Application of the Cohort Component Model to Development of Local Population Projections

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By

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Abstract

Projections of local population size play an important role in determining the future housing and transportation needs of local communities in the regional plan framework. This study intends to present a useful technique for developing the demographic characteristics (e.g., age, sex, and race/ethnicity) of projected populations at the local jurisdiction level within a regional plan framework. A proposed approach is to combine both the housing unit method and the cohort component model. Total population can be derived by using the housing unit method, and it can be further disaggregated into detail demographic characteristics using cohort-component model. This paper specifically proposes a local cohort-component model using: 1) gross migration approach; 2) county/regional demographic assumptions; and 3) local population projection derived from the housing unit method. The newly developed modeling framework for local population projections can be a useful scenario testing tool for urban and regional planners. The housing unit method offers urban and regional planners the opportunity to seriously discuss the different scenarios of housing development and population size together with their implication on the components and demographic characteristics of population growth. The detailed information of the future population characteristics will help local planners to better prepare for those diverse community services needs.

Introduction

Projections of local population size play an important role in determining the future housing and transportation needs of local communities in the regional plan framework (Siegel, 2002). Although the national level population projections widely use the cohort component model to develop demographic characteristics of projected populations (George et al, 2004), the local level (e.g., the sub-county) population projections tend to apply trend extrapolation methods to estimate the size of population due to the limited availability of data (e.g., demographic and migration data) and resources. This study intends to present a useful technique of developing the demographic characteristics (e.g., age, sex, and race/ethnicity) of projected populations at the local jurisdiction level within a regional plan framework.

At a result of the regional growth forecast process, the region/county level population projections are made available by major demographic characteristics (e.g., age, sex, and race/ethnicity) and the population size of local jurisdictions is projected using diverse mathematical methods and the collaborative process. This study uses the cohort-component model to project the changing demographic characteristics (age and race/ethnicity) of local population and the components (births, deaths, net domestic migration, net international migration) of local population growth during the projection period. The number of local births and deaths can be derived using the county specific birth rates, death rates, and migration rates and the local share of the county level net immigration.

With the aging of the baby boomer generation and increase of the minority population in local communities, the local jurisdictions will experience the changing community service needs in the future. The community service needs will include services for poor people, school, housing, energy use, hospital, police, transportation, etc. The detailed information of the future population characteristics will help local jurisdictions to better prepare for those diverse community services needs.

Local Population Projections and Cohort Component Model

The cohort-component model has been consistently used for projecting the national population in the USA by the US Census Bureau for decades (George et al, 2004). The major benefit of using the cohort-component model for population projection is to provide more detailed demographic information (e.g., age) of population growth. The cohort-component model has been gradually extended to population projection of smaller areas (e.g., state, county) with availability of key demographic information. With the proper assumptions of three major components (births, deaths, migration) by age cohort, the model would produce the reasonable population projections at the smaller areas.

Migration, among three major components, is the major source of projection uncertainty due to its volatility and unavailability of direct measures at the smaller areas (Isserman, 1993; Pittenger, 1976). Scholars have been developing diverse migration projection techniques (George et al, 2004; Plane & Rogerson, 1994). Trend extrapolation method is widely used and produces a range of migration projections using migration amounts for a different base year period (e.g., recent five year average, recent ten year average). Migration projection is also derived by linking it to employment patterns. The area of more job opportunities would attract more migration. Migration itself tends to bring more employment opportunities due to increased service job needs. Employment driven migration process can be modeled at the metropolitan areas, where historical migration and employment statistics are easily available.

There are two major approaches toward developing migration flows for smaller areas. Gross migration approach has been found to produce more adequate population projections than net migration approach (George et al, 2004; Isserman, 1993; Smith, 1987; Roger, 1990). There are many reasons why gross migration approach is better than net migration approach. Key reasons include: 1) gross migration is closer to the true migration process; 2) gross migration traces gross migration flows; 3) gross migration rates are based on population at risk; and 4) gross migration can account for differences in growth rates between origin and destination populations (Isserman, 1993; Smith & Swanson, 1998).

With the availability of county-to-county migration data from the Census and the US Internal Revenue Services (IRS), regional and county demographers and planners have a choice of using a theoretically sound gross migration approach. But, they still prefer net migration approach to gross migration approach. One major reason is that gross migration is difficult to apply due to its more complicated nature. The difficulty comes from two-way adjustment process of in-migration and out-migration. There is much need to develop easily applicable gross migration assumptions for local or metropolitan population projections.

Two region gross migration approach, a simplified version of multiple region model, focuses on gross migration of two regions: the study region and the rest of the country, and overcomes the complexity of modeling multi-regional migration flows. Two-region based approach retains many of the benefits of full-blown multiregional models (Smith et al, 2001). Major benefits include use of proper migration rates, less data need, fewer calculations, and less cost (Isserman, 1993; Smith et al, 2001). Two region gross migration approach was applied to the county level (Isserman, 1993; Choi & Cho, 2007). Choi & Cho (2007) used Microsoft Excel Solver to determine the changing size of in- and out-migration. The two region gross migration optimization technique efficiently finds two optimal adjustment factors: one for in-migration and the other for out-migration. Two factors are similar to those of the plus-minus method (Akers and Siegel, 1965), widely used to adjust net migration composed of the positive and negative frequencies.

The local (e.g., sub-county, city) population projections generally apply trend extrapolation or other methods (e.g., housing unit method) to estimate the size of total population due to the limited availability of demographic and migration data. Traditionally vital statistics on births and deaths at the sub-county level was available from the decennial Census every ten years, or was accessible through PUMS data published by the State health statistics agency. PUMS data is not free to the general public and hard to deal with.

The information of the sub-county births and deaths is now freely available through public sources, such as California Department of Public Health (DPH) and US census Bureau. CA DPH posts birth and death profiles on its website (http://www.cdph.ca.gov/data/statistics/Pages/default.aspx). Birth Profiles by Zip Code consist of the number of live births, based on the mother's residence at the time of delivery and include aggregates by Race/Ethnic Group of Mother, Age of Mother, Infant Birthweight, and Prenatal Care Trimester by Zip Code. Death Profiles by Zip Code contain the number of deaths to California residents by Zip Code of decedent's residence. Data are aggregated by decedent's sex, age, and cause of death and is obtained from registered death certificates for California residents who died in California and from registered death certificates in other states for California residents who died out of state. CA DPH expects that birth and death profiles at the Zip code level be used to monitor the small area change and perform small area analysis to identify and target areas within cities and counties where public health programs may be needed.

The US Census Bureau has released the American Community Survey (ACS) since 2000. As an ongoing survey, ACS provides data every year and includes estimates of demographic, social, housing, and economic characteristics of people for small areas. The smallest geography of ACS data would the Census Block Group Level and the data (5 year average) will be available in 2011. Although the sub-county death information is not available, birth data (e.g., number of births from women 15 to 50 years old in the past 12 months or number of population for age 0-4) is available. The net, in-, and out- migration at the sub-county level is also not available.

Hamilton-Perry Method (Hamilton & Perry, 1962) uses the cohort-change ratio between two decennial census years to project the age characteristics and total population. Once the births are projected using the assumption of children 0-4 to women 15-49 ratio, projections of total population and its age composition are made available. The Hamilton-Perry method has been a good candidate for developing the local population projections with detailed demographic characteristics for its relatively simple and easy applicability. The major concern is the reasonableness of total population projections, in particular, migration. The historical migration pattern of two base periods (e.g., decennial years) is implicitly factored in total population projections. With the volatile nature of migration associated with economic conditions, the implicit migration assumption and total population projections are easily challenged by local and regional stakeholders.

The weakness of the pure cohort-component model associated with difficulty of developing a reasonable range of births, deaths, and local migration flows can be overcome by linking local (sub-county) population projections and related assumptions to regional (county) population projections and related assumptions. The historical or current local-regional demographic linkage can be used to develop the initial local population projections in a regional forecasting/planning framework. With adjustment of county birth and death rates reflecting the recent local trends, migration flows are also reasonably derived using a residual method. The revised local-regional demographic linkage can be established and used to implement the local cohort-component model, but it still faces a difficulty of developing migration assumptions.

A proposed approach is to combine both the housing unit method and the cohort component model. Total local population can be derived by using the housing unit method, and it can be further disaggregated into detailed demographic characteristics using the cohort-component model. The combination of the housing unit method and the cohort component model for local population projections can be a useful scenario testing tool for urban and regional planners. The housing unit method offers urban and regional planners the opportunity to seriously discuss the upcoming housing development and population size, and the cohort component model further presents the implication of the changing population size on the components and demographic characteristics of population growth. For example, as the recent effort of the State of California to reduce the statewide greenhouse gas (GHG) emissions, local jurisdictions are recommended to promote alternative growth patterns (compact development, transit oriented development, etc) (Choi et al, 2009). The development capacity to promote alternative urban growth patterns can be expanded to contain more housing growth and the resulting population growth. We might easily translate the expanded development capacity and housing growth into population size and demographic characteristics by using both housing unit method and cohort component model.

This paper proposes a local cohort-component model using: 1) gross migration approach; 2) county/regional demographic assumptions; and 3) local population projection derived from the housing unit method.

Application of Local Cohort Component Model to the Southern California Region

1) Overview of the Current Population Projection Process and Methods

The Southern California Association of Governments (SCAG) is the largest of nearly 700 councils of government in the United States, functioning as the Metropolitan Planning Organization for six counties: Los Angeles, Orange, San Bernardino, Riverside, Ventura, and Imperial, and 190 cities. The region encompasses a population approaching 19 million persons in an area of more than 38,000 square miles. As the designated Metropolitan Planning Organization, SCAG is mandated by the federal and state governments to research and draw up plans for transportation, growth management, hazardous waste management, and air quality, housing, hazardous waste management, and waste treatment management.

According to California Health and Safety Code Section 40460 (b), SCAG, with the assistance of counties and cities, is responsible for preparing and approving the portions of the Air Quality Plan related to regional demographic projections on which emission of pollutants are based. SCAG prepares a consistent socioeconomic data set for Cities, Counties, and other government agencies in the region.

