Washoe County Consensus Forecast

2010 - 2030

May 2010

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Thanks To

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Introduction

The consensus forecast for Washoe County uses a number of leading forecasts, which has several advantages over using a single source for forecasting population. Not only does the consensus approach minimize the risk of large forecast errors, but consensus forecasts consistently outperform individual forecasts across a range of variables. The consensus approach is discussed in further detail in the article titled "Consensus Forecasts in Planning," found in Appendix A.

Four reputable sources of long-term forecasts for Washoe County were used: Global Insight, a national forecasting firm in Massachusetts that prepares national, state and county forecasts; Woods and Poole, a national forecasting firm in Washington, DC, that forecasts for every county in the United States, as well as state and national forecasts; Truckee Meadows Water Authority's *Population and Employment Econometric Model*; and the 2008 Nevada State Demographer's Forecast (2010 forecast not available at date of publication).

The *Washoe County Consensus Forecast 2010-2030*, uses these sources and outlines the projected population, employment and income for Washoe County through the year 2030. The forecasts in this document are for all of Washoe County (Reno MSA) including both the cities of Reno and Sparks and the unincorporated areas of Washoe County, including Incline Village. A summary of the consensus forecast for Washoe County is shown in Table 1.

Table 1
Washoe County Consensus Forecast Summary

Year	Total Population	Total Establishment -Based Employment	Total Personal Income $ ('000)	Per Capita Income
2010 (Forecast Trend)	434,519	239,455	$17,421,365	$47,467
2015	472,718	261,641	$21,160,211	$57,366
2020	512,137	284,459	$25,969,219	$69,625
2025	551,012	307,643	$31,575,402	$84,353
2030	590,490	332,335	$38,429,313	$103,178

The population forecasts prepared by Global Insight, Truckee Meadows Water Authority, Woods and Poole, and the 2008 Nevada State Demographer's Forecast were compared for consistency and then averaged to arrive at a consensus number. When comparable numbers were not available from each of the four sources, only the numbers that were comparable were averaged. When less than four sources were used, it is noted in the text. Only Woods and Poole and Global Insight provided data for Total Establishment-Based Employment, Total Personal Income, and Per Capita Income. The 2010 population number in Table 1 is a trend line number from all four forecasts. This number differs from the Governor's Certified Annual Population Estimate, prepared each year by the State Demographer in cooperation with Washoe County.

Table 2
The 2008 Nevada State Demographer's Forecast of Washoe County Population
(2008 – 2030)*

Year	Population
2008	426,966
2009	436,776
2010	445,329
2011	453,875
2012	462,514
2013	471,132
2014	479,581
2015	487,936
2016	496,119
2017	503,940
2018	511,366
2019	518,351
2020	524,944
2021	531,204
2022	537,270
2023	543,087
2024	548,709
2025	554,134
2026	559,373
2027	564,448
2028	569,371
***2029**	**576,491**
***2030**	**583,612**

Source: Washoe County and Nevada State Demographer.

*Note: *The latest version (2009) of the Nevada State Demographer's Forecast is not available at time of printing. The number of new persons added for each year from 2008 to 2028 (142,405) was averaged over 20 years (7,120) and applied to this existing forecast in order to extend the population figures to 2029 and 2030.*

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Population

Total population in Washoe County is projected to grow from 434,519 in 2010 to 590,997 in 2030. This represents an average annual growth rate of 1.32 percent. The highest forecasted population for 2030 was 622,660 from Global Insight, and the lowest forecasted population was 570,511 from Truckee Meadows Water Authority (TMWA). The 2010 and 2030 forecasted population by each source is shown in Table 3.

Table 3
Population by Forecast Source

Forecast Source	**2010 Forecast Trend Line Population**	**2030 Population**
Global Insight	426,740	622,658
Truckee Meadows Water Authority (TMWA)	440,081	570,511
Woods and Poole	425,927	585,178
*2008 State Demographer's Forecast	445,329	583,612
Consensus Forecast (Four Sources)	**434,519**	***590,490***

Source: Washoe County, Global Insight, Woods and Poole, 2008 State Demographer's Forecast (Adjusted) and TMWA.

**Note: The latest version (2009) of the Nevada State Demographer's Forecast is not available at this time. The number of new persons added for each year 2008 to 2028 was averaged (7,120) and applied to this existing forecast in order to extend the population figures to 2030.*

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The consensus population forecast for each year is shown in Table 4.

