Using a Demographic-Economic Accounting Matrix (DEAM) to Project Income Distribution in Southern California

(draft on 3/5/2008)

By

Simon Choi
Southern California Association of Governments
818 West 7th Street 12th Floor
Los Angeles, CA 90017
choi@scag.ca.gov
213-236-1849

Paper Prepared for the Population Association of America (PAA) 2008 Annual Meeting,
New Orleans, Louisiana, April 17-20, 2008

Abstract

Projections of key socioeconomic variables play a key role in projecting the future needs of housing, transportation, energy, water, waste, schools, hospitals, land use, etc. in the metropolitan region. The key socioeconomic variables include population and employment. Projections of population and employment have a long term tradition and are based on diverse projection methods. The projection methods of population and employment are independently developed and not closely linked with each other. An economic-demographic model is sometimes used to achieve a balanced population and employment. Income distribution can be projected expanding an economic-demographic model, since it is highly correlated with demographic characteristics and employment structure.

An expanded economic-demographic model is expected to produce more logically consistent projection of income distribution. Eventually, projection of more consistent income distribution can benefit regional planners in estimating dependable diverse needs of physical infrastructure and social service (e.g., transportation and water) and in measuring effects of public projects on low income people through environmental justice analysis.

The purpose of this study is to develop a projection model reflecting a linkage of population, employment, and income distribution. The new projection model will help to measure the effects of changing population and employment on income distribution. The study employs an economic-demographic model to link population and employment projections. After both population and employment are independently projected, they are linked using the algorithm to achieve the balance of labor supply and demand. A recursive model is widely used and based on the assumption that patterns of migration into and out of the region are influenced by the availability of jobs. The study uses the demographic-economic accounting matrix (DEAM) based on the most recent census data base (e.g., PUMS 5%), to link demographic characteristics to employment sectors to income level/distribution, or vice versa.

1. Introduction

Projections of key socioeconomic variables play a key role in projecting the future needs of housing, transportation, energy, water, waste, schools, hospitals, land use, etc. in the metropolitan region. The key socioeconomic variables include population and employment. Projections of population and employment have a long term tradition and are based on diverse projection methods. The projection methods of population and employment are independently developed and not closely linked with each other. An economic-demographic model is sometimes used to achieve a balanced population and employment. Income distribution can be projected expanding an economic-demographic model, since it is highly correlated with demographic characteristics and employment structure.

An expanded economic-demographic model is expected to produce more logically consistent projection of income distribution. Eventually, projection of more consistent income distribution can benefit regional planners in estimating dependable diverse needs of physical infrastructure and social service (e.g., transportation and water) and in measuring effects of public projects on low income people through environmental justice analysis.

The purpose of this study is to develop a projection model reflecting a linkage of population, employment, and income distribution. The new projection model will help to measure the effects of changing population and employment on income distribution. With recent and expected trends in demographic characteristics (aging, ethnic diversification, immigrants with different time of arrival), employment structure (more share of service jobs), and income distribution (more inequality of income), The newly developed projection model is expected to discuss the following questions: what are effects of aging on income level/distribution?; what are effects of ethnic diversity on income level/distribution?; what are effects of immigrants with different time of arrival on income level/distribution?; what are effects of employment structure on income level/distribution?; what are policy implications of employment sector policy on demographic characteristics and income level/distribution?

The study employs an economic-demographic model to link population and employment projections. After both population and employment are independently projected, they are linked using the algorithm to achieve the balance of labor supply and demand. A recursive model is widely used and based on the assumption that patterns of migration into and out of the region are influenced by the availability of jobs. The study uses the demographic-economic accounting matrix (DEAM) based on the most recent census data base (e.g., PUMS 5%), to link demographic characteristics to employment sectors to income level/distribution, or vice versa.

II. Why Do We Project Income Distribution?

The distribution of income across a population is relevant to many policy domains, including economic development, tax and transfer programs, public sector employment, education and training, workforce productivity (PPIC Research Brief, July 1996).

According to research by PPIC (July 1996), the income inequality has increased dramatically in the United States over the past 30 years. (Berstein et al, 2000) The widening income gap results from real earnings growth at the top of the income range and an absolute decline at the bottom (PPIC research brief, July 1996). What are the major causes of increasing wage inequality? The key factors affecting increasing wage inequality includes the decline of manufacturing jobs and the expansion of low-wage service jobs, immigration, and the weakening of labor market institutions – the lower real value of the minimum wage and fewer and weaker unions (Bernstein et al, 2000).

Daly, Reed, and Royer (2001) reviewed the trends in family income inequality between 1969 and 1999. They concluded that low income immigrants and the rising value of skills such as schooling and labor market experience have contributed to growth in income inequality in California.

Although the Census Bureau has been measuring income for a half century, and a large number of factors have been identified as contributing to changes in inequality, the causes are still not entirely understood.(Jones Jr. and Weinberg, The Changing Shape of the Nation's Income Distribution, 1947-1998, June 2000)

California including Southern California faces three major demographic trends: California is big and getting bigger; it is diverse and becoming more so; and it is getting older. (California Budget Project, Budget Backgrounder, November 2005)

In contrast to a relatively better understanding of what happened in the past, the projection of future income distribution is very limited. The demand for the projected distribution of income is increasing in the metropolitan planning context. The income distribution has been widely used as an explanatory variable in the travel demand modeling process. The higher household income implies more cars available for travel, more trip generation, and more driving than transit use. The projection of income distribution is needed to estimate the future travel demand. As a first step of developing small area income distribution, this study intends to develop the regional income distribution of workers.

III. Previous Efforts of Income Distribution Model

There are three major approaches toward modeling the income distribution: the mathematical modeling approach, the demographic approach, and the social accounting matrix (SAM) approach.

The mathematical modeling approach:
According to the mathematical modeling approach, the mathematically derived income distribution functions determine the income distribution. They include the Lorenz curve, the Pareto distribution, a heteroscedastic Box-Cox model, the gamma distribution, the lognormal function (See Fonseca and Tayman (1989) for more description). The usual

focus of the advanced mathematical modeling approach is to find the best fit income distribution function. Fonseca and Tayman (1989) argued that the modified lognormal distribution function can best reflect the household income distribution of counties in California. They analyzed the accuracy of the modeled income distribution by comparing both estimated and modeled income distributions. The mathematical approach is efficient in estimating the income distribution. But it is so mechanical that it does not allow for important demographic and economic factors affecting income distribution.

The demographic approach:
The demographic characteristics including age and race/ethnicity affect income distribution (Bianchi, 1972). OSP income distribution model utilizes age- and race/ethnic specific incomeship rates to estimate the income distribution.(OSP, 198*). The incomeship rates available from the most census data are assumed to remain constant during the projection period. The changing composition of age and race/ethnic group will play a key role in determining the future income distribution.