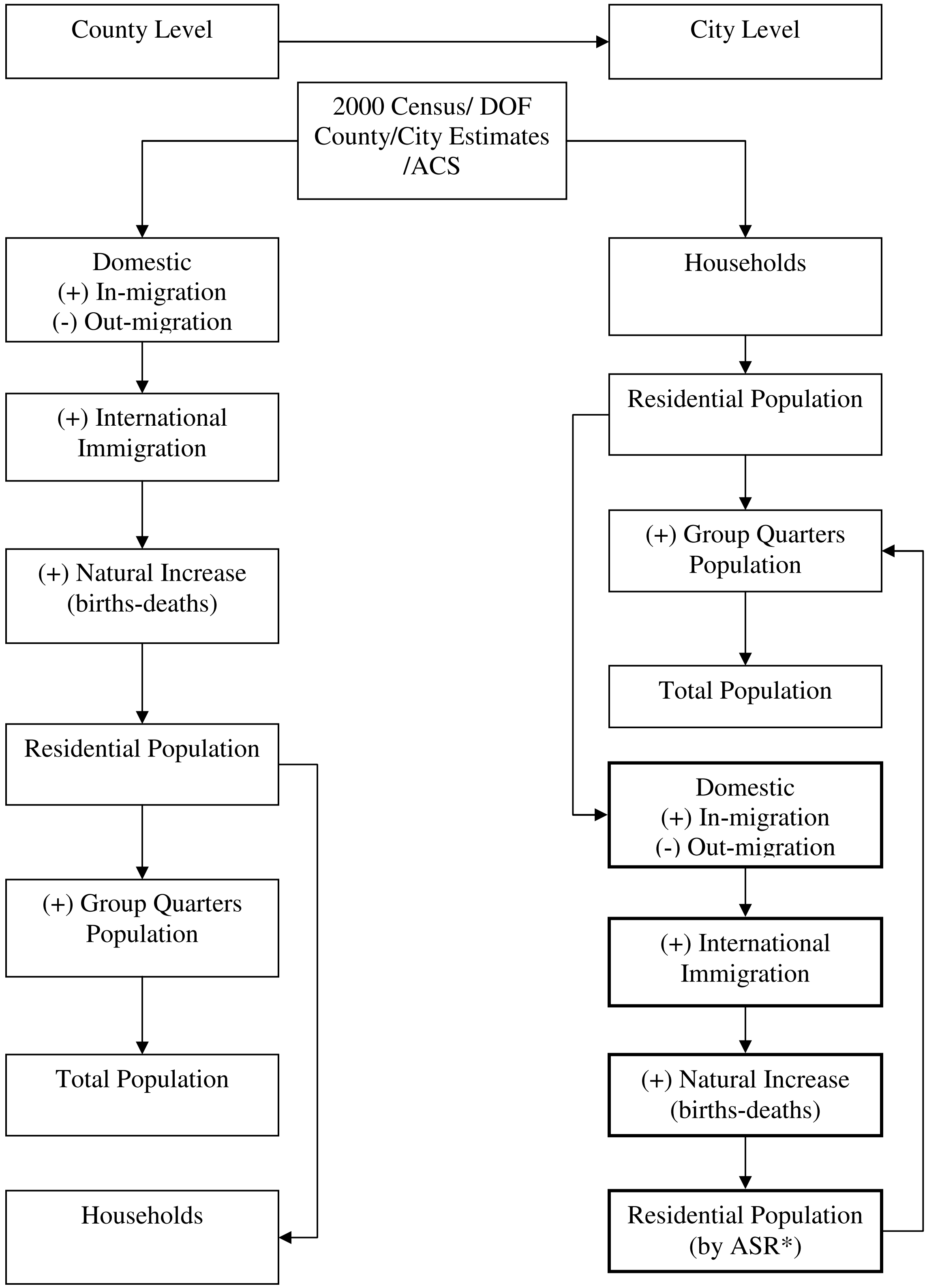
The minimum requirement of growth projections in the regional planning process is to maintain the "consistency" among variables (e.g., population, households, employment) at different levels of geography over time. The major factor triggering growth is varying depending on the different levels of geography. The current modeling practice assumes that the regional level growth is generally driven by employment, while the city level growth is driven by housing growth. The following is the standard population projections process at three different levels of geography (e.g., region, county, city) in the Southern California Region (SCAG, 2008).

Regional Population Projections: A first phase is to use a standard demographic cohort-component model to project population at the regional level. The components are fertility, mortality and migration. Projections are derived for 18 age cohorts in five years intervals for the projection timeline. The cohort-component model computes the population at a future point in time by adding to the existing population the number of births and persons moving into the region during a time interval, and by subtracting the number of deaths and the number of persons moving out of the area. Fertility, mortality and migration rates are projected in 5 year intervals for each age group, for four mutually exclusive ethnic groups: Non-Hispanic White, Non-Hispanic Black, Non-Hispanic Asian and Hispanic, by these population classes: residents, domestic migrants and international migrants. The regional demographic assumptions, in particular, of birth rates and mortality rates are derived by considering the historical patterns and the recent demographic assumptions used by US Census Bureau or California Department of Finance. A second phase links population dynamics to economic trends, and is based on the assumption that patterns of migration into and out of the region are influenced by the availability of jobs. The future labor force is computed from the population projection model. Projected labor force participation rates are applied to the working age population. This labor force number is compared to the number of jobs projected by the shift/share economic model. If any imbalance occurs between the two figures, it is corrected by adjusting the migration assumptions of the demographic projection model.

County Population Projections: As used in the regional population projection, the cohort-component model is used to project the county population. The sum of the county projections is compared to the regional independent projections. If the results are significantly divergent, input data at the county level is adjusted to bring the sum of counties projection and the regional independent projections more closely in line. Migration is still the most important factor affecting the future population growth. International migration is driven by the long term historical trend, while domestic migration is based on the county share of the regional domestic net migration. The county's share is determined considering the county's relative attractiveness (e.g., job availability, wage level, housing price, accessibility to jobs, etc). Domestic net migration is further disaggregated into the domestic in- and out- migration by demographic characteristics (e.g., age, sex, and ethnicity). The projected age/gender distribution of domestic in/out migrants is based on 1995-2000 domestic in/out-migrants at the county level from 2000 Census. The projected race/ethnic distribution of domestic in/out-migrants is based on the trending of county distribution to projected race/ethnic change in the regional distribution. International migration is determined using the county's long term net immigration (e.g., 15 year average). The projected distribution of age/gender is based on 1995-2000 net immigrants at the county level from 2000 Census. The projected race/ethnic distribution of net immigrants is based on the average of 2000 Census and 2005 Pew Hispanic Center Report at the county level.

