Demographic Rates and Household Change in the United States, 1900-2000

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Abstract

Over the twentieth century, fewer people in the United States resided with kin and more lived alone, with a spouse, or with only their own children. Over the same period, mortality decreased, fertility fell, rose and fell again, and more marriages were postponed, foregone, or ended by divorce. This paper combines techniques of microsimulation and decomposition to determine how much household change in the United States over the twentieth century was caused by fertility, mortality, or marriage and divorce changes. The analysis indicates that much of the movement away from more complex household types was not due to demographic change. However, change in the prevalence of less complex household types such as married couple, single parents, nuclear and living alone, was largely demographic in nature, stemming from the century's changing fertility and population aging. As most people now live in these less complex households, this research suggests that household change in the future will continue to be largely driven by changes in demographic rates and population structure.

1 Introduction

Over the twentieth century, the distribution of Americans across different types of households has changed a great deal, with a shrinking share of the population living in extended family and married with children households, and a rising share living alone, as married couples, or with own children exclusively. These changes have often been interpreted as the product of shifts in the types of households people prefer, reading household change as indicative of changes in our preferences and fundamental ideas about families and households. (Examples can be found in Angel and Tienda 1982, Lesthaeghe 1983, Kramarow 1995, and Goldscheider and Lawton 1998.) Alternately, they have been attributed to economic growth and the increasing ability of persons to purchase more privacy in living arrangements. (See Engelhardt, Gruber, and Perry 2002, or Costa 1997 for examples.)

While these explanations are certainly true in part, they only recognize certain constraints on the choice each person makes among all of the possible household types at any given time. The social and economic constraints mentioned above are often discussed, but in such a life cycle- and family-based institution as the household, we would expect that demographic change should play a large role as well. Most studies attempt to take demographic constraints into account either by confining the study to a very specific demographic group (elderly widows or widowers, most frequently) or by entering demographic variables into the analysis to asses the affect on the average individual of some demographic characteristic, such as age or the availability of certain types of kin. Such studies of household change, however, can never capture the effects of compositional change in the population. For example, while micro-level studies indicate that older women lived alone more often due to rising incomes (McGarry and Schoeni 2000), the ultimate impact of income increase on the population-level of percentage living alone over any particular period was determined by how many older women were in the population as incomes rose. Similarly, results indicating that numbers of offspring affect the probability that elderly widowed women reside with their offspring (Macunovich, Easterlin, Schaeffer, and Crimmins 1995) offer only part of the story. They indicate the direction of change, but without knowing how the distribution of offspring is changing, as well as the proportion of the population represented by elderly widowed women, we cannot know the overall magnitude of change in coresidence.

How much of the change in households, then, is due to changes that we would consider demographic, such as population age distribution changes and changing living kin networks? As mentioned above, much of the research concerning this question has only considered pieces of the story, either because they are focused on the living arrangements of a sub-group, or because they employ individual-based methods such as regression that are unequipped to include the influence of compositional change in population. Another reason that compositional population change may be discounted as influential even at the level of change in the total population is that various demographic influences may cancel each other out. For example, the existence of a living spouse is an important part of determining living arrangements, but the probability of having a living spouses may be fairly constant if decreasing widowhood is counteracted by increasing divorce.

This paper attempts to analyze the overall-demographic influence on household change in such a way as to avoid both of these issues. Attributing household change over the twentieth century to demography by assessing the entire United States population in a decomposition framework is a departure from research on sub-groups that are focused on the individual. Breaking down effects of demography on household change to the changing vital rate components of fertility, mortality, marriage and divorce allows for the examination of potentially counteracting influences.

The rest of this paper proceeds as follows. To begin, the empirical record of household and demographic change in the United States over the twentieth century is reviewed. A short discussion follows detailing the theoretical model of households that allows for the separation of demographic compositional change from other influences, as well as just what is meant by compositional change. The next section describes the methodology, which involves both decomposition techniques and microsimulation. As the microsimulation is a crucial part of the analysis, some time is spent examining the microsimulation's ability to reflect the reality of population change. After the methodology is described and its validity supported, the results are presented in which overall household change is attributed to five components: fertility change, mortality change, marriage and divorce change, population momentum and other factors. Finally, the implications of the analysis on the future of household change are discussed.

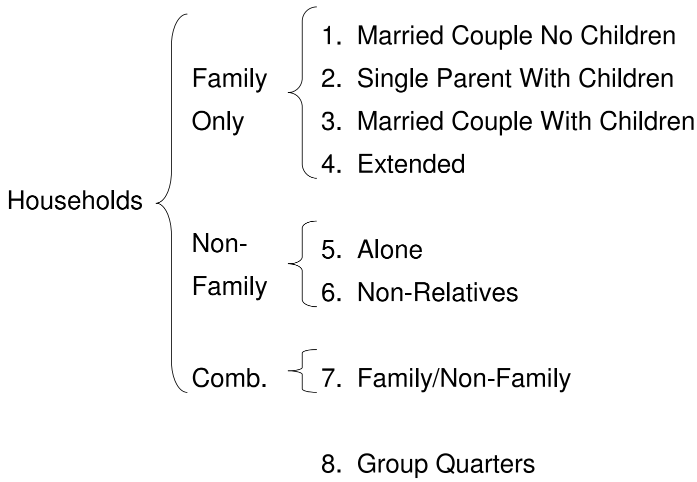

Figure 1: Classification of Living Arrangements

2 Data and Empirical Context

Beginning the discussion of household change and demographic rates, this section sets out the empirical record being addressed. The household data used in this chapter come from decennial census samples, gathered together and coded for consistency in the Integrated Public Use Microdata Series, or IPUMS. (Ruggles and Sobek 2003) This research follows the Census Bureau methodology in defining households based on shared dwellings, which restricts the concept of households that can be examined to one of living arrangements, rather than a broader concept based on mutual exchange or obligation. Also following the Census Bureau methodology, this research recognizes persons classified as living in group quarters, as opposed to households. For consistency, the 1970 definition of group quarters - more than five unrelated persons in the household - is applied to the entire century.

Households are classified as belonging to one of seven types, plus group quarters, as shown in Figure 1. The first four types are family households that include only persons related to one another by blood, marriage or adoption: married couple families including two spouses but no children, single parent families including only an unmarried parent and his or her own children,[1] nuclear families containing married parents and their own children,[2] and extended families which include all households in which everyone in the household is related, but the household does not qualify as one of the three simpler family-only types. There are two non-family types of households: alone and non-relatives. Alone households contain only one person recorded as living at that dwelling. Non-relative households contain up to five persons, none of whom are related by blood, marriage, or adoption. The size is limited at five as more than five unrelated persons would qualify the dwelling as group quarters. Next, there is a category called family/non-family combination in which there are some persons in the household related

[1] This includes biological, adopted and step-children, but not children-in-law. "Children" can also be of any age, as long as they are so related.

[2] As in single parent families, children may be related biologically, adopted, or step-children, but not children-in-law. They may also be of any age.

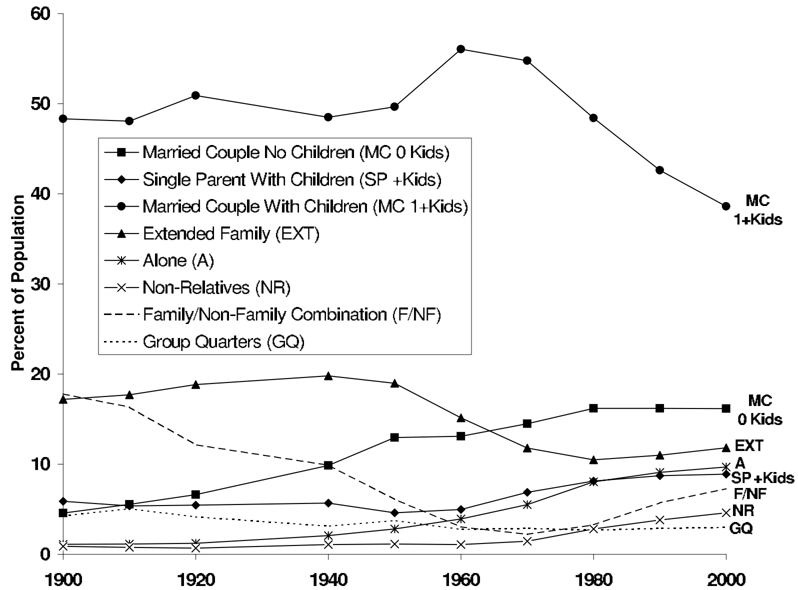

Figure 2: Proportion of Persons in each Household Type, 1900-2000. Author's classification and tabulations based on data in IPUMS census samples.

to one another, but at least one pair of persons in the household who are not related at all.[3]

A small proportion of the households in the IPUMS samples present classification difficulties because the information used in defining household types is in conflict. For example, a woman's marital status is listed as not married, but she is identified as the spouse of someone in the household. Overall levels by household types, as well as the results in the rest of this paper, are robust to deletion of these problem households, however, as well as to various schemes of apportioning these problem households to one type or another.

Figure 2 shows how the distribution of persons across different household types and group quarters has changed over the century. The percentage of persons living in the family-only types (married couple no children, single parent, married couple with children, and extended) has remained fairly constant over the century, starting in 1900 at 76% and ending in 2000 with 75%. Within this class, however, population has shifted away from the more complex types of extended and married couple with children, toward the more atomized types of married couple and single parent. The family/non-family combination proportion fell steadily until 1970 and has since risen. Alone has risen steadily and non-relative households have risen since 1960.[4]

We can imagine many demographic reasons for some of the changes seen in Figure 2,

[3]Most of these households have one family unit in them, such as a married couple with children family or single parent with children unit, plus one person not related to anyone in that family. Results not shown here indicate that early in the century these households were generally the product of families coresiding with a servant, or border or lodger. Recently, these households are more likely to be the product of cohabitation between a single parent and unmarried partner.

[4]Subsequent analyses will be restricted to the native-born population for methodological reasons. The distributions for the entire population versus native-born population are largely similar, with the exception that the native-born population tends to have a somewhat higher proportion in married couple with children households, and slightly less living with extended family, compared to the total population.

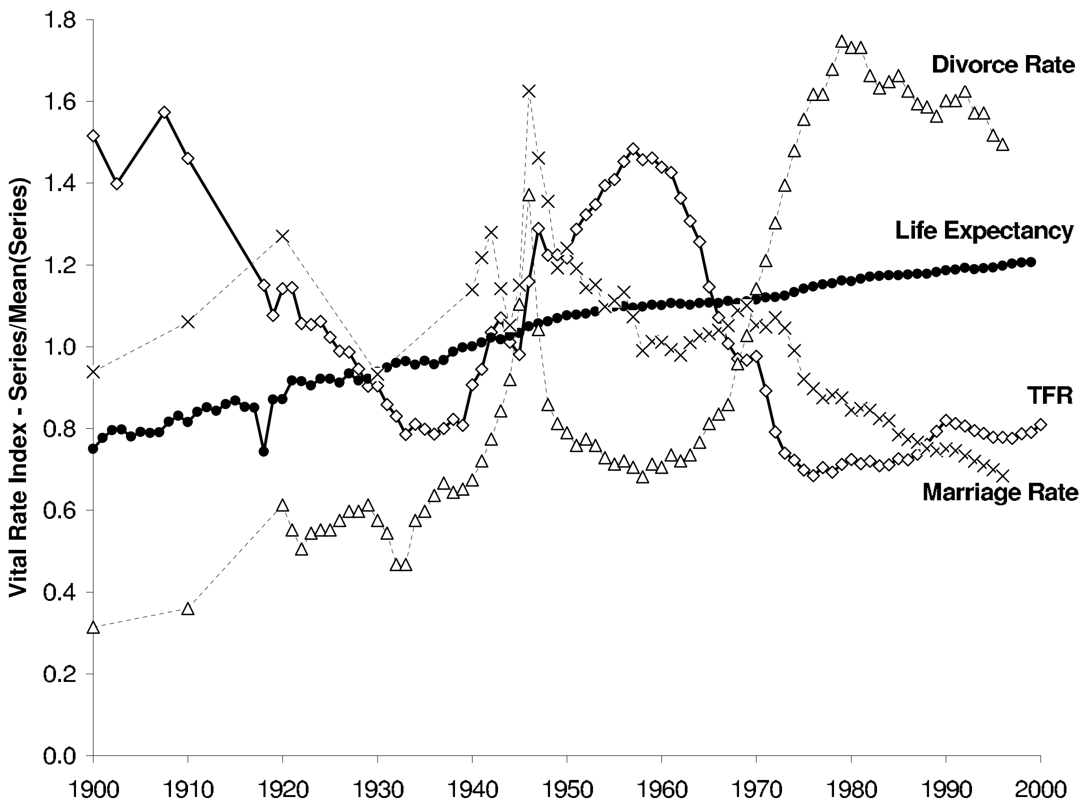

Figure 3: Vital Rate Trends, 1900-2000. Indices are created by dividing each series by its mean value for the century. Life expectancy is period life expectancy for each year. The total fertility rate is calculated using five-year age groups for women age 10 to 49. The marriage rate is marriages per 1,000 unmarried women age 15+ and the divorce rate is divorces per 1,000 married women age 15+. Data are from vital statistics sources and historical estimates. See Appendix A for full source details.

defining "demographic reasons" as those based in the rates of birth, death, marriage and divorce that determined the population age and sex structure, as well as the kin networks of living people. The basic shapes of vital rate change over the century can be seen in Figure 3. This figure presents indices of each rate over time. Of course, these summary measures leave out the age-specific changes in vital rates that are so important in determining population structures, but they do indicate the basic trends. Some of the rate trends look clearly related to the trends in the household type distribution. The increase and decrease in the share of nuclear families mirrors the fertility boom and bust, while the recent decrease in nuclear families and rise in single parent families occurs simultaneously with increasing divorce rates. The steady increase in married couple families may be influenced by the similar steady increase in average life span that the average spouse enjoys after the childbearing and childrearing years are over. These explanations posit vital events as setting the stage for household change by determining the numbers of people in the society who are, because of their demographic characteristics, more or less likely to live in a given household type.

