consistent with the long-run existence of government deficits, as long as these deficits are smaller than the amount needed simply to service the level of outstanding debt.

The first summation on the left-hand side of (1) adds together the generational accounts (the present value of the remaining lifetime net payments) of existing generations. The term $N_{t,t-s}$ stands for the account of the generation born in year *t-s*. The index *s* in this summation runs from age 0 to age D, the maximum length of life.[4]

The second summation on the left side of (1) adds together the present values of remaining net payments of future generations, with *s* representing the number of years after year *t* that the generation is born. The first term on the right hand side of (1) expresses the present value of government consumption. In this summation the values of government consumption in year *s*, given by G_s, are discounted by the pre-tax real interest rate, *r*. The remaining term on the left hand side, W_t^g, denotes the government's net wealth in year *t* – its assets minus its explicit debt. As in past applications, we ignore real government assets and the flows from such assets in calculating G_s and W_t^g, so that the latter simply corresponds to minus the value of government debt.

Equation (1) indicates the zero sum nature of intergenerational fiscal policy. Holding the present value of government consumption fixed, a reduction in the present value of net taxes extracted from current generations (a decline in the first summation on the left side of (1)) necessitates an increase in the present value of net tax payments of future generations.

The term $N_{t,k}$ is defined by:

(2) $$N_{t,k} = \sum_{s=k}^{k+D} T_{s,k} P_{s,k} (1+r)^{-(s-k)}$$

[4] Hence, the first element of this summation is $N_{t,t}$, which is the present value of net payments of the generation born in year *t*; the last term is $N_{t,t-D}$, the present value of remaining net payments of the oldest generation alive in year *t*, namely those born in year *t-D*.

where $k = \max(t,k)$. For generations born prior to year t, the summation begins in year t. For generations born in year $k > t$, the summation begins in year k.

In expression (2) $T_{s,k}$ stands for the projected average net tax payment made to the government in year s by a member of the generation born in year k. The term $P_{s,k}$ stands for the number of residents in year s belonging to the cohort born in year k. As discussed above, the traditional generational accounting methodology treats each of these as survivors of those present in year k. That is, immigrants have their taxes and transfers attributed to natives of the same cohort.

A set of generational accounts is simply a set of values of $N_{t,k}$, one for each existing and future generation, with the property that the combined present value adds up to the right hand side of equation (1). Though we distinguish male and female cohorts in the results presented below, we suppress sex subscripts in (1) and (2) to ease notation.

Note that generational accounts reflect only taxes paid less transfers received. With the occasional exception of government expenditures on education, the accounts presented in past research typically have not imputed to particular generations the value of the government's purchases of goods and services. Therefore, the accounts do not show the full net benefit or burden that any generation receives from government policy as a whole, although they can show a generation's net benefit or burden from a particular policy change that affects only taxes and transfers. Thus generational accounting tells us which generations will pay for government spending, rather than telling us which generations will benefit from that spending. Another characteristic of generational accounting that should be understood at the outset is that, as its name suggests, it is an accounting exercise that, like deficit accounting, does not incorporate induced behavioral effects or macroeconomics responses of policy changes.[5] As a corollary, it does not incorporate the deadweight loss of taxation in its measure of fiscal burden, again following the tradition of budget incidence analysis.

The left-hand-side of equation (1) is estimated assuming current projected fiscal policy and then compared to the right-hand-side. If the sum of the current and future generational accounts is smaller in present value than total future government consumption and initial net debt, current policy is unsustainable and a policy that adjusts at least part of the equation is required. There is, of course, no unique way to make this adjustment. Our base case assumes that any residual amount needed to satisfy the government's budget constraint will be borne entirely by future generations. The traditional approach has been to spread this burden among future generations in such a way that the average present value lifetime net tax payment per initial member of each future generation is constant except for productivity growth. Again, the methodology did not account for the fact that some of these taxes would actually be paid by immigrants, and did not separate the burdens of immigrants from those of natives.

Generational Accounting and Immigration

To take explicit account of the impact of immigrants, we rewrite equation (1), breaking its components into those attributable to immigrants and those attributable to natives.

[5] For further discussion, see Fehr and Kotlikoff (1999), who consider the impact of general equilibrium effects on generational accounts, using the Auerbach-Kotlikoff simulation model. They find that the accounts as normally calculated typically provide a good approximation of the full general equilibrium impact. Integrating our disaggregated accounts into a general equilibrium model is an interesting topic for future research. Progress in this direction has been made by Storesletten (1998), who incorporates three skill classes of immigrants in an Auerbach-Kotlikoff-type simulation model to study to study the impact of changes in the immigration mix on U.S. fiscal balance.

(3) $$\sum_{s=0}^{D}(N_{t,t-s} + F_{t,t-s}) + \sum_{s=1}^{\infty}\left(N_{t,t+s} + F_{t,t+s}\right)(1+r)^{-(s-t)} = \sum_{s=t}^{\infty} G_s(1+r)^{-(s-t)} - W_t^g$$

where we now define $N_{t,t-s}$ to be the account of the native generation born in year t-s, and define $F_{t,t-s}$ to be the account for all others born in year t-s. Expression (2) still provides the definition of $N_{t,k}$, but now the term $P_{s,k}$ stands for the number of natives born in year k that survive at least until year s. Thus, the two sets of terms $F_{t,k}$ in (3) represent, respectively, the accounts for all immigrants to existing cohorts and the accounts for all immigrants to future cohorts. That is,

(4) $$F_{t,k} = \sum_{s=k}^{k+D} T_{s,k} Q_{s,k} (1+r)^{-(s-k)}$$

where k = max(t,k) and $Q_{s,k}$ is the number of immigrants in generation k present in the United States in year s. The evolution of this value over time (i.e., holding k fixed and varying s) will reflect not only mortality, but also additional immigration and out-migration of previous immigrants.

Because the accounts defined by expression (4) incorporate the net taxes resulting from additional immigration after year k, there is no simple way to divide them by the associated year-k population, $Q_{s,k}$, to produce generational accounts that are comparable to the per-capita accounts of natives. For example, because essentially all first-generation immigrants arrive after age 0, their aggregate age-0 account is attributable to net taxes paid by individuals not in the population as of age 0; the per capita generational account would appear to be infinite. Thus, one should view the construction of the accounts in (4) primarily as a necessary step in deriving correct accounts for natives.