The social accounting matrix (SAM) approach (Bigsten, XX)
Social Accounting Matrix (SAM) represents flows of all economic transactions that take place within an economy (regional or national). It is a statistical representation of the economic and social structure of a country. SAMs refer to a single year providing a static picture of the economy. SAMs are square (columns equal rows) in the sense that all institutional agents (Firms, Households, Government and Foreign sector) are both buyers and sellers. Columns represent buyers (expenditures) and rows represent sellers (receipts). (http://en.wikipedia.org/wiki/Social_accounting_matrix). The SAM approach was applied to estimate income distribution among households (Bigsten). The SAM approach accounts for the income distribution by expanding the input-output framework. The SAM approach tries to measure the income distribution among households, while containing the merit of the input-output analysis, reflecting the complicated linkage among industry sectors. The SAM approach, however, does not apply to more detailed types of households.

IV. Southern California Income Distribution Model (SCIDM)

SCIDM is intended to project income distribution of workers by reflecting demographic characteristics (e.g., age, sex, and race/ethnicity), industrial sectors, and incomeship rates of workers. The major benefit of using this model is to reflect the effects of changing composition of age, sex, race/ethnicity, and industrial sectors of workers and incomeship rates on the workers' income distribution.

SCIDM fully utilizes the existing SCAG economic-demographic model. The following is a brief description of SCAG regional population and employment projection model (SCAG, 1998).

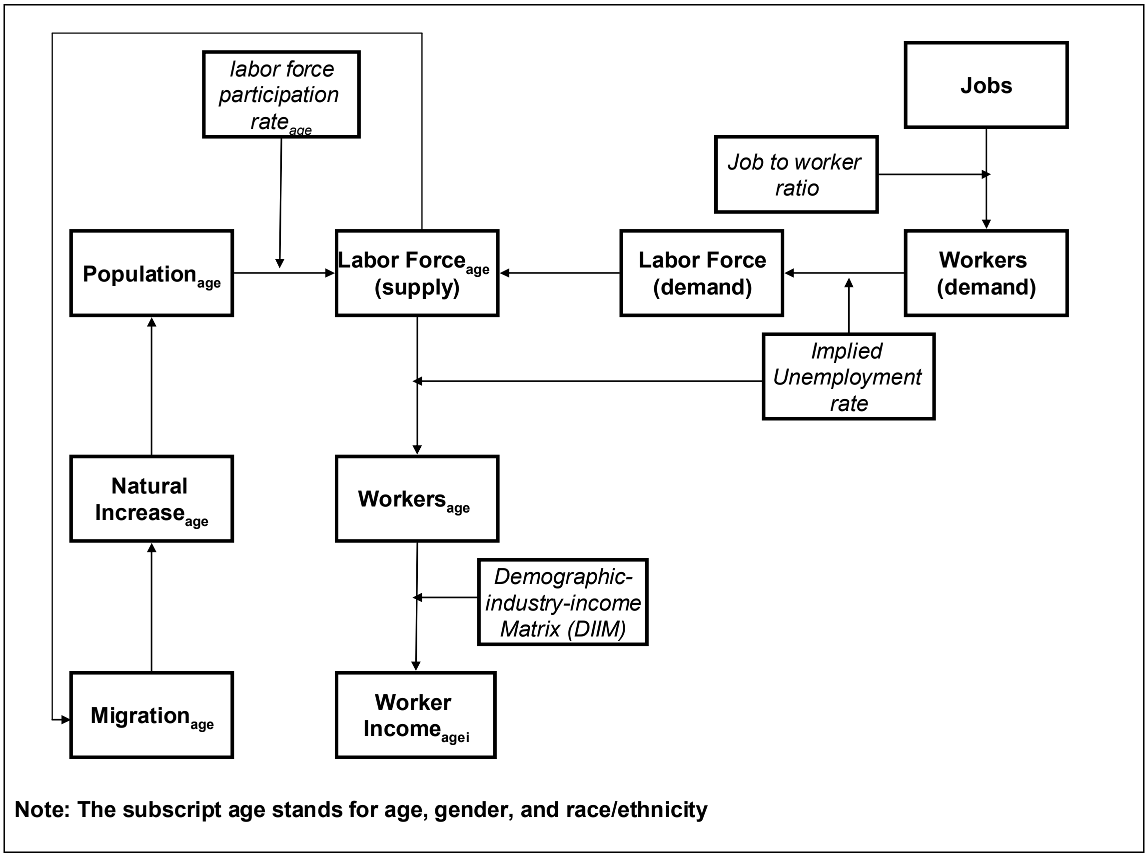

Figure 1.Process of Projecting Workers Income Distribution in an Economic-Demographic Model

SCAG initially develops regional population projections using the cohort-component model. The model computes the population at the future point in time by adding to the existing population the number of group quarters population, births and persons moving into the region during a projection period, and by subtracting the number of deaths and the number of persons moving out of the region. Two region gross migration approach is used to develop two domestic migration components for its theoretical soundness, less data needs, and easy applicability. This process is represented as the demographic balancing equation.

$$P_t = P_0 + B - D + DIM - DOM + NIM$$

where P_t is the population at time t, P_0 is the population at time *0*, *B* is births between times *0* and *1*, *D* is deaths between times *0* and *1*, *DIM* is domestic in-migrants, *DOM* is domestic out-migrants, and *NIM* is net international migrants.

The fertility, mortality and migration rates are projected in five year intervals for eighteen age groups, for two sexes, for four mutually exclusive ethnic groups: Non-Hispanic White, Non-Hispanic Black, Non-Hispanic Asian and Others, and Hispanic. The birth rates are also projected by population classes: residents (domestic migrants) and international immigrants.

The future labor force supply is computed from the population projection mode by multiplying civilian resident population by projected labor force participation rates. This labor force supply is compared to the labor force demand based on the number of jobs by the shift share employment projection model.

The labor force demand is derived using three step processes. The first step is to develop independent job projections using the shift-share technique. The second step is to convert jobs into workers using the worker to job ratio. The application of the worker to job ratio is intended to reflect the proportion of workers holding two jobs or more. The third step is to convert workers into labor force demand using the ideal implied unemployment rate. If any imbalance occurs between labor force demand and labor force supply, it is corrected by adjusting the migration assumptions of the population projection model. This kind of equilibrium model is relatively less costly and easy to implement (George et al, 2004). Adjustment of migration assumption is translated into total population changes using the established conversion ratio.

Three key assumptions are developed to link population projection to employment projection. They include labor force participation rates, implied unemployment rates, and worker to job ratio. Labor force participation rates and worker to job ratio are based on the historical trends and the national projections, while implied unemployment rates are set at 5%-7%. Two high or too low unemployment rates are not assumed in developing reasonable population projections.

The worker's income distribution module is developed by using the existing SCAG economic-demographic model and the demographic-industry-income matrix (DIIM). The DIIM is intended to link worker's demographic characteristics (e.g., age, gender, race/ethnicity, immigration status, etc), industry (e.g., sector), and income. The base DIIM is developed using the 2000 US Census PUMS 5% data.

Projected population and employment are disaggregated into different income level of workers using the DIIM. The base DIIM is based on the cross tabulation of age, sex, race/ethnicity, industry, income using the 2000 US Census PUMS 5% data. Additional demographic variables including migration status could be included in the DIIM. The DIIM is intended to represent the income distribution probability controlling for demographic characteristics of workers and industry which workers are hired for. The DIIM allows us to see the effects of the changing demography of workers (including age, sex, and race/ethnic composition of (or immigrant) workers), the changing industry sectors that workers are hired for, and the changing income distribution probability of those workers on the future income distribution of workers.