Much historical research on the demographic influences on the household focused on whether nuclear or extended families were more prevalent in pre-industrial and early industrial populations, due to changing kin availability caused by changing demographic rates. Simulation was used to determine whether observed rates of mortality and fertility resulted in kin networks with enough living kin to allow for the existence of large, extended families. While the results of one such study did not seem to preclude the existence of extended household structures in preindustrial England (Wachter, Hammel, and Laslett 1978), another study found constraints on the existence of extended family coresidence due to high mortality (Ruggles 1987). The contrast in results is difficult to apportion, given the complex simulation techniques and differing assumptions. While both studies agreed on the basic effects, that mortality decline worked towards increasing available kin while fertility decline reduced available kin, the contrasting results indicate that the measured net effect depends on when and how you look for it. In contrast with that literature, the study here focuses more on demographic composition of the population, broadly defined as encompassing the age, sex, marital and parity status distribution, rather than the role of the availability of kin for potential extended kin-based households.

Most researchers acknowledge that household change involves both demographic and non-demographic factors. What has not been systematically attempted before is the separation of these two families of factors. Before describing the task, however, some discussion is needed about the model of households that this separability implies.

3 Theoretical Framework

3.1 The Two-Stage Model

The main theoretical framework used here is a two-stage model. Stage one, that has been referred to thus far as "demographic" or "compositional," determines the probability that a randomly selected individual will have certain demographic characteristics. Stage two, or the "other" set of factors, determines the individual's propensity to live in a certain type of household arrangement, given his demographic characteristics. The first stage is determined by the vital rates of the past. The second stage is the remainder, reflecting all other impacts. The main assumption of the analysis is that the two stages are independent and analytically separable.

3.2 Stage One: Composition of Demographic Characteristics

The demographic characteristics we wish to include in the first stage as representing the composition of the population are ones that are determined by vital rates and are thought to influence which types of household arrangements are available to an individual. Age, sex and numbers of various types of living kin satisfy these two criteria. We expect that age is an important determinant of household arrangement as dependency at the beginning and perhaps at the end of life may constrain household choices. A baby is born into the household of his parent or parents, usually, and spends many years as a dependent in that household. That household may undergo changes, such as a divorce or the addition of extended family members, but those changes will usually be driven by the parents and not the dependent children. There are also laws, such as minimum age at marriage laws, that prohibit certain types of household arrangements until a certain age. Sex is to be included because males and females have somewhat different household distributions, making sex another important piece of information in predicting household type. For example, women are more often the head of single-parent families than men and there may be different propensities for elderly widows versus widowers to live alone or with kin. Kin matter because households are so often kin-based. Part of this is certainly biological with dependent children needing care from parents. Beyond the parent-child bond, there is also the historical legacy, biological perhaps but also socially enforced, that one's kin have a greater obligation to help one out in times of need than strangers do. Thus, when looking for those with whom to share a household, kin are often the choice. In addition, as with laws that govern household types by age, there are laws the enforce support relationships among given types of kin, such as laws against child abandonment. Of course, none of these laws insist that this support must be expressed by sharing a household, although that is most often the case. There is also the simple fact of availability or not. An elderly widow cannot live with her children if she has none. Thus, the availability of different types of kin are important constraints on household type choice.

Ideally, we would like to know the entire extent of the living kin network in order to evaluate the extent to which the network affects household arrangements. In the IPUMS, however, we only know the numbers of kin inside the household. There are two exceptions to this: we know if a spouse exists even if he is not in the household[5] and, for most decades, we know the number of children ever born to women.[6]

Thus, for some of these analyses, the only demographic information will be age, sex and marital status. For the subset of women only, we can include the number of children ever born as well. All pieces of the kin network left out will have their impact counted not as part of the stage one compositional component, but as a second stage effect. As an example, if we do not include living siblings as part of the kin structure in the analysis, then the effect of changing sibling availability on household formation becomes a second-stage impact, even though the probability of having a living sibling is determined by vital rates. This problem will be more

[5]The marital status categories of "Married Spouse Absent" and "Separated" indicate that a spouse exists but is not in the household.

[6]There is variation in the population universe for this data over time. In some years this question was asked of all women and in others it was only asked of married women. The age range asked increased over the century as well, from including those age 12 and over in 1900 to age 15 and over in 2000. The analysis assumes that women not asked about their parity status had no children.

acute for the early part of the century when living with kin other than spouse and own children was much more common.[7] Research on kin availability in the early part of the century does not point to this as a strong demographic constraint on extended family households when all types of extended families are considered. Three-generation households may have been constrained early on by relatively short life expectancies and long generations (Ruggles 1994), but at the same time lateral generation sizes were large due to high fertility at the turn of the century and rapidly falling infant and child mortality. Of course, it may be that only certain types of kin were desired for the formation of extended households, perhaps due to the existence of specific family formation systems. The effects of such a system would be outside of this analysis' ability to detect or count as a compositional effect. In fact, it is not entirely clear that the effects of such a system would be a stage one effect or not.

3.3 The Role of Vital Rates

Vital rates determine the demographic characteristics of age, sex and kin distribution in the population which then feeds into the household distribution. When making this chain from vital rates to population structure to household structure, what piece of the household formation process is being examined? While some changes in vital rates can be considered exogenous to the household formation process, others are quite central to it.

Fertility, mortality, marriage and divorce rates are summaries of millions of individual planned and unplanned transitions. Some of those vital events occur outside of the process of household formation. Death is the most obvious example, as rarely does a person choose death in order to alter his living arrangements. An unplanned pregnancy is another example. These types of events can be considered as exogenous to household formation and it is clear which causes the other: the death of a family member or an unplanned pregnancy causes a household transition. On the other hand, some events are very much a part of the process of household formation. Marriage is overwhelmingly associated with co-residence of spouses, just as divorce is most often about the end of a certain type of household arrangement. Similarly, a married couple's planned pregnancy represents a choice to transition from a married couple no children household to a married couple with children household.

That some vital rates set the stage for a change in living arrangements while others are actively on that stage leaves open the question of how to characterize the piece of change that the analysis here hopes to isolate and evaluate. In this framework, the demographic characteristics representing ongoing constraints on the household choice. For changes that are exogenous to the process, the constraint aspect is clear. The death of a spouse, for example, precludes the ability to live in a married couple household, at least until the time of a remarriage. For demographic changes that are more closely related to explicit household choices, we can think of the demographic effects as representing the continuing constraints on living arrangements due to the vital events in the past. In other words, the decision resulting in a birth, marriage or divorce occurs instantaneously, and immediately turns the event into a demographic constraint on household arrangements rather than the expression of a household preference. For example, at the time of marriage, the vital event represents the explicit household choice of two individuals. From that moment on, however, the marriage exerts a strong constraint on living arrangements through the obligation to coreside with a spouse until

[7] By 1970, the probability that an average adult resided with any kin other than a spouse and/or own children was fairly low.

death or divorce. Similarly, the decision to have a birth entails a long period of childrearing where the preference that was expressed in the past is a continuing constraint on household arrangements for the parents. One other aspect of fertility decisions can be characterized as exogenous to a deliberate process of the formation of certain types of households: fertility decisions of parents produces children who are household members but who made no decision about what sort of household arrangement was preferred. For the newborn, the parents' fertility decision was entirely exogenous.

3.4 Stage Two: Conditional Household Probabilities

The analysis here focuses on the effects of vital rates and population structure, and all of household change that cannot be accounted for becomes a remainder. Its status as a remainder, however, should not conceal the fact that it contains a great deal of information. What forces push individuals to live in this or that type of household, given that they are a certain age, sex and have a given set of kin? The conditional probabilities (probability of living in a certain type of household, conditional upon demographic characteristics) are determined by individual preferences for certain types of households, income constraints on the expression of those preferences, social norms constraining or shaping preferences, and housing market conditions which may also constrain the expression of preferences. While the conditional probabilities are not the focus of research here, their impact will be presented in contrast to that evaluated for the demographic impacts and it is one of the objectives of the research to compare their relative magnitudes.

3.5 Strengths and Weaknesses of Two-Stage Model

The main strength of this model is its empirical usefulness in that it isolates different effects and makes possible scenario-based projection of future change. The main weakness of the model is the central assumption of the separability of the two stages. The previous section argued for their theoretical separability. In the statistical realm, this is an assumption about the independence of the two stages. One can critique the model by arguing that household formation norms did not occur independently, but rather in the context of demographic reality, making the two stages dependent. One can also argue, as De Vos and Palloni (1989) do, that stage two probabilities are linked to stage one characteristics because different population structures have different "supply curves" of possible household types.

These critiques are less valid in the short-term where one could consider the normative environment more stable. More importantly, these critiques are not valid if the entire kin network is included in the first stage. Making the stage two probabilities conditional upon known age, sex and kin structures means that, by definition, there is no age, sex or kin information left in the second stage, so they must be independent. Of course, due to data limitations, the subsequent analyses do not include much of the necessary kin information. However, given the household types that are classified here, only the extended family includes types of kin not available in the IPUMS dataset.[8] The family/non-family combination type may also be affected by the lack of some kin data, although to a lesser extent because many of its members are, by definition, non-relatives. Also, very few of the family unit members in the

[8] This is true for women, for whom parity data is available. For men, number of children is not available.

family/non-family combination members have relationships other than spouse, parent-child or sibling.

4 Methodology

4.1 Introduction

The analysis has two main parts. The first part is a decomposition technique based on standardization, resulting in an estimate of how much change from one period to another is caused by the changing population composition of demographic characteristics, versus all other factors, embodied by the probability of living in a certain household type, conditional on demographic characteristics. The second part of the analysis uses microsimulation to calculate a further decomposition of the compositional element of change into that caused by each of fertility, mortality or marriage and divorce changes. The rest of this section specifies which demographic characteristics are considered as part of the population composition, how the standardization works, and what role microsimulation plays.

4.2 Decomposition into Demographic versus Other Factors

Given what data are available, the demographic characteristics in the population composition are the individual's age, sex and marital status for the two sex analysis. For the women-only analysis the demographic characteristics include age, marital status and parity (number of children ever born). Both of these analyses will be restricted to the native-born population, necessitated by aspects of the simulation discussed in the next section. The demographic composition is represented mathematically as a vector of proportions in each age/sex/marital status for the whole-population analysis or age/marital/parity status group for the women-only analysis. Call this demographic composition vector D_t at time t. The non-demographic factors are contained in a vector of probabilities of living in a particular household type, conditional upon membership in a particular demographic characteristics "cell" defined by age, sex and marital status for the two sex analysis or age, marital status and parity for the women-only analysis. Call this conditional probability vector C_t. The probability that a randomly chosen individual lives in a particular household type at time t, call this h_t, is the cross-product of the D and C vectors: $h = f(D, C) = D \times C$. So h is the weighted average of the conditional probabilities of living in a particular household type, with the weights provided by the demographic composition (the proportions of people with each combination of demographic characteristics in the population). There is an h value for each decade for each household type and it is the change in h over time that the decomposition seeks to explain.

The separation of change into that due to changes in D_t versus C_t is an application of a general methodology for decomposing change into additive parts (Das Gupta 1991). As h changes from time 1 to time 2, allowing demographic composition D to change while holding conditional probabilities C constant generates an estimate of the portion of change in h that is caused by changes in demographic characteristics. As the conditional probabilities can be held constant at their levels at time 1 or time 2, this generates two estimates of the D effect, which can be averaged together for a better estimate of the total D effect over the period. The process is similar for estimating the effect of changing conditional probabilities C.

Specifically from time 1 to time 2:

$$\begin{aligned} h_1 - h_2 &= f(D_1, C_1) - f(D_2, C_2) \\ &= \text{D-effect} + \text{C-effect} \end{aligned}$$

$$\begin{aligned} \text{D-effect} &= \frac{[f(D_1, C_1) - f(D_2, C_1)] + [f(D_1, C_2) - f(D_2, C_2)]}{2} \\ \text{C-effect} &= \frac{[f(D_1, C_1) - f(D_1, C_2)] + [f(D_2, C_1) - f(D_2, C_2)]}{2} \end{aligned}$$

The decomposition is performed in four time segments: 1900 to 1940, 1940 to 1960, 1960 to 1980 and 1980 to the final decade. For the two-sex analysis, the final decade is 2000. For the woman-only analysis, the final decade is 1990. The shortened analysis is necessitated by the lack of a parity question in the 2000 census. There was no parity question in 1920 either, necessitating the initial 40 year segment.