Given adequate data, calculation of the burdens on existing generations remains straightforward after this decomposition: we simply allocate burdens to natives and immigrants based on the taxes and transfers attributable to each group. However, for future generations, which the standard methodology treats as a residual group, there is no obvious analogy to the procedure used in the no-immigrant case. We can no longer simply assign to each future native generation the same (adjusted for growth) per capita generational account, for this leaves open the question of what adjustment should be imposed on future immigrants.

One approach might be to extend the current assumption used to distinguish future burdens by sex, requiring that the percentage per capita increase in generational accounts be the same for natives and immigrants.[6] But this is unappealing given that immigrants have a very different population structure than natives. Put more simply, it seems implausible that any realistic policy to raise the fiscal burdens on future generations would have the same *percentage* impact on the lifetime fiscal burdens of natives and immigrants. Immigrants inherently have a different lifetime pattern of U.S. residence and hence of U.S. taxes and transfers. Indeed, as immigrants arrive at different ages, it is not even clear how they should be aggregated to perform such a calculation.

To deal with this problem, we propose an alternative method of assigning the residual. The method involves first calculating the burdens on future generations (both native and immigrant) under current policy, and then adjusting proportionally some combination of taxes paid and transfers received by these future generations until expression (3) is satisfied. This allocation of the extra burden on future generations typically will yield different percentage

[6] A recent analysis using generational accounting to study immigration in Germany (Bonin et al 1998) did rely an such an assumption. That paper also assumed that the age structure of immigrants among future generations was the same as same as that of current immigrants, an assumption that we do not make here.

increases for men and women, and for natives and immigrants, but will be based on a concrete change in actual policy variables. Because the allocation also depends on the tax or transfer components being adjusted, we consider different policy combinations, namely proportional increases in all taxes, proportional decreases in all transfers, or the combination of the two (with the same proportional changes in taxes and transfers). We also consider making the proportional adjustment of taxes and transfers immediately, so that the new policy affects current as well as future generations.

Data Sources

Construction of generational accounts requires population data and projections, tax and transfer profiles for different demographic groups within each cohort, projections for the path of government purchases, a value for the initial stock of government debt, and assumptions about the government's discount rate.

For much of this, we rely on the recently updated calculation for the United States by Gokhale, Page and Sturrock (GPS 1999). In particular, we use their base year of 1995, their aggregate projections for the growth of government spending, G_t through the year 2070, based on the actual long-term CBO forecast. We benchmark age-based profiles of government spending used by Auerbach, Gokhale and Kotlikoff (1991) to the 2070 aggregate, and assume that these profiles grow with the rate of labor productivity after 2070. Thus, government spending growth is permitted to deviate from the general growth rate to the extent that there are shifts in the age structure of the population. We also use GPS's projections of aggregate taxes and transfers, based on the CBO forecast through 2070 and assumed to grow with labor productivity thereafter. Finally, we use their assumption of a 1.2 percent rate of labor productivity growth after 2070, their real discount rate of 6 percent, and their initial value of W_t^g = -$2.1 trillion.

However, GPS's population projections and their tax and transfer profiles are disaggregated only by sex, and not by nativity, and so we must supplement them with data from other sources. For population projections, we simply use an alternative source that provides information at a more disaggregate level. For tax and transfer profiles, we combine the information in GPS with that provided by another data source.

Our alternative population projections were provided by Barry Edmonston, based on an adaptation of the population projection model used in the recent National Research Council study (1997, Appendix 3.A). The model generates annual population projections through the year 2100, broken down by age, sex and nativity, the last of which has three categories of nativity: first-generation immigrants, second-generation immigrants (i.e., native children of immigrants) and all others, to whom we refer simply as natives. We assume a stationary population after 2100.[7]

Tax and transfer profiles also broken down by nativity come from estimates by Lee and Miller (1997). However, as these profiles were broken down by nativity but not by sex, and the profiles in Gokhale et al were broken down by sex but not by nativity, we developed an algorithm, described in the Appendix below, to use the two sets of profiles in conjunction to generate tax and transfer profiles disaggregated by both sex and nativity. The algorithm requires additional assumptions regarding relative patterns across nativity groups. We choose the restriction that the male-female ratio for each per capita tax or transfer component is constant at

[7] Whether we specify the population to be constant after 2100 or 2200 does not significantly alter our results. The present-value nature of generational accounting places relatively little weight on projections that far in the future.

each age across the three nativity groups. For example, we assume that the ratio of income taxes per age-46 male to income taxes per age-46 female is the same for first-generation immigrants, second-generation immigrants, and natives.

Initial Results: Impact of the Change in Methodology

Table 1 presents generational accounts constructed under different assumptions, to illustrate the impact of the change in methodology just described. For each simulation, the table presents the generational accounts for existing generations of males and females, at five-year intervals, and the accounts for future generations implied by the need to satisfy intertemporal fiscal balance. Our base year is 1995; those born in 1995 represent age 0 in the table, and future generations begin with those born in 1996.

The first two columns present the accounts for males and females based on the traditional methodology, using the aggregate male and female tax and transfer profiles from GPS but our alternative population projections. The accounts for existing generations show the standard pattern, higher in general for men than women and rising and then falling with age as taxes and then transfers because a more significant factor. They also show an imbalance between current and future generations of 54 percent, somewhat lower than the imbalance of 72 found by GPS. The explanation lies in our faster projected population growth. With the initial debt level and projected growth in aggregate government purchases through 2070 held fixed, higher population translates into lower per capita burdens.

The next set of calculations shows the impact of the alternative method of allocating the residual burden to future generations, by cutting all transfers and increasing all taxes in an equiproportional manner. The accounts in these columns still aggregate the taxes and transfers of immigrants with those of natives. Because the only change here is in the allocation of burden among future generations, the accounts for existing generations are unchanged. Listed below the accounts for current generations are the percent increase in taxes and cut in transfers, as well as the corresponding percentage increases, relative to current newborns, in the accounts of future generations of males and females. Note that the percentage increases in the generational accounts are no longer equal for males and females, because the new methodology adjusts taxes and transfers, rather than overall burdens, proportionally. As can be seen by inspection of (2) and the definition of the net tax payment $T_{s,k}$, increasing the accounts proportionally, regardless of the pattern of taxes and transfers, would require an equal percentage increase in all taxes and an equal percentage *increase* in all transfers.[8] Moreover, this approach doesn't necessarily impose an equal per capita net tax burden (adjusted for growth) on all future generations. Even though tax and transfer profiles are the same, changes in mortality (and, in this simulation, immigration patterns as well) will cause different generations to have different lifetime tax burdens. Thus, the "future generation" listed in the table refers to the first future generation only, the cohort born in 1996. Given the change in methodology, there is no assurance that the burden on future generations will be the same as in the first simulation, and indeed the burdens on future males and females born in 1996 are projected to be higher here for both males and females. The explanation for this increase lies primarily in the fact that members of later generations are projected to live longer. As longer life translates into an increase in transfer payments and hence a decline in net tax liabilities, a greater share of the fiscal burden must be placed on the initial future generations, while the burden on later generations will be smaller.