The number of projected workers by industry sector is determined using the projected workers and the DIIM ($(Wrkr_{a,g,e,ind,inc} / Wrkr_{a,g,e,ind})$), which is a matrix linking age, gender, race/ethnicity, industry, and income (See (1) and (2)).

$$Wrkrincp^{t+n}_{a,g,e,ind,inc} = Wrkr^{t+n}_{a,g,e,ind} * (Wrkr^{t+n}_{a,g,e,ind,inc} / Wrkr^{t+n}_{a,g,e,ind}) \quad (1)$$

Where $Wrkrincp^{t+n}_{a,g,e,ind,inc}$ is income distribution of workers by age, gender, race/ethnicity, and industry for the target year, $Wrkr^{t+n}_{a,g,e,ind}$ is projected workers by age, gender, race/ethnicity, and industry for the target year, and $Wrkr^{t+n}_{a,g,e,ind,inc}$ is projected workers by age, gender, race/ethnicity, industry, and income for the target year.

The equation (1) is converted into the equation (2) for computation purpose.

$$Wrkrincp^{t+n}_{a,g,e,ind,inc} = Wrkr^{t+n}_{a,g,e} * (Wrkr^{t+n}_{a,g,e,ind} / Wrkr^{t+n}_{a,g,e}) * (Wrkr^{t+n}_{a,g,e,ind,inc} / Wrkr^{t+n}_{a,g,e,ind}) \quad (2)$$

Where $Wrkr^{t+n}_{a,g,e}$ are projected workers by age, gender, and race/ethnicity for the target year. $(Wrkr^{t+n}_{a,g,e,ind} / Wrkr^{t+n}_{a,g,e})$ is the demographic-industry matrix (DIM), which allows for matching employment projection with a projection of workers by demographic characteristics. Since workers by demographic characteristics and workers by industry are produced using different modeling procedure, the original DIM results in the inconsistent demographic-industry distribution of workers. Therefore, the original DIM is adjusted by using the iterative proportional fitting (IPF) process (Myers, 1992; Plane & Rogerson, 1994).

There are three major types of assumptions: demographic characteristics, employment structure, and income distribution pattern. These assumptions may lead to different steps of developing income distribution of workers. The first type of assumptions is related to different demographic characteristics (aging, ethnic diversification, immigrants with different time of arrival) of workers, others being equal. The change of $Wrkr^{t+n}_{a,g,e}$ will affect $(Wrkr^{t+n}_{a,g,e,ind} / Wrkr^{t+n}_{a,g,e})$, while $(Wrkr^{t+n}_{a,g,e,ind,inc} / Wrkr^{t+n}_{a,g,e,ind})$ remains constant. The second type of assumptions is related to different employment structure, others being equal. The change of employment structure will affect $(Wrkr^{t+n}_{a,g,e,ind} / Wrkr^{t+n}_{a,g,e})$, while $Wrkr^{t+n}_{a,g,e}$ and $(Wrkr^{t+n}_{a,g,e,ind,inc} / Wrkr^{t+n}_{a,g,e,ind})$ remain constant. The third type of assumptions is related to different income distribution, others being equal. The change of income distribution will affect $(Wrkr^{t+n}_{a,g,e,ind,inc} / Wrkr^{t+n}_{a,g,e,ind})$, while $Wrkr^{t+n}_{a,g,e}$ and $(Wrkr^{t+n}_{a,g,e,ind} / Wrkr^{t+n}_{a,g,e})$ remain constant.

How do we measure income distribution? There are several ways of measuring income distribution: percentile distributions, Lorenz curve, Gini coefficient, Robin Hood index, Theil index, and Standard deviation of income (http://en.wikipedia.org/wiki/Income_inequality). This study uses Gini coefficient to measure the income distribution. The Gini coefficient is a measure of statistical dispersion most prominently used as a measure of inequality of income distribution or inequality of wealth distribution. (http://en.wikipedia.org/wiki/Gini_coefficient). It falls between 0 and 1. A Gini coefficient of 1 indicates complete inequality, while 0 corresponds to perfect equality. The formula for the Gini coefficient (G) is summarized as follows (Shryock and Siegal, 1973; Rowland, 2003; McKibben and Faust, 2004):

$$G = \left[\sum_{i=1}^{n} X_i Y_{i+1} \right] - \left[\sum_{i=1}^{n} X_{i+1} Y_i \right]$$

Where
X_i and Y_i are the cumulative frequency distributions
n is the number of categories

The index of dissimilarity (IOD) can be used to measure the difference between two different distributions. (Duncan, 1959; Duncan and Duncan, 1955;Fonseca and Tayman, 1989; Philips, 1993;Plane and Rogerson, 1994; McKibben and Faust, 2004;Hobbs, 2004). This index measures the percentage of one group that would have to change its own percentage in order to produce an even distribution of the two groups. The formula for calculating the IOD is

$$IOD = \sum_{i=1}^{n} \frac{| x_i - y_i |}{2}$$

Where *i* represents the number of groups, x_i is the percentage of workers in subset group *i*, and y_i is the percentage of workers in parent group *i*.

V. Scenario Development and Model Results

1. Scenario Development

Six scenarios (S1-S6) are prepared to understand the implication of different demographic composition (e.g., age, gender, and race/ethnicity) of workers and employment structures of workers on income distribution of workers.

Scenario 1 is based on the baseline projection and the year 2000 DIIM. Scenario 1 fairly reflects the historical trends of socioeconomic growth. The region's population is aging and becomes ethnically more diverse (see figure xx and table xx). The region's employment increases the share of professional and educational services, while decreasing the share of the manufacturing sector. The incomeship rates from the 2000 DIIIM are assumed to remain constant during the projection period. Scenario 1 is used as a reference scenario.

Scenario 2 is based on the year 2000 age, gender, race/ethnic, industry composition of workers and the 2000 DIIM. Scenario 2 can be used to understand the effects of the changing demography and employment structure by comparing with scenario 1.

Scenario 3 is based on the year 2000 age, gender, and race/ethnic composition of workers and the 2035 industry composition of workers and the 2000 DIIM. Scenario 3 can be used to understand the effects of the changing employment structure by comparing with scenario 1.

Scenario 4 is based on the year 2000 industry composition of workers and the year 2035 age, gender, and race/ethnic composition of workers and the 2000 DIIM. Scenario 4 can be used to understand the effects of the changing demography by comparing with scenario 1.

Scenario 5 is based on the different employment structure reflecting 1) 2035 age, gender, and race/ethnic composition of workers, 2) the doubling of the year 2000 share of three high paying industries (information, FIRE, professional), and 3) the 2000 DIIM. Scenario 5 can be used to understand the effects of the changing employment structure by comparing with scenario 1.

Scenario 6 is based on the year 2035 age, gender, race/ethnic, industry composition of workers and the 2000 DIIM of the White group. Scenario 6 can be used to understand the effects of the changing incomeship rates of the minority race/ethnic groups by comparing with scenario 1. Seven scenarios are summarized in the table below. (see table xx)

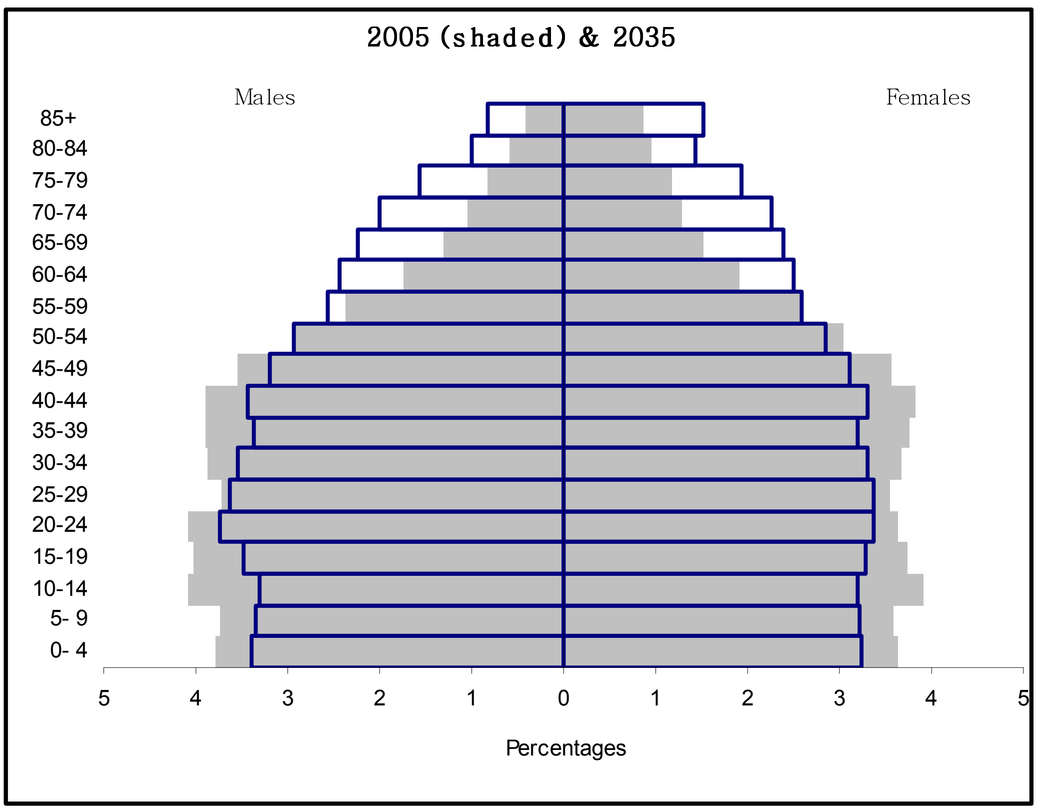

Figure 2. Population Age Pyramid, 2005 and 2035

Table 1. Demographic Indicators, 2005 and 2035

	2005	2035	Difference (2005 vs.2035)
Population ('000)	18,185	24,015	5,830
Growth rate (05-35)			32%
Persons under 16 years old (%)	24.3	21.1	-3.2
Persons 16-64 years old (%)	65.8	61.8	-3.9
Persons 65 years old and over (%)	10.0	17.1	7.1
Median age	33.0	36.8	3.8
Total dependency ratio*	52.0	61.7	9.7
Child dependency Ratio	36.9	34.1	-2.8
Old-Age dependency Ratio	15.2	27.6	12.4
Births per 1,000 population	15.7	14.4	-1.3
Total fertility rate (per woman)	2.05	2.05	0.00
Deaths per 1,000 population	6.3	7.1	0.9
Natural increase (%) (2000-2005, 2005-2035)	52.6	79.6	
Net migration (%) (2000-2005, 2005-2035)	47.4	20.4	
Non-Hispanic White persons (%)	36.6	23.6	-13.0
Non-Hispanic Black persons (%)	7.2	6.4	-0.7
Non-Hispanic Asian & Other persons (%)	13.5	14.1	0.6
Hispanic persons (%)	42.7	55.8	13.1

Note: * a measure showing the number of dependents (aged 0-15 & over 65) to working age population (aged 16-64). Dependents per 100 working age population. ** Total population

Source: SCAG, Preliminary Regional Baseline Growth Forecasts, April 2007.

Table 2. Summary Employment Indicators, 2005 and 2035

	2005	2035	Difference (2005 vs.2035)
Agrcultural	0.9%	0.7%	-0.2%
Mining	0.1%	0.1%	0.0%
Construction	6.0%	6.6%	0.6%
Manufacturing	10.7%	7.7%	-3.0%
Wholesale Trade	5.0%	4.5%	-0.5%
Retail Trade	10.8%	10.8%	0.0%
Transportation and Warehousing, Utilities	4.5%	4.0%	-0.4%
Information	3.6%	3.5%	0.0%
FIRE & Rental & Leasing	6.5%	5.9%	-0.6%
Professional, Scientific and Technical Servi	15.4%	17.3%	1.9%
Educational, Health Care and Social Servic	19.9%	22.3%	2.4%
Arts, Entertainment, and Recreation, etc	9.6%	10.0%	0.4%
Other Services	4.0%	3.6%	-0.5%
Public Administration	3.0%	2.9%	-0.1%
Total	100.0%	100.0%	0.0%

Source: SCAG, Preliminary Regional Baseline Growth Forecasts, April 2007.

Table 3. Six Scenarios of Developing Alternative Income Distributions of Workers

<table>
<tr><th>Scenario</th><th>Base Assumptions</th><th>Scenario Assumptions for 2035</th></tr>
<tr><td>S1</td><td rowspan="6">Projection Horizon:
2005-2035

National Level:
- Labor force participation rate: declines
- Unemployment rate: 4%
- Jobs per worker: 1.045

Regional Level:
- Labor force participation rate: declines
- Unemployment rate: 5%-7%
- Jobs per worker: 1.045
- Fertility: declines
- Mortality: declines
- Net immigration: levels off
- Net domestic migration: fluctuates</td><td>Use the baseline 2035 age, gender, race/ethnic, industry composition of workers and the 2000 DIIM</td></tr>
<tr><td>S2</td><td>Use the year 2000 age, gender, race/ethnic, industry composition of workers and the 2000 DIIM</td></tr>
<tr><td>S3</td><td>Use the year 2000 age, gender, and race/ethnic composition of workers and the baseline 2035 industry composition of workers and the 2000 DIIM</td></tr>
<tr><td>S4</td><td>Use the year 2000 industry composition of workers and the baseline 2035 age, gender, and race/ethnic composition of workers and the 2000 DIIM</td></tr>
<tr><td>S5</td><td>Double the baseline 2035 share of three high paying industries (information, FIRE, professional). Use the 2000 DIIM</td></tr>
<tr><td>S6</td><td>Use the baseline 2035 age, gender, race/ethnic, industry composition of workers. Apply the 2000 DIIM of the White group to other race/ethnic groups</td></tr>
</table>

2. Model Results

The income distribution of workers of the past and six scenarios is summarized in Table 4. S1 (baseline scenario), which is the most likely scenario reflecting the changing demography and industry structure, shows the more share of low income workers ($20k below) than 2000, while showing the less share of middle or higher income workers ($50k or above) than 2000. As a result of the changing share of different income categories, the ratio of low income workers ($20k below) to high income workers ($75k or above) is 6.0, which s higher than 2000. The Gini coefficient of S1 is 0.421, which is the highest among six scenarios. We might say that demographic and employment change might worsen the future income distribution, which is not consistent with the historical trend of income distribution. The historical trend indicates that the low income workers ($20k below) maintain their share at 40%, while the high income workers ($75k or above) tend to increase their share from 6% in 1980 to 10% in 2000. The income distribution in the past was not stable and was not moving toward one direction. The only one income category ($75k or above) shows a consistent increase of its share between 1980 and 2000. (see figure 3).

S3 and S4 are intended to show the effect of demographic change or industrial change on the income distribution. S3, assuming 2000 demographic composition and 2035 industry composition, shows an income distribution similar to S2 (or 2000). S4, assuming 2000 industry composition and 2035 demographic composition, shows an income distribution similar to S1 (baseline scenario), different from S2 (or 2000). This implies that income distribution seems more sensitive to demographic change than industrial change. S4 supports this finding. S4, assuming the doubling of the share of three high paying industries (information, FIRE, professional), still shows an income distribution similar to S1.

S6, assuming that minority workers would show the income distribution pattern of the White workers, shows the different income distribution than S1 (see figure 4). S6 shows the less share of low income workers ($20k below) than S1, while showing the more share of middle or higher income workers ($50k or above) than S1. As a result of the changing share of different income categories, the ratio of low income workers ($20k below) to high income workers ($75k or above) is reduced from 6.0 of S1 to 2.1. The Gini coefficient of S1 is 0.380, which is the lowest among six scenarios (see figure 5). This implies that the minority workers composed of many immigrants (30% of residents are found to be foreign born) might show a much different income distribution pattern than the White workers, even though they are in the same cohort of age and gender, and work in the same industry. S1 also shows the highest weighted average income of workers among six scenarios (see figure 6). S6 shows 30% more average income of workers than that of S1.

Two different DIIMs (2000 constant DIIM and 2000 White DIIM) produce a completely different income distribution. What would be an appropriate DIIM? It seems that both S1 and S6 produce extremely different pattern of income distribution as well as income level. Although we have a difficulty in understanding the long term historical pattern of DIIM due to the changing industry codes, the historical pattern of the overall income distribution suggests that the future income distribution would be somewhere between S1 and S6. (Tables 5, 6, 7, 8, 9 are provided to understand the difference in the effects of six scenarios on income distribution)

Table 4. Income Distribution of Workers, Actual (1980-2000) and Projected (in 1999 Dollars)

	20k-	20k-50k	50k-75k	75k+	20k-/75k+	Gini
1980	40%	41%	12%	6%	6.4	0.407
1990	40%	39%	13%	8%	5.1	0.404
2000	40%	37%	13%	10%	4.2	0.410
S1	45%	37%	11%	8%	6.0	0.421
S2	41%	37%	13%	10%	4.3	0.411
S3	41%	37%	12%	10%	4.2	0.414
S4	45%	37%	11%	7%	6.0	0.418
S5	43%	37%	11%	9%	4.8	0.418
S6	31%	38%	16%	15%	2.1	0.380

Note: Gini coefficient was computed using seven income categories. They include 0-10k, 10k-20k, 20k-30k, 30k-40k, 40k-50k, 50k-75k, 75k+.
Source: US Bureau of Census, US PUMS 5%, 1980, 1990, and 2000

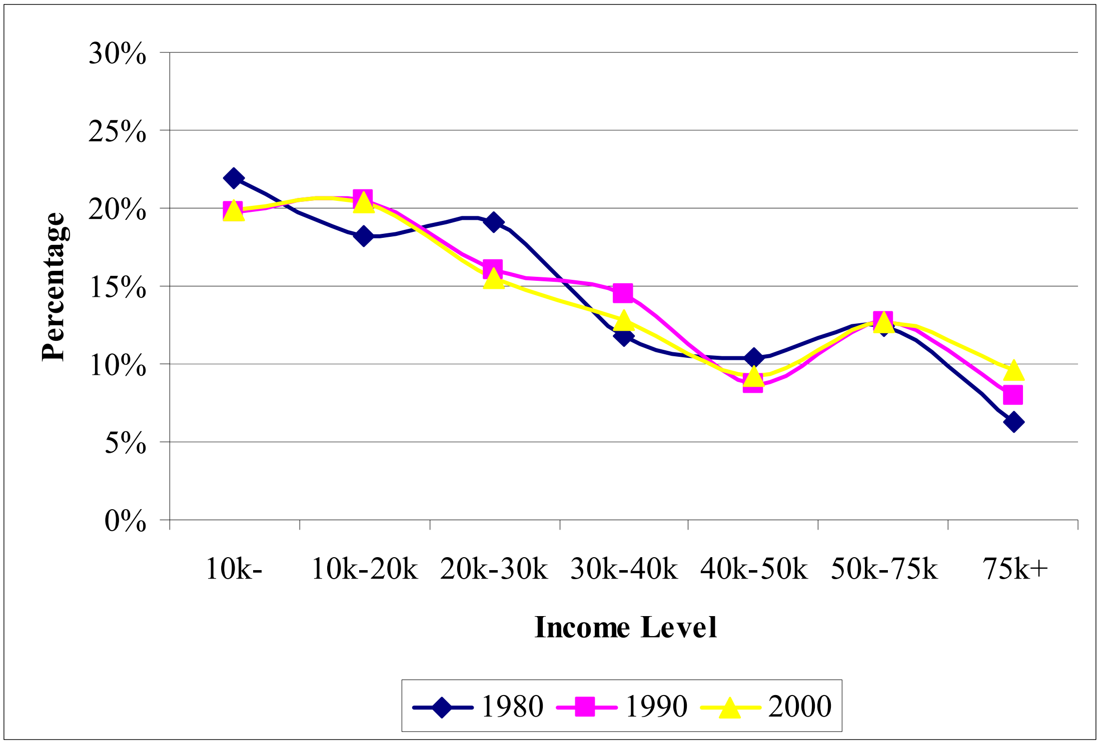

Figure 3. Income Distribution Probability of Workers, 1980-2000

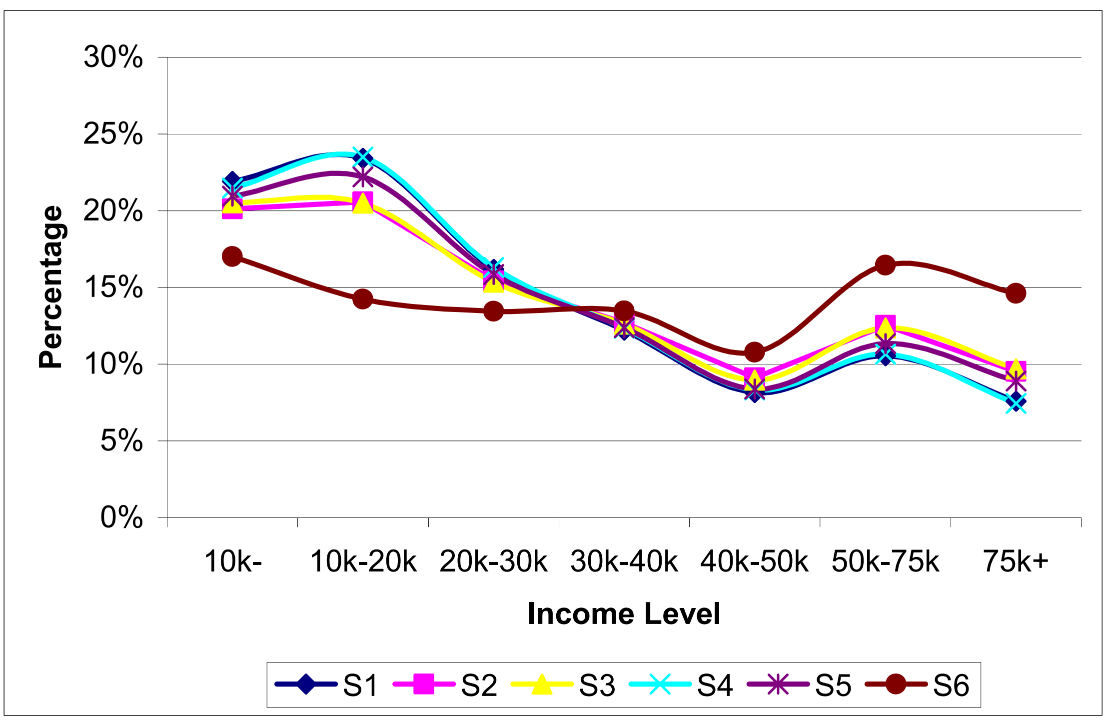

Figure 4. Income Distribution Probability of Workers by Scenario

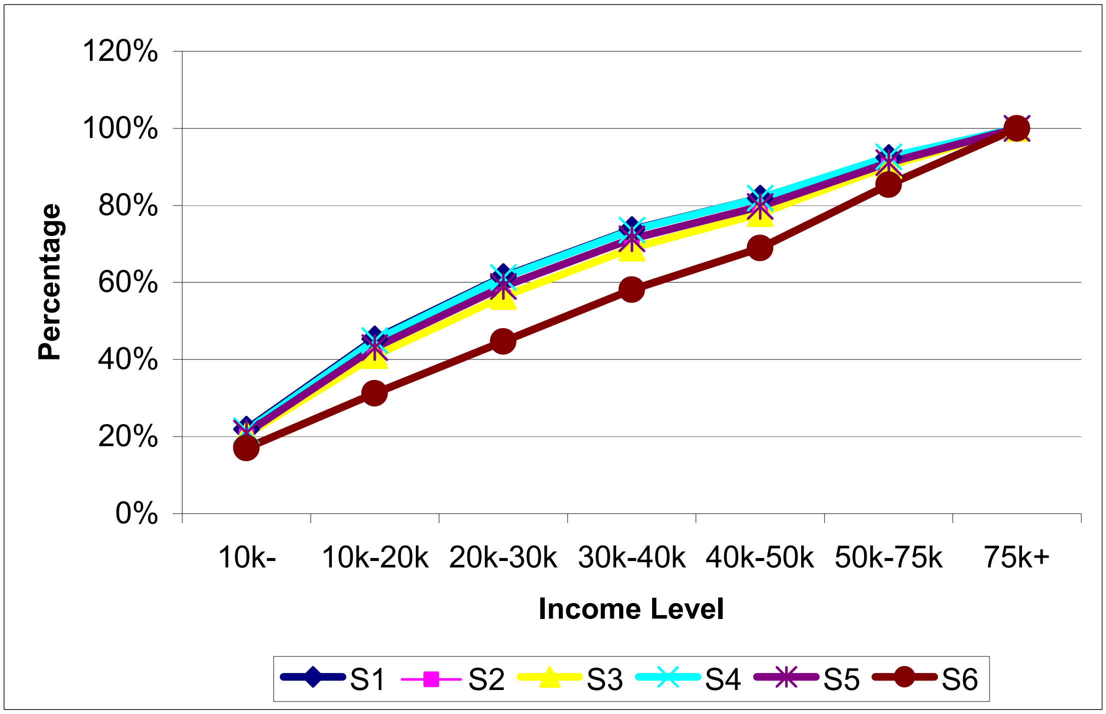

Figure 5. Accumulated Income Distribution Probability of Workers by Scenario

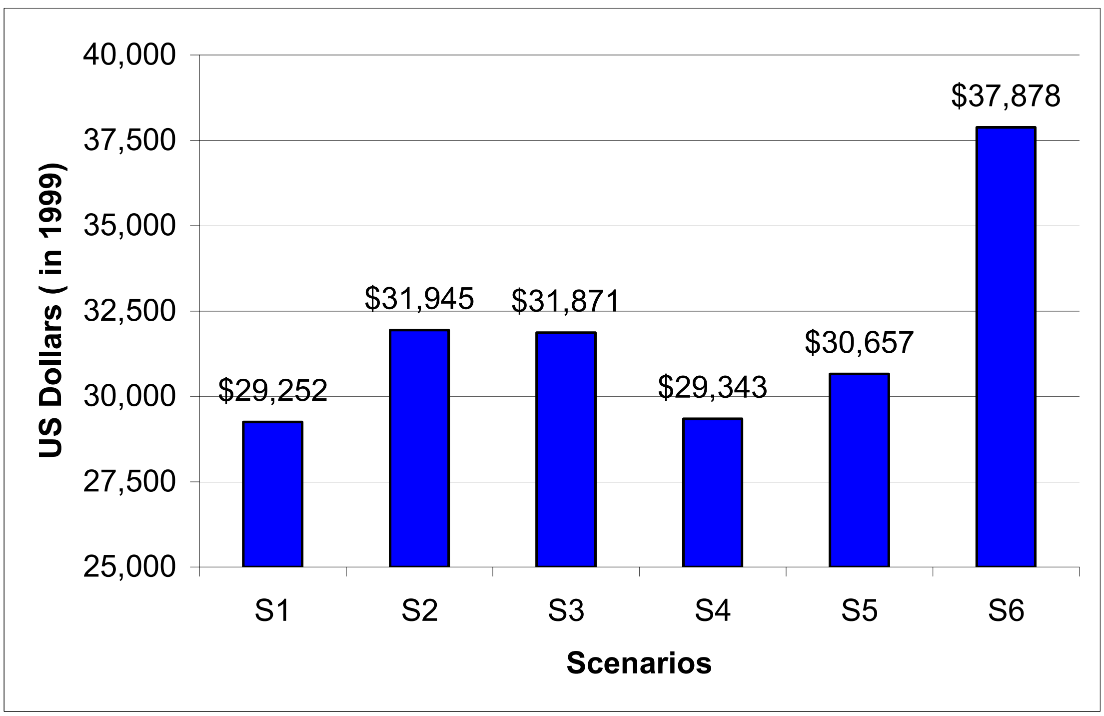

Figure 6. Weighted Average Income of Workers by Scenario

Table 5. Gini Coefficients by Scenario

		S1	S2	S3	S4	S5	S6
Sex	Male	0.407	0.391	0.396	0.402	0.408	0.349
	Female	0.428	0.421	0.422	0.427	0.421	0.399
	Total	0.421	0.411	0.414	0.418	0.418	0.380
Race/Ethnicity	NH White	0.379	0.367	0.370	0.376	0.369	0.379
	NH Black	0.391	0.385	0.390	0.386	0.386	0.370
	NH Asian & Others	0.399	0.403	0.403	0.399	0.387	0.372
	Hispanic	0.414	0.410	0.413	0.411	0.418	0.384
	Total	0.421	0.411	0.414	0.418	0.418	0.380
Age	16-24	0.395	0.400	0.401	0.394	0.400	0.426
	25-34	0.379	0.374	0.376	0.377	0.378	0.338
	35-44	0.383	0.367	0.369	0.381	0.378	0.322
	45-54	0.382	0.355	0.358	0.379	0.376	0.310
	55-64	0.404	0.373	0.376	0.401	0.404	0.334
	65+	0.493	0.490	0.491	0.491	0.496	0.487
	Total	0.421	0.411	0.414	0.418	0.418	0.380
Industry	Agrcultural	0.435	0.458	0.456	0.437	0.432	0.427
	Mining	0.269	0.259	0.258	0.271	0.272	0.241
	Construction	0.399	0.390	0.390	0.399	0.399	0.337
	Manufacturing	0.395	0.390	0.390	0.396	0.396	0.297
	Wholesale	0.390	0.382	0.382	0.391	0.391	0.330
	Retail	0.431	0.440	0.439	0.433	0.431	0.427
	Transportation& ware	0.337	0.333	0.332	0.338	0.339	0.310
	Info	0.360	0.346	0.345	0.361	0.365	0.323
	FIRE & rental & leasi	0.377	0.366	0.365	0.378	0.378	0.353
	Professional	0.430	0.407	0.407	0.430	0.433	0.361
	Educational,healthan	0.414	0.403	0.403	0.414	0.417	0.384
	Arts,entertainment et	0.440	0.463	0.462	0.442	0.437	0.463
	Other services	0.442	0.445	0.444	0.443	0.441	0.426
	Public administration	0.312	0.295	0.293	0.314	0.315	0.290
	Total	0.421	0.411	0.414	0.418	0.418	0.380

Table 6. Index of Income Dissimilarity by Socioeconomic Characteristics of Workers and by Scenario

		S1	S2	S3	S4	S5	S6
Sex	Male	5%	7%	6%	6%	5%	9%
	Female	7%	8%	8%	7%	7%	12%
Race/Ethnicity	NH White	18%	14%	14%	18%	18%	2%
	NH Black	10%	8%	8%	10%	10%	2%
	NH Asian & Others	9%	3%	4%	8%	10%	2%
	Hispanic	12%	19%	19%	12%	12%	1%
Age	16-24	38%	42%	42%	38%	37%	46%
	25-34	11%	12%	12%	10%	10%	13%
	35-44	9%	10%	10%	9%	9%	11%
	45-54	11%	14%	14%	12%	12%	14%
	55-64	7%	11%	11%	7%	6%	10%
	65+	15%	16%	16%	15%	16%	23%
Industry	Agrcultural	27%	28%	28%	27%	30%	11%
	Mining	37%	34%	35%	37%	34%	26%
	Construction	5%	5%	5%	4%	6%	8%
	Manufacturing	7%	6%	6%	6%	9%	15%
	Wholesale	7%	6%	7%	7%	9%	9%
	Retail	10%	12%	12%	10%	13%	13%
	Transportation& ware	18%	16%	17%	17%	17%	13%
	Info	20%	18%	19%	20%	16%	12%
	FIRE & rental & leasi	14%	13%	13%	14%	11%	7%
	Professional	4%	6%	6%	4%	4%	8%
	Educational,healthan	4%	5%	5%	4%	4%	5%
	Arts,entertainment et	23%	26%	25%	24%	27%	21%
	Other services	19%	18%	18%	19%	22%	16%
	Public administration	29%	27%	28%	28%	26%	18%

Table 7. Index of Income Dissimilarity of Workers by Scenario and by Income Category

	10k-	10k-20k	20k-30k	30k-40k	40k-50k	50k-75k	75k+
	Sex						
S1	16%	8%	7%	6%	2%	2%	15%
S2	18%	10%	10%	9%	3%	3%	16%
S3	17%	10%	10%	9%	4%	2%	16%
S4	18%	9%	8%	6%	1%	3%	15%
S5	14%	6%	8%	9%	4%	3%	15%
S6	18%	17%	16%	14%	6%	1%	16%
	Race/Ethnicity						
S1	19%	26%	16%	7%	2%	11%	22%
S2	21%	30%	17%	7%	2%	9%	19%
S3	21%	29%	17%	8%	2%	9%	18%
S4	19%	27%	15%	7%	2%	11%	22%
S5	20%	27%	16%	8%	3%	9%	21%
S6	2%	2%	2%	1%	1%	0%	2%
	Age						
S1	26%	16%	10%	7%	5%	9%	13%
S2	33%	22%	14%	8%	5%	9%	15%
S3	33%	22%	14%	9%	6%	9%	15%
S4	26%	16%	10%	7%	5%	9%	13%
S5	26%	16%	11%	7%	5%	7%	13%
S6	36%	22%	15%	11%	7%	5%	12%
	Industry						
S1	18%	16%	8%	5%	6%	8%	13%
S2	23%	17%	8%	6%	5%	8%	12%
S3	21%	16%	8%	6%	5%	8%	13%
S4	20%	17%	8%	5%	5%	8%	12%
S5	17%	16%	8%	5%	5%	8%	11%
S6	23%	18%	10%	8%	5%	7%	12%

Table 8. The Income Level of Workers Relative to the Overall Income (Weighted Average Income)