City Population Projections: City level population is projected using the housing unit method, which is one of the most widely used methods for estimating local area households and population for planning purposes (U.S. Bureau of the Census, 1990; Simpson et al, 1996). The housing unit method consists of the following four procedures. First, occupied housing units (households) are estimated by extrapolating the past trend of occupied housing units. The methodology for developing the occupied housing projection is a constrained extrapolation using stochastic simulation. The input data series can include the long term trend from the California Department of Finance E-5 series with enumeration-based values from the 1980, 1990, and 2000 censuses. The model parameters are estimated using the long term observation series for each city from CA DOF. Second, household (residential) population is estimated by multiplying occupied housing units (households) by the projected average household size. A constrained trend extrapolation of the average household size values from CA DOF is used with bounds determined by expert opinion, currently [1.2, 5.5]. Third, projected group quarter population is added to projected residential population. The group quarter population is projected based on the ratio of the city level group quarter population to the city level total population recently estimated by us Census Bureau or CA DOF. The ratio is assumed to remain constant during the projection horizon. Fourth, projected total population of local jurisdictions are adjusted or smoothed out in order to maintain its consistency with the projected County population.

Figure 1. Proposed Local Population Projection Process



* ASR refers to age, sex, and race/ethnicity

2) Proposed Local Cohort-Component Model: Methods and Assumptions

Currently the trend extrapolation scenario is purely based on historical trends in the data. General plan or zoning constraints, land constraints, and build-out scenarios from general plans, and infill potentials should be considered in developing housing development policy scenarios. The projected city level population from the housing unit method is further decomposed into three components (e.g. births, deaths, and migration) and demographic characteristics using the local cohort component model.

The local cohort-component model computes the city level population at a future point in time by adding to the existing population the number of group quarter population, births and persons moving into the city during a projection period, and by subtracting the number of deaths and the number of persons moving out of the city (see figure 1). The fertility, mortality and migration rates are projected in 5 year intervals for 18 age groups, for four mutually exclusive ethnic groups: Non-Hispanic White, non-Hispanic Black, non-Hispanic Asian and Hispanic. The projected demographic rates (birth rates, death rates, migration rates) are generally borrowed from the County cohort-component model due to unavailability of them at the city level. The launch year of local population projection is 2000 and the target year of the local population projection is 2040. The population projection process is formalized in the demographic balancing equation

$$P_{t_{2040}}^{city} = P_{t_{2000}}^{city} + GQ_{t_{2000-2040}}^{city} + B_{t_{2000-2040}}^{city} - D_{t_{2000-2040}}^{city} + IN_{t_{2000-2040}}^{city} - OM_{t_{2000-2040}}^{city} + IM_{t_{2000-2040}}^{city}$$

where

$P_{t_{2040}}^{city}$ = total population in 2040

$P_{t_{2000}}^{city}$ = total population in 2000

$GQ_{t_{2000-2040}}^{city}$ = group quarter population between 2000 and 2040

$B_{t_{2000-2040}}^{city}$ = births between 2000 and 2040

$D_{t_{2000-2040}}^{city}$ = deaths between 2000 and 2040

$IN_{2000-2040}^{city}$ = domestic inmigrants to the city between 2000 and 2040.

$OM_{t_{2000-2040}}^{city}$ = domestic outmigrants from the city between 2000 and 2040.

$IM_{t_{2000-2040}}^{city}$ = international net immigrants (including legal and undocumented) to the city between 2000 and 2040.

The following is a description of how components of local population change are projected using the projection period of 2010-2015 as an example.

(1)Group quarter population

$$GQ_{t_{2015}}^{city} = RES_{t_{2015}}^{city} * GQR_{t_{2015}}^{city}$$

where
$GQ_{t_{2010}}^{city}$ = group quarter population in 2010.
$RES_{t_{2010}}^{city}$ = regional civilian resident population in 2010
$GQR_{t_{2010}}^{city}$ = the ratio of group quarter population to total population in 2010 from CA DOF

(2)Births

$$B_{t_{2010-2015}}^{city} = BASEFEM_{t_{2010}}^{city} * (\alpha * FERTR_{t_{2010-2015}}^{county})$$

where
$B_{t_{2010-2015}}^{city}$ = births of the city between 2010 and 2015
$BASEFEM_{t_{2010}}^{city}$ = base female population of the city would be one of civilian resident female population, female inmigrants, female immigrants of child bearing ages (10-49)
α = adjustment factor
$FERTR_{t_{2010-2015}}^{county}$ = county fertility rate between 2010 and 2015

(3)Deaths (Survived Population)

$$D_{t_{2010-2015}}^{city} = BASEPOP_{t_{2010}}^{city} * (\beta * MORTALR_{t_{2010-2015}}^{county})$$
$$SURVR_{t_{2010-2015}}^{city} = 1 - (\beta * MORTALR_{t_{2010-2015}}^{county})$$
$$S_{t_{2010-2015}}^{city} = BASEPOP_{t_{2010}}^{city} * SURVR_{t_{2010-2015}}^{city}$$

where
$D_{t_{2010-2015}}^{city}$ = deaths between 2010 and 2015
β = adjustment factor
$MORTALR_{t_{2000-2005}}^{region}$ = life table mortality rate (q_x) between 2010 and 2015
$SURVR_{t_{2010-2015}}^{region}$ = life table survival rate (1-q_x) between 2010 and 2015
$S_{t_{2010-2015}}^{city}$ = survived population between 2010 and 2015

(4)Migration

$$IN_{t_{2010-2015}}^{city} = PSHARE_{t_{2000}}^{city} * (BASEPOP_{t_{2010}}^{us} * INR_{t_{1995-2000}}^{county})$$
$$OM_{t_{2010-2015}}^{city} = PSHARE_{t_{2000}}^{city} * (BASEPOP_{t_{20010}}^{county} * OMR_{t_{1995-2000}}^{county})$$
$$IM_{t_{2010-2015}}^{city} = ISHARE_{t_{1985-2000}}^{city} * IM_{t_{2010-2015}}^{county}$$

where

$IN^{city}_{t_{2010-2015}}$ = domestic inmigration to the city between 2010 and 2015

$OM^{cityn}_{t_{2010-2015}}$ = domestic outmigration from the city between 2010 and 2015

$IM^{city}_{t_{2010-2015}}$ = international net immigration (including legal and undocumented) to the city between 2010 and 2015

$INR^{county}_{t_{1995-2000}}$ = domestic inmigration rates measured in the ratio of inmigration between 1995 and 2000 to total US population in 1995

$OMR^{county}_{t_{1995-2000}}$ = outmigration rates measured in the ratio of outmigration between 1995 and 2000 to total county population in 1995

$IM^{county}_{t_{2010-2015}}$ = net international immigration into county between 2010 and 2015

$PSHARE^{city}_{t_{2000}}$ = city's share of county level population in 2000

$ISHARE^{city}_{t_{1985-2000}}$ = city's share of county level international immigration (including legal and undocumented) for the period of 1985-2000

Model Validation and Results

The local cohort-component model was applied to the City of Los Angeles as a demonstration. Los Angeles is the second most populous city in the United States, and the most populous city in the state of California. According to the California Department of Finance, the City's population is estimated at 4.1 million as of January 1, 2010 (California Department of Finance, 2010).

The initial local cohort-component model results are derived using the base population of the City of Los Angeles from 2000 Census and the county specific demographic rates. Table 1 presents the comparison of the historical estimates of vital statistics and migration with projections for the period of 2000-2005 and 2005-2010. The historical estimates are derived from three major sources: zip code level births and deaths from California Department of Public Health (CA DPH), 2000 Decennial Census, 2006-2008 American Community Survey (ACS) 3 Year Estimates.

First, as Table 1 shows, the differences between the estimates and projections of the births of the City of Los Angeles are 4,434 (-7.8% of percent difference) for the period of 2000-2005 and 5,045 (-9.0% of percent difference) for the period of 2005-2008 (2010) (see Table 1). The annual average of three year births (2006-2008) from ACS supports the annual average of CA DPH zip code based city estimates between 2005 and 2008. The difference between CA DPH and ACS (2006-2008) is marginal. The sources of difference between the estimates and projections of the births of the City of Los Angeles might be related to the 2008 zip code to city correspondence table or the age-gender-ethnic birth rates for the County of Los Angeles.

The zip code level birth and death statistics were converted into births and deaths for the City of Los Angeles using the 2008 zip code to city correspondence table. This conversion process might result in estimate errors for measuring historical trends of births and deaths for the City of Los Angeles. First, since one zip code might be split into two or more local jurisdictions, a 2008 zip code to city correspondence table was prepared using the ratio of city land area to a zip code land area. The land area based correspondence table might produce an error because of lack of consideration of population and its demographic characteristics at the smaller zone. Second, zip code boundary is conveniently created, delineated, and annually updated by US Post Office for the purpose of efficiently delivering mail. Although 2008 zip code to city correspondence table might be acceptable for year 2008 statistics, it might not be applicable to other year statistics with the same degree of errors.

The age-gender-ethnic specific birth rates for the County of Los Angeles might not be 100% in sync with the age-gender-ethnic specific birth rates for the City of Los Angeles. Women of four race/ethnic groups (Non-Hispanic White, Non-Hispanic Black, Non-Hispanic Asian and Others, and Hispanic) with a different residence status (residents or immigrants) tend to show a different pattern of fertility behavior, and the county cohort-component model reflects the difference by using four racial/ethnic groups' women's fertility behavior. Given the increasing size of the more diversified ethnic population, the current level of categorization might not represent the actual fertility behavior of the population of the City of Los Angeles.

Second, the differences between the estimates and unadjusted projections of the deaths of the City of Los Angeles are 1,176 (-5.4% of percent difference) for the period of 2000-2005 and 1,811 (-8.5% of percent difference) for the period of 2005-2007 (2010). The percent difference for the death data is a little smaller than that for the birth data. As discussed in the birth estimates and projection, the sources of difference might be related to the 2008 zip code to city correspondence table or the age-gender-ethnic birth rates for the County of Los Angeles.

The major source of migration data at the local jurisdictional level is the 2000 Census and the recent ACS estimates. It is impossible to get annual migration estimates from the administrative records of governments. The 2000 Census provides two types of migration data (e.g., domestic inmigration from the city to city to the city between 1995 and 2000 and immigration between January 1990 and March 2000) useful to assess the reasonableness of migration data for the local cohort-component model. The domestic migration is collected for movers from the city to the city. The international migration covers only immigrants coming from other countries, and does not include emigrants leaving the city. International migration from the decennial census tends to underestimate the number of immigrants due to non-response of some immigrants or undercount of unauthorized immigrants.

ACS also collects the annual migration data including domestic inmigration and international migration. Although ACS collects immigration data comparable to the decennial census, domestic inmigration from ACS does not include movement of the city to the city. This study shows only the average number of people from other counties to the City of Los Angeles during the period of 2006-2008. The existing migration data from the decennial census or ACS, if available, is hard to be fairly compared with the projections of the migration in the local cohort-component model due to the different definition and coverage of migration data. The projected domestic migration represents the city to city movement, and the international migration reflects net international migration, which already accounted for emigration.

The county-age-racial/ethnic specific birth and survival rates were adjusted to reflect the estimates of births and deaths for the City of Los Angeles from CA DPH.