[8] Indeed, the traditional approach, in implicitly raising taxes and raising transfers proportionally, can lead to strange results. For example, if current newborn males have positive generational accounts and females have negative generational accounts, and burdens must be raised on future generations, the standard methodology calls for making the burdens on females more negative.

The last set of calculations, presented in the table's last two columns, illustrates the further impact of distinguishing immigrants from others in the population.[9] It presents the generational accounts for natives based on expression (3), from the model in which the generational accounts of first- and second-generation immigrants are calculated separately. Looking first at the accounts for current generations, we note that these accounts do not follow a consistent pattern relative to those in the previous two columns, based on aggregate native and immigrant populations. These changes are due to two factors. First, the profiles of taxes and transfers for natives are slightly different from those based on the total population. However, as Figures 1(for males) and 2 (for females) show, the differences are not large, in part because the total population is dominated by natives. The second source of difference in the two methods of computing generational accounts is the fact that the populations used previously include varying shares of natives and immigrants at different ages. In particular, as Figure 3 shows, the immigrant share of the elderly in the base year is higher than that for the general population; a similar patterns exists for later years. Because the elderly are net transfer recipients, the previous methodology tends to overstate the transfers expected by those in middle age, for it attributes to a primarily native group the future transfers received by both natives and immigrants. This explains why the accounts in the last set of columns are higher in middle age.

Thus, considering immigrants and natives separately does affect our estimates of generational accounts. However, because this methodology also separates immigrants from future generations of natives, the net impact of the correction on our estimate of generational imbalance is minor. This can be seen by comparing the "% difference" values for males and females in the last two columns of the table with those in the previous two columns.

---

[9] The program used to produce these simulations, written to run using MATLAB version 5, is available at the web site of the Burch Center for Tax Policy and Public Finance (http://emlab.berkeley.edu/users/burch/).

At the bottom of these last two columns are the accounts for the first future native generation. As explained when discussing the previous set of results, these accounts reflect a larger imbalance than was obtained using the traditional method because greater longevity of subsequent generations reduces their generational accounts. This trend is evident in Figure 4, which graphs the accounts for males and females for future generations, beginning with the generation born in 1996.

In addition to the scenario just considered, in which all taxes and transfers are adjusted, the last two columns also present the accounts for the first future generation under the two alternative scenarios in which only taxes or only transfers are adjusted. When taxes and transfers are adjusted, a 42 percent increase in taxes and cut in transfers is required to restore fiscal balance. This is the same percent change required in the previous case, when immigrants were not considered separately, because there has been no change in policy or in aggregate population projections – we are simply separating the burdens on natives and immigrants in our reporting. A 58 percent increase in taxes or a 153 percent cut in transfers (not feasible using transfers alone, of course) would be required if either set of instruments were adjusted separately. While all three policies have similar impacts on current generations, note that the policy of adjusting only taxes falls more heavily on males, while that of adjusting only transfers falls more heavily on females.

These results suggest that the conclusions in past studies that ignored the presence of immigrant populations have not been significantly biased. However, with the new technique, we are now in a position to evaluate the impact of changes in immigration policy.

The Impact of Immigration

What impact would a change in immigration have on the fiscal burdens of current and future generations? To address this question, we must first specify the exact change in policy envisioned. While we do not consider it a realistic policy option, simply halting all immigration in the year 2000 provides a useful polar case for analyzing the impact of less extreme changes in policy as well. Thus, we consider such a policy, based on an alternative set of projections provided by Barry Edmonston, which takes account not only of the direct effect of a drop in first-generation immigrants, but also the drop in the second-generation immigrant and native descendents of these excluded immigrants.

It is also necessary to specify a fiscal policy environment in which the change in immigration policy takes place. We consider two such environments. In the first, the burden of the government's intertemporal fiscal imbalance falls entirely on future generations. This corresponds to the simulations reported in Table 1. In the second fiscal environment, government's fiscal policy is assumed to change immediately, with taxes being raised and transfers being cut on *all* generations from the base year onward, until the government's fiscal imbalance is eliminated, under the current immigration scenario. This policy leaves the current newborn and first future native generations with roughly the same generational accounts, adjusted for growth. The accounts for the first future generation are slightly lower, reflecting their greater life expectancy and the predominance of transfer payments during the last years of life. Note, too, that this policy implies a much lower burden on future generations than does the other scenario.

The impact of these alternative fiscal scenarios may be seen by comparing the first two and last two columns in Table 2, which present the burdens on current and future generations of males and females under the alternative fiscal policies.[10] The first row under "future generations" corresponds to the case of present immigration policy. Reading across the table, we observe that stabilizing fiscal policy would require an increase in $7,600 in the burden on newborn males, and $5,900 in the burden on newborn females, corresponding to an immediate 6 percent increase in all taxes and a 6 percent cut in all transfers.[11] This immediate adjustment would permit a significant drop in the burdens on future generations.

Now, consider the impact of eliminating immigration.[12] Eliminating immigrants also eliminates the taxes they pay and the transfers they receive. It may also have some impact on the level of government purchases, depending on what we wish to assume about the nature of these goods (i.e., "public" goods vs. "private" goods) and how their provision changes with population. Initially, we assume that government purchase profiles remain constant, meaning, for example, that a reduction in the population size with no change in population structure will induce a reduction of equal proportion in the level of government purchases.

Under this assumption about government purchases, the impact of eliminating immigration is shown in the second set of numbers labeled "future generations" in Table 2. For the fiscal scenario that allocates the entire burden to future generations, eliminating immigration hurts the remaining population, raising the burden on males by $4,300 and the burden on females by $3,400. Thus, immigration is helpful in restoring fiscal balance. However, this picture changes under the alternative assumption that fiscal policy is immediately adjusted to institute

[10] The results in this table were originally presented in Auerbach and Oreopoulos (1999).