4.3 Decomposition of Demographic Effect into Vital Rate Components

The decomposition above gives the basic "demographic composition versus other" results. To expand the demographic results and express change in terms of the effects of changing fertility, mortality, marriage and divorce, we use microsimulation to make demographic composition D a function of rates of fertility F, mortality M, and nuptiality[9] N, i.e. $D = g(F, M, N)$. The decomposition examines the effect of letting vital rates change as they were observed to change during the time segment, versus holding them at the level of the decade before the beginning of the segment. There is one other element, population momentum. Population momentum is the change in population that would occur even if the vital rates had not changed from one time period to the next, due to the pre-existing demographic composition of the population.

Using microsimulation, different counter-factual Ds can be generated, depending on which vital rates are held constant at F_1, M_1 or N_1, the levels that produced D_1, and which are allowed to change to F_2, M_2 or N_2, the levels that were observed during the period and which produced D_2. The decomposition technique is thus the same as the D versus C decomposition, but expanded to three factors. As this is a decomposition of the D effect only, the changes in the conditional probability vector C over the period are not important, but some C vector is still necessary to reduce the effect of changes in each element of the D vector into a single scalar value in units of h (proportion of persons in a particular household type). The average C for the period is used for this purpose, designated as C_{avg}.[10] Alternately, the vectors C_1 or C_2 could be used, changing the results somewhat. Although not reported here, the full simulation and decomposition results using the other C vectors have been computed and the results are largely robust to the change.

The idea behind the vital rates decomposition is the same as in the two factor case: the effect of one of the elements is the change observed when all other elements are held constant. When the function has more than two factors, there are multiple ways that the other factors can be held constant, such as all at time 1 levels, all at time 2 levels, one at time 1 level and others at time 2 levels, etc. Whereas we were concerned with changes in $D \times C$ in the two

[9] Nuptiality includes marriage and divorce rates.

[10] The vector of weights C_{avg} is made up of element by element averages of C_1 and C_2.

factor case, we are now concerned with changes in $g(F, M, N) \times C_{avg}$ in the three factor case. The effects are calculated as follows:

$$\begin{aligned}\text{F-effect} &= \frac{[g(F_1, M_1, N_1) - g(F_2, M_1, N_1) + g(F_1, M_2, N_2) - g(F_2, M_2, N_2)] \times C_{avg}}{3} \\ &+ \frac{[g(F_1, M_1, N_2) - g(F_2, M_1, N_2) + g(F_1, M_2, N_1) - g(F_2, M_2, N_1)] \times C_{avg}}{6}\end{aligned}$$

$$\begin{aligned}\text{M-effect} &= \frac{[g(F_1, M_1, N_1) - g(F_1, M_2, N_1) + g(F_2, M_1, N_2) - g(F_2, M_2, N_2)] \times C_{avg}}{3} \\ &+ \frac{[g(F_1, M_1, N_2) - g(F_1, M_2, N_2) + g(F_2, M_1, N_1) - g(F_2, M_2, N_1)] \times C_{avg}}{6}\end{aligned}$$

$$\begin{aligned}\text{N-effect} &= \frac{[g(F_1, M_1, N_1) - g(F_1, M_1, N_2) + g(F_2, M_2, N_1) - g(F_2, M_2, N_2)] \times C_{avg}}{3} \\ &+ \frac{[g(F_1, M_2, N_1) - g(F_1, M_2, N_2) + g(F_2, M_1, N_1) - g(F_2, M_1, N_2)] \times C_{avg}}{6}\end{aligned}$$

Each effect has four versions of the "hold all constant and let one change" contrast. In the two-factor case, the decomposition was done taking the simple average of contrasts which treated interaction effects between D and C symmetrically.[11] The symmetric treatment of interactions in the three factor case requires the differential weighting of contrasts as shown in the equations above. Finally, the effect of momentum is backed out by subtracting the F-, M-, and N- effects from the total D-effect calculated in the two-factor D versus C decomposition.

4.4 The Simulation Program

The simulation program used is SOCSIM (Hammel, Hutchinson, Wachter, Lundy, and Deuel 1976), developed at the University of California at Berkeley. The program itself is highly customizable to model different demographic regimes and to take as inputs vital rates for very detailed sub-groups of the population. In the simulations used here, only some features of the program are used. There are three inputs to the simulations constructed for this analysis: sets of vital rates for each decade, a starting population for 1900, and a population of immigrants for each decade who are "migrated" into the simulation. These inputs are discussed first, followed by a discussion of the mechanisms used by the simulation to turn the inputs into populations.

Each decade has one rate set that holds sway for the entire period. Rates used here are all based on data from the vital statistics system, although there is some degree of variability in the extent to which the rates used are those published in Vital Statistics publications, or estimates based on Vital Statistics information. Some estimates were made by researchers for times in

[11] The symmetric treatment of errors involves apportioning any interaction effects to all of the factors equally.

which published vital statistics data were either suspect or not available. Other estimates are the result of assumptions about rates in periods during which they were not available. Some early century rates based on smaller areas of the country were adjusted slightly on an ad hoc basis to increase the agreement in population composition between the IPUMS and the baseline simulation.[12] Appendix A contains full details on the sources, construction and, in some cases, assumptions and adjustments concerning each decade's rates. To review the major features of the rate sets, each is constructed by averaging single-year rates during the period. For some decades, rates for each year are not available and the decade rate set is an average of only some years in the decade, or is an estimate of the rates for the decade. Birth, death, and marriage rates are age- and sex-specific. In addition, marriage rates are also specific to previous marital status (never married, divorced or widowed) and birth rates are specific to unmarried or married women. Divorce rates are intended as duration specific in the simulation program, however not enough detailed data on duration-specific divorce is available to provide accurate rates. Overall divorce rates are adjusted to apply from after the first year through year 30, thus the simulation assumes no divorce within the first year of marriage or after the thirtieth year. The simulations also assume no births to unmarried women and no divorce until the 1940-1949 decade. As with the divorce by duration of marriage assumption, these additional assumptions are necessitated by the lack of sufficiently detailed rates for these periods although these events were fairly rare during that time. Where rates were estimated or assumed, alternative analyses assuming some other guesses of the actual rates were conducted and the results were not materially different from those shown here.

A starting population is the next input element to the simulation. The starting population for 1900 must have the correct age and sex structure. It must also enter the simulation with the same marital status as the actual starting population, or the fertility of the early decades will be hampered by the need for individuals to first get married before they can have children. A properly aged and married population is created by starting with a small unmarried population and simulating it for 100 years. The rates that were used for this pre-simulation were roughly similar to the 1900 rates, adjusted in an ad-hoc fashion until a starting population was achieved with the proper demographic characteristics. The size of the pre-simulation population for each run of the simulation is about 1,200 persons, simulated through 100 years resulting in a 1900 starting population of about 5,000 living persons. The total starting population can be made arbitrarily large, however, by running the simulation multiple times. After a starting population was achieved that had distributions across sex, age, marital and parity status similar to the IPUMS population of 1900, some individuals were then designated as being foreign-born so that the proportion foreign-born by age and sex for the 1900 population matched that observed in the IPUMS.[13] This brings the discussion to the need to include immigration in the simulation.

Beyond accurate rates and starting population, the simulation needs to take immigration into account. This presents a challenge, as entering immigrants into the simulation accurately would require detailed knowledge about the age, marital and parity status of incoming immigrants. As that would introduce much more uncertainty and sources of variation into the simulation, the analyses are confined to native-born persons only. The simulation still requires

[12]The baseline simulation is one in which rates change from 1900 to 2000 they were observed to have changed in reality.

[13]The cells for designation of foreign-born status are not expanded to include marital and parity status due to the small cell sizes obtained in the IPUMS when increasing to this level of specificity in 1900.

some immigrants to enter the population, however, as they are often adults in their child-bearing years and their native-born children must be introduced into native-born simulated population in order to grow the population appropriately. This is accomplished in the simulation by comparing the number of immigrants in each age and sex group in the simulation with the same number in the IPUMS at the end of each decade. If more immigrants are needed in a particular age-sex group, they are created and added to the simulated population. Unfortunately, they must be created as single and childless. We know that this was not the case for many immigrants, of course, but this stylized immigration system at least allows the new immigrants to find spouses and have children who are then classified as native-born. The list of immigrants at the end of each decade is created for the baseline simulation using the observed rates for each decade and that list of immigrants is used for all counter-factual simulated populations. This system, while it includes the population growth due to immigration, does not accurately account for the marital status and parity of immigrants. Thus, while the simulated population contains immigrants, the decomposition analyses can only be done accurately for the native-born population.

Finally, how does the simulation program actually work? Each "person" is simply an observation in a rectangular data file with records of date of birth and other information on demographic characteristics and family relationships. Each person is subject to vital rates, expressed as monthly probabilities of an event for a person with given characteristics, and the simulation takes place one month at a time. For example, there is some probability that a divorced woman age 30-34 will get married in a month. Of course, there are other events that could happen to this same woman, such as a birth or death. Which event will occur and what the waiting time until that event will be are determined stochastically using a competing risks model. (Wachter, Blackwell, and Hammel 1997) Waiting times are drawn for each event an individual is eligible for based on the event probability and a random perturbation, drawn anew each time. In the case of drawing waiting times until births, there is an additional element of randomness provided by a fertility multiplier, which was added to the program to create sufficiently varying parity distributions. The shortest waiting time to the next possible event determines which event occurs next. If the winning event is a birth, then when the waiting time to birth is over, a new line with the date of birth and other information for the offspring is added to the dataset. If the event is a death, the date of death is recorded. Marriages are kept track of in a separate marriage file, so if the event is a marriage or divorce, the marriage file is updated. Once that process is completed for all individuals in the population, the list of eligible events for the next month is generated, along with the probabilities of the next month's possible events, and the process continues.

The event of marriage is somewhat more complicated than that for births and deaths, as someone who has drawn marriage as the next event must find another person who has drawn marriage as the next event. Such persons are entered into a marriage queue at the end of the waiting time to marriage and each person searches through the list of opposite-sex persons in the marriage queue. SOCSIM can be programmed to place limitations on what is considered a suitable marriage partner, such as age limitations or membership in a certain group. None of those customizations are used here, however, so the waiting time to marriage after entering the queue is not long.

At the end of a simulation, the products are a population file and a marriage file containing a list of everyone who ever lived in the population, and a list of every marriage that ever occurred. These files contain enough information to determine the main demographic features

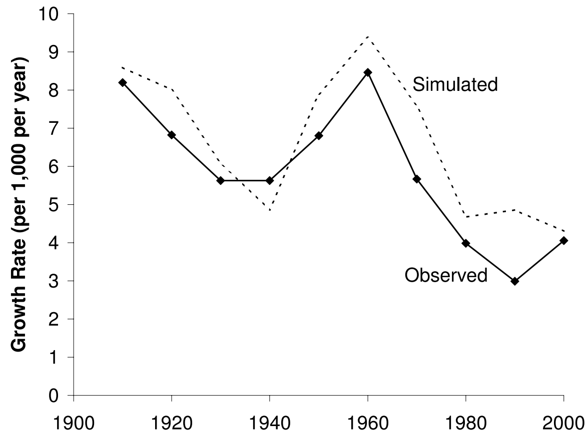

Figure 4: Observed versus Simulated - Growth Rate of Native-Born Population, 1900-2000. Observed growth rates are for the IPUMS native-born population. Note that the IPUMS has no 1930 sample available, so the growth rate shown for 1930 and 1940 is the annual growth rate in effect from 1920 to 1940.

of the population, and to determine the entire kin network of any individual at any time. Unfortunately, few actual sources can approach a broad kin accounting outside of the household, especially over time. Therefore, beyond very close family members, we are largely left to guess at the effects of availability of extended kin over time. Using the IPUMS information we can estimate, however, the effects of age and sex distribution, marital status and parity.

The final simulation question is of how many times to simulate. This question was dealt with in this analysis in an ad hoc fashion through which it was determined how many simulations were necessary to generate stable results both in the main facets of population change, and in the decomposition results. Running as few as 25 repetitions, thus having a starting population of $5,000 \times 25 = 125,000$, creates a reasonable amount of stability in decomposition analysis results. The simulation data presented here are based on 50 runs of the necessary 200 year simulations (100 years of pre-simulation to achieve the 1900 population and then the main simulation of the population from 1900 to 2000). Increasing the number of repetitions to 100 leaves the results virtually unchanged, compared to the 50 repetition results.

5 Vetting the Simulation

Theoretically, accurate and detailed vital rates should lead to an accurate simulation. In reality, vital rates with enough detail are rarely available and when they are they often contain various unspecified errors. Furthermore, many of the assumptions and procedures of the simulation described in the previous section oversimplify matters to the extent that makes an accurate baseline simulation impossible. There may be more error introduced by any inaccuracies of the IPUMS census samples in representing the entire census and of the census itself in representing the entire population. The question is one of extent. Does the simulation mirror the observed reality enough to capture the main facets of population change over the course of the century? To argue in the affirmative, this section presents some statistics describing the baseline simulation in which the vital rates change appropriately at each decade. If the past

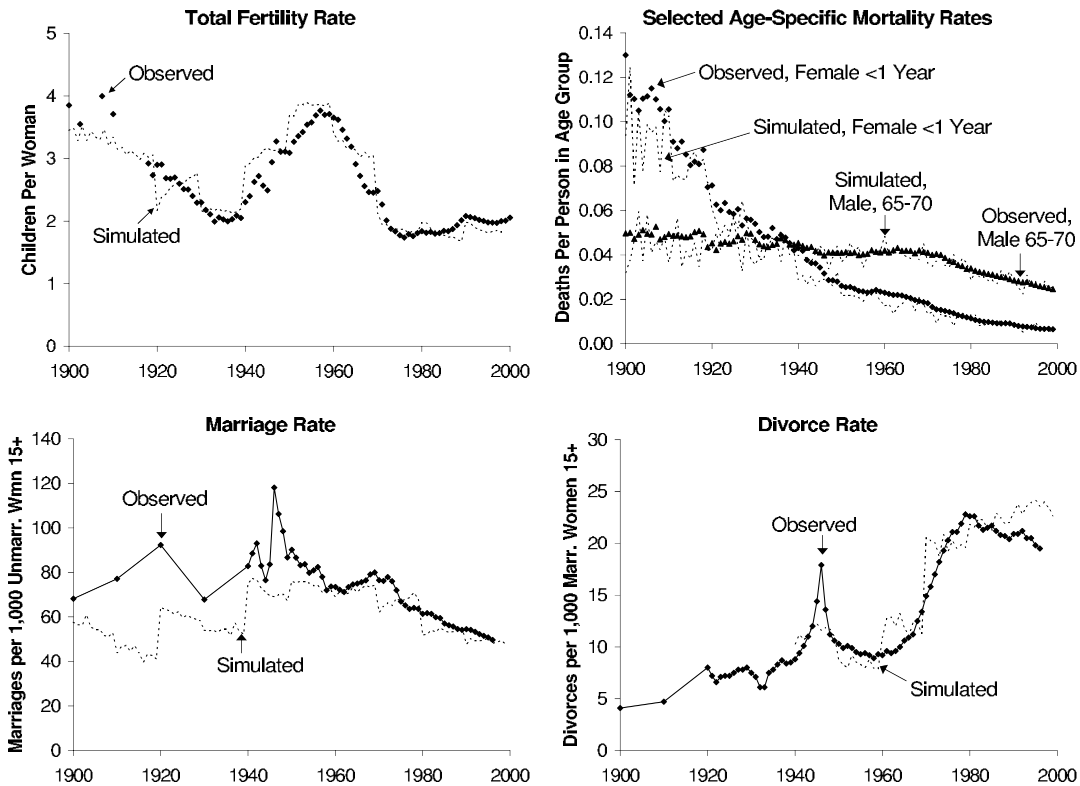

Figure 5: Observed versus Simulated - Vital Rates, 1900-2000. Data represent rates applying to the whole population. See Appendix A for details on sources and estimation of observed rates.

century's population can be realistically recreated, in terms of the characteristics important in the analysis, then the validity of using the counter-factual simulations is supported. As the decomposition analysis is limited to the native-born population, many of the "observed versus simulated" comparisons will be for native-born persons only.

The first question addressed is whether or not the population grows as it should. This is shown in Figure 4, comparing the average annual growth rate from the previous decade to the next for the IPUMS native-born population and for the simulated native-born population. While the simulated population does grow at a slightly higher rate for most of the century, its growth does closely mirror the shape of population growth observed in the IPUMS data. The generally higher growth rate for the simulation is reflected in the growth factor over the whole century: the IPUMS native-born population (using appropriate weights to net the sample up to represent the entire nation) grows from 65 million in 1900 to 248 million in 2000, increasing by a factor of 3.8. The simulated populations increase by a factor of 4.6 on average, which would have made the observed population approximately 300 million by century's end. The overall pattern of growth in the simulation over the century, however, captures the shape of change in the observed population quite closely.

Given the variation between observed and simulated reality seen in Figure 4, there is a need to verify that the rates put into the simulation are the rates that come out. This comparison is done for the entire population instead of the native-born, as the input vital rates were representative of the whole population. That this is generally the case is shown in Figure 5. The total fertility rate achieved by the simulated population mirrors the observed rate very closely, with the exception of the first two decades. Observed fertility rates for these decades are researcher estimates (see Appendix A) rather than estimates from the nation's vital statistics system and are not used in the simulation. Rates used in the simulations were estimated for married women based on overall fertility rates and an assumption of no extramarital childbearing, and that estimation procedure may have introduced a bias downwards for overall fertility. As we will see in subsequent comparisons, however, the effect of this discrepancy on the size of simulated birth cohorts for the first two decades, compared to observed cohorts, is not severe. Simulated mortality rates in the next panel of Figure 5 also closely mirror the input rates for the two example age-sex groups shown. (All other age-sex groups exhibit roughly similar degrees of dispersion of simulated rates around the observed values.) Marriage and divorce, shown in the bottom two graphs, are somewhat more problematic. Observed marriage rates in the first half of the century are generally lower than those reported in vital statistics publications. This is most likely due to estimated rates of remarriage after widowhood being too low, as we shall see in subsequent sections. The trend over the century is fairly consistent, ignoring the late 1940's marriage and divorce spikes. There is a very gradual rise in marriage through the 1940s, followed by a steady decline. Finally, we can see that, although the simulation assumes no divorce before 1940, there was some, if very little. Also, the simulated divorce rate in the final years of the century is somewhat higher than observed. This could be due to the input divorce rate's lack of specifying rates by duration.

While any deviation from observed rates is a concern for the simulation, the first goal of the simulation is to mimic the overall shape of change. The effect of all of these deviations will be to distort the distributions of persons by age, sex, marital and parity status from observed reality. It is the degree of those distortions that are most important for the decomposition analyses. As the overall fertility and mortality rates in the simulation look accurate, we would expect that simulated age distributions should match observed IPUMS age distributions as well. That seems to be the case observing Figure 6, showing simulated and observed percentages in five-year age groups over the century for the native-born population. The simulation catches the baby boom and bust throughout the century's age structure, as well as the steady increases in population share of the oldest age groups. Moving on to the distribution of persons across marital states, Figure 7 shows that the inaccuracy in the simulated marriage rates mentioned previously are mostly confined to problems in older age groups. Some of the simulated versus observed discrepancy in the early century may also be due to the fact that marriage rates were calculated based on information from only a very few states. The federal-state partnership that provides the most accurate recent data was not begun until the 1950s. (Grove and Hetzel 1968) Despite the lack of perfect match, however, change over time in the simulation is reasonably reflective of change over time in the IPUMS population. Many young people get married in the 1950s and 60s and many stay married, although divorce rises for all age groups starting at around 1970. Widowhood becomes increasingly rare over time, while young people are delaying marriage more and more as the century ends. Finally, the parity status of women for the simulation versus the observed distributions are shown in Figure 8. The shape of change in the parity distribution from year to year is very consistent in the simulation compared to

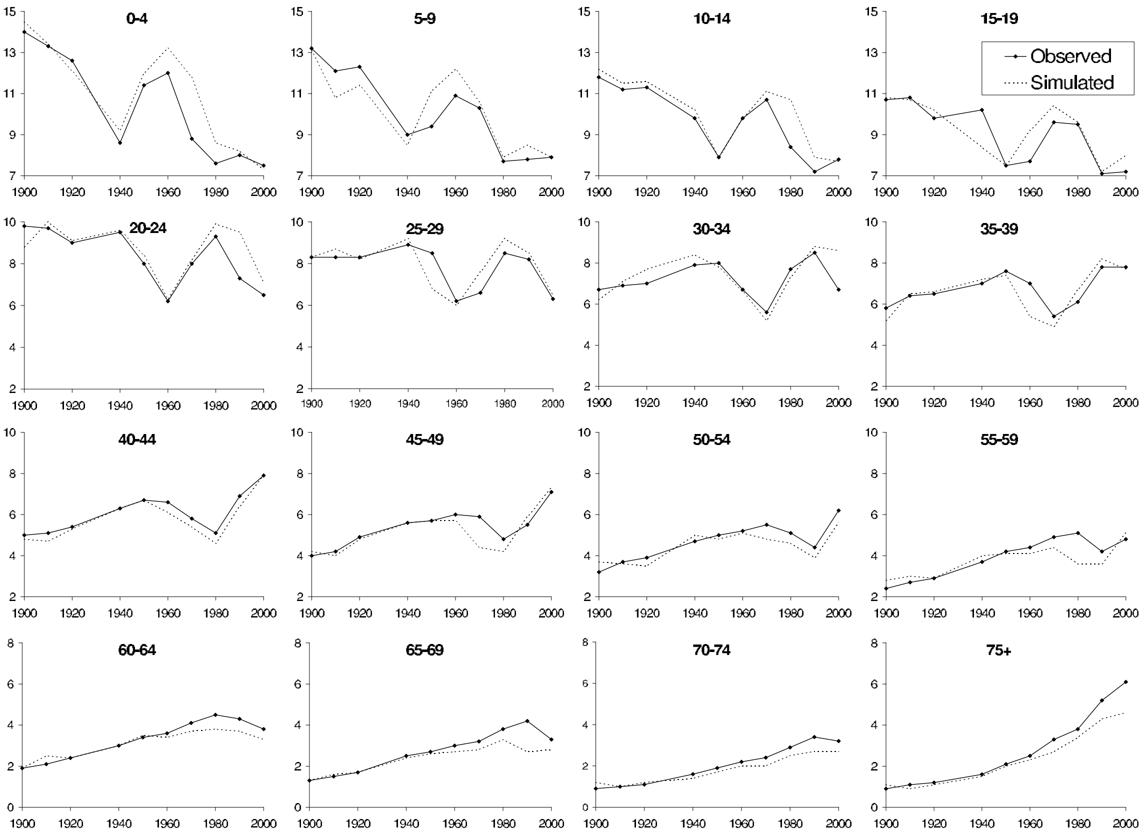

Figure 6: Observed versus Simulated - Age Distribution, 1900-2000. Data are percent in each age group for the observed native-born population in the IPUMS (solid lines) and the simulated native-born population (dotted lines). Note that the y-axis ranges vary for the rows of graphs, but all axes represent a range of seven percentage points, making vertical distance comparable in each graph.

the observed IPUMS population. There is some discrepancy by 1980 as to whether 1 or 2 is the modal parity category, but the directions of change are largely faithful to observed reality.

The simulation seems to captures the main facets of population change over the century, and the simulated population responds to changing demographic rates in roughly the same manner as the actual population did. Where there are discrepancies between the simulation and reality, however, they will affect the analysis results. Recall that the overall proportion h living in a certain household type was the cross-product of the population vector by demographic characteristics (D) and the conditional household vector, (C). The baseline simulation provides a slightly different D than was observed in the IPUMS, so the overall household change that is the object of explanation is somewhat different as well. The final comparisons in the section, then, are between the simulated household distributions, and the observed household distributions. One comparison, shown in Figure 9, is of the distributions of all native-born persons across household types over the century, where the demographic groups are defined by age, sex and marital status. The other comparison, shown in Figure 10, is of the distributions

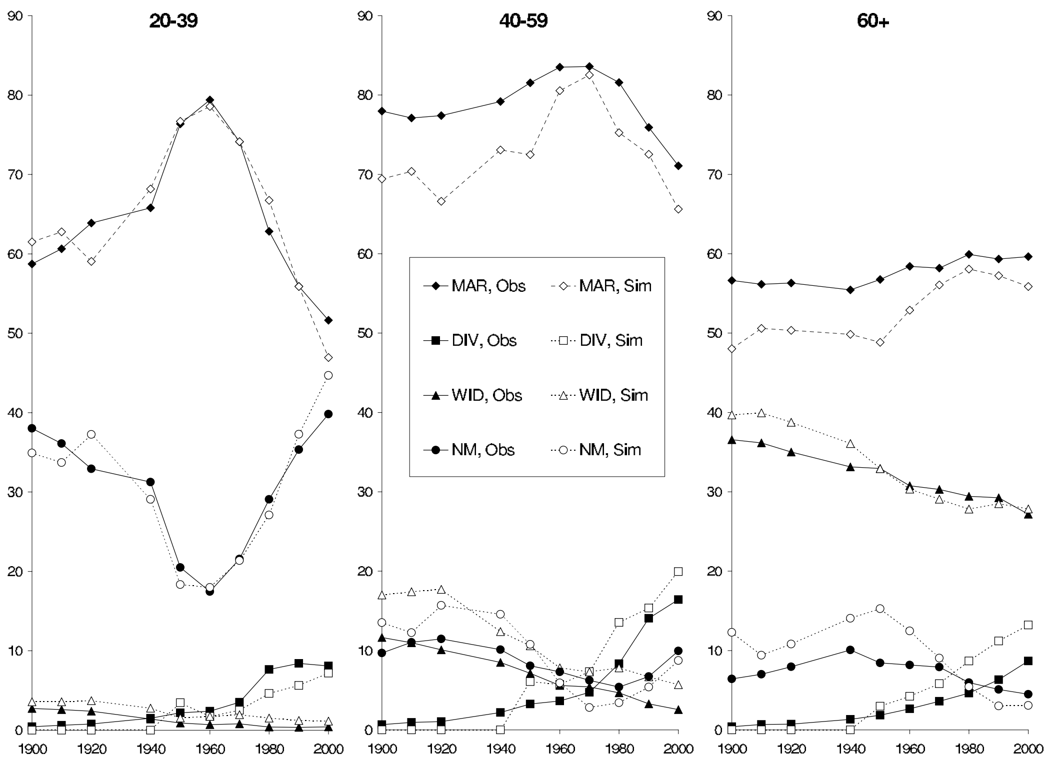

Figure 7: Observed versus Simulated - Marital Status, 1900-2000. Data are percent in given marital status for the designated age group of the observed native-born population in the IPUMS (solid lines) and the simulated native-born population (dotted lines).

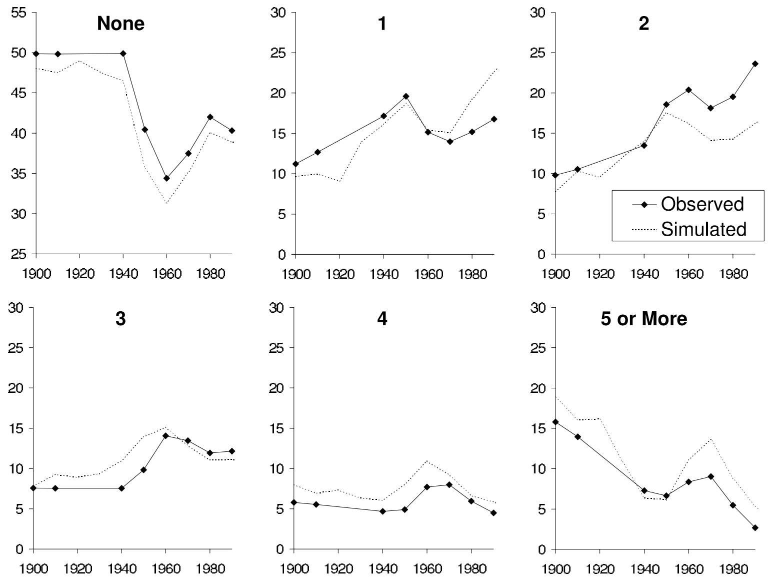

Figure 8: Observed versus Simulated - Parity Distribution, 1900-1990. Data are percent at given parity for native-born women age 15-49.

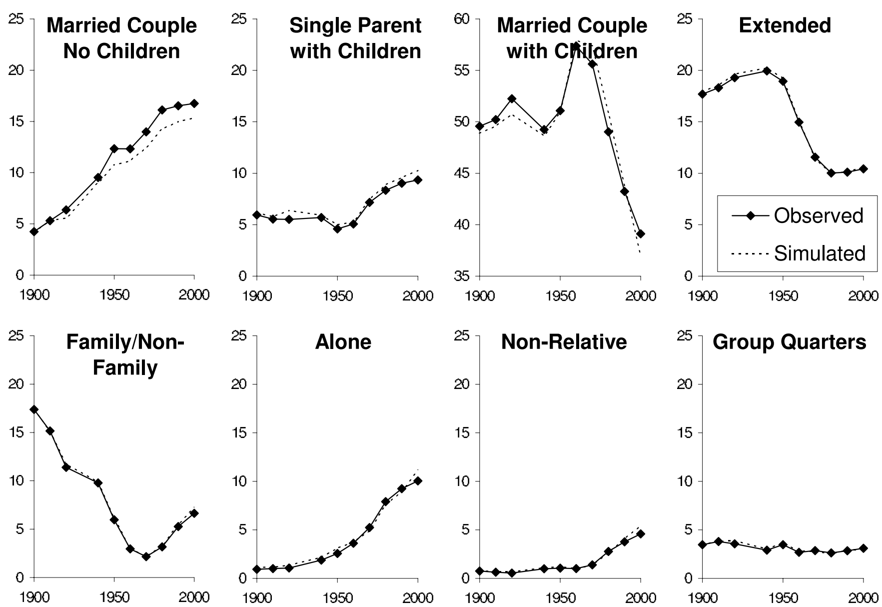

Figure 9: Observed versus Simulated - Native-Born Household Distribution. Simulated household distributions are the product of simulated demographic compositions multiplied by observed demographic characteristic-specific household type probabilities.

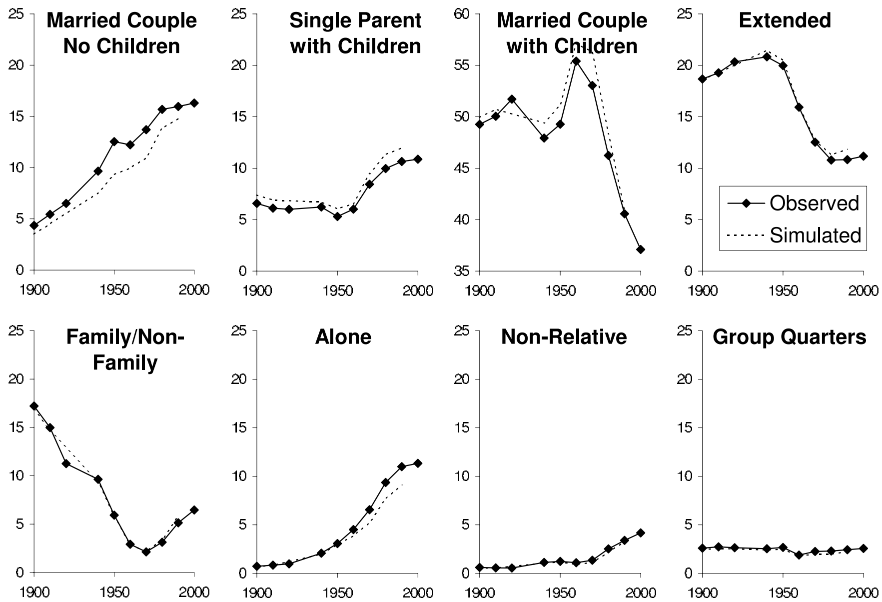

Figure 10: Observed versus Simulated - Native-Born Women Household Distribution. Simulated household distributions are the product of simulated demographic compositions multiplied by observed demographic characteristic-specific household type probabilities.

of native-born women across household types where demographic groups are defined by age, marital status, and children ever born. This comparison is only through 1990 as the parity data is only available through this point.

The main discrepancy in the native-born simulation is that there are fewer persons in married couple households than observed, and slightly more in most of the other categories. For the native-born women simulation, the discrepancy between simulation and observed percentages in married couple households is more acute. The overall increasing trend is there, however, indicating that the decomposition analysis will still be dealing with change moving in a generally correct direction. The magnitude will be smaller than observed, however. In addition to making sure that the simulation could reproduce the observed population, however, the purpose of this detailed examination of the baseline simulation is to support the claim that the vital rates cause the expected change in the population. This supports the idea that we can now mix and match those vital rates sets in order to isolate the effect of changes in each type of rate.

6 Results

6.1 Analysis of Native-Born by Sex, Age, and Marital Status, 1900-2000

To begin with the results from the two-factor decomposition of household change into a component due to the changing demographic composition of the population and a component due to other factors, Figure 11 shows those results for the analysis of the native-born. Recall

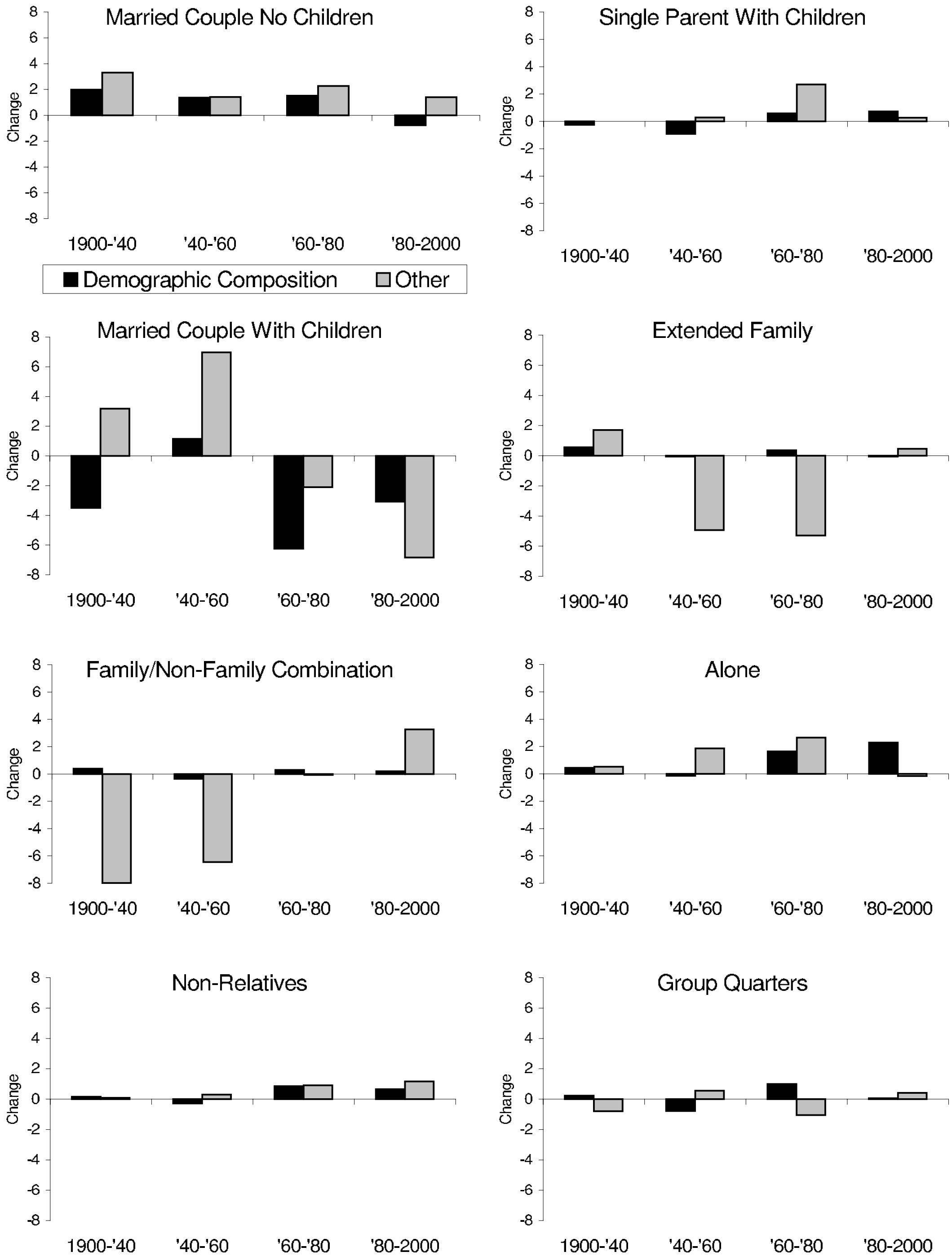

Figure 11: Simple Decomposition - All Native-Born. All y-axes are the same, making all vertical distances comparable.

that the population composition in this analysis is by sex, age and marital status. There is a graph of results for each of the eight possible living arrangements, including seven types of households plus group quarters. Each graph shows four time segments and each segment has a black and a gray bar. The black bar represents the demographic composition component, the gray bar represents the other component. The net height of the two bars added together is the total change in the proportion of persons living in that particular household type in that segment. Taking the first segment of the married couple no children analysis as an example, we see a black bar with a height of +2.0 and a gray bar with a height of +3.3 next to it.[14] Thus, the total change in the proportion of native-born persons living in married couple no children households from 1900 to 1940 was +5.3, 2.0 of which was due to compositional change and 3.3 of which was due to other factors.

It is clear that in most segments, the larger bars are the gray bars, especially for the more complex household types of extended family and family/non-family combination. For the more atomized household types such as married couple with and without children, living alone and non-relatives, the magnitudes of compositional versus other effects are much closer. Of course, sometimes the effects are moving in opposite directions, as in the first segment of the married couple with children analysis. During this segment, between 1900 and 1940, the relative size of the birth cohorts fell, moving the population away from children who are very likely to live in married couple with children households. This is the main reason for the negative population composition effect. Moving in the opposite direction, the married couple with children household became a more popular choice between 1900 and 1940, holding population characteristics constant, causing the positive effect of other factors to be visible in the results.

Some clues about the nature of the compositional and other changes can be gathered through observation of where the opposite direction compositional or other effects can be found. In any one time segment, the total net height of all of the black bars must be zero, just as the total net height of all of the grey bars must be zero. The analysis shows that compositional changes favor some types of households, while detracting from others in equal measure. Similarly, preferences and non-demographic constraints make one particular type of household preferable, but always at the expense of another.

Thus, the positive other effect in the first segment married couple with children analysis finds its opposite effect in the negative gray bar for family/non-family combination. We observe persons in the first segment becoming more likely to live in a married couple with children household and less likely to live in a family/non-family combination household. Thus, even while demography was working against the prevalence of nuclear family units in the population over this segment, the disappearance of many border/lodger type arrangements that made for a family/non-family household in 1900 revealed many of those nuclear units as their own households in 1940. The process seems to have continued through the 1940 to 1960 segment, with family/non-family households continuing to be less favored compared to living alone, or in either of the married couple-based household types, holding compositional change constant. Extended families also decrease during the period, with no indication that compositional change played a part. In fact, this segment sees very little compositional effect at all. Moving on to the 1960 to 1980 segment, the baby bust is in evidence in the strong compositional component decreasing the share of married couple with children households and

[14] Complete tables of numerical values of results are available in Appendix B.

increasing slightly the share of married couple no children and living alone. The extended family household became even more scarce during this period, but not due to any compositional effect. The simultaneous positive effect of other factors on single parent with children households does suggest that single parent family units that used to be residing with kin before 1960 became much more likely reside independently. Looking at the final segment of the analysis, demographic composition continued to move away from characteristics that favored married couple with children households and towards characteristics that favored living alone and, to a lesser extent, living with non-relatives or in a single parent household. Non-demographic factors worked against married couple with children households as well, favoring instead the family/non-family combination household, non-relatives and married couple no children households.

In order to understand more fully what sort of population characteristics are responsible for the compositional component, Figure 12 shows the same gray bars as in Figure 11, but now the black bar for the demographic composition effects is divided into four components: momentum represented in black, fertility shown with diagonal bars, mortality shown with vertical bars, and nuptiality shown in white bars. To take the first segment of the married couple no children graph again, the positive demographic composition effect of +2.0 is now shown to be made up of +0.7 from population momentum, +1.4 from fertility change , +0.1 from mortality change, and -0.3 from changes in marriage and divorce. The interpretation is now based on rates. The decreased fertility observed between 1900 and 1940 increased the prevalence of married couple no children households, as did the lower mortality and the pre-existing demographic composition that, over the forty years in the segment, moved towards a population structure that favored married couple no children households somewhat, compared to the structure in 1900. The slight decrease in marriage through the 1930s, however, mostly due to marriage delay, worked against this type of household.

Looking then at this new picture, we can safely say that the large decreases in extended family households and family/non-family combination households were not demographic in nature. There are no counter-acting demographic effects revealed by the new decomposition. Instead, these findings support the idea that there was a broad secular trend away from coresiding with kin that was not based in the age or sex structure, or in anyone's ability to find a spouse. While the extent to which it was affected by kin availability is not evident from this analysis, we will be able to see in the next section if it was very affected by women's parity.

For the married couple no children and with children households, however, we see the varying ways that different demographic phenomena affected these two types of households. The fertility effects between these two types of households are always in the opposite direction. The decreasing fertility of the 1900 to 1940 period reduced the prevalence of married couple with children families while it increased the married couple no children families. These impacts switched with the fertility increases of the baby boom and switched back with the baby bust and then recovered slightly in the most recent period as fertility rose again slightly. The opposite effects are because fertility decrease extends the period for married couples between their wedding and the transition to married couple with children families, indeed for some it delays it permanently. It also shortens the period between childbearing and the return to living as a married couple without children after the children transition to their own households. The fertility effect is larger for married couple with children households than in married couple no children households because the effect of the relative size of the child cohort is directly felt

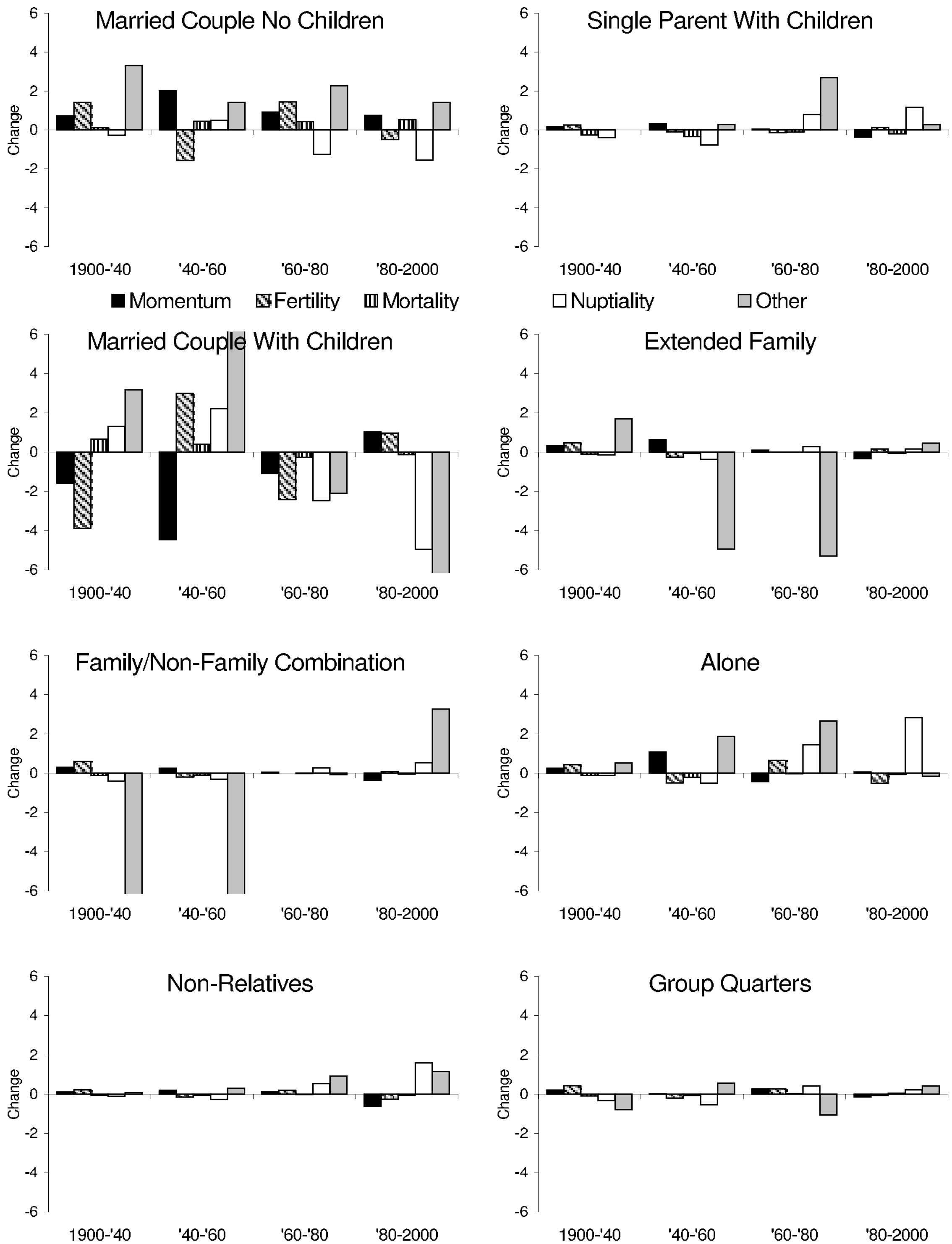

Figure 12: Vital Rates Decomposition - All Native-Born. All vertical distances comparable. Axes are expanded somewhat compared to Figure 11, in order to show demographic component detail. This truncates some of the "other" factor bars.

in the married couple with children household through the abundance or lack of children. It is only indirectly affecting the married couple no children household by increasing slightly all other household types in keeping the total distribution adding to 100%.

Looking more closely at the decomposition of effects for married couple with children households reveals the nature of a strange result from the two-factor analysis. In that analysis, the two-factor result for the period 1940 to 1960 showed a relatively small impact of demographic composition during the period of the baby boom. This does not seem to make sense as the baby boom had such a huge impact on age- and family-composition in the United States. Looking at the full decomposition however, we can see that the small effect of the demographic composition component masks large, counter-acting effects of fertility and population momentum. The fertility effect is obvious - the baby boom was characterized by increased fertility at all ages. The population momentum effect is due to the fact that the childbearers of the baby boom were from the relatively small birth cohorts of the depression era of the 1930s. Population momentum was thus not favoring large birth cohorts between 1940 and 1960. The huge fertility and marriage increases that characterized the baby boom more than overcame the negative effect of population momentum.

Going back to comment further on married couple no children, we see that even greater than the volatile fertility effects on this household type were steadily positive effects of population momentum and mortality decline. The population momentum effect can be thought of as a delayed mortality decline effect. It does not show up as a mortality decline effect because the mortality change in question acted earlier than that particular time segment. In other words, the surviving spouses of the most recent decades are living as married couples with no children because they had greater survival rates through childhood and adult years, as well as during their older years in that particular time segment.

Given the large effect of population momentum and aging on married couple no children households, why do we not see a similar effect on the households of persons living alone? Much of the household change literature does focus on older people, especially elderly widows, living alone, but the results to not indicate a large role for population aging in increasing the proportion of those living alone. This is due to several factors. One is that, despite their position as the focus of research concern, elderly widows are not a very large proportion of the overall population. Another reason is that we are combining both sexes here and the results for men, who are less likely to spend an end-of-life spell without a spouse, dampen those for women. (Effects for women will be discussed in the next section, where population aging effects are shown more clearly on those living alone.) Finally, rather than focusing on older people, this analysis shows larger effects on overall population prevalence of living alone coming from younger people who are delaying marriage more and, once they are married, getting divorced more.

Final comments on the full decomposition of native born persons by age, sex, and marital status focus on the role of marriage. It is shown clearly in the last two decades that the decrease in marriage and increase in divorce acted negatively on the married couple-based households, while favoring single parent households, those living alone and non-relatives. These changes interact with other types of changes through increased cohabitation: family/non-family households increase through the increasing cohabitation of single parents with unmarried partners, as well as two single people cohabiting to form a non-relative household.

6.2 Analysis of Native-Born Women by Age, Marital and Parity Status, 1900-1990

Seeing all of the changes demographic composition causes when it includes only the characteristics of age, sex and marital status, we move to the native-born women analysis that includes age, marital and parity status. The two factor results are shown in Figure 13, but only through 1990 for data reasons. The black bars signaling the contribution of compositional change seem to be consistently larger in this analysis compared to the two-sex case, as we would expect from adding such an important factor on household composition as whether or not a woman had children. The differences are most notable in the two married couple-based household types, but also in the single parent with children and alone households. Of course, some of these differences will be due to the addition of the parity information. Some of them, however, will be due to the fact that men and women have slightly different preferences and demography.

Distinguishing between these two causes of difference between the two-sex and one-sex analysis is facilitated by moving to the full decomposition for the women-only analysis, shown in Figure 14. The effect of adding the parity information is largely shown in the increasing magnitude of the bars showing the fertility component of change, when comparing them with the fertility bars for the two-sex analysis when parity was not a part of the demographic composition. The effect of looking at women only instead of women and men together is shown clearly in the alone household type. Population aging plays a larger role here, shown by the consistently positive effect of population momentum. Women are more likely to be the ones left behind after the death of an elderly spouse.

7 Conclusions

7.1 Understanding the Past

To summarize the discussion of results in the previous section, complex household types have become less prevalent over the century due to changing preferences, economic and social factors, but not due to the large population changes seen during the twentieth century in the United States. Given the fact that, by their very complexity, these household types include persons of all different demographic profiles, the low explanatory power of demography in predicting change in these types of households is expected. Demographic compositional changes are those caused by the increase or decrease in a particular type of person favoring a particular household type. If a household type draws in many different types of people, it cannot be greatly affected by the demographic regime's favoring of one or another specific type of person in the population.

Among the less complex household types, demographic change played a much larger role. Clearly, the size of birth cohorts makes a large difference on the population prevalence of married couple with children households. The volatility of fertility over the century is therefore reflected in the volatility of the proportion of people living in married couple with children households. Married couple no children households had an inverse relationship with married couple with children households, as lower fertility was often the product of delayed childbearing after a couple was married and then also resulted in an earlier transition back to married couple no children households for parents for whom a smaller number of children means a shorter time spent sharing a household with them. We do not see the proportion of persons living in married couple no children behaving with the same volatility as married couple with children

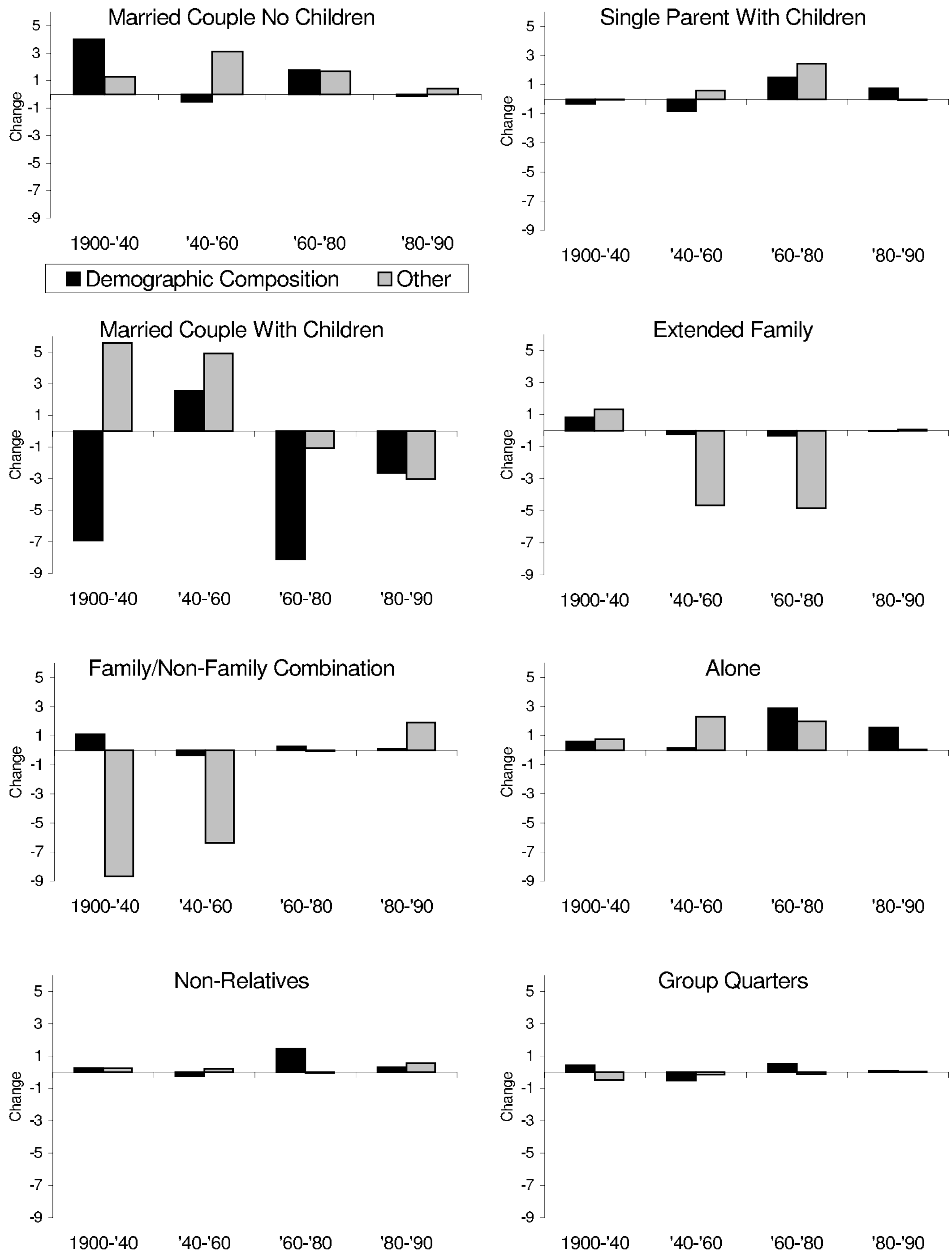

Figure 13: Simple Decomposition - Native-Born Women. All y-axes are the same, making all vertical distances comparable.

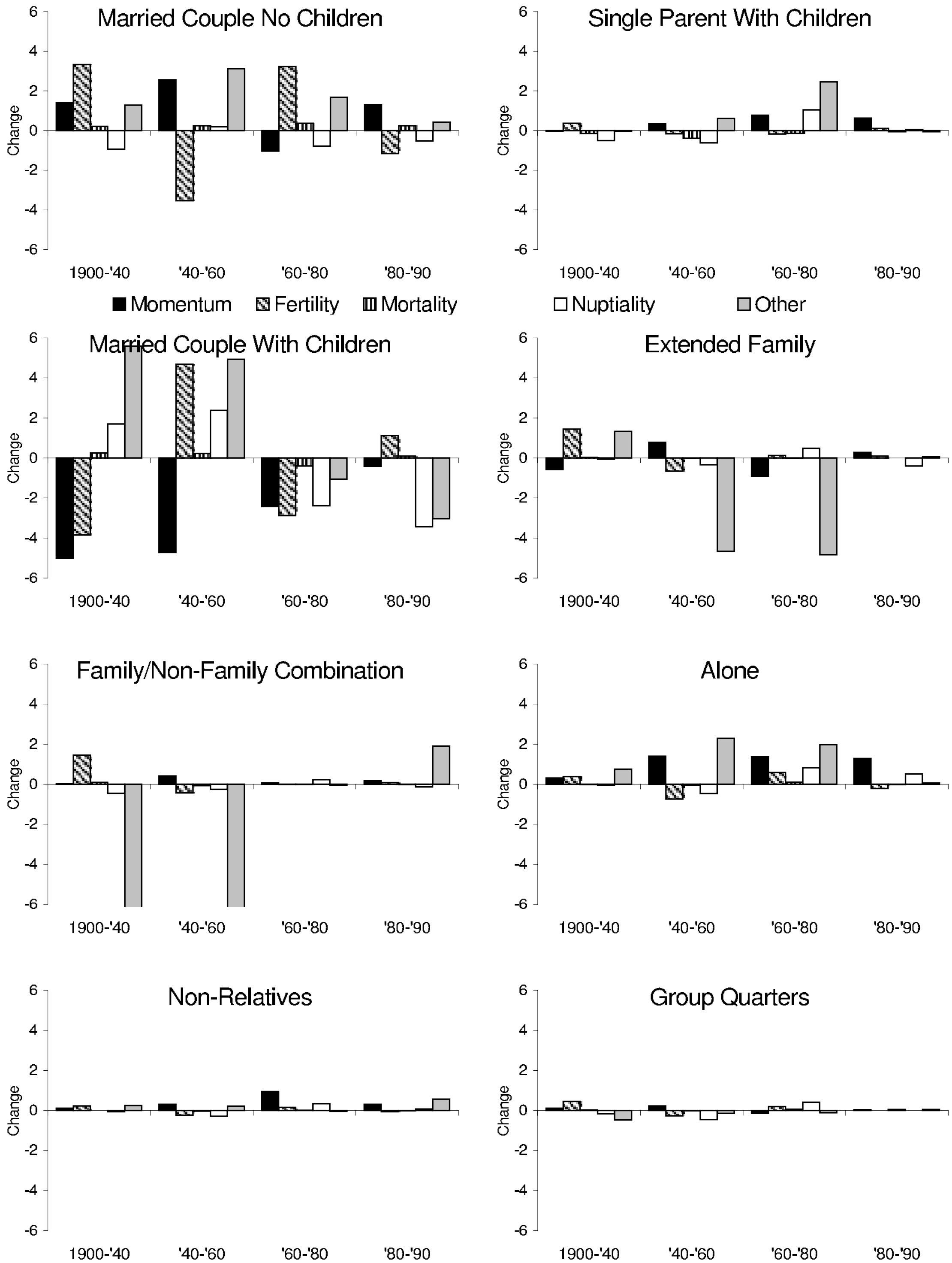

Figure 14: Vital Rates Decomposition - Native-Born Women. All vertical distances comparable. Axes are expanded somewhat compared to Figure 13, in order to show demographic component detail. This truncates some of the other factor bars.

households, however, because of the long century trend towards longer lives. Mortality decline and the steady momentum of population aging meant both that older couples who managed to stay married after the childbearing years enjoyed ever more years of the "second honeymoon" after the children left home, but also that these couples' share of the population grew and grew over time.

Of course, the "second honeymoon" only lasts while both spouses are alive and married. As the average life expectancy gap between men and women widened in the second half of the century, more women found themselves living for some time as widows at the oldest ages. As divorce increased during this period also, more women found themselves living as divorced women also. These demographic changes came at or after many non-demographic changes that led widowed and divorced elderly women to live alone much more often than with family.

7.2 Imagining the Future

The analysis in this paper suggests some ways to think about household change in the future. While the changes in complex household types were not the product of demographic change, they bring us to a household distribution at the end of the century tilted towards less complex household types. Because these less complex types are more affected by changes in the composition of the population, household change in the future is more likely to be demographically driven. As the trend of population aging is not likely to be reversed, then, we can only expect more married couple no children households, as well as more alone households made up of older divorced or widowed women. Other demographic trends, such as fertility and marriage, are less certain in the future.

There is potential, however, for the non-demographic element to change, turning around from favoring less complex household types to favoring more complex ones. There is an indication that the rise of cohabitation since 1980 has already begun that process somewhat, splitting some of the persons who would have made up married couple no children households in the past into non-relative households, and combining some of the persons who would have made single parent families with a parent's unmarried partner who might have lived alone, resulting in a family/non-family household. Apart from cohabitation, the rise of persons of Hispanic ethnicity in the population could increase the prevalence of extended family households, which are much more common among Hispanics than non-Hispanics. While such a change was considered in the "other" category in the research shown here, given enough ethnicity-specific data it could be included as a demographic characteristic.

What the research and techniques in this paper give us, ultimately, is a specific data-driven way to imagine these different future scenarios by performing the same type of mix-and-match demographic and non-demographic estimation that made up the decomposition technique. The next steps for this research, then, are to estimate these scenarios which will then generate not just directions of future change, but rough estimates of their magnitudes as well.

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A Sources and Calculation of Vital Rates

A.1 Mortality

Construction of Rate Files for Simulation. Mortality rate files used in the simulation for each decade are for each sex by single years of age and are computed as the average of single year rates from the beginning to the end of the decade. The rate file for the 1920s, for example, is computed using rates for each year from 1920 to 1929. As rates by age and sex only are used, no interaction between mortality and marital status or parity is considered in the analysis.

Data Sources. The mortality rates from 1900 to 1958 are computed using period life tables constructed by the Office of the Actuary of the Social Security Administration (SSA), made available by the Berkeley Mortality Database, or BMD (Wilmoth 2003). The life tables were constructed for each sex by single years of age and time by the SSA. Mortality rates from 1958 on are also period rates by sex for single years of age and time, from the Human Mortality Database, or HMD (Wilmoth and Shkolnikov 2003). These rates are calculated using vital event and exposure data made available by the National Center for Health Statistics.

Sources of Mortality Data Shown in Figures. The mortality rates for five years of age by one year of time used in Figure 5 are from the BMD for 1900 to 1958, computed by the Berkeley Mortality Database based on the SSA life tables. The same rates for 1959 on are computed by the HMD. Similarly, the life expectancy series shown in Figure 3 is from the original SSA estimates, available from the BMD for 1900-1958, and calculated by the HMD for 1959-1999.

A.2 Fertility

Construction of Rate Files for Simulation. Age-specific fertility rate files for each decade are for varying age groups of women aged 10 to 49. Most of the age groupings are five years, although from 1970 on the rates have the 15-19 year age group broken down into 15-17 and 18-19. The rate files are computed as the average of the single year rates, as described for the mortality rates above. The construction of fertility rate sets is somewhat more complex than that for mortality due to the need to have rates specific to marital status. Such data is available for 1940-1999, for unmarried versus married women, and for those decades the rate files are constructed as the average of each of the decades' single year published rates. Prior to 1940, the simplifying assumption is made that no extramarital births occurred. This makes it possible to estimate rates for married women based on the published rates for all women. Thus the numerator of the all women birth rate for a particular age group is assumed to refer to babies born to married women of that age group only. The all women rate can then be inflated to reflect the rate applying to married women only by dividing through by the proportion of women in the age group who are married. This proportion is estimated for census years using the IPUMS data for that census year, and intercensal years are estimated using linear interpolation. Finally, the all-women fertility rates by age are only available back to 1918. For each year from 1900 to 1917, the birth rate for all women age 15-44 combined is available. Age-specific rates for married women are estimated from this all-women all-age rate as follows. The age pattern of fertility by five-year age groups for ages 15-44 for the years

1900 to 1917 is assumed to be the same as that calculated by averaging the age pattern of fertility observed in 1918, 1919 and 1920. Using the age distribution of women calculated by linear interpolation from the IPUMS age distributions for 1900, 1910 and 1920, the all-women all-age rate is broken down into age-specific all-women rates. Then the married women rates are calculated as described above for the years 1918 to 1940.

Data Sources. Starting from the most recent data, fertility rates specific to five-year age groups for women aged 10 to 49 years are available for married versus unmarried women for each year from 1940 to 1999. Rates for the 1990's have been revised since their publication in the National Center for Health Statistics' annual Vital Statistics of the United States and those revised rates are used here (Hamilton, Sutton, and Ventura 2003). Rates for 1960-1980 are as published in the annual Vital Statistics publication (National Center for Health Statistics 2001), and rates for 1940-1959 are from a National Center for Health Statistics special study (Grove and Hetzel 1968). Prior to 1940, the age-specific rates for all women are available from 1918 to 1939 (Linder and Grove 1947). Data used here are for each calendar year from 1918 to 1939. Prior to 1918, the fertility rates for women age 15-44 are used (U. S. Bureau of the Census 1961).

Sources of Fertility Data Shown in Figures The total fertility rates shown in Figures 3 and 5 are computed from the age-specific rates described above for 1918-2000. The TFR's shown before 1918 are researcher estimates based on census data (Haines 1989).

A.3 Marriage and Divorce

Construction of Rate Files for Simulation. The marriage rate files used in the simulation are computed as the average of the year's rates in the relevant decade where those rates were available. They are age- and sex-specific and specific to three marital statuses: never married, widowed and divorced. The age groups vary a great deal over time and by marital status. For never married persons, the sex-specific age groupings were generally five-year age groups from age 15 to 44, followed by wider age groups until the 65+ group. Only those age groupings available for the entire decade were used to compute the decade average. For widows, the groups for most decades were 15-44, 45-64 and 65+. Age group specificity for divorced persons were somewhere in between that for never married and widowed. This detailed data was available for 1950 and for single years from 1960 to 1990. From these data, marriage rate files were constructed for the decades 1960-1969, 1970-1979, and 1980-1989 as the average of ten years of age-, sex-, and marital status-specific rates. The file for 1950-1959 is the average of the rates for 1950 and 1960. The file for 1990-1999 is constructed by extrapolating the linear trend in the 1980-1990 rates to 1995. For decades prior to 1950, marriage rates used were estimated by Kenneth Wachter for U.S. whites and adjusted for differing age pattern on an ad hoc basis to increase agreement between observed and simulated marital distributions.

Although there is some age- or duration-specific divorce rate information available for some recent years, the only consistent series for the century was the overall divorce rate for married women age 15+, available for 1900, 1910, and each year from 1920 to 1996. The simulation assumes no divorce, however, prior to 1940 because the available data is based on a marriage registration area of only a few states. The divorce rate is calculated as the average of the ten years of overall divorce rates for the decades from 1940-1949 through 1980-1989. The rates for 1990-1999 are the average of rates from 1990 to 1996. As the simulation uses duration-specific divorce rates, the calculated decade's rates apply to marriages of one to 30 years, thus assuming no divorce before the first or after the thirtieth year of marriage.

Data Sources. Marriage rate data by age, sex, and previous marital status described above are available for 1950 from a Vital Statistics special report (Grove and Hetzel 1968) and for each year from 1960-1988 from annual Vital Statistics System publications (National Center for Health Statistics 1996 and prior years). Data for 1989 and 1990 are from a Monthly Vital Statistics report (Clarke 1995). Divorce rate data, specifically divorces per 1,000 married women age 15+, from 1940-1984 are from one Vital Statistics of the United States annual publication (National Center for Health Statistics 1996). Rates from 1985 to 1996 were reported in the U. S. Bureau of the Census (2001).

Sources of Fertility Data Shown in Figures The overall marriage rates (marriages per 1,000 unmarried women age 15+) shown in Figures 3 and 5 are from various sources. From 1991 to 1996, they were reported in the Statistical Abstract of the United States (2001). Prior to that, the marriage rate for 1940-1990 comes from a Monthly Vital Statistics report (Clarke 1995). Prior to 1940, the marriage rates are from a special report of the National Vital Statistics System (Plateris 1973). All divorce rates shown in figures are from the same sources used to make the rate files, described above.

A.4 Computation of Monthly Event Probabilities from Annual Rates

The computations described above give average rates for the decade on an annual basis while the simulation requires monthly event probabilities. The final step in preparing the rate files, then is to convert an annual rate into a monthly probability. Assuming that the annual rate is a probability, the conversion to a monthly probability is as follows:

$$\text{Monthly Probability} = 1 - (1 - \text{Annual Rate})^{\frac{1}{12}}$$

B Decomposition Results

The following tables provide the numerical results that are presented graphically in Figures 11 through 14. The tables of the simple results show the total proportion in each household type in the first line for each household type. The lines following show the change from the decade listed in the previous column to the decade listed for that column, for the total change and then for demographic component and other component. The final column sums up change for the whole time period. Recall that for the whole native-born population the analysis covers the entire century from 1900 to 2000. For the women only analysis, the time period covered is 1900 to 1990.

For the tables showing the sub-division of the demographic component into its vital rates components, each column represents change over the time period listed in the column heading. The components for momentum, fertility, mortality and nuptiality add to the number listed as the demographic component in that analysis' two-factor decomposition table.

Table 1: Simple Decomposition Results - All Native Born

		1900	1940	1960	1980	2000	1900-2000
Married Couple No Children							
Proportion		4.24	9.53	12.32	16.12	16.76	
Change	Total		5.30	2.79	3.80	0.64	12.52
	Demography		1.99	1.37	1.52	-0.77	4.11
	Other		3.31	1.42	2.27	1.41	8.41
Single Parent With Children							
Proportion		5.95	5.70	5.07	8.35	9.34	
Change	Total		-0.25	-0.63	3.28	1.00	3.40
	Demography		-0.24	-0.91	0.59	0.72	0.15
	Other		0.00	0.28	2.69	0.28	3.25
Married Couple With Children							
Proportion		49.57	49.25	57.37	49.03	39.11	
Change	Total		-0.32	8.12	-8.35	-9.91	-10.46
	Demography		-3.50	1.15	-6.25	-3.08	-11.69
	Other		3.18	6.98	-2.10	-6.83	1.22
Extended Family							
Proportion		17.70	19.95	14.96	10.02	10.43	
Change	Total		2.26	-4.99	-4.94	0.40	-7.27
	Demography		0.56	-0.06	0.36	-0.06	0.80
	Other		1.70	-4.94	-5.30	0.46	-8.07
Family/Non-Family Combination							
Proportion		17.38	9.78	2.97	3.18	6.63	
Change	Total		-7.61	-6.81	0.21	3.46	-10.75
	Demography		0.38	-0.35	0.29	0.19	0.51
	Other		-7.99	-6.46	-0.08	3.27	-11.26
Alone							
Proportion		0.93	1.88	3.62	7.91	10.04	
Change	Total		0.96	1.73	4.30	2.13	9.12
	Demography		0.44	-0.14	1.64	2.29	4.24
	Other		0.52	1.87	2.65	-0.16	4.88
Non-Relatives							
Proportion		0.75	0.99	1.01	2.78	4.59	
Change	Total		0.24	0.02	1.77	1.81	3.83
	Demography		0.16	-0.28	0.85	0.65	1.38
	Other		0.08	0.30	0.92	1.16	2.45
Group Quarters							
Proportion		3.48	2.91	2.68	2.62	3.10	
Change	Total		-0.57	-0.23	-0.06	0.48	-0.38
	Demography		0.22	-0.78	1.00	0.06	0.50
	Other		-0.79	0.55	-1.06	0.41	-0.88

Table 2: Decomposition of Demographic Component - All Native Born

	1900-1940	1940-1960	1960-1980	1980-2000	1900-2000
Married Couple No Children					
Momentum	0.73	2.01	0.91	0.75	4.40
Fertility	1.41	-1.57	1.44	-0.49	0.78
Mortality	0.11	0.44	0.43	0.52	1.51
Nuptiality	-0.27	0.50	-1.26	-1.55	-2.58
Single Parent With Children					
Momentum	0.16	0.32	0.04	-0.37	0.14
Fertility	0.25	-0.11	-0.14	0.14	0.15
Mortality	-0.27	-0.35	-0.11	-0.20	-0.93
Nuptiality	-0.39	-0.78	0.80	1.16	0.79
Married Couple With Children					
Momentum	-1.58	-4.46	-1.09	1.03	-6.11
Fertility	-3.88	2.99	-2.41	0.97	-2.33
Mortality	0.65	0.40	-0.27	-0.13	0.65
Nuptiality	1.31	2.22	-2.48	-4.95	-3.90
Extended Family					
Momentum	0.33	0.63	0.10	-0.33	0.73
Fertility	0.47	-0.26	-0.01	0.16	0.36
Mortality	-0.10	-0.06	-0.01	-0.06	-0.23
Nuptiality	-0.14	-0.37	0.28	0.16	-0.06
Family/Non-Family Combination					
Momentum	0.30	0.25	0.05	-0.36	0.24
Fertility	0.60	-0.20	0.00	0.08	0.48
Mortality	-0.12	-0.10	-0.02	-0.05	-0.29
Nuptiality	-0.41	-0.31	0.27	0.53	0.08
Alone					
Momentum	0.25	1.08	-0.43	0.06	0.96
Fertility	0.43	-0.50	0.65	-0.52	0.06
Mortality	-0.12	-0.21	-0.03	-0.07	-0.44
Nuptiality	-0.12	-0.51	1.45	2.83	3.65
Non-Relatives					
Momentum	0.11	0.20	0.13	-0.63	-0.19
Fertility	0.21	-0.15	0.20	-0.26	0.00
Mortality	-0.06	-0.06	-0.02	-0.06	-0.19
Nuptiality	-0.11	-0.27	0.54	1.60	1.76
Group Quarters					
Momentum	0.21	0.02	0.27	-0.14	0.37
Fertility	0.43	-0.20	0.27	-0.07	0.43
Mortality	-0.09	-0.07	0.03	0.05	-0.07
Nuptiality	-0.33	-0.54	0.42	0.22	-0.23

Table 3: Simple Decomposition Results - Native Born Women Only

		1900	1940	1960	1980	1990	1900-1990
Married Couple No Children							
Proportion		4.35	9.65	12.23	15.69	15.97	
Change	Total		5.30	2.58	3.46	0.28	11.61
	Demography		4.02	-0.54	1.78	-0.15	5.11
	Other		1.28	3.12	1.68	0.42	6.50
Single Parent With Children							
Proportion		6.57	6.23	6.01	9.97	10.66	
Change	Total		-0.35	-0.22	3.96	0.69	4.08
	Demography		-0.32	-0.82	1.50	0.74	1.11
	Other		-0.03	0.60	2.46	-0.05	2.98
Married Couple With Children							
Proportion		49.26	47.93	55.41	46.24	40.57	
Change	Total		-1.33	7.48	-9.17	-5.67	-8.69
	Demography		-6.92	2.56	-8.10	-2.64	-15.10
	Other		5.59	4.92	-1.06	-3.03	6.41
Extended Family							
Proportion		18.67	20.83	15.94	10.79	10.84	
Change	Total		2.15	-4.89	-5.14	0.05	-7.83
	Demography		0.83	-0.23	-0.31	-0.03	0.26
	Other		1.33	-4.66	-4.84	0.08	-8.09
Family/Non-Family Combination							
Proportion		17.21	9.63	2.92	3.13	5.14	
Change	Total		-7.58	-6.71	0.21	2.01	-12.07
	Demography		1.10	-0.35	0.26	0.10	1.11
	Other		-8.68	-6.36	-0.05	1.91	-13.18
Alone							
Proportion		0.72	2.07	4.51	9.36	10.99	
Change	Total		1.35	2.43	4.86	1.63	10.27
	Demography		0.60	0.14	2.88	1.57	5.19
	Other		0.75	2.30	1.97	0.06	5.07
Non-Relatives							
Proportion		0.61	1.12	1.09	2.52	3.40	
Change	Total		0.51	-0.03	1.42	0.88	2.79
	Demography		0.26	-0.25	1.46	0.31	1.79
	Other		0.24	0.22	-0.04	0.57	0.99
Group Quarters							
Proportion		2.59	2.54	1.89	2.30	2.43	
Change	Total		-0.05	-0.65	0.41	0.13	-0.16
	Demography		0.43	-0.51	0.52	0.09	0.53
	Other		-0.48	-0.14	-0.11	0.05	-0.68

Table 4: Decomposition of Demographic Component - Native-Born Women

	1900-1940	1940-1960	1960-1980	1980-2000	1900-2000
Married Couple No Children					
Momentum	1.41	2.56	-1.03	1.29	4.23
Fertility	3.33	-3.54	3.23	-1.15	1.86
Mortality	0.22	0.24	0.37	0.24	1.07
Nuptiality	-0.94	0.20	-0.79	-0.53	-2.06
Single Parent With Children					
Momentum	-0.04	0.36	0.77	0.63	1.72
Fertility	0.37	-0.16	-0.17	0.11	0.15
Mortality	-0.15	-0.39	-0.14	-0.06	-0.74
Nuptiality	-0.50	-0.62	1.04	0.06	-0.02
Married Couple With Children					
Momentum	-5.01	-4.73	-2.43	-0.41	-12.58
Fertility	-3.85	4.68	-2.89	1.12	-0.94
Mortality	0.25	0.23	-0.40	0.09	0.17
Nuptiality	1.70	2.38	-2.38	-3.44	-1.75
Extended Family					
Momentum	-0.57	0.78	-0.90	0.28	0.42
Fertility	1.44	-0.66	0.12	0.09	0.99
Mortality	0.03	-0.02	-0.01	0.00	0.01
Nuptiality	-0.07	-0.34	0.48	-0.40	-0.33
Family/Non-Family Combination					
Momentum	0.01	0.41	0.07	0.18	0.67
Fertility	1.45	-0.43	-0.01	0.08	1.08
Mortality	0.09	-0.08	-0.01	-0.02	-0.02
Nuptiality	-0.45	-0.25	0.22	-0.14	-0.62
Alone					
Momentum	0.30	1.40	1.37	1.29	4.36
Fertility	0.38	-0.74	0.59	-0.21	0.01
Mortality	-0.02	-0.05	0.11	-0.02	0.01
Nuptiality	-0.06	-0.47	0.825	0.51	0.81
Non-Relatives					
Momentum	0.11	0.31	0.95	0.31	1.68
Fertility	0.23	-0.24	0.16	-0.06	0.08
Mortality	-0.01	-0.03	0.01	-0.01	-0.03
Nuptiality	-0.07	-0.29	0.34	0.07	0.06
Group Quarters					
Momentum	0.11	0.22	-0.14	0.04	0.23
Fertility	0.45	-0.27	0.19	0.00	0.37
Mortality	0.02	-0.01	0.06	0.05	0.13
Nuptiality	-0.16	-0.45	0.41	0.00	-0.21