Table 4
Washoe County Population (Draft Consensus Forecast), 2010 – 2030

Year	Population
2010	434,519
2011	442,076
2012	449,680
2013	457,288
2014	464,924
2015	472,718
2016	480,610
2017	488,592
2018	496,440
2019	504,353
2020	512,137
2021	519,974
2022	527,680
2023	535,538
2024	543,242
2025	551,012
2026	558,624
2027	566,359
2028	574,048
2029	582,266
2030	590,490

Source: Washoe County, Global Insight, Woods and Poole, TMWA, and 2008 State Demographer's Forecast.

**Note: The latest version (2009) of the Nevada State Demographer's Forecast is not available at this time. The number of new persons added for each year 2008 to 2028 was averaged (7,120) and applied to this existing forecast in order to extend the population figures to 2030.*

The age distribution of the population is expected to shift over the next two decades. Changes of note include the continued aging of the baby boomer population, a decrease in the working group (ages 20-64) and a marked increase in the retired group (ages 65 and older). Population by cohort data is available from Global Insight and Woods and Poole, however, this data is not available from TMWA or the 2008 State Demographer's Forecast. Population by 5-year Age Cohort for 2010 - 2030 is shown in Table 6 on page 6.

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Table 5
Population and Percent Composition of Total Population by Generalized Age Groups

Generalized Age Group	2010		2030	
	Population	Percent of Total	Population	Percent of Total
Preschool (Ages 0-4)	31,435	7%	45,000	7%
School (Ages 5-19)	85,269	20%	124,530	21%
Working (Ages 20-64)	258,520	61%	334,406	55%
Retired (Ages 65 and older)	51,110	12%	99,983	17%
Totals*	426,333	100%	603,918	100%

Source: Washoe County, Global Insight, and Woods and Poole.

Note: **Population by cohort is not available from Truckee Meadows Water Authority or the 2008 State Demographer's Forecast*

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Table 6
Consensus Population Forecast by 5-year Age Cohort, 2010 – 2030

Age	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
0-4	31,435	31,803	32,196	32,619	33,106	33,664	34,282	34,939	35,613	36,323	37,029
5-9	29,241	29,827	30,319	30,777	31,348	31,681	32,117	32,645	33,218	33,853	34,501
10-14	27,813	28,248	28,789	29,501	29,961	30,664	31,339	31,981	32,598	33,400	33,878
15-19	28,215	28,774	29,290	29,712	30,380	30,971	31,525	32,118	32,913	33,388	34,182
20-24	27,994	28,720	29,573	30,336	30,917	31,540	32,323	33,035	33,589	34,445	35,147
25-29	29,297	28,934	29,042	29,116	29,527	30,080	30,604	31,273	31,782	32,168	32,583
30-34	27,934	28,971	29,112	29,410	29,440	29,670	29,453	29,747	29,982	30,539	31,166
35-39	28,651	28,437	28,732	29,239	29,914	30,397	31,471	31,723	32,186	32,400	32,768
40-44	28,933	29,102	29,232	29,189	28,896	28,727	28,577	28,982	29,588	30,389	30,958
45-49	33,051	32,865	32,681	32,526	32,533	32,869	33,308	33,724	33,975	34,003	34,159
50-54	32,022	32,467	32,761	32,985	33,349	33,391	33,337	33,325	33,351	33,535	33,983
55-59	26,720	27,223	27,868	28,404	28,703	29,133	29,555	29,875	30,129	30,530	30,565
60-64	23,920	24,677	24,829	25,167	25,720	26,202	26,682	27,278	27,774	28,073	28,493
65-69	17,518	18,336	19,414	20,299	21,108	21,991	22,741	22,943	23,306	23,858	24,324
70-74	12,225	12,785	13,489	14,225	14,906	15,558	16,252	17,223	18,047	18,816	19,626
75+	21,367	22,030	22,844	23,721	24,679	25,647	26,672	27,918	29,177	30,438	31,745
Total	**426,333**	**433,195**	**440,168**	**447,222**	**454,483**	**462,182**	**470,235**	**478,724**	**487,225**	**496,153**	**505,104**