[11] For this and all other simulations in the second set of columns in Table 2, the "% change" lists two numbers, the first being the policy change imposed on current generations, the second being the policy change imposed on future generations. The first number equals the policy change that, when imposed on current and future generations, initially (under current immigration policy) balances fiscal policy. In Table 1, and in the first set of columns of Table 2, the first of these numbers is always 0 (and hence not listed separately), as all imbalances are imposed on future generations.

[12] This policy simulation also eliminates the return migration of immigrants already in the United States.

balance under present immigration policy. As shown in the table's last two columns, eliminating immigration now *reduces* the burdens of those that remain in future generations, implying that a smaller adjustment would have been needed with immigrants absent; future generations of males gain $4,100, and females gain $3,100.

What explains the difference for the two fiscal policies? It is helpful to consider this in the context of expression (3), the government's intertemporal budget constraint. Under the "responsible" fiscal policy scenario, more of the burden is being placed on current generations, who make up the first term on the left-hand side of (3), and less on future generations, who make up the second term on the left-hand side. Immigrants in future generations are primarily *new* immigrants (whose presence in the United States would be eliminated by the reform)[13], while those in current generations include some *new* immigrants but also all immigrants already present in the United States. Hence, *new* immigrants account for a greater fraction of this second term than of the first: their fiscal contribution, relative to that of others in the population, is weighted more strongly toward future generations. Thus, their average contribution is lower under the policy of immediate adjustment, which raises burdens on those included in both terms, than under the policy of "letting future generations pay," which raises burdens only on those accounted for by the second term. Therefore, eliminating *new* immigrants from the population has a more favorable impact under the scenario of immediate fiscal adjustment. Put another way, with immediate fiscal adjustment, each immigrant's net contribution to fiscal balance is negative, taking account of the associated change in government purchases.

This conclusion hinges, of course, on our assumption regarding the change in government purchases, and in some sense represents an extreme case in which there are no economies of

[13] We say "primarily" because, under the policy considered, there will still be some *second*-generation immigrants born in the future to first-generation immigrant parents who arrived before the elimination of immigration.

scale in the consumption of the goods and services government provides. While this may be a reasonable assumption for some government provided goods, there may be others for which their "public-goods" nature implies significant economies of scale in consumption. To evaluate the importance of this issue, we consider the alternative extreme assumption that all spending on defense, roughly 25 percent of all government purchases, is purely "public" in nature, and does not vary at all with the size of the immigrant population. This means that eliminating immigrants has no impact on this portion of government purchases, which will make reducing immigration appear less attractive from the fiscal perspective.

The last set of numbers labeled "future generations" in Table 2 illustrates the impact of this change in assumption. Now, eliminating immigration after the year 2000 increases the fiscal losses under the "irresponsibility" scenario, and converts the gains to losses under the "responsibility" scenario. In the latter case, the losses to future generations from eliminating immigration are $2,200 for males and $1,700 for females. It is also possible to express this impact of immigration in terms of its impact on all generations, not just future generations. That is, we estimate the increase in generational accounts that would result from the *immediate* adjustment of taxes and transfers – on all generations – required by a ban on immigration. For the scenario that holds defense spending fixed, the answer (not shown in the table) is $300 for each newborn male and $200 for each newborn female (growing with the economy over time), much smaller than the corresponding values of $2,200 and $1,700 if the burden fell only on future generations. Whichever way this calculation is done, the measured impact is very small relative to the size of the overall fiscal imbalance, respectively equal to $49,700 for newborn males and $38,000 for newborn females. Given the many other assumptions inherent in the calculation, the sign of this effect is uncertain.

To examine this sensitivity, we present in Table 4 the results of simulations for alternative interest rate and growth rate assumptions, reporting the percentage change in taxes and transfers for the six cases (two fiscal policy scenarios and three immigration scenarios). In all cases, immigration is beneficial when fiscal policy is irresponsible – that is, when all additional net tax payments required to satisfy the government's budget constraint are made by future generations. In all cases, immigration is has essentially no effect or is slightly harmful when fiscal policy has been adjusted immediately and there are no economies of scale in the consumption of government goods and services. However, adding the assumption that defense spending is unaffected by immigration again leads to the conclusion, in all cases, that immigration is fiscally beneficial. As in the base case (repeated in bold in each table), the fiscal impact of immigration continues to be quite small relative to the overall imbalance facing future generations under current policy. The size of the gain decreases with increases in the discount rate. It also generally declines with the growth rate.

We also performed sensitivity analysis with respect to the method of fiscal adjustment (only taxes or only transfers, rather than taxes and transfers). This variation also does not affect the pattern of fiscal impacts; for each type of fiscal adjustment, immigration is beneficial except when fiscal policy is immediately adjusted and defense spending changes with the size of the immigrant population.

Although it is not surprising in light of the use of common data sources, these results are consistent with those presented in the report of the National Research Council (1997). For a 3 percent discount rate, that study found a small positive impact of immigration under similar assumptions about the existence of some public goods and the assumption of immediate stabilization of the debt-GDP ratio. This assumption is related to our policy of equalizing the burdens on current and future generations, although the two assumptions lead to different patterns of tax increases over time. Using a somewhat different estimation approach, it calculated that each U.S. native would achieve a net tax reduction of $30 if immigration increased by 100,000 individuals per year. This is roughly a 12 percent increase in immigration from projected levels, and hence a policy about one-eighth the size of our policy that ends immigration. Multiplying $30 by 8 yields a number almost exactly equal to our average for males and females for the case in which fiscal policy is initially in balance and all generations share the burden or benefit of any policy change.

That study, too, found that gains decreased with a rise in the discount rate. It also found that immigrants represented a fiscal drag if no plan to stabilize the debt-GDP ratio were in place. In our terminology, this would correspond to an experiment not considered, roughly to grouping immigrants and their descendents with current generations before determining the residual burden to be allocated to the remaining members of future generations. In contrast, we have found here that shifting the burden of adjusting an unsustainable fiscal policy onto *all* future generations makes the presence of immigrants a major benefit. Thus, the fiscal benefit of immigration may be positive or negative, but becomes more positive with delays in addressing the current U.S. fiscal imbalance. However, we have also found that the impact of immigration, regardless of the assumptions regarding the discount rate, the timing and nature of fiscal adjustment, or the existence of government public goods, is very small in comparison to the overall adjustment that would be required to eliminate the entire fiscal imbalance. Given that the simulations presented consider the impact of a complete elimination of immigration, it is clear that the impact of a much smaller change in the rate of immigration would correspondingly have even smaller effects on fiscal balance.