		S1	S2	S3	S4	S5	S6
Sex	Male	111%	113%	112%	111%	110%	114%
	Female	86%	85%	85%	85%	87%	82%
	Total	100%	100%	100%	100%	100%	100%
Race/Ethnicity	NH White	132%	123%	123%	132%	132%	102%
	NH Black	107%	97%	96%	108%	106%	102%
	NH Asian & Others	115%	102%	103%	113%	115%	102%
	Hispanic	80%	70%	70%	80%	80%	98%
	Total	100%	100%	100%	100%	100%	100%
Age	16-24	43%	40%	39%	43%	44%	36%
	25-34	93%	91%	91%	93%	95%	96%
	35-44	114%	116%	116%	114%	115%	116%
	45-54	122%	124%	125%	121%	121%	121%
	55-64	114%	121%	121%	114%	111%	116%
	65+	85%	84%	84%	85%	82%	75%
	Total	100%	100%	100%	100%	100%	100%
Industry	Agrcultural	60%	60%	60%	60%	57%	87%
	Mining	159%	151%	152%	158%	150%	136%
	Construction	101%	103%	103%	101%	94%	108%
	Manufacturing	101%	105%	105%	101%	94%	122%
	Wholesale	105%	107%	107%	104%	97%	113%
	Retail	83%	80%	81%	82%	78%	81%
	Transportation& ware	123%	115%	116%	122%	116%	110%
	Info	135%	131%	132%	134%	127%	120%
	FIRE & rental & leasi	122%	119%	120%	121%	115%	110%
	Professional	107%	111%	112%	107%	99%	112%
	Educational,healthan	101%	99%	99%	101%	95%	93%
	Arts,entertainment et	65%	63%	64%	65%	61%	72%
	Other services	70%	70%	70%	69%	65%	76%
	Public administration	145%	140%	141%	144%	137%	123%
	Total	100%	100%	100%	100%	100%	100%

Table 9. The Income Level of Workers Relative to the Baseline Income (Weighted Average Income)

		S1	S2	S3	S4	S5	S6
Sex	Male	100%	111%	110%	101%	104%	133%
	Female	100%	108%	108%	99%	107%	124%
	Total	100%	109%	109%	100%	105%	129%
Race/Ethnicity	NH White	100%	102%	102%	100%	105%	100%
	NH Black	100%	99%	98%	101%	104%	123%
	NH Asian & Others	100%	97%	98%	99%	105%	115%
	Hispanic	100%	95%	95%	101%	105%	159%
	Total	100%	109%	109%	100%	105%	129%
Age	16-24	100%	102%	101%	101%	107%	111%
	25-34	100%	107%	107%	100%	106%	133%
	35-44	100%	111%	111%	100%	106%	132%
	45-54	100%	112%	112%	100%	105%	129%
	55-64	100%	115%	115%	100%	102%	132%
	65+	100%	108%	108%	101%	101%	116%
	Total	100%	109%	109%	100%	105%	129%
Industry	Agrcultural	100%	108%	108%	100%	98%	186%
	Mining	100%	104%	104%	100%	99%	111%
	Construction	100%	112%	111%	100%	98%	138%
	Manufacturing	100%	114%	113%	100%	97%	157%
	Wholesale	100%	111%	111%	100%	98%	139%
	Retail	100%	105%	106%	99%	98%	126%
	Transportation& ware	100%	103%	103%	100%	99%	116%
	Info	100%	106%	106%	100%	98%	115%
	FIRE & rental & leasi	100%	107%	107%	100%	98%	117%
	Professional	100%	114%	114%	100%	97%	136%
	Educational,healthan	100%	107%	107%	100%	98%	119%
	Arts,entertainment et	100%	106%	106%	100%	98%	142%
	Other services	100%	110%	110%	100%	98%	140%
	Public administration	100%	105%	106%	99%	99%	110%
	Total	100%	109%	109%	100%	105%	129%

VI. Conclusions

This study developed an expanded economic-demographic projection model reflecting a linkage of population, employment, and income distribution of workers. The new projection model was able to measure the effects of changing population and employment on income distribution. With expected trends in demographic characteristics and employment structure, the newly developed projection model discussed the following questions: what are effects of demographic changes on income level/distribution?; what are effects of employment structure on income level/distribution?; what are effects of employment sector policy on income level/distribution?; what are effects of changing DIIM on income level/distribution?

The key discussion during the income distribution development process was focused on developing the "core assumptions" of DIIM. The core assumptions above are major determinants of the forecast accuracy (Ascher, 1978). The most popular approach is to use the trend extrapolation of historical trends of demographic rates. However, those historical rates are oftentimes instable (Myers et al, 2002) or unknown like DIIM. There is fear that the trend extrapolation based demographic rates might produce inaccurate population projections. To complement the weakness of the trend extrapolation based demographic rates, the scenario approach with different assumptions can be used. As oftentimes found in population projections (Smith, 2001), the average of income distribution projections might produce more accurate projections.

Sources of data:

U.S. Dept. of Commerce, Bureau of the Census. Census of Population and Housing, 2000 [UNITED STATES]: Public Use Microdata Sample: 5-Percent Sample Computer file]. Washington, DC: U.S. Dept. of Commerce, Bureau of the Census [producer], 2003.

Southern California Association of Government, Regional Trend Growth Forecasts of Population and Employment. 2004.

References:

California Budget Project, Boom, Bust and Beyond: The State of Working California, January 2003.

David Holland and Peter Wyeth, SAM Multipliers: The Interpretation and Relationship to Input-Output Multipliers, Microcomputer-Based Input-Output Modeling: Applications to economic Development, Daniel M. Otto and Thomas G. Johnson (eds), Boulder: Westview Press. 1993.

David L. Phillips, Compare: Comparative Analysis Techniques, Richard E. Klosterman, Richard K. Brail, and Earl G. Bossard (eds), Spreadsheet Models for Urban and Regional Analysis. 1993. pp. 107-132.

Donald A. Kruekeberg & Arthur L. Silvers, Urban Planning Analysis: Methods and Models, Chapter 3. Decision Models of Choice and Chance. Pp. 62-95. 1974.

Dowell Myers, Analysis with Local Census Data: Portraits of Change, Rates x Composition, pp. 263-264, 287-288, 1992.

Dowell Myers, John Pitkin, and Julie Park, California Demographic Futures: Projections to 2030, by Immigrant Generations, Nativity, and Time of Arrival in the US, January 2005.

M. Yusof Saari, Erik Dietzenbacher, and Bart Los, The Impact of Growth on Distribution of Income across Ethnic Groups: a Social Accounting Matrix (SAM) Approach, 16th international input-Output Conference, Istanbul, Turkey, 2-6 July 2007.

Stanley K. Smith, Jeff Tayman, and David A. Swanson, State and Local Population Projections: Methodology and Analysis, pp. 185- 214. pp. 260-266. 2001.

S. Murdock, L. Jones, R. Hamm, S. Hwang & B Papia, An Assessment of the Accuracy of A Regional Economic-Demographic Projection Model, Demography, 21, 383-404. 1984.

Deborah Reed, Recent Trends in Income and Poverty, California Counts: Population Trends and Profiles Vol. 5, No. 3. Public Policy Institute of California, 2004.

Daly, Reed, and Royer (2001) Population Mobility and Income Inequality in California, Vol 2 No 4, may 2001. Hans Johnson (ed.), California Counts: Population Trends and Profiles, Public Policy Institute of California.

Southern California Association of Governments, The State of the Region 2004: Measuring Regional Progress. December 2004.

US Bureau of Labor Statistics, BLS Releases 2004-14 Employment Projections, December, 2005.

Pyatt and Round, "Social Accounting Matrices: A Basis for Planning", The World Bank, 1985. Retrieved from "http://en.wikipedia.org/wiki/Social_accounting_matrix"

…