Age	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
0-4	37,775	38,533	39,338	40,125	40,945	41,754	42,585	43,379	44,187	45,000
5-9	35,188	35,864	36,565	37,267	37,993	38,722	39,509	40,265	41,016	41,783
10-14	34,467	35,100	35,799	36,524	37,278	38,030	38,810	39,538	40,272	41,016
15-19	34,960	35,691	36,430	37,357	37,931	38,597	39,365	40,117	40,909	41,732
20-24	35,814	36,486	37,386	37,881	38,805	39,674	40,546	41,357	42,381	42,987
25-29	33,196	33,727	34,139	34,802	35,292	35,686	36,014	36,785	37,080	37,848
30-34	31,710	32,369	32,869	33,208	33,590	34,149	34,656	35,174	35,994	36,620
35-39	32,678	33,066	33,421	34,053	34,756	35,355	36,062	36,744	37,281	37,891
40-44	32,124	32,402	32,943	33,172	33,576	33,486	33,892	34,369	35,116	35,921
45-49	34,362	35,107	36,098	37,265	38,239	39,792	40,554	41,306	41,798	42,468
50-54	34,514	34,971	35,294	35,361	35,593	35,837	36,702	37,530	38,557	39,344
55-59	30,482	30,382	30,322	30,373	30,679	31,013	31,303	31,354	31,152	31,095
60-64	28,921	29,244	29,533	29,938	30,011	29,953	29,921	29,869	29,942	30,233
65-69	24,769	25,295	25,752	25,998	26,374	26,733	27,012	27,251	27,626	27,661
70-74	20,332	20,545	20,928	21,464	21,918	22,336	22,845	23,288	23,540	23,912
75+	33,118	34,854	36,557	38,200	39,937	41,591	43,140	44,864	46,654	48,411
Total	**514,407**	**523,631**	**533,370**	**542,984**	**552,913**	**562,706**	**572,911**	**583,186**	**593,504**	**603,918**

Source: Washoe County, Global Insight and Woods and Poole.

Note: *Population by cohort is not available from Truckee Meadows Water Authority or 2008 State Demographer's Forecast, therefore the total population number is slightly higher than the Washoe County Consensus Forecast figures.*

Employment

According to the Woods and Poole forecast, employment for all of Washoe County is projected to grow from 281,090 in 2010 to 392,244 in 2030. This represents an average annual growth rate of 1.4 percent. The 2010 and 2030 forecasted employment and percent of total employment by industry group is shown below in Table 7. To allow for consistency within employment sectors, only employment data from the Woods and Poole forecast is used in this table as the methodologies of Woods and Poole and Global Insight use different employment assumptions.

Table 7
Employment and Percent Composition of Total
Establishment-Based Employment by Industry Group

Employment by Industry Group	2010		2030	
	Jobs	Percent of Total	Jobs	Percent of Total
Natural Resources	1,493	1%	1,469	<1%
Construction	20,500	7%	33,465	9%
Manufacturing	16,093	6%	17,333	4%
Transportation, Communication and Public Utilities	16,124	6%	20,337	5%
Wholesale Trade	11,593	4%	13,848	4%
Retail Trade	29,712	11%	40,991	10%
Finance, Insurance, & Real Estate	31,299	11%	48,572	12%
Services	123,219	44%	172,003	44%
Government	31,057	11%	42,196	11%
Totals	**281,090**	**100%**	**392,244**	**100%**

Source: Washoe County and Woods and Poole.

Note: The employment data include wage and salary workers, proprietors, private household employees, and miscellaneous workers of full and part-time jobs. Because part-time workers are included, a person holding two part-time jobs would be counted twice. Jobs are counted by place of work and not place of residence of the worker. Therefore, a job in the Reno Metropolitan Area is counted in Washoe County, regardless of where the worker resides. Due to rounding, the "Percent of Total" may not add up to 100%.

Industry sectors remain remarkably stable from 2010 to 2030. An increase is seen in Construction, up from 7% to 9%, while the Manufacturing sector suffers a slight decline, from 6% to 4%. The industries that represent the largest percentage of total employment in 2030 are Services, Finance, Insurance and Real Estate (FIRE), Retail Trade and Government. The largest numeric increase is in the Services sector, up 48,784 jobs.

The industries that represent the smallest percentage of total employment in 2030 are Natural Resources, Manufacturing, Wholesale Trade and Transportation, Communication and Public Utilities. The smallest numeric change is seen in the Natural Resources category (comprised of Mining, Agricultural Services, Other and Farm Based employment sectors) with a forecasted decrease of 24 jobs.

The consensus employment forecast by year is provided on the next page.