We have not considered changes in immigration policy aimed at altering the skill mix of immigrants, rather than their number. Highly educated immigrants, who accounts for a relatively small proportion of all immigrants, make much larger net fiscal contributions per capita than the typical immigrant (National Research Council 1997). Thus, as suggested by simulations in Storesletten (1998), an increase in the number of highly skilled immigrants would contribute much more to fiscal balance than the increase we have considered, which holds the skill mix of immigrants constant.

Conclusion

We may summarize our results with three findings, which are robust to differences in assumption regarding the government discount rate, the economy's growth rate, and the extent to which fiscal adjustments are made by changes taxes or transfer payments.

First, whether immigration contributes to or helps alleviate fiscal stress depends on the extent to which that stress will be borne by future generations. Because *new* immigrants represent a larger fraction of future generations than of present ones, shifting the burden onto future generations also shifts it, relatively, onto new immigrants. Thus, if the entire fiscal imbalance currently estimated for the United States is placed on future generations, then the presence of new immigrants reduces the burden borne by natives.

Second, when a policy of "fiscal responsibility" is followed, with taxes and/or transfers adjusted immediately on all generations to restore the government's intertemporal budget constraint, the fiscal gain from immigration is reduced. Indeed, whether there is a gain at all depends on the extent to which government purchases rise with the immigrant population. We considered two relatively extreme cases. When defense spending rises in proportion to population size, immigration worsens the fiscal imbalance. When defense spending is a “pure” public good, unaffected by population size, immigration lessens the fiscal imbalance.

Third, the impact of immigration on fiscal balance is extremely small relative to the size of the overall imbalance itself. Thus, immigration should be viewed neither as a major source of the existing imbalance, nor as a potential solution to it.

In producing these results, we have also extended the methodology of generational accounting to accommodate heterogeneity among members of current and future generations other than the distinction by sex that has been present in prior work. To deal with the very different tax and transfer profiles of immigrants and natives, we developed an alternative method of calculating fiscal imbalance that does not require the assumption of equal percentage changes in lifetime tax burdens. An obvious application of this methodology would be to the construction of generational accounts that recognize other forms of heterogeneity within generations, notably by lifetime income class.

References

Auerbach, Alan J., Jagadeesh Gokhale, and Laurence J. Kotlikoff, 1991, "Generational Accounts: A Meaningful Alternative to Deficit Accounting," in D. Bradford, ed., *Tax Policy and the Economy*, vol. 5, Cambridge, MIT Press, 55-110.

Auerbach, Alan J. and Laurence J. Kotlikoff, 1999, "The Methodology of Generational Accounting," in A. Auerbach et al, eds., *Generational Accounting Around the World*.

Auerbach, Alan J., Laurence J. Kotlikoff, and Willi Leibfritz, eds., 1999, *Generational Accounting Around the World*, Chicago: University of Chicago Press, forthcoming.

Auerbach, Alan J., and Philip Oreopoulos, 1999, "Analyzing the Fiscal Impact of U.S. Immigration," *American Economic Review Papers and Proceedings*, May, forthcoming.

Bonin, Holger, Bernd Raffelhüschen, and Jan Walliser, 1998, "Can Immigration Alleviate the Demographic Burden?" Universität Freiburg, June.

Fehr, Hans, and Laurence J. Kotlikoff, 1999, "Generational Accounting in General Equilibrium," in in A. Auerbach et al, eds., *Generational Accounting Around the World*.

Gokhale, Jagadeesh, Benjamin R. Page, and John R. Sturrock, 1999, "Generational Accounting for the United States: An Update," in A. Auerbach et al, eds., *Generational Accounting Around the World*.

Lee, Ronald D. and Timothy Miller, 1997, "Immigrants and Their Descendants," Project on the Economic Demography of Interage Income Reallocation, Demography, UC Berkeley.

National Research Council, 1997, *The New Americans*, Washington: National Academy Press.

Storesletten, Kjetil, 1998, "Sustaining Fiscal Policy Through Immigration," IIES paper, Stockholm.

Appendix

This appendix describes the method used to combine two sets of tax/transfer profiles, one broken down only by age and sex and the other broken down by age and nativity, to generate estimated profiles broken down by age, sex and nativity. Our procedure is the same for each age, and so age is omitted from the discussion. The algorithm uses data from three sources. The first set of data is population projections, provided by Barry Edmonston. These projections are broken down by nativity *i* (equal to 1, 2, or 3 for first-generation immigrants, second-generation immigrants, and all others) and sex *j* (taking a value of *m* for males or *f* for females), P_j^i. The second set of data is the tax and transfer profiles by sex, used by Gokhale et al (GPS 1999). These profiles, $\bar{r}_j$ ($j = m,f$) are expressed as ratios, normalized by the values for 40-year-old males. The third set of data is the tax and transfer profiles by nativity, constructed by Lee and Miller (1997), which we denote T^i (i=1, 2, 3). We seek to use these data to construct normalized profiles for taxes and transfer by sex and nativity, r_j^i.

Before applying our algorithm to combine these two sets of profiles, it is necessary for us to make their categories compatible. GPS apply profiles that have been used and described in earlier generational accounting work for the United States, for example Auerbach et al (1991). Each male and female at each age is assigned a profile, relative to that of a 40-year-old male, for 6 categories of taxes (labor income, FICA, excise, capital income, property and seignorage) and 7 categories of transfer payments (OASDI, Medicare, Medicaid, UI, general welfare, AFDC, and food stamps). For purposes of estimating government expenditures (which are not included in the generational accounts), the methodology uses separate federal and state and local government purchase profiles. Our calculations are based on these same tax, transfer and government consumption groupings, although we wish to distinguish by immigrant status as well.

To construct profiles for immigrants, we use average per capita amounts from Lee and Miller (1997) for first- and second-generation immigrants and natives, for males and females combined.[14] However, these profile categories are broader than the ones used by GPS. For taxes, these are: state and federal income, FICA, property, sales, federal business and excise taxes. For transfers, 25 different local, state, and federal programs are used; OASDI, Medicare, Medicaid (noninstitutional), Medicaid (institutional), SSI, AFDC, school lunch, food stamps, Special Supplemental Nutrition Program for Women, Infants and Children (WIC), energy assistance, rent subsidy, public housing, earned income tax credit, unemployment insurance, elementary and high school, bilingual education, public college, federal student aid, incarceration costs, federal retirement, military retirement, railroad retirement, workers' compensation state and local retirement, and refugee assistance.

Lee and Miller aggregate individuals into five-year age groups, beginning from 15-19 and ending with 80+. To convert their data into individual age amounts, we assume that individual cohorts in each five-year age grouping have identical values, and that those cohorts under 15 have the same values as the 15-19 group.

The categories are then aggregated to fit those used by GPS by adding the per capita amounts. For example, federal and state income taxes are combined into one category, while institutional and noninstitutional Medicaid expenditures are combined into another. Many of the smaller categories from Lee and Miller were reclassified as part of either state or federal government consumption.

[14] See also National Research Council (1997) for a detailed discussion of these profiles.

To construct the normalized tax and transfer profiles by sex and nativity, r_j^i , we start by requiring that they be consistent with the two sets of profiles we already have; that is:

(A1) $$\frac{r_m^i P_m^i + r_f^i P_f^i}{r_m^3 P_m^3 + r_f^3 P_f^3} = \frac{T^i}{T^3} \qquad i = 1,2$$

(A2) $$r_j^1 P_j^1 + r_j^2 P_j^2 + r_j^3 P_j^3 = \bar{r}_j (P_j^1 + P_j^2 + P_j^3) \qquad j = m, f$$

This gives us four equations in the six unknowns, r_j^i . To obtain the two additional equations needed for a solution, we assume that the relative profiles for males and females are the same across the three groups, i.e.,

(A3) $$\frac{r_m^i}{r_f^i} = \frac{r_m^3}{r_f^3} \qquad i = 1,2$$

Using these six equations for each age group, we solve for the relative profiles by sex, immigrant status, and age, which are used in turn to compute the generational accounts.

Table 1. Generational Accounts: Alternative Methodologies

(in thousands of dollars; r=.06, g=.012)

Method:

Age	*Traditional Method* Males	*Traditional Method* Females	*New Method of Allocating Burden on Future Generations* Males	*New Method of Allocating Burden on Future Generations* Females	*New Method of Allocating Burden Natives Only* Males	*New Method of Allocating Burden Natives Only* Females
0	77.4	52.9	77.4	52.9	71.6	49.6
5	98.3	65.9	98.3	65.9	91.2	61.5
10	122.0	80.6	122.0	80.6	114.7	76.1
15	152.6	99.3	152.6	99.3	145.2	94.6
20	186.0	118.8	186.0	118.8	180.9	115.2
25	205.2	128.0	205.2	128.0	203.9	127.4
30	203.8	124.0	203.8	124.0	206.2	126.1
35	195.4	116.9	195.4	116.9	200.0	121.1
40	177.3	102.0	177.3	102.0	183.6	108.1
45	143.9	74.9	143.9	74.9	148.9	79.9
50	97.2	38.5	97.2	38.5	100.5	42.4
55	39.2	-5.4	39.2	-5.4	39.6	-3.7
60	-26.3	-52.9	-26.3	-52.9	-27.0	-52.3
65	-78.4	-89.1	-78.4	-89.1	-80.5	-90.3
70	-87.8	-94.7	-87.8	-94.7	-88.6	-95.0
75	-85.1	-92.0	-85.1	-92.0	-83.1	-90.8
80	-73.2	-80.5	-73.2	-80.5	-72.4	-79.9
85	-64.1	-66.0	-64.1	-66.0	-63.9	-65.9
90	-49.4	-49.8	-49.4	-49.8	-49.1	-49.7
Future Generations	119.5	81.7				
% difference	54		72	80	69	77
Taxes & Transfers			132.9	95.3	121.3	87.6
% change			42		42	
Taxes only					124.0	87.5
% change					58	
Transfers only					113.9	88.0
% change					153	

Table 2. Generational Accounts: The Impact of Immigration

(in thousands of dollars; r=.06, g=.012)

	Initial Fiscal Balance Assumption:			
	No Change		*Immediate Change*	
Age	Males	Females	Males	Females
0	71.6	49.6	79.2	55.5
5	91.2	61.5	100.7	68.6
10	114.7	76.1	126.3	84.8
15	145.2	94.6	159.3	105.1
20	180.9	115.2	197.9	127.8
25	203.9	127.4	222.9	141.1
30	206.2	126.1	225.5	139.8
35	200.0	121.1	219.2	134.7
40	183.6	108.1	202.4	121.6
45	148.9	79.9	166.6	93.1
50	100.5	42.4	116.8	55.1
55	39.6	-3.7	54.5	8.6
60	-27.0	-52.3	-13.2	-40.0
65	-80.5	-90.3	-67.6	-78.3
70	-88.6	-95.0	-77.4	-84.5
75	-83.1	-90.8	-73.9	-82.0
80	-72.4	-79.9	-65.3	-72.9
85	-63.9	-65.9	-58.7	-60.6
90	-49.1	-49.7	-45.1	-45.6
Immigration Policy Assumption:	**Burdens on Future Generations** (and percent changes in taxes and transfers)			
Baseline	121.3	87.6	79.0	55.2
% change (current/future)	42		6/6	
No Immigration after 2000	125.6	91.0	74.9	52.1
% change (current/future)	46		6/3	
No Immigration after 2000; defense a public good	131.9	95.8	81.2	56.9
% change (current/future)	51		6/8	

Table 3. Burdens on Future Generations: Alternative Fiscal Policies

(in thousands of dollars; r=.06, g=.012)

Immigration Policy Assumption:	Initial Fiscal Balance Assumption: No Change		Immediate Change	
	Percent Change in:			
Taxes and Transfers				
Baseline	121.3	87.6	79.0	55.2
% change	42		6/6	
No Immigration after 2000	125.6	91.0	74.9	52.1
% change	46		6/3	
No Immigration after 2000; defense a public good	131.9	95.8	81.2	56.9
% change	51		6/8	
Taxes Only				
Baseline	124.0	87.5	80.5	55.9
% change	58		10/10	
No Immigration after 2000	128.0	90.4	76.3	52.9
% change	62		10/5	
No Immigration after 2000; defense a public good	134.5	95.1	82.8	57.6
% change	69		10/13	
Transfers Only				
Baseline	113.9	88.0	76.3	53.8
% change	153		18/18	
No Immigration after 2000	119.1	92.7	72.7	50.6
% change	172		18/5	
No Immigration after 2000; defense a public good	124.7	97.8	78.3	55.6
% change	192		18/25	

Table 4. Percentage Change In Taxes and Transfers: Sensitivity Analysis

Interest Rate:	.03		.03		.03		.06		**.06**		.06		.09		.09		.09	
Growth Rate:	.007		.012		.017		.007		**.012**		.017		.007		.012		.017	
	Immediate Fiscal Policy Change?																	
Immigration Policy Assumption:	*no*	*yes*	*no*	*yes*	*no*	*yes*	*no*	*yes*	*no*	*yes*	*no*	*yes*	*no*	*yes*	*no*	*yes*	*no*	*yes*
Baseline	32	13	23	11	33	19	86	12	**42**	**6**	73	13	191	11	80	5	157	11
No Immigration after 2000	38	13	26	11	38	19	97	9	**46**	**3**	82	9	209	5	85	-1	172	4
No Immigration after 2000; defense a public good	43	18	31	15	43	24	103	15	**51**	**8**	88	15	217	13	92	6	179	12

Figure 1. Annual Flows of Net Taxes, Native versus Total: Males

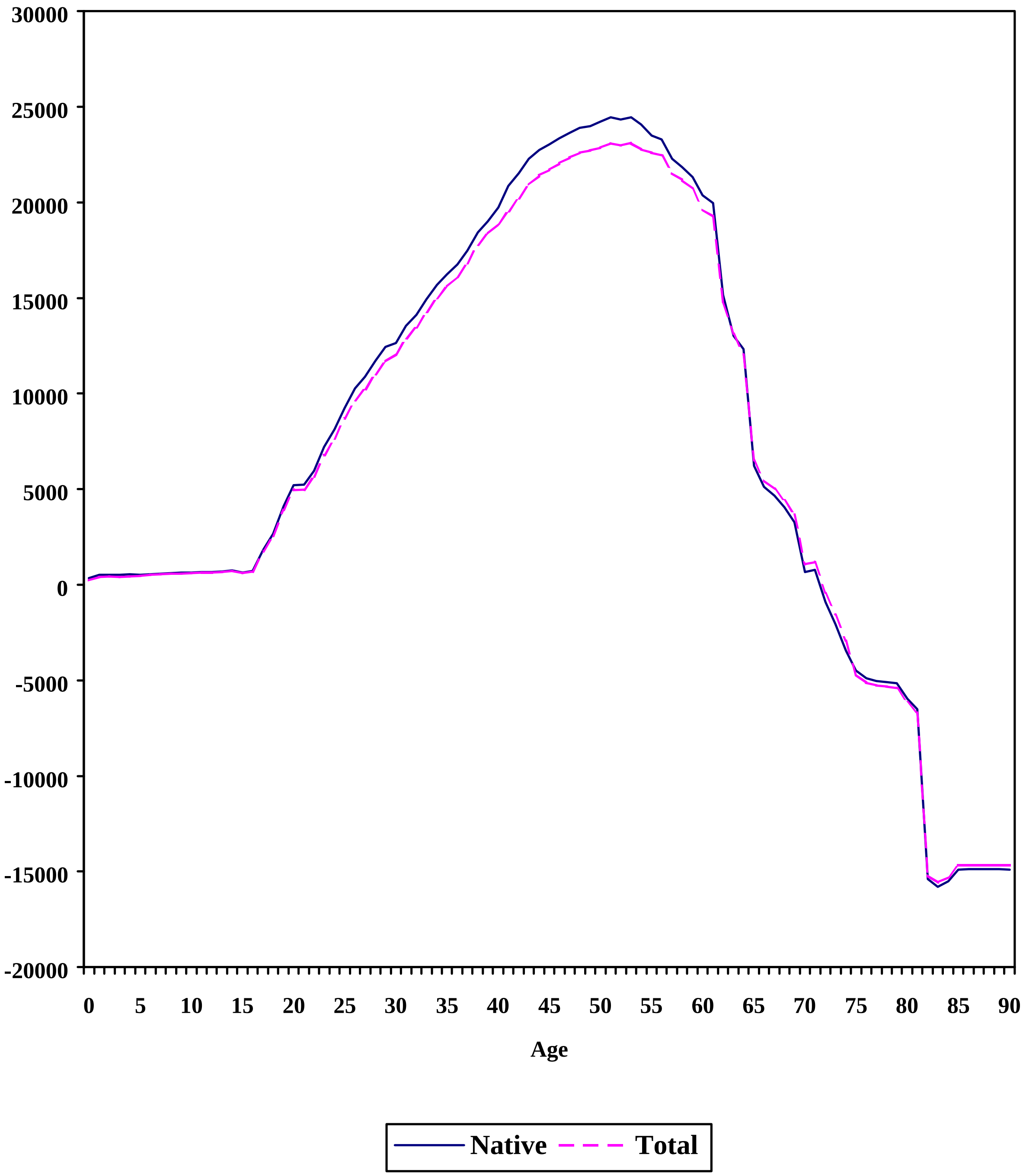

Figure 2. Annual Flows of Net Taxes, Native versus Total: Females

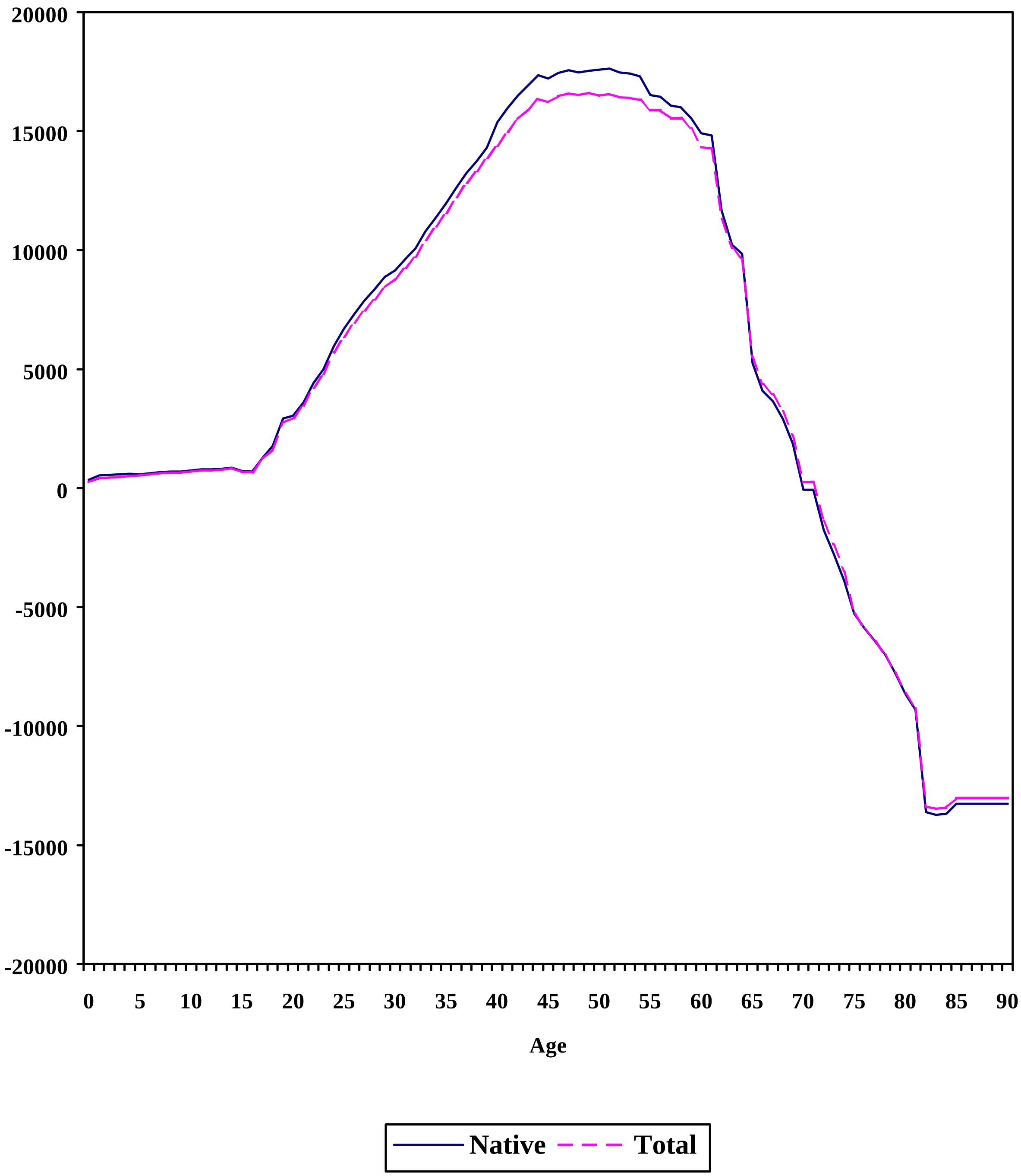

Figure 3. Share of Immigrants (First and Second Generation) in Total Population

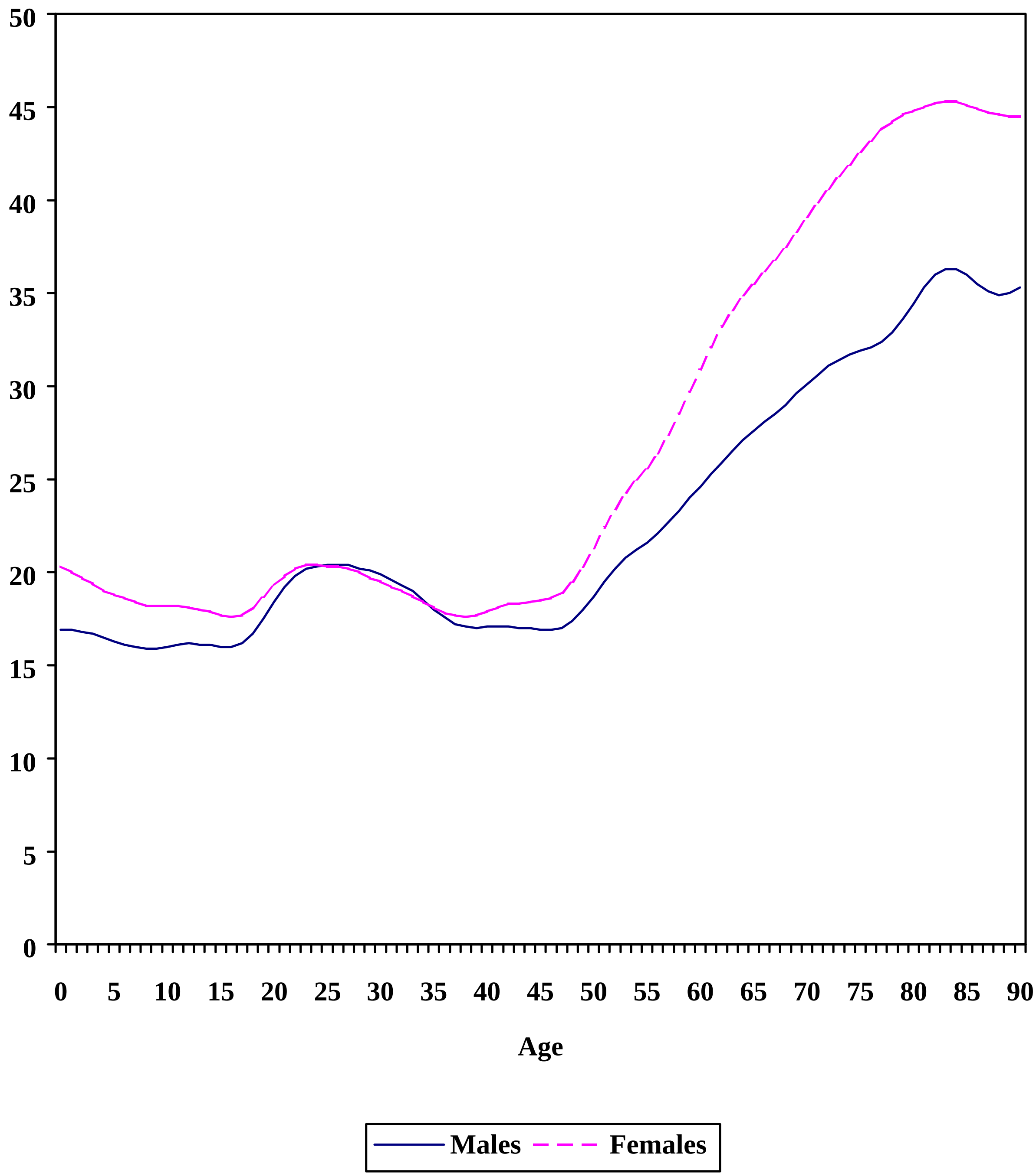

Figure 4. Accounts for Future Native Generations: Base Case