Table 1. Annual Average of Components of Population Change: Estimates vs. Projected (Unadjusted)

Components	Estimate		Projected (Unadjusted)		Difference (Actual-Projected)	% Difference
	Period	Number	Period	Number		
Births	95-00[1] 00-05[1] 05-08[1] 06-08[2] (age0-4)	60,989 57,094 55,882 55,054	 00-05 05-10	 61,528 60,927	 -4,434 -5,045	 -7.8% -9.0%
Deaths	95-00[3] 00-05[3] 05-07[3]	22,415 21,852 21,326	 00-05 05-10	 23,028 23,137	 -1,176 -1,811	 -5.4% -8.5%
Net Migration		N/A	00-05 05-10	10,878 -4,305		
Net Immigration		N/A	00-05 05-10	35,594 35,218		
Immigration	95-00[4] 06-08[2]	44,400 47,707				
Net Domestic Migration		N/A	00-05 05-10	-24,716 -39,523		
Domestic Inmigration	95-00[4] 06-08[2]	100,000 79,913	00-05 05-10	127,722 127,838		
Domestic Outmigration		N/A	00-05 05-10	152,439 167,361		

Sources: 1. State of California, Department of Public Health. 2009. Birth Profiles by Zip Code, 1989-2008. 2. US Census Bureau. 2009. 2006-2008 American Community Survey for 3-Year Estimates. 3. State of California, Department of Public Health. 2008. Number of Deaths by Zip Code of Decedent's Residence by Sex and Age of Decedent and Selected Leading Causes of Death, 1989-2007. 4. US Census Bureau, 2000 Census SF3.

Table 2. Annual Average of Components of Population Change, 2000-2005 & 2005-2010: Projected (Unadjusted) vs. Projected (Adjusted)

Components	Period	Projected (Unadjusted)[1]	Projected (Adjusted)[2]	Difference (Adjusted – Unadjusted)	% Difference
Births	00-05	61,528	57,354	-4,174	-6.8%
	05-10	60,927	56,571	-4,356	-7.1%
Deaths	00-05	23,028	21,821	-1,207	-5.2%
	05-10	23,137	21,372	-1,765	-7.6%
Net Migration	00-05	10,878	13,912	3,034	27.9%
	05-10	-4,305	-1,612	2,693	-62.6%
Net Immigration	00-05	35,594	35,594	0	0%
	05-10	35,218	35,218	0	0%
Net Domestic Migration	00-05	-24,716	-21,682	3,034	-12.3%
	05-10	-39,523	-36,839	2,684	-6.8%
Domestic Inmigration	00-05	127,722	129,790	2,068	1.6%
	05-10	127,838	129,810	1,972	1.5%
Domestic Outmigration	00-05	152,439	151,472	-967	-0.6%
	05-10	167,361	166,649	-712	-0.4%

Figure 2. Population Age Pyramid, 2010 & 2040: City of Los Angeles vs. County of Los Angeles

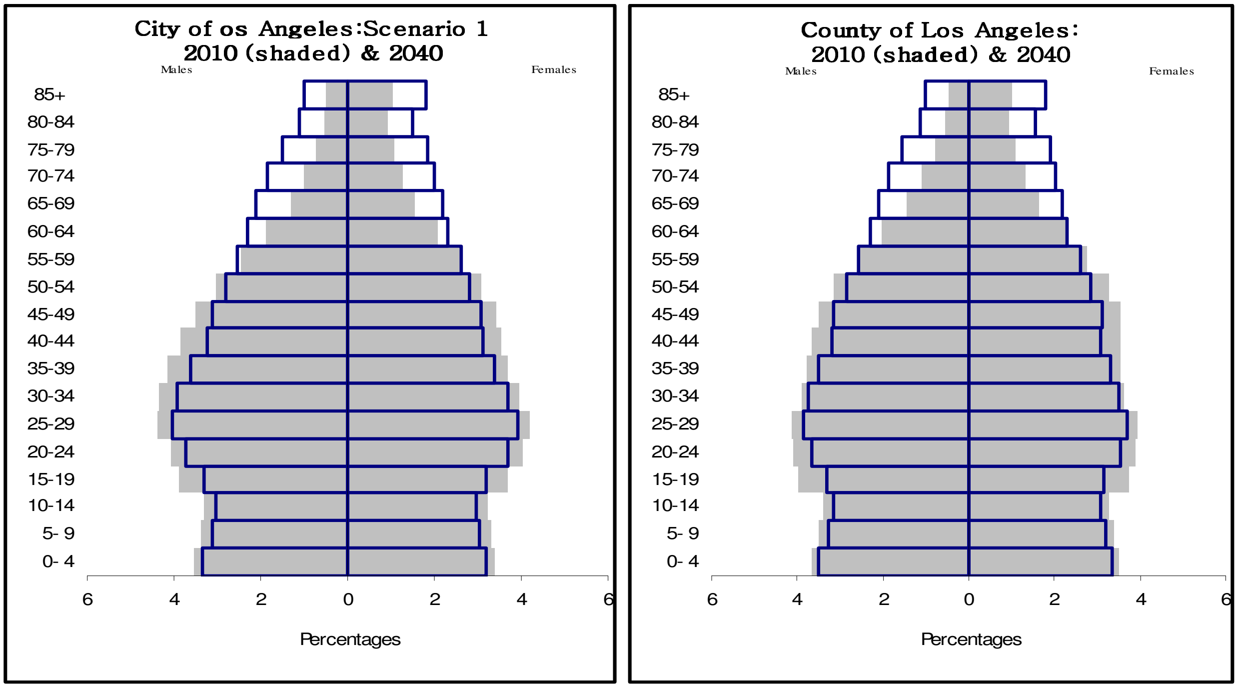


Table 3. Demographic Measures, 2010 & 2040: City of Los Angeles vs. County of Los Angeles

	City of Los Angeles: Scenario 1				County of Los Angeles			
	2010	2040	Difference (2010-2040)	% Difference	2010	2040	Difference (2010-2040)	% Difference
Population ('000), % Change (2010-2040)	4,115	4,519	404	10%	10,451	12,670	2,219	21%
Persons under 16 years old (%)	21.7	20.0	-1.7		22.3	20.9	-1.4	
Persons 16-64 years old (%)	68.4	63.1	-5.3		67.4	62.0	-5.3	
Persons 65 years old and over (%)	9.9	16.9	7.1		10.4	17.1	6.7	
Median age	33.3	36.3	3.0		33.6	36.4	2.8	
Total dependency ratio*	46.1	58.5	12.4		48.5	61.2	12.7	
Child dependency Ratio	31.7	31.7	0.0		33.1	33.6	0.5	
Old-Age dependency Ratio	14.4	26.8	12.4		15.4	27.5	12.2	
Births per 1,000 population (05-10, 35-40)	14.3	13.5	-0.9		14.7	14.2	-0.4	
Total fertility rate (per woman) (05-10,35-40)	1.78	1.82	0.0		1.93	1.99	0.1	
Deaths per 1,000 population (05-10,35-40)	5.4	6.1	0.7		6.0	6.5	0.6	
Natural increase (%) (2000-2010, 2010-2040)	84.9	238.4	153.5		104.4	122.7	18.4	
Net migration (%) (2000-2010, 2010-2040)	15.1	-138.4	-153.5		-4.4	-22.7	-18.4	
Non-Hispanic White persons (%)	27.3	17.1	-10.3		27.4	17.6	-9.8	
Non-Hispanic Black persons (%)	9.4	5.5	-3.9		8.4	5.4	-3.0	
Non-Hispanic Asian & Others (%)	14.7	19.8	5.1		16.1	18.9	2.9	
Hispanic persons (%)	48.6	57.6	9.0		48.0	58.0	10.0	
Households ('000), % Change (2010-2040)	1,356	1,512	156	11%	3,300	4,060	760	23%
Population** per household (PPH)	3.03	2.99	-0.04		3.17	3.12	-0.05	
Householders 65 years old and over (%)	16.1	26.4	10.3		16.6	26.8	10.2	

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

The preliminary results of the City of Los Angeles cohort-component model are presented using the major demographic measures (see Figure 2 & Table 3): age pyramid, age and ethnic composition, dependency ratio, vital statistics (births per 1000 population, deaths per 1000 population), components of growth (natural increase and net migration), % elderly households, etc. Scenario 1 is based on the slow housing growth of the City of Los Angeles between 2010 and 2040, and presents the potential implication of the slow housing growth on the demographic dynamics during the same period (see Table 3). The City's household growth (156,000) between 2010 and 2040 accounts for only 20% of the County level household growth (760,000) during the same period, while the city household growth represented almost 50% of the county level household growth between 2000 and 2010. According to Scenario 1, the City of Los Angeles will experience the change in the composition of age groups and race/ethnicity as a result of the increasing role of natural increase and domestic outmigration. The median age increases from 33.3 in 2010 to 36.3 in 2040 by 3 years. The working age population decreases from 68.4% in 2010 to 63.1% in 2040 by 5.3%. In particular, the share of the old age population (age 65+) dramatically increases its share from 9.9% in 2010 to 16.9% in 2040 by 7%. Old age householders also increase from 16.1% in 2010 to 26.4% in 2040 by 10.3%. As a result, total dependency ratio increases from 46.1% in 2010 to 58.5% in 2040 by 12.4%. The Hispanic and Asian population will increase from 63.3% in 2010 to 77.4% in 2040 by 14.1%, while the Non-Hispanic White and Black population will see their share decline from 36.7% in 2010 to 22.6% in 2040 by 14.1%. The preliminary model results for the City of Los Angeles population projections scenario 1 are generally consistent with the model results for the County of Los Angeles from the perspective of the directional change of demographic characteristics. The only major difference might be the different level of growth change during the projection period. The City of Los Angeles population grows only 10% between 2010 and 2040, and its growth level is half the growth rate (21%) of the County during the same period.

Figure 3. City of Los Angeles Population Age Pyramid, 2010 & 2040: Scenario 1 vs. Scenario 2

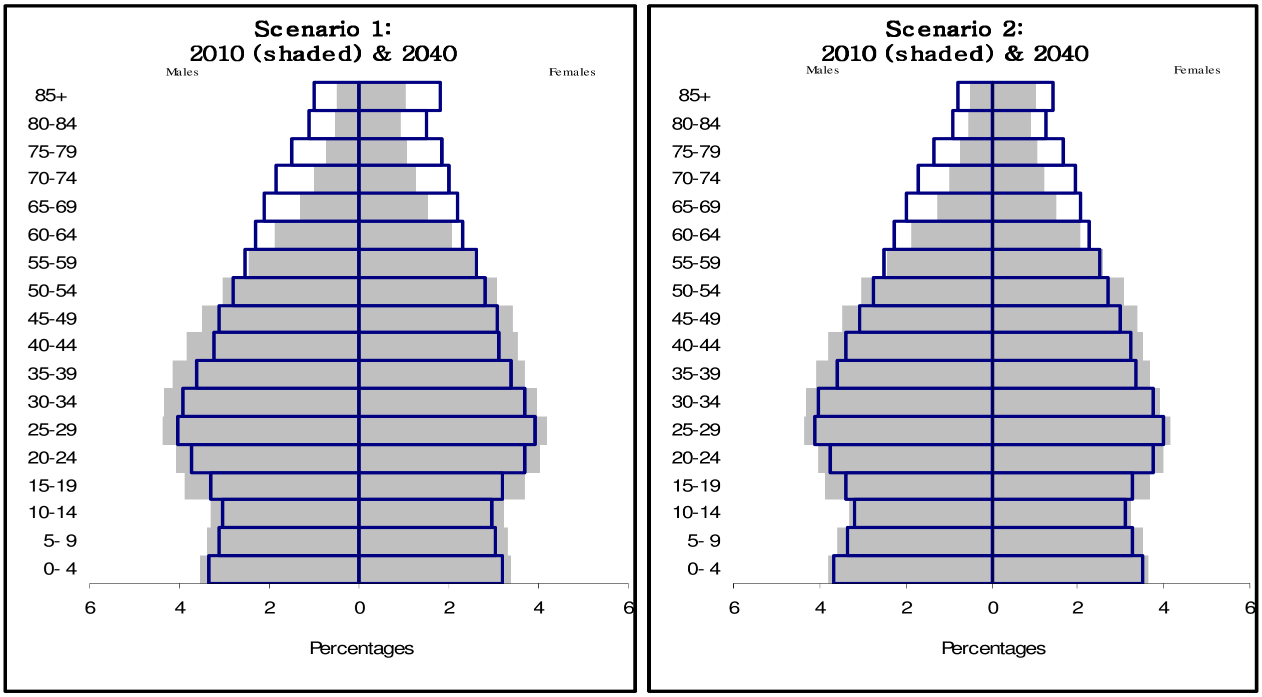


Table 4. City of Los Angeles Demographic Measures, 2010 & 2040: Scenario 1 vs. Scenario 2

		Scenario 1			Scenario 2		
	2010	2040	Difference (2010-2040)	% Difference	2040	Difference (2010-2040)	% Difference
Population ('000), % Change (2010-2040)	4,115	4,519	404	10%	5,399	1,284	31%
Persons under 16 years old (%)	21.7	20.0	-1.7		20.1	-1.6	
Persons 16-64 years old (%)	68.4	63.1	-5.3		63.7	-4.7	
Persons 65 years old and over (%)	9.9	16.9	7.1		16.2	6.3	
Median age	33.3	36.3	3.0		36.1	2.8	
Total dependency ratio*	46.1	58.5	12.4		56.9	10.8	
Child dependency Ratio	31.7	31.7	0.0		31.5	-0.2	
Old-Age dependency Ratio	14.4	26.8	12.4		25.4	11.0	
Births per 1,000 population (05-10, 35-40)	14.3	13.5	-0.9		13.8	-0.6	
Total fertility rate (per woman) (05-10,35-40)	1.78	1.82	0.0		1.80	0.0	
Deaths per 1,000 population (05-10,35-40)	5.4	6.1	0.7		5.8	0.4	
Natural increase (%) (2000-2010, 2010-2040)	84.9	238.4	153.5		87.3	2.3	
Net migration (%) (2000-2010, 2010-2040)	15.1	-138.4	-153.5		12.7	-2.3	
Non-Hispanic White persons (%)	27.3	17.1	-10.3		19.3	-8.1	
Non-Hispanic Black persons (%)	9.4	5.5	-3.9		5.7	-3.7	
Non-Hispanic Asian & Others (%)	14.7	19.8	5.1		19.8	5.1	
Hispanic persons (%)	48.6	57.6	9.0		55.2	6.7	
Households ('000), % Change (2010-2040)	1,356	1,512	156	11%	1,806	450	33%
Population** per household (PPH)	3.03	2.99	-0.04		2.99	-0.04	
Householders 65 years old and over (%)	16.1	26.4	10.3		25.3	9.2	

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

The preliminary results of the City of Los Angeles cohort-component model scenario 1 are compared with scenario 2 (see Figure 3 & Table 4). While scenario 1 was developed using the City's slow household growth (156,000) between 2010 and 2040, scenario 2 was developed to represent the fast household growth (450,000) during the same period. Although the city's slow housing growth scenario is justified by the limited availability of the new developable land, the City's fast housing growth scenario is also possible by the smart growth movement to expand the development capacity through infill process. The housing growth of scenario 2 will account for over 59% of the county level household growth between 2010 and 2040. The city's share (59%) of the projected county household growth slightly exceeds the historical city's share (50%) of the county household growth between 2000 and 2010. The fast household growth of the City of Los Angeles in scenario 2 results in a different role of natural increase and domestic outmigration. The domestic outmigration is reduced, while domestic inmigration is increased. The City of Los Angeles of scenario 2 will experience the change in the composition of age groups and race/ethnicity different from scenario 1. Compared with scenario 1, scenario 2 will have a lower median age (36.1), a higher share (63.7%) of the working age population, a lower share (16.2%) of the old age population, a lower share (25.3%) of the old age householders, a lower level (56.9%) of total dependency ratio, a lower share (75%) of Asian and Hispanic population, a higher share (23%) of Non Hispanic White and Black population. Scenario 2 shows a slower change of demographic dynamics than that of scenario 1.

Conclusion

This study presented a modeling framework for developing local level population projections including key demographic characteristics (e.g., age, sex, and race/ethnicity) in a regional forecasting context, and presented the modeling process and the preliminary model results. This study was able to combine two widely used techniques (cohort component model and housing unit method) to produce the consistent results.

Under the current forecasting framework, local population are projected using the housing unit method and there is no information of key demographic characteristics (age and race/ethnicity) of projected population available during the process of developing a regional plan. The historical trend of housing growth, the availability of the new developable land, the infill development potential linked to the local land use and growth policy tend to be a basis for additional housing growth for the local jurisdictions. There was no room for using the cohort component model due to the limited information of vital statistics and migration.

The new modeling framework is to use both the county specific demographic rates assumption from the county level cohort component model and total local population and household projections from the housing unit method. The modeling process presents consistent model results and the derived demographic characteristics are compatible to the county level demographic characteristics. The model also shows a certain level of sensitivity of demographic changes with different housing growth scenario.

The newly developed modeling framework for local population projections can be a useful scenario testing tool for urban and regional planners. The housing unit method offers urban and regional planners the opportunity to seriously discuss the different scenarios of housing development and population size together with their implication on the components and demographic characteristics of population growth.

The changing population characteristics including the source of population growth, its growing diversity and its heterogeneity might be considered important in formulating public policies on housing, transportation, community development, and environmental strategies, etc. With the aging of the baby boomer generation and increase of the minority population in local communities, the local jurisdictions will experience changing community service needs in the future. The community service needs will include services for poor people, school, housing, energy use, hospital, police, transportation, etc. The detailed information of the future population characteristics will help local jurisdictions to better prepare for those diverse community services needs

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