Table 8
Washoe County Establishment-Based Employment 2010 – 2030

Year	Employment
2010	239,455
2011	243,255
2012	248,180
2013	253,023
2014	257,374
2015	261,641
2016	266,052
2017	270,440
2018	274,887
2019	279,518
2020	284,459
2021	289,035
2022	293,606
2023	298,224
2024	302,913
2025	307,643
2026	312,351
2027	317,288
2028	322,273
2029	327,299
2030	332,335

Source: Washoe County, Woods and Poole and Global Insight.

Note: Total establishment-based employment is based on Global Insight and Woods and Poole forecasts. The Truckee Meadows Water Authority forecast and 2008 State Demographer's Forecast do not provide data regarding employment.

The methodologies for the employment forecasts for Global Insight and Woods and Poole are located in Appendices B and C.

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Income

Total personal income is expected to grow from $17,421,365 in 2010 to $38,429,315 in 2030. This represents the total personal income received by persons from wages and salaries, other labor income, and transfer payments less personal contributions for social insurance as adjusted for place of residence. All personal income data are presented in 2004 dollars. This is used to measure the “real” change in earnings and income when inflation is taken into account. The consensus forecast for total personal income for each year is shown in Table 9.

Table 9
Washoe County Total Personal Income, 2010 –2030

Year	Total Personal Income $ (‘000)
2010	17,421,365
2011	17,944,975
2012	18,680,875
2013	19,496,860
2014	20,331,125
2015	21,160,215
2016	22,033,795
2017	22,946,155
2018	23,908,740
2019	24,927,349
2020	25,969,220
2021	27,021,015
2022	28,087,440
2023	29,212,780
2024	30,345,845
2025	31,575,400
2026	32,829,675
2027	34,150.985
2028	35,525,900
2029	36,960,780
2030	38,429,315

Source: Washoe County, Global Insight and Woods and Poole.

Note: Total personal income is based on Global Insight and Woods and Poole forecasts. The Truckee Meadows Water Authority forecast and the 2008 State Demographer’s Forecast do not provide data regarding income.

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The consensus forecast for per capita personal income for each year is listed below:

Table 10
Washoe County Per Capita Personal Income, 2010 –2030

Year	Per Capita Personal Income
2010	47,469
2011	48,875
2012	50,824
2013	52,995
2014	55,231
2015	57,366
2016	59,595
2017	61,938
2018	64,396
2019	66,994
2020	69,624
2021	72,327
2022	75,105
2023	78,048
2024	81,082
2025	84,352
2026	87,751
2027	91,318
2028	95,103
2029	99,064
2030	103,177

Source: Washoe County, Global Insight and Woods and Poole.

Note: Total per capita personal income is based on Global Insight. and Woods and Poole forecasts. The Truckee Meadows Water Authority forecast and the 2008 State Demographer's Forecast do not provide data regarding income.

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Jurisdictional Splits

Reno, Sparks and Washoe County use the Governor's certified population estimates of 2008* as a starting point for determining jurisdictional forecasts for the year 2030.

Table 11
2008 Governor's Certified Population Estimates

Washoe County Total 2008	423,833
Reno City Total 2008	223,012
Sparks City Total 2008	91,684
Unincorporated Washoe County Total 2008	109,137

In 2008, each jurisdiction contained the following percent of total population:

Table 12
2008 Jurisdictional Percent of Total Population

Reno Percent of Total	52.6%
Sparks Percent of Total	21.6%
Unincorporated Washoe County Percent of Total	25.8%

An analysis of historic census and estimated population figures since 1980 shows these jurisdictional percentages have remained relatively stable over time, with little apparent impact attributable to previous regional plans (prior to the 2007 Truckee Meadows Regional Plan Update) or conforming jurisdiction master plans.

In this 2010 Consensus Forecast, there was a desire to reflect a potential impact of the 2007 Truckee Meadows Regional Plan on jurisdictional shares of population through the year 2030. The influence of plan policies on growth and development patterns, and the possible impacts on future settlement patterns are the subject of significant debate and reflect a different approach to forecasting in a multi-jurisdictional environment than forecasts based on a mere reflection and continuation of historic trends. While all forecasts reflect inherent uncertainties, especially in regions with highly variable decadal growth rates, forecasts associated with regional plan policies can provide a useful guide, over time, as to the effectiveness and need for amendment of such growth policies.

The year 2030 Washoe County Consensus Forecast of 590,490 persons exceeds the 2008 Governor's certified estimate of 423,833 by a growth increment of 174,365 persons.

Reno, Sparks and Washoe County have decided to allocate the growth increment of 166,657 persons in the following manner:

Table 13
Growth Increment Allocation

25% of Growth Increment (41,664 persons) at Year 2030	Allocate to Centers, TOD Corridors, Emerging Employment Centers in Reno and Sparks
75% of Growth Increment (124,993 persons) at Year 2030	Allocate based on adjusted jurisdictional shares of population of 50% City of Reno, 24% City of Sparks and 26% Unincorporated Washoe County.

**Note:* *Cooperatively, Washoe County and the Nevada State Demographer prepare annual population estimates for Washoe County for July 1 of each year.*

The approach that allocates 25% of the growth increment to Centers, TOD Corridors and Emerging Employment Centers recognizes that the 2007 Regional Plan policies have increasing impact over time. Thus, the growth increment attributed to these policies increases from 2010 to 2030 in a linear fashion. Interpolation of jurisdictional population forecasts from 2010 to 2030 is the responsibility of each jurisdiction and is addressed in local population master plan elements, if desired. This consensus forecast establishes only the beginning (2008 certified estimates) and end points (allocated 2030 consensus forecast by jurisdiction) of that forecast series for each jurisdiction through the year 2030.

Analysis of the 25% population increment (41,664 persons) allocated to each jurisdiction's Centers, TOD Corridors and Emerging Employment Centers (EECs) yielded the following assumptions based on corridor, center and emerging employment center land areas and density assumptions:

- 21.3% of the increment will be allocated to the City of Reno (35,497 persons);
- 3.7% of the increment will be allocated to the City of Sparks (6,167 persons).

While the City of Sparks has major emerging employment centers in its jurisdiction, it is recognized that these EECs have lower densities than centers and corridors and that these EECs are located in or near to Sparks' traditional growth areas. Spark's EECs, however, are extremely important to jobs-housing balance and trip reduction policies.

In the near future, Washoe County is expected to designate at least one Secondary Transit Corridor and to designate Infill Opportunity Areas under the policies of the 2007 Regional Plan. Under the forecast approach of the Consensus Forecast, Washoe County may analyze the impact of these designations and include any appropriate and related population shares in its Population Element to be submitted to the Regional Planning Agency.

Allocation of the remaining (non-centers, corridors and EEC) growth increment (75% or 124,993 persons) to the jurisdictions is based upon a minor modification of the historic jurisdictional distribution of population, as follows:

Table 14
2030 Jurisdictional Distribution of Population (of remaining growth increment)

City of Reno Year 2030 Allocation	50%	62,497 persons
City of Sparks Year 2030 Allocation	24%	29,998 persons
Unincorporated Washoe County Year 2030 Allocation	26%	32,498 persons

Table 15
Year 2030 Total Jurisdiction Forecasts

Jurisdiction	2008 Certified Estimates	Centers, Corridors and EEC Increment	Remaining Increment	2030 Jurisdiction Forecast
Reno	223,012	35,497	62,497	321,006
Sparks	91,684	6,167	29,998	127,849
Unincorporated Washoe County	109,137	N/A	32,498	141,635
Total County	423,833	41,664	124,993	590,490

Appendix A

Consensus Forecasts in Planning

By Michael R. Sykes*

Externally produced macroeconomic forecasts are frequently used as an input to the planning process, often to provide the broad framework within which more specific questions can be addressed. However, the quality of the output is partially dependent on the quality of the macroeconomic inputs chosen. A consensus forecast aggregates the views of a number of leading macroeconomic forecasters who use different approaches and attach different weights to the importance of the various factors that impact the economy. Research suggests that few, if any, individual forecasters consistently outperform the consensus across a range of variables, although some forecasters may perform well for some individual series. Studies also suggest that the use of a consensus minimizes the risk of large forecast errors, which has obvious benefits for firms operating in sectors of the economy particularly sensitive to swings in overall economic activity. The consensus approach allows the user to examine the range or distribution of forecasts, and also permits comparison of individual forecasts, whether produced by external advisers or internal analysts, with the mainstream view.

MACROECONOMISTS generally summarize the economic outlook by producing projections for a handful of very broad aggregate indicators. On their own, these projections represent only a general template for planners looking at the outlook for a (comparatively) narrowly defined sector of the economy. But as most corporate and strategic planners know, in many industries macro forecasts are regularly used as inputs to the planning process, often to establish a starting point or a broad framework of assumptions within which the more specific problems under consideration can be examined.

For many businesses, product demand in a given market that is sensitive to the strength of economic activity may be well correlated with the behaviour of one or more broad macroeconomic indicators. For example, demand for semiconductor chips in many markets has historically been relatively well correlated with growth in overall industrial production, which is therefore often considered by sector analysts as the best indicator to use in predicting future chip demand. One major industrial company also focuses on expected industrial production growth in various (mainly European) markets, as an indicator of future demand for ball bearings and other products widely used in the industrial production processes.

Obviously, obtaining a reliable set of forecasts for a macroeconomic variable in various countries or markets is far from being the whole story: the relationship between industrial production and demand for computer chips may vary quite widely across markets, depending, for example, on the level of technology employed. Information or knowledge that is more specific to the industry, or to the past experience of the individual firm, also will be necessary. Thus, extrapolating historical relationships between demand for a product and a macroeconomic indicator is a widely used approach but is dependent upon the quality of both the interpretation of events and the macro benchmark forecasts used.

THE ECONOMIC CYCLE

In the short term, predictions of the timing of turning points in the economic cycle also can be invaluable in reaching decisions on production, inventory and manning levels, marketing strategies

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and pricing. In the trough of an economic cycle, weak demand is likely to mean that producers are facing strong competition for the few available orders, are running plant at well below full capacity and have cut inventory and manning levels. In spite of the rising unit labour costs that usually accompany a downturn in output, producers may be under considerable pressure either to cut prices or to offer significant discounts, and profit margins are inevitably squeezed. The question of whether to cut employment further in order to reduce costs, or possibly to close or scrap plant, will depend to a considerable extent on when and from what level the economy is expected to begin recovering. Producers will not wish to find themselves having cut capacity and employment as the economy is about to turn up, and also will wish to be well positioned from a marketing standpoint as demand begins to revive.

The economic cycle in different industrial sectors is frequently out of phase with that of the economy overall, however. In many countries, for example, construction sector activity turns down ahead of demand in the economy as a whole and often leads the revival. Producers of construction-related materials and equipment therefore also will feel the effects of a downturn and the subsequent revival relatively early. On the other hand, business investment often responds more slowly to a recovery in overall output, as producers first take up the excess capacity resulting from recession before investing in new plant. But even so, in examining either the short-term influence of economic cycles or the longer-term outlook, once a general relationship between demand for a particular product and a broad indicator of total output (such as gross domestic product [GDP] or industrial production) has been established, macroeconomic forecasts adjusted for leads or lags can be used to "drive" a more specific model of demand for the individual sector or product.

CROSS COUNTRY COMPARISONS

Over a longer time horizon, the expected *relative* performance of various economic indicators in different countries can be a useful guide in reaching decisions about the location of production units, distribution networks and marketing investment. Equally, expected developments in relative wage costs and inflation rates may have a significant bearing on investment or other location decisions. One of the problems here is likely to lie in finding forecasts for all the individual countries under consideration that have been produced on as simultaneous and consistent a basis as possible.

CHANGING EXPECTATIONS

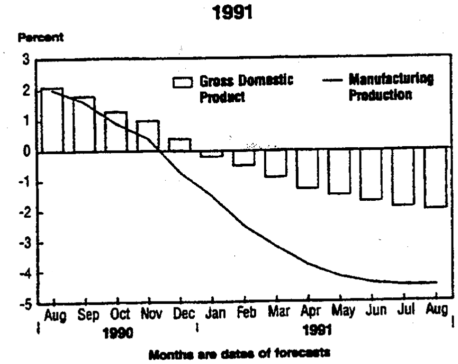
Expectations regarding future trends in output, inflation or other macro variables can change quite rapidly over time, suggesting that forecasts for demand growth in different countries made even a few months apart might provide misleading comparisons. The outbreak of the Gulf crisis in August 1990, for example, marked the beginning of a nine-month period during which 1991 growth forecasts for most economies were revised sharply and continuously downwards. In the United Kingdom, where the gathering gloom was compounded by the realization that tight monetary policy was finally beginning to bite, the deterioration in the consensus outlook for GDP growth and Manufacturing Production was particularly severe (see Figure 1).

Such rapid shifts in expectations can obviously pose problems for companies where the planning cycle involves relatively infrequent reviews of the forecasts underlying the plan. A company conducting an annual forecast review for the United States in August 1990, for example, would, by the beginning of 1991, have found itself with a plan based on assumed GNP growth for 1991 of 2 percent. In the meantime, however, the average independent growth forecast had deteriorated to the point where the economy was expected to contract by around 0.3 percent. Changes in expectations of this magