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LONG-TERM PROJECTIONS OF NATIONAL,
REGIONAL, AND STATE POPULATION

by

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FOREWORD

Under the auspices of the National Acid Precipitation Assessment Program (NAPAP), activities supporting the preparation of future assessments have been planned and delegated to task groups. Task Group B (TG-B), "Man-Made Sources" (subsequently redesignated Task Group I, "Emissions and Controls"), of the Interagency Task Force on Acid Precipitation is responsible for developing and testing models that can be used to project fuel use and air pollutant emissions by energy use sector. Argonne has participated in the TG-B program since 1984.

The TG-B program is being carried out in two phases. Phase 1 includes development of the models for generation of baseline scenarios. Phase 2 will address the capabilities for modeling emission-control scenarios. Under Phase 1, the sector models are being developed and tested. This testing is designed to aid in model development and help prepare the models for use by the task force. Upon completion, the sector models will be incorporated into the TG-B emissions model set and linked to a system of models that provide scenario-consistent input data.

The Argonne Energy-Economic Modeling Program is publishing a series of reports that document the steps undertaken to prepare national and regional projections of energy and economic activity required as input to the sector emissions models. This report is part of that series; it documents the selection and extension of regional and state-level population forecasts needed to drive the sector models.

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1 INTRODUCTION

In the National Acid Precipitation Assessment Program (NAPAP), Task Group B (TG-B) is responsible for developing and testing models that can be used to project fuel use and air pollutant emissions by energy use sector. As discussed in the Foreword, this work is being carried out in two phases. All activities described in this report have taken place under Phase 1 of the program. This report addresses one aspect of the work to supply energy-economic driver data to the TG-B emissions model set: long-term (1980-2030) projections of population for the nation, regions, and states. The components of the energy-economic driver module are shown in Fig. 1.

FIGURE 1 Block Diagram of the Energy-Economic Driver Module

1.1 BACKGROUND AND SCOPE

This report examines several population projections for the United States, its regions, and individual states; one projection is recommended for use in the 1985 test runs of the TG-B model set. As part of this examination, various issues that arise in the projection of populations are analyzed. In addition, alternative methods to generate projections of regional and state population beyond the year 2000 are described; such methods are explored because subnational population projections do not generally extend beyond 2000 or 2010. One method is used to extend the regional and state population projections to 2030 for the Phase 1 test runs. Recommended population projections for the years 1980 to 2030 are appended to this report. Such long-run projections are critical to several components of the TG-B emissions model set.

A projection of total U.S. population is a key input for the long-term extension (2009-2030) of the Data Resources, Inc., (DRI) macroeconomic forecasts; this projection is part of the energy-economic driver task.* Moreover, population projections at the regional and state level are crucial direct inputs to the residential, commercial, utility, and transportation sector models. One of Argonne's activities for the 1985 test runs is to ensure that the population projections used as driver data for the various components of the emissions model set are the best available and that our own population projections (where needed) are consistent with the best projections of others. This report documents our efforts to ensure that these requirements are met.

1.2 ORGANIZATION

Four basic questions are addressed in this report:

1. What is the best long-term (to 2030 or beyond) projection of total U.S. population? Does the U.S. Bureau of the Census³ produce the best available set of projections?
2. What are the best population projections for regions and states? Are these projections consistent with the best projection of total U.S. population?
3. How can the population projections for regions (and states) be extended to 2030 in a manner that is consistent with the best projection of total U.S. population?
4. What is the best projection of the U.S. age-sex distribution?

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*DRI-generated macroeconomic forecasts were selected for use in the 1985 test runs of the TG-B emissions model set. Typically, these forecasts cover only the period 1985-2008. For this exercise, a macroeconomic forecast was needed through 2030. Argonne developed a methodology to extend the DRI forecast.¹ That methodology was later used by DRI in a long-run macroeconomic forecast delivered to Argonne.² Population was the key parameter in the preparation of this macroeconomic forecast.

Sections 2-5 address each of these issues in turn. Appendix A contains the national, regional, and state population projections for the period 1980 to 2030 that will be used as driver data in the 1985 test runs. The regional and state population projections are scenario-specific, whereas the national population projection does not differ by scenario. Appendix B presents an alternative (more elaborate) method to extend regional and state population projections to the year 2030.

In brief, the conclusions reached in this report are as follows:

1. The projections prepared by the U.S. Bureau of the Census are the best available projections of total U.S. population.
2. The DRI projections of population at the regional and state level to the year 2008 are the best available and are consistent with the U.S. Bureau of the Census projections of total U.S. population.
3. The DRI regional and state projections can be extended from 2008 to 2030 with a simple model based on economic opportunity (see App. B), although an even simpler model -- constant shares -- is used for the 1985 test runs (see Sec. 4 for the rationale behind this decision).
4. The U.S. Bureau of the Census prepares the best available projections of the U.S. age-sex distribution.

2 PROJECTIONS OF TOTAL U.S. POPULATION

Alternative projections of total U.S. population are presented and analyzed in this section. The projections prepared by the U.S. Bureau of the Census are examined more closely because they are used by the major macroeconomic forecasting services.

2.1 U.S. BUREAU OF THE CENSUS PROJECTIONS

The U.S. Bureau of the Census (USBC) issued population projections in October 1982³ that are used by the major macroeconomic services (including DRI) to project economic growth and regional population. Consequently, a careful examination of the USBC projections is in order. A more recent USBC projection has revised the 1982 projection for the year 2000 upward by 0.18%, so the control total used in this paper is still very close to the current USBC projection.⁴

The USBC produced alternative population projections by varying assumptions about fertility, mortality, and net immigration. The middle population projection, used by DRI to project economic growth to 2008 and by Argonne and DRI to extend these projections to 2030,^{1,2} is based on the middle projection for each of these three factors. The alternative assumptions used by USBC for these three factors are listed in Table 1. The lowest and highest USBC projections make use of the low and high assumptions, respectively.

In addition to the lowest, middle, and highest projections, USBC made projections in which two of the three key assumptions are held at their middle levels, while the third assumption varies. Thus, a middle projection was prepared assuming a high and low fertility (or mortality or net immigration) rate.

**TABLE 1 Alternative U.S. Bureau of the Census
Assumptions about Population Projection**

Projection Factors	Low	Middle	High
Fertility (ultimate lifetime births per woman)	1.6	1.9	2.3
Mortality (life expectancy in 2050)	76.7	79.6	83.3
Immigration (yearly net in thousands)	250	450	750

Source: Ref. 3.

All of the USBC population projections for the years 1990, 2000, 2025, and 2050 are displayed in Table 2. It is evident that the alternative assumptions matter a great deal by 2025. In that year, the lowest, middle, and highest population projections span a considerable range: 259.7 million, 301 million, and 356.6 million, respectively. Furthermore, Table 2 shows that the alternative fertility assumptions have the largest impact on the projections. Within the middle series, the projections for 2025 with low and high fertility are 276.1 million and 329.3 million, respectively. The alternative mortality assumptions (in the middle series) only change the projected 2025 population from 294.7 million to 308.3 million, a difference of 4.6%. The net immigration assumption is also of some importance; total population for the middle series in 2025 increases from 290.1 million to 319.5 million when net immigration is increased from 250,000 to 750,000 per year. The increase from a net immigration of 450,000 (middle) to 750,000 (high) increases the middle projection in 2025 from 301 million to 319.5 million, or 6.2%.

There appears to be no basis for selecting fertility and mortality assumptions other than those used in the USBC middle series. As USBC stated, regarding the middle fertility assumption of 1.9 lifetime births per women,

This was consistent with recent levels of fertility, women's expectations of future births, and social and economic trends leading to lower fertility -- increases in labor force participation, education attainment, and age at first marriage. (Ref. 3, p. 2)

TABLE 2 U.S. Bureau of the Census Population Projections (10⁶ persons)

Projection Series	1990	2000	2025	2050
Lowest	245.5	255.6	259.7	230.8
Middle	249.7	268.0	301.0	308.9
Fertility				
High	251.2	273.3	329.3	379.2
Low	247.8	261.5	276.1	257.0
Mortality				
High	249.3	266.3	294.7	297.8
Low	250.2	269.9	308.3	322.1
Net Immigration				
High	252.7	274.9	319.5	339.6
Low	247.8	263.7	290.1	291.2
Highest	254.7	282.3	356.6	428.7

Source: Ref. 3.

On the basis of this statement, and the fact that the projections are not very sensitive to the mortality assumption, we believe that the middle series is the most reasonable set of population projections.

Within the middle series, however, the net immigration assumption must be examined more closely. As USBC stated,

The middle set of immigration projections uses an assumption of a constant annual net inflow of 450,000 -- roughly equal to the *measured* [emphasis added] level of net annual immigration over the past decade. A wide range between the high and low assumptions of net immigration is needed given the uncertainty as to the future course of refugee movements, possible changes in immigration legislation over the next 70 years, and the lack of adequate data on the legal flows of emigrants from the United States and the flows of undocumented aliens into and out of the United States. The high assumption of 750,000 can accommodate most of these concerns. (Ref. 3, p. 3)

In other words, the middle assumption of 450,000 makes no allowance for illegal immigration. The high assumption of 750,000 appears to be more reasonable because illegal immigration can be expected to continue. Indeed, population projections for Mexico produced by Keyfitz et al.⁵ suggest that there will be a strong incentive for migration from Mexico to the United States. The Keyfitz projections for the population of Mexico are:

<u>Year</u>	<u>Population (10⁶ persons)</u>
1975	59.2
2000	112.2
2025	154.4
2050	179.5

These projections show that the Mexican population will increase by 89.5% between 1975 and 2000, and then will increase by another 37.6% between 2000 and 2025. In contrast, the U.S. population is projected to grow by 12.3% from 2000 to 2025 in the USBC middle scenario.

Although immigration is an important issue, we believe that population projections for the 1985 test runs should be based on the USBC middle scenario, including net immigration of 450,000 per year. This population projection is embedded in the DRI macroeconomic forecasts and is the basis for all available regional and state population projections. Therefore, even though this net immigration assumption may produce population projections that are slightly low, there are no viable alternatives at this time. We introduced this issue for future research consideration and potential inclusion in subsequent TG-B model set activities.

2.1 OTHER PROJECTIONS OF U.S. POPULATION

This section briefly compares the USBC projections with those made by some other researchers, as summarized by Keyfitz et al.⁵ The projections made by Keyfitz et al. for 2000, 2025, and 2050 are shown in Table 3, along with the USBC projections. The Keyfitz projections are somewhat lower than the USBC middle scenario. In fact, the Keyfitz projection for 2000 (254.4 million) is virtually identical to the lowest USBC projection for that year (255.6). However, the Keyfitz projection for 2025 (281.8 million) is closer to the middle USBC projection (301.0 million) than to the lowest USBC projection (259.7 million). It appears, though, that Keyfitz et al.⁵ did not update their projection to account for the 1980 Census, and it is widely recognized that there was an undercount in the 1970 Census. This may account for some of the difference. The updating of the USBC projection to include the 1980 Census resulted in an increase in the USBC year 2000 projection from 248.4 million to 268.0 million (middle scenario).^{3,9} Thus, if this same adjustment were made to the Keyfitz projection, it would not be at variance with the USBC middle scenario.

**TABLE 3 Alternative Projections of U.S. Population
(10⁶ persons)**

Source	2000	2025	2050
U.S. Bureau of the Census			
Lowest	255.6	259.7	230.8
Middle	268.0	301.0	308.9
Highest	282.3	356.6	428.7
Keyfitz et al.	254.4	281.8	288.1
United Nations			
Low	251.0	--	--
Medium	264.0	--	--
High	300.0	--	--
Community and Family Study Center, University of Chicago			
Low	246.0	--	--
Medium	247.0	--	--
High	248.0	--	--
Population Reference Bureau	260.4	--	--

Sources: U.S. Bureau of the Census (Ref. 3), Keyfitz et al. (Ref. 5), United Nations (Ref. 6), University of Chicago (Ref. 7), and Population Reference Bureau (Ref. 8).

Other projections for the year 2000 shown in Table 3 were produced by the United Nations,⁶ the Community and Family Study Center at the University of Chicago,⁷ and the Population Reference Bureau.⁸ These projections were also made before the 1980 Census, and all are somewhat below the latest USBC middle scenario projection for the year 2000.

This section can be summarized with the following statement: the USBC middle scenario is not substantially at variance with other leading projections. Indeed, because the USBC is the only one which takes the 1980 Census into account, the USBC projections are probably the most accurate.

3 PROJECTIONS OF REGIONAL AND STATE POPULATION

This section reviews alternative projections of regional and state population. In particular, we compare the results obtained by DRI with other regional and state projections in order to decide whether the DRI forecasts are reasonable. The two other projections available at this geographic level are those prepared by the USBC¹⁰ and the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce.¹¹ All three sources include projections for the year 2000; the projections are therefore compared in that year. The alternative projections, along with the 1980 population figures, are shown in Table 4. This section discusses the three projections in turn, and then presents a conclusion regarding the reasonableness of the recommended DRI projections.

3.1 U.S. BUREAU OF THE CENSUS PROJECTIONS

The USBC regional and state population projections are generated with a simple methodology. The starting point is the USBC middle projection of total U.S. population, 267.5 million. Section 2.1 provided a detailed discussion of this middle projection series. Projections of births and deaths at the state level make use of standard demographic methods.

The projections of net migration have the largest impact on state population projections. USBC simply assumed that the 1970-1980 rate of net migration to a state would continue through 1990 and 2000. In other words, the trends in net migration from 1970 to 1980 are assumed to continue. USBC faced the difficult problem of calculating net migration rates from 1970 to 1980, when a population undercount in the 1970 Census existed. To resolve the problem, USBC calculated net migration rates as a remainder after the 1970 Census figures were adjusted upward to correct for the undercount.¹⁰

The USBC projections (Table 4) show a decline in the population of the Northeast from 1980 to 2000, particularly in Massachusetts, New York, and Pennsylvania. The population of the North Central region is projected to increase slightly (1.4%), while the populations of the South and West are projected to increase 31.2% and 44.2%, respectively. The national increase is projected to be 18.1%. These projections clearly are the result of the assumption that migration to the South and West that occurred during the 1970s will continue undiminished. The states projected to grow by the greatest magnitudes between 1980 and 2000 are Florida (9.7 to 17.4 million), Texas (14.2 to 20.7 million), Arizona (2.7 to 5.9 million), and California (23.7 to 30.6 million).

3.2 BUREAU OF ECONOMIC ANALYSIS PROJECTIONS

The BEA state and regional projections reflect the USBC projection of total U.S. population for the year 2000.¹¹ State population is projected on the basis of state birth and death rates and the assumption that interstate migration of working-age population is mainly determined by economic opportunity; the number of employed residents is used as an indicator of economic opportunity. State employment projections were made by the BEA and based on projections of earnings by industry. The projections of earnings make use of an export-base model for each state.

TABLE 4 Alternative Regional and State Population Projections for the Year 2000 (10⁶ persons)^a

Geographic Area	1980	2000		
		USBC	BEA	DRI
<u>Nation and Major Areas</u>				
United States	226.5	267.5	267.5	267.8
Areas				
Northeast	49.1	46.4	54.3	54.2
North Central	58.9	59.7	62.0	62.4
South	75.3	98.8	93.2	95.4
West	43.2	62.3	58.1	56.7
<u>4 Major Areas and 9 Regions</u>				
Northeast				
New England	12.3	12.8	14.7	14.2
Middle Atlantic	36.8	33.6	39.6	39.9
North Central				
E. North Central	41.7	41.6	42.9	43.5
W. North Central	17.2	18.1	19.1	19.0
South				
South Atlantic	36.9	49.0	46.6	47.7
E. South Central	14.7	17.2	16.1	15.7
W. South Central	23.7	32.7	30.5	31.9
West				
Mountain	11.4	20.1	16.6	16.0
Pacific	31.8	42.4	41.5	40.8
<u>9 Regions and 50 States</u>				
New England				
Connecticut	3.1	3.1	3.8	3.6
Maine	1.1	1.3	1.3	1.3
Massachusetts	5.7	5.5	6.8	6.5
New Hampshire	0.9	1.4	1.2	1.2
Rhode Island	0.9	0.9	1.1	1.0
Vermont	0.5	0.6	0.6	0.6

TABLE 4 (Cont'd)

Geographic Area	1980	2000		
		USBC	BEA	DRI
Middle Atlantic				
New Jersey	7.4	7.4	8.6	8.3
New York	17.6	15.0	19.0	19.2
Pennsylvania	11.9	11.2	12.0	12.4
East North Central				
Illinois	11.4	11.2	11.8	12.2
Indiana	5.5	5.7	5.8	5.5
Michigan	9.3	9.2	9.4	9.5
Ohio	10.8	10.4	10.9	11.3
Wisconsin	4.7	5.2	5.1	5.0
West North Central				
Iowa	2.9	3.0	3.0	3.0
Kansas	2.4	2.5	2.7	2.8
Minnesota	4.1	4.5	4.8	4.7
Missouri	4.9	5.1	5.3	5.4
Nebraska	1.6	1.7	1.7	1.6
North Dakota	0.7	0.7	0.8	0.7
South Dakota	0.7	0.7	0.7	0.7
South Atlantic				
Delaware	0.6	0.6	0.7	0.7
District of Columbia	0.6	0.4	0.6	0.7
Florida	9.7	17.4	14.6	15.4
Georgia	5.5	6.7	6.9	6.9
Maryland	4.2	4.6	4.7	4.8
North Carolina	5.9	6.9	7.0	6.9
South Carolina	3.1	3.9	3.8	3.9
Virginia	5.3	6.4	6.3	6.4
West Virginia	1.9	2.1	2.0	2.0
East South Central				
Alabama	3.9	4.4	4.2	4.1
Kentucky	3.7	4.4	3.9	3.9
Mississippi	2.5	2.9	2.8	2.8
Tennessee	4.6	5.4	5.2	4.9
West South Central				
Arkansas	2.3	2.8	2.6	2.8
Louisiana	4.2	5.2	4.9	5.6
Oklahoma	3.0	3.9	3.7	3.9
Texas	14.2	20.7	19.3	19.7

TABLE 4 (Cont'd)

Geographic Area	1980	2000		
		USBC	BEA	DRI
Mountain				
Arizona	2.7	5.9	4.4	4.2
Colorado	2.9	4.7	4.3	4.0
Idaho	0.9	1.5	1.2	1.1
Montana	0.8	1.0	0.9	0.9
Nevada	0.8	1.9	1.3	1.4
New Mexico	1.3	1.7	1.7	1.8
Utah	1.5	2.8	2.2	2.0
Wyoming	0.5	1.0	0.6	0.6
Pacific				
Alaska	0.4	0.6	0.7	0.6
California	23.7	30.6	31.2	30.9
Hawaii	1.0	1.3	1.2	1.3
Oregon	2.6	4.0	3.1	3.1
Washington	4.1	5.8	5.3	5.0

^aNumbers may not add due to rounding.

Source: Refs. 10-12.

The BEA projections (in Table 4) indicate that the Northeast and North Central regions will fare better in terms of population growth than they do in the USBC projections. The largest difference is in the Middle Atlantic region, where BEA projects 6 million more people than does USBC. Higher population levels for the year 2000 within the Northwest and North Central regions is attained by lower levels in the South and West regions, relative to USBC projections. Within these regions, BEA projects slower growth than does USBC for Florida, Texas, and Arizona.

3.3 DRI PROJECTIONS

The DRI projections¹² of regional and state population* are based on a more complex economic model than are the USBC and BEA projections. Population in a region

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*Produced by the DRI Regional Information Service (DRI/RIS).

or state is projected with an equation that has been estimated by econometric methods. This equation states that the regional (or state) share of U.S. population is a function of

- Share of employment (3-year moving average),
- Relative wage (3-year moving average),
- Attractiveness (share of tourism employment),
- Educational level (percentage college educated),
- Rainfall, and
- Heating degree-days.

The employment variable is the most important variable in the equation, and the relative wage variable is second in importance. In other words, population in a region or state is primarily dependent on economic opportunity (i.e., employment), but other factors are considered.*

DRI prepares regional and state population projections to the year 2008. The projections for the year 2000 are shown in Table 4 for comparative purposes. These population projections coincide with the DRI Spring 1984 Trend Scenario forecast. In making these regional and state population projections, DRI calibrates them to the USBC middle scenario for total U.S. population.

The DRI regional projections are very close to the BEA projections; therefore, the following discussion contrasts DRI with USBC projections. In the Northeast and North Central regions, DRI projects modest population growth; these DRI projections are larger than the USBC projections for both regions. Unlike USBC, DRI projects growth in the population of New York (9.1% from 1980 to 2000). Moreover, DRI generally projects larger populations than does USBC for states in the Northeast and North Central regions. In the South and West, DRI projects less population growth than does USBC. DRI population projections for states in the South and West, however, are generally lower than the corresponding USBC projections. Significant exceptions to this general statement are the states of Louisiana and California, where DRI projects slightly more population growth than does USBC.

3.4 WHY THE PROJECTIONS DIFFER

The basic projection methods used by USBC and DRI, together with their results, have been presented above. This section uncovers the reasons for the differences in these two sets of projections by examining the projection methods more closely. The

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*Regression analysis results in Secs. 3.4, B.1, and B.2 document the high correlation between employment and population. Most estimates show a 0.999 correlation.

BEA projections are not included in this examination because the DRI and BEA projections are quite similar.

The methods used by the USBC to project net migration, births, and deaths were discussed in Sec. 2.1. Table 5 summarizes the USBC projections for these three components of population change at the regional level (the nine regions defined by the USBC). Because these components do not include the adjustment to bring the sum of the regional projections into agreement with the national projections, the sum of the components does not equal the net change in population. Projected births and deaths for 1980-2000 are stated as percentages of the 1980 population. Because the age composition of the female population differs across regions, and because fertility within age groups differs across states, the birth rate varies from 25.1% in the Middle Atlantic

TABLE 5 U.S. Bureau of the Census Regional Population Projections^a

Geographic Area	Births, 1980-2000 (% of 1980 pop.)	Deaths, 1980-2000 (% of 1980 pop.)	Net Migration Rates (%)	
			1970-80 ^b	1980-2000 ^c
Northeast				
New England	25.9	19.2	-0.4	1.2
Middle Atlantic	25.1	19.3	-5.6	-10.6
North Central				
E. North Central	30.4	17.7	-4.3	-8.8
W. North Central	32.0	19.2	-2.0	-3.4
South				
South Atlantic	31.5	21.0	8.6	27.0
E. South Central	33.6	18.9	2.5	6.7
W. South Central	41.4	18.1	7.5	19.4
West				
Mountain	32.8	18.0	17.3	52.3
Pacific	36.6	17.9	7.8	19.9

^aThese components do not include the adjustment to bring the sum of the regional projections into agreement with the national population projections. Thus, the net sum of the components does not equal the net change in population.

^bNet migration rate as a percent of surviving population (1970 population plus births minus deaths).

^cNet migration rate as a percent of surviving population [1980 population plus births (1980-2000) minus deaths (1980-2000)].

region to 41.4% in the West South Central region. Clearly the birth rate projections account for some of the differences in the regional population projections, but it is also clear that the high rates of population growth projected for the South Atlantic and Mountain regions (reported in Table 4) do not stem from high birth rates.

The death rate projections shown in Table 5 do not vary appreciably across regions, so death rates do not play a major role in explaining the regional population growth differences. The net migration rates differ most across regions. Table 5 shows the regional net migration rates for 1970-80 calculated by the USBC¹⁰ and the projected rates for 1980-2000. Naturally these rates vary substantially across regions, and the regional pattern for the 1970s is clearly reflected in the projected rates. The rank orders of the nine regions for the two sets of net migration rates in Table 5 are identical.

The numbers in Table 5 lead us to ask whether the USBC population projections can be inferred from the USBC net migration projections. Table 6 presents the results of simple regression analyses in which the USBC regional population growth rate

TABLE 6 Regression Analysis of U.S. Bureau of the Census Regional Population Projections

Parameters and R ² Value	Parameter Coefficients for Each Regression ^{a,b}		
	Growth vs. Migration Rate	Growth vs. Birth Rate	Growth vs. Death Rate
Constant	7.19 (3.65)	-73.13 (-1.35)	134.24 (0.76)
Net migration rate	1.28 (14.53)	--	--
Birth rate	--	2.96 (1.78)	--
Death rate	--	--	-5.96 (-0.64)
R ² (adj.)	0.963	0.212	-0.080

^aThe dependent variable for each regression is the projected growth in regional population, in percent, for 1980-2000. There were nine observations in each case.

^bThe t values are in parentheses.

(1980-2000) is the dependent variable and the projections of the three components (net migration rate, birth rate, and death rate) are the alternative independent variables. The projected regional net migration rate does a reasonably good job of "explaining" the regional population projection; the adjusted R^2 value is 0.963 and the coefficient of the net migration rate is 1.28 ($t = 14.53$). Neither the regional birth rate nor the regional death rate "explains" the regional population projection. Clearly the USBC population projections primarily depend on net migration rates.

In a similar vein, it is possible to discover whether the DRI population projections have a simple explanation. The DRI regional population projections primarily depend on regional employment projections. The regional employment projections themselves are the output of a complex regional econometric model, but the population projections are quite straightforward. A simple regression was run in which the DRI projection of population growth for 1980-2000 at the nine-region level is a linear function of DRI regional employment growth for the same period. The result is that

$$\text{POP} = -11.10 + 1.01 \text{ EMP} \quad \text{and} \quad R^2(\text{adj.}) = 0.984 \quad (1) \\ (-7.35) \quad (22.08)$$

where POP is regional population growth (percentage), EMP is regional employment growth (percentage), and t values are given in parentheses. Although the DRI equation for population projections includes five additional variables, the employment projections are clearly the key to the population projections.

The evidence presented in this section suggests that, in essence, the USBC and DRI regional population projections differ because DRI implicitly projects a change in the pattern of net migration from the pattern of the 1970s while USBC projections are based on a continuation of that pattern. To make this statement, one must assume that net migration responds to employment opportunities and that births and deaths essentially do not (in comparison to the response of net migration). Obviously USBC did not use an economic model to project net migration, while DRI used an elaborate regional econometric model in developing its employment and population projections. The USBC projections answer the question, "What will the regional population pattern be in 2000 if the age-specific migration pattern of the 1970s continues (and births and deaths are projected by standard methods)?" The DRI projections answer the question, "What will the regional population pattern be if population follows employment opportunities and employment is projected with a regional econometric model?" Thus a comparison of the two projections shows the change in the projected regional population pattern in 2000 that results from the change in the net migration pattern implied by the DRI employment and population projections.

Which method is better for the 20-year projections discussed above? Clearly these projections should not be based on the assumption that a past trend will continue unchanged unless there is evidence that the causes of that trend will also continue unchanged, or unless there is no better method or assumption available. In this particular case, the DRI regional econometric model and its projections support neither type of statement. Sound causal models are better than extrapolation procedures. The USBC did, however, provide a useful answer to the question it asked.

3.5 CONCLUSIONS

Nothing in this section leads to the conclusion that the DRI projections of regional and state population are unreasonable. The USBC projections, which are based on the assumption that net migration to the South and West (which began in the 1970s) would continue undiminished, indicate greater population growth in the South and West than do alternative projections based on economic opportunity (i.e., BEA and DRI). Both the BEA and DRI economic models are more favorable to population growth in the Northeast and North Central regions. As our tests indicated, the DRI projections (and the similar BEA projections) are based on the assumption that the pattern of age-specific net migration of the 1970s will not continue to 2000. This appears to be a reasonable assumption.*

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*The DRI regional population projections are also preferable because they are consistent with the macroeconomic scenario forecasts selected for use in the 1985 test runs of the TG-B model set.

4 EXTENSION OF THE DRI REGIONAL AND STATE POPULATION PROJECTIONS TO 2030

The conclusion of Sec. 3 is that DRI produces reasonable regional and state population projections to the year 2008. Phase 1 of the TG-B program, however, requires such projections to the year 2030. This section describes a simple method by which this extension could be accomplished. Appendix A contains regional and state population projections from 2009 to 2030 based on this method. Appendix B describes a more elaborate method that might be employed in the future.

4.1 METHODS OF EXTENDING POPULATION PROJECTIONS

Two simple methods for extending DRI regional and state population projections are fairly obvious: assume the regional (or state) share of U.S. population remains constant at its 2008 level from 2009 to 2030 or use regional and state employment projections (2009-2030) to project population (as DRI did for 1980-2008). In fact, for the 1985 test runs of the TG-B model set, these two methods are the same because the extension of employment projections to 2030 assumes constant regional and state shares.* Consequently, assuming constant regional and state shares is the recommended method of extending population projections. The regional population and employment shares used are shown in Table 7.

4.2 RATIONALE FOR EXTENSION METHOD

The forecast extension method used in Phase 1 of the TG-B program, holding population and employment shares constant at the regional and state levels, is derived from a particular demographic-economic hypothesis. For example, note in Table 7 that New England is projected to have 5.33% of the U.S. population and 6.01% of U.S. employment in 2008, so the region's share of population is 0.68% less than the employment share. We assume that this difference in shares remains constant from 2008 to 2030. Examination of the DRI projections indicated that very little change in this difference is projected in the years just prior to 2008. We hypothesize that region-specific factors cause the region's population share to be less than or greater than the region's employment share and that these unknown factors will continue to be influential from 2008 to 2030. An alternative hypothesis is that the absolute value of the difference between these two shares would decrease over time, but we have no basis for this hypothesis. Indeed, the mean absolute deviation between these two shares in 1980 is

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*The extension of DRI economic projections (to 2030) was confined to the macro-economic forecast. The structure of the DRI regional economic modeling system (RIS), as well as available resources, did not permit a corresponding extension of regional economic variables (e.g., population and employment). Constant shares (regional or state) for both of these variables were determined to be acceptable for use in the Phase 1 test runs after DRI projections for the period 2000-2008 were examined.

TABLE 7 Regional Shares of Population and Employment, 1980 and 2008 (%)

Region	1980		2008 ^a	
	Popula- tion	Employ- ment	Popula- tion	Employ- ment
New England	5.45	6.04	5.33	6.01
Middle Atlantic	16.22	16.53	14.83	15.27
East North Central	18.36	18.41	16.06	15.94
West North Central	7.58	7.60	7.05	7.27
South Atlantic	16.33	16.17	17.90	17.31
East South Central	6.47	5.66	5.81	5.07
West South Central	10.51	10.24	12.01	11.68
Pacific Northwest	4.14	4.01	4.19	3.94
Pacific Southwest	14.95	15.34	17.15	17.51

^aDRI Spring 1984 Trend Scenario projection.

Source: Ref. 12.

0.30% and 0.41% in 2008, so there is some evidence to suggest that these deviations do not converge in the DRI projections. In summary, because regional employment shares are held constant from 2008 to 2030, regional population shares are also held constant to reflect region-specific population factors.

If the regional employment projections used implied *changing* regional shares, the corresponding population projection method would be a bit more complex. In this case, the population projections would be based on the following equation:

$$\text{POPSH}_{jt} = a + b \text{EMPSH}_{jt} + c_j \quad (2)$$

where:

POPSH_{jt} = share of population in region j at time t ,

EMPSH_{jt} = share of employment in region j at time t ,

a , b = coefficients estimated using actual data and DRI projections to 2008, and

c_j = difference between the DRI population projection for 2008 and the projection for 2008 based solely on coefficients a and b .

The c_j values are the residuals from the estimated equation for each region in 2008 and capture the region-specific effects on population share. Appendix B contains a more detailed discussion of this method and empirical estimates of the relationship between the population and employment shares for the regions and the states within each region.

5 PROJECTION OF THE AGE-SEX DISTRIBUTION OF THE U.S. POPULATION

One input required for the transportation sector model* of the TG-B emissions model set is the age-sex distribution of the projected population. Since the USBC middle projection of total U.S. population has been determined (Sec. 2) to be the best available, the USBC projections of the age-sex distribution will also be used. The assumptions underlying the USBC middle projection were discussed in Sec. 2.1. The age-sex distributions of that middle projection are shown in Table 8 for the years 1985, 1990, 2000, 2025, and 2050.

Some of the key results in Table 8 are as follows:

- The percentage of the population age 65 and over rises from 12.0% in 1985 to 19.5% in 2025.
- The number of teenagers age 15-19 is projected to decline to 1990, then increase from 1990 to 2000, before declining to its 1985 level by 2025.
- The number of people age 20-29 is projected to decline slowly, but steadily, to 2025.
- Modest growth of 5.9% is projected for people age 30-39 from 1985 to 2025.
- Substantial growth of 44.3% is projected for people age 40-49 from 1985 to 2025.
- The population aged 50-59 is projected to grow 57.4% from 1985 to 2025.

In short, the population is projected to become, on average, much older by 2025. The median age increases from 31.5 in 1985 to 40.0 in 2025.

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*Transportation Energy and Emissions Modeling System (TEEMS). See Ref. 13 for a further discussion of the input requirements to the transportation activity modules in TEEMS.

TABLE 8 Projection of the Age-Sex Distribution of the U.S. Population (10⁶ persons)

Age Categories	Projection Years and Sex									
	1985		1990		2000		2025		2050	
	M	F	M	F	M	F	M	F	M	F
under 5	9.45	9.01	9.83	9.37	9.02	8.60	9.19	8.76	9.04	8.61
5 to 9	8.49	8.11	9.52	9.08	9.60	9.16	9.47	9.03	9.22	8.79
10 to 14	8.58	8.20	8.58	8.20	9.99	9.53	9.60	9.16	9.32	8.89
15 to 19	9.39	9.02	8.66	8.29	9.69	9.26	9.44	9.03	9.32	8.91
20 to 24	10.80	10.48	9.43	9.13	8.71	8.42	9.23	8.89	9.35	9.01
25 to 29	10.96	10.87	10.86	10.65	8.79	8.59	9.40	9.15	9.56	9.31
30 to 34	9.94	10.02	11.01	10.99	9.57	9.44	9.96	9.77	9.83	9.64
35 to 39	8.85	9.04	9.93	10.07	10.90	10.83	10.25	10.11	9.88	9.75
40 to 44	6.93	7.18	8.79	9.05	10.93	11.05	9.84	9.77	9.61	9.55
45 to 49	5.67	5.97	6.83	7.15	9.73	10.02	8.75	8.79	9.25	9.27
50 to 54	5.21	5.61	5.51	5.90	8.44	8.90	8.54	8.70	9.14	9.27
55 to 59	5.33	5.93	4.96	5.49	6.36	6.92	8.84	9.21	9.25	9.55
60 to 64	5.05	5.90	4.93	5.71	4.91	5.58	9.40	10.11	8.96	9.52
65 to 69	4.12	5.11	4.46	5.55	4.11	5.00	8.54	9.77	7.84	8.75
70 to 74	3.21	4.43	3.40	4.65	3.66	4.93	6.55	8.23	6.08	7.36
75 to 79	2.14	3.37	2.42	3.81	2.84	4.41	4.56	6.54	4.80	6.55
80 to 84	1.20	2.28	1.41	2.65	1.74	3.22	2.49	4.28	3.70	5.92
85 and over	0.80	2.00	0.96	2.50	1.39	3.74	2.07	5.61	4.63	11.44
Total	116.12	122.52	121.50	128.23	130.38	137.61	146.11	154.92	148.77	160.06

Source: Ref. 3.

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APPENDIX A**REGIONAL AND STATE POPULATION PROJECTIONS: 1980-2030**

TABLE A.1 Regional and State Population Projections, 1980-2030 (10⁶ persons)^a

Region/State	FIPS Code ^b	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030
New England		12.36	12.68	13.26	13.86	14.33	14.67	15.03	15.42	15.75	16.01	16.20
Connecticut	9	3.11	3.19	3.33	3.47	3.59	3.68	3.78	3.87	3.96	4.02	4.07
Maine	23	1.13	1.16	1.21	1.27	1.32	1.36	1.40	1.44	1.47	1.49	1.51
Massachusetts	25	5.74	5.85	6.11	6.39	6.61	6.75	6.91	7.09	7.24	7.36	7.45
New Hampshire	33	0.92	0.99	1.06	1.13	1.19	1.25	1.30	1.33	1.36	1.38	1.40
Rhode Island	44	0.95	0.96	0.98	1.00	1.00	1.00	0.99	1.02	1.04	1.06	1.07
Vermont	50	0.51	0.53	0.56	0.59	0.62	0.64	0.65	0.67	0.69	0.70	0.70
Middle Atlantic		36.80	37.40	38.32	38.98	39.31	39.55	39.93	40.95	41.84	42.53	43.02
New Jersey	34	7.37	7.60	7.86	8.06	8.10	8.11	8.16	8.37	8.56	8.70	8.80
New York	36	17.56	17.92	18.36	18.63	18.83	18.99	19.21	19.70	20.13	20.46	20.70
Pennsylvania	42	11.87	11.87	12.10	12.29	12.38	12.45	12.56	12.88	13.15	13.37	13.53
East North Central		41.68	41.57	42.24	42.48	42.69	42.78	42.95	44.04	45.00	45.75	46.28
Illinois	17	11.43	11.47	11.63	11.76	11.84	11.92	11.99	12.30	12.57	12.77	12.92
Indiana	18	5.49	5.49	5.57	5.61	5.62	5.61	5.60	5.75	5.87	5.97	6.04
Michigan	26	9.25	9.07	9.27	9.25	9.31	9.32	9.35	9.59	9.80	9.96	10.08
Ohio	39	10.80	10.76	10.89	10.95	10.95	10.94	10.96	11.24	11.48	11.67	11.81
Wisconsin	55	4.71	4.78	4.88	4.92	4.97	5.00	5.04	5.17	5.28	5.37	5.43
West North Central		17.20	17.50	17.75	17.83	17.92	18.02	18.16	18.62	19.03	19.34	19.57
Iowa	19	2.91	2.88	2.87	2.87	2.85	2.84	2.84	2.91	2.97	3.02	3.06
Kansas	20	2.37	2.45	2.52	2.56	2.60	2.65	2.70	2.77	2.83	2.87	2.91
Minnesota	27	4.08	4.18	4.32	4.41	4.51	4.62	4.72	4.84	4.94	5.02	5.08
Missouri	29	4.92	5.00	5.06	5.06	5.04	5.02	5.03	5.15	5.27	5.35	5.42
Nebraska	31	1.57	1.60	1.60	1.58	1.56	1.55	1.54	1.58	1.61	1.64	1.66
North Dakota	38	0.65	0.68	0.68	0.67	0.67	0.67	0.68	0.69	0.71	0.72	0.73
South Dakota	46	0.69	0.70	0.70	0.69	0.69	0.68	0.67	0.69	0.70	0.71	0.72
South Atlantic		37.08	40.21	43.05	45.55	47.79	50.17	52.40	53.74	54.91	55.82	56.46
Delaware	10	0.60	0.62	0.64	0.67	0.69	0.71	0.73	0.75	0.77	0.78	0.79
District of Columbia	11	0.64	0.62	0.61	0.61	0.61	0.61	0.62	0.63	0.65	0.66	0.67
Florida	12	9.81	11.32	12.73	14.05	15.31	16.64	17.83	18.29	18.68	19.00	19.22
Georgia	13	5.48	5.96	6.37	6.69	6.96	7.26	7.54	7.73	7.90	8.03	8.12
Maryland	24	4.22	4.39	4.55	4.68	4.80	4.92	5.04	5.17	5.28	5.37	5.43
North Carolina	37	5.89	6.25	6.57	6.82	7.01	7.22	7.41	7.60	7.77	7.90	7.99
South Carolina	45	3.13	3.36	3.58	3.76	3.91	4.07	4.22	4.33	4.42	4.49	4.55
Virginia	51	5.36	5.71	5.97	6.21	6.41	6.64	6.86	7.04	7.19	7.31	7.39
West Virginia	54	1.95	1.97	2.02	2.05	2.08	2.11	2.15	2.20	2.25	2.29	2.31

TABLE A.1 (Cont'd)

Region/State	FIPS Code ^b	1980	1985	1990	1995	2000	2005	2010	2015	2020	2025	2030
East South Central		14.68	15.11	15.52	15.85	16.19	16.54	16.88	17.31	17.69	17.99	18.19
Alabama	1	3.90	4.01	4.11	4.20	4.29	4.37	4.45	4.57	4.66	4.74	4.80
Kentucky	21	3.66	3.74	3.84	3.92	4.01	4.09	4.18	4.29	4.38	4.45	4.50
Mississippi	28	2.53	2.61	2.68	2.75	2.84	2.91	2.99	3.07	3.13	3.19	3.22
Tennessee	47	4.59	4.75	4.89	4.97	5.06	5.16	5.26	5.39	5.51	5.60	5.67
West South Central		23.85	26.58	27.92	29.77	31.21	32.45	33.68	34.53	35.29	35.87	36.28
Arkansas	5	2.29	2.40	2.53	2.67	2.77	2.85	2.93	3.01	3.07	3.12	3.16
Louisiana	22	4.22	4.57	4.76	5.10	5.39	5.63	5.87	6.02	6.15	6.25	6.32
Oklahoma	40	3.04	3.38	3.49	3.70	3.86	3.99	4.12	4.23	4.32	4.39	4.44
Texas	48	14.30	16.23	17.14	18.30	19.19	19.98	20.75	21.28	21.75	22.11	22.36
Mountain		11.43	12.86	14.17	15.36	16.47	17.57	18.53	19.01	19.42	19.74	19.97
Arizona	4	2.73	3.14	3.58	3.95	4.31	4.70	5.03	5.16	5.27	5.36	5.42
Colorado	8	2.90	3.28	3.57	3.85	4.13	4.40	4.63	4.75	4.85	4.93	4.99
Idaho	16	0.95	1.00	1.04	1.09	1.11	1.13	1.14	1.17	1.20	1.22	1.23
Montana	30	0.79	0.83	0.86	0.89	0.90	0.91	0.92	0.94	0.96	0.98	0.99
Nevada	32	0.81	0.93	1.08	1.23	1.38	1.53	1.67	1.71	1.75	1.78	1.80
New Mexico	35	1.31	1.46	1.59	1.72	1.85	1.97	2.07	2.12	2.17	2.20	2.23
Utah	49	1.47	1.69	1.89	2.02	2.16	2.28	2.40	2.46	2.51	2.55	2.58
Wyoming	56	0.47	0.52	0.56	0.61	0.63	0.65	0.68	0.69	0.71	0.72	0.73
Pacific		31.90	34.82	37.57	40.02	42.13	43.97	45.57	46.73	47.75	48.54	49.10
Alaska	2	0.41	0.51	0.50	0.51	0.53	0.54	0.52	0.53	0.54	0.55	0.56
California	6	23.75	26.19	28.51	30.42	32.13	33.65	34.96	35.85	36.63	37.24	37.67
Hawaii	15	0.97	1.06	1.14	1.21	1.27	1.34	1.39	1.43	1.46	1.49	1.50
Oregon	41	2.64	2.69	2.84	3.03	3.14	3.24	3.33	3.42	3.49	3.55	3.59
Washington	53	4.14	4.38	4.58	4.86	5.05	5.21	5.37	5.50	5.62	5.72	5.78

^aPopulation projections for 1980-2005 period extracted from DRI/RIS output (Spring 1984 Trend Scenario).¹²
 Projection for 2010-2030 period derived using constant state shares of U.S. population in 2008 and total U.S.
 population projections for 2009-2030.³

^bFIPS = Federal Information Processing Standard.

APPENDIX B

ALTERNATIVE METHOD OF EXTENDING POPULATION PROJECTIONS

APPENDIX B

ALTERNATIVE METHOD OF EXTENDING POPULATION PROJECTIONS

As indicated in Section 3.4, the most important variable in the equation used by DRI to project regional or state population is regional or state employment. An alternative approach to extend population projections is based on this premise: use only DRI regional employment projections to forecast population at the regional level.

This method comprises two steps: (1) project regional population from 2009 to 2030 and (2) project the population of states within each region. Nine regions are used, as defined by DRI and shown in Table B.1. These regions correspond to the nine census divisions.

The projection of regional population is also a two-step process. First, a regression equation is estimated for the nine regions pooled together using actual

TABLE B.1 DRI Definitions of Regions in the United States

Regions	States
New England	Maine, Vermont, New Hampshire, Massachusetts, Connecticut, Rhode Island
Middle Atlantic	New York, New Jersey, Pennsylvania
East North Central	Ohio, Michigan, Indiana, Illinois, Wisconsin
West North Central	Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas
South Atlantic	Delaware, Maryland, District of Columbia, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida
East South Central	Kentucky, Tennessee, Mississippi, Alabama
West South Central	Arkansas, Louisiana, Oklahoma, Texas
Pacific Northwest	Wyoming, Montana, Idaho, Washington, Oregon, Alaska
Pacific Southwest	Colorado, New Mexico, Utah, Arizona, Nevada, California, Hawaii

1980-83 employment and population figures, and DRI employment and population projections from 1984 to 2008. This regression equation is specified as

$$\frac{POP_{jt}}{POP_t} = b_0 + b_1 \frac{EMP_{jt}}{EMP_t}, \quad (B.1)$$

where:

POP_{jt} = region j population (j = 1, 2, ..., 9) at time t (t = 1980 to 2008),

POP_t = U.S. population at time t,

EMP_{jt} = region j employment at time t,

EMP_t = U.S. employment at time t, and

b_0, b_1 = coefficients estimated using actual data and DRI projections to 2008.

This regression equation, however, generates an aggregate projection that must be adjusted to reflect regional differences that are built into the DRI population model. Thus, in the second step, regional population is projected for years beyond 2008 by calculating

$$POPSH_{jt} = b_0 + b_1 EMP_{SH_{jt}} + a_j \quad (B.2)$$

where:

$POPSH_{jt}$ = share of U.S. population for region j at time t (t = 2009 to 2030),

$EMP_{SH_{jt}}$ = share of U.S. employment for region j at time t, and

a_j = regional adjustment factor for region j that captures the effects of variables in the DRI population equation but are, of necessity, omitted from Eq. B.1.

The projection of state populations within a region can follow a similar methodology, as discussed below.

B.1 REGIONAL POPULATION PROJECTIONS*

The primary reason for recommending the above method (to extend the DRI regional population projections from 2009 to 2030) is that the share of population in a region closely follows the share of employment in that same region. Table 7 illustrated this pattern for the year 1980 in regions defined by DRI. In this table a region's share of U.S. population deviates only marginally from its corresponding share of U.S. employment during 1980. The largest deviation between these two figures is 0.81% in the East South Central region (where the population share exceeds the employment share). The next-largest deviation is 0.59% in New England (where the employment share exceeds the population share). The mean absolute deviation between the 1980 population and employment shares for the nine regions is only 0.30%.

Table 7 also displayed the population and employment shares for the nine regions in the year 2008, as projected by DRI. Once again, the projected population share practically replicates the projected employment share. The mean absolute deviation between these two projections is 0.41%, only slightly above (0.11%) the 1980 deviation. Also, those regions in which the population share deviated the most from the employment share in 1980 also tend to do so in the 2008 projections. The East South Central and New England regions have the largest such deviations in the 2008 projections (and in the same directions as in 1980). Table B.2 shows the deviations between population share and employment share by region for 1980 and 2008. Note that the sign of the deviation is the same for eight out of nine regions in these two years. Only the sign of the deviation for the East North Central region changes (because the population and employment shares are virtually identical in this region).

In summary, two facts have been established:

1. A region's population share is closely related to its employment share, and
2. The DRI projection method preserves this close relationship.

Moreover, the DRI projection method generally maintains, to 2008, the deviations between the regional population and employment shares observed in 1980 (as shown in Tables 7 and B.2).

This method for projecting regional population between 2009 and 2030 regresses the population share of a region (across regions and over time) on the employment share of that region. The method replicates, in a simplified form, the equation used by DRI to project regional population. The equation is structured so that population shares can adjust to changing employment shares. If future (i.e., post-2008) employment shares do not change, regional population shares would not change from their values in 2008. In addition, the estimated regional equation presented below would not differ by scenario; there is a fixed relationship between population shares and employment shares, both here

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*The data and regression results presented in this section are based on DRI's Spring 1984 Trend Scenario projections.

TABLE B.2 Deviations of Population and Employment Shares by Region, 1980 and 2008 (POPSH - EMPSH)

Region	1980	2008 ^a
New England	-0.59	-0.68
Middle Atlantic	-0.31	-0.44
East North Central	-0.05	0.12
West North Central	-0.02	-0.22
South Atlantic	0.16	0.59
East South Central	0.81	0.74
West South Central	0.27	0.33
Pacific Northwest	0.13	0.25
Pacific Southwest	-0.39	-0.36
Mean of absolute values	0.30	0.41

^aDRI Spring 1984 Trend Scenario projection.

Source: Ref. 12.

and in the DRI model. Only the values for these two variables would change by scenario; their relationship would be unaltered.

Such a regression has been estimated with actual data for 1980-83 and DRI projected values for 1984-2008 (Spring 1984 Trend Scenario). The regression equation is a simple linear equation estimated as

$$\text{POPSH}_{jt} = 0.001643 + 0.986874 \text{ EMPSH}_{jt}, \quad R^2 = 0.993 \quad (\text{B.3})$$

(2.57)   (189.37)

where *t* values are in parentheses. The number of observations is 261 (9 regions x 29 years). The test of the hypothesis that the coefficient of EMPSH is not significantly different from 1.0 generates a *t* value of 2.57. This value leads to a rejection of the hypothesis that the coefficient is equal to 1.0.

However, the use of this equation to project population for each region in the year 2009 (for example) would lead to results that do not account for the regional characteristics projected for 2008 (Table B.2). Table B.3 displays the regional population and employment projections for 2008 as provided by DRI (Spring 1984 Trend Scenario), along with the population projections generated by the regression equation previously specified (Eq. B.3). It is evident in Table B.3 that these latter (i.e., calculated)

TABLE B.3 Alternative Regional Population-Share Projections for 2008

Region	DRI Projection		Calculated ^a	
	EMPSH	POPSH	POPSH	a_j
New England	0.06007	0.05332	0.06093	-0.00761
Middle Atlantic	0.15271	0.14833	0.15235	-0.00402
East North Central	0.15937	0.16058	0.15892	0.00166
West North Central	0.07272	0.07046	0.07341	-0.00295
South Atlantic	0.17314	0.17897	0.17251	0.00646
East South Central	0.05068	0.05810	0.05165	0.00645
West South Central	0.11680	0.12012	0.11691	0.00321
Pacific Northwest	0.03940	0.04190	0.04052	0.00138
Pacific Southwest	0.17512	0.17148	0.17446	-0.00298

^aPOPSH is calculated as in Eq. B.3. The a_j value is the DRI projected value of POPSH minus the calculated POPSH.

population projections are closer to the DRI employment projections than are the DRI population projections. To better replicate the DRI population projections, the form of the estimated equation should be modified to include the term a_j . Thus, a region's population share would be projected as

$$\text{POPSH}_{jt} = 0.001643 + 0.986874 \text{ EMPSH}_{jt} + a_j \quad (\text{B.4})$$

where a_j is the difference between the DRI population projection for 2008 and the projection for 2008 based solely on the coefficients in Eq. B.3.

In other words, the a_j values are the residuals from the estimated equation for each region in the year 2008. The a_j values are shown in Table B.3. It should be emphasized that the a_j values are not arbitrary adjustment factors; instead, they capture the effects of the additional variables included in the DRI equation but not in the estimated equation (Eq. B.3). Their values are implied by the DRI regional projections.

The sum of the adjustment factors (a_j) is slightly greater than zero (0.0016), so the use of these adjustments will lead to a sum of regional population shares that slightly exceeds 1.0. Nothing in the simple regression analysis framework will, in general, prevent this problem. To ensure that the regional population projections for time t always sum to 1.0, we calculate

$$\text{POPSH}_{jt}^* = \frac{\text{POPSH}_{jt}}{\sum_j \text{POPSH}_{jt}},$$

where $POPSH_{jt}^*$ is the final projected population share for region j at time t . These regional population shares can then be multiplied by the projected U.S. population at time t to provide regional population projections in each year.

The method for projecting regional population presented in this section has three basic advantages:

1. The region-specific features that DRI introduces via a more complex six-variable econometric equation are preserved by use of region-specific adjustments (a_j).
2. Setting the region-specific adjustments (a_j) to the year 2008 as a benchmark minimizes the "jump" in the population projections from 2008 (the last year projected by DRI) to 2009 (the first year of our extension of the DRI projection).
3. No time trends in the region-specific adjustments (a_j) are presumed because we have no reason to believe any will exist. In effect, the a_j values capture differences across states and regions that we assume will persist through time at the same magnitude as measured for the year 2008.

B.2 STATE POPULATION PROJECTIONS*

State population projections beyond 2008 can be generated with the method described in Sec. B.1 to generate regional population projections. The projected population for a state (as a share of its region) is calculated as

$$POPSH_{ijt} = b_{0j} + b_{ij} EMPSH_{ijt} + a_{ij}, \quad (B.5)$$

where:

$POPSH_{ijt}$ = state i 's share of region j population at time t ,

$EMPSH_{ijt}$ = state i 's share of region j employment at time t ,

b_{0j}, b_{ij} = region-specific coefficients (for region j), and

a_{ij} = adjustment coefficient for state i in region j , calculated as the residual from Eq. B.5 for state i in region j in the year 2008.

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*The data and regression results presented in this section are based on DRI Spring 1984 Trend Scenario projections.

This method replicates, in a simplified form, the equation used by DRI to project state population. The equation is structured so that population shares can adjust to changing employment shares. If future (post-2008) employment shares do not change, state population shares would not change from their values in 2008. In addition, the estimated values in Table B.4 would not differ by scenario; there is a fixed relationship between population shares and employment shares, both here and in the DRI model. Only the values for these two variables would change by scenario; their relationship would be unaltered.

The results of the regression analysis for each region are shown in Table B.4 (based on DRI Spring 1984 Trend Scenario data). These results reveal that the coefficients b_{0j} and b_{ij} are quite different across regions. In only one region (Middle Atlantic) is the coefficient of EMP SH not significantly different from 1.0. The test of this hypothesis is shown in the right-hand column of Table B.4 (i.e., t test). Indeed, two regions have coefficients of EMP SH that exceed 1.0, and one region (East South Central) has a coefficient of EMP SH that is equal to 0.755.

As in the regional projection methodology documented in Section B.1, the final state population projections are adjusted so that the sum of the population shares of the states in a region equals 1.0. The final state population projection shares are thus determined by

$$POPSH_{ijt}^* = \frac{POPSH_{ijt}}{\sum_i POPS H_{ijt}}$$

These state population shares are then multiplied by the projected regional population (derived from the regional projection step described in Sec. B.1) at time t to provide state-level population projections in each year. The advantages of this state population projection method are the same as those identified for the regional projection method. (See Sec. B.1.)

TABLE B.4 Results of the Regression Analysis of State Share of Regional Population

Region	Coefficients ^a		Statistics	
	Constant	EMPSH	R ²	t ^b
New England	0.010646 (21.88)	0.936071 (441.72)	0.999	29.87
Middle Atlantic	0.004436 (1.56)	0.986668 (122.31)	0.994	1.65
East North Central	0.008936 (4.08)	0.955445 (92.33)	0.983	4.31
West North Central	0.006326 (6.28)	0.955344 (161.93)	0.992	7.57
South Atlantic	-0.013659 (-10.19)	1.122933 (112.59)	0.980	-12.33
East South Central	0.061142 (25.59)	0.755431 (81.64)	0.983	26.43
West South Central	0.018969 (35.87)	0.924287 (593.78)	0.999	48.63
Pacific Northwest	-0.001640 (-2.56)	1.009135 (346.56)	0.999	-3.14
Pacific Southwest	0.002341 (4.94)	0.983629 (555.55)	0.999	9.25

^aThe t values are in parentheses.

^bResults of a t test of the hypothesis that the EMPSH coefficient is 1.0. The calculation is $t = (1 - \hat{b}_1)/\hat{\sigma}$, where $\hat{b}_1$ = one estimated coefficient of EMPSH and $\hat{\sigma}$ = estimated standard deviation of b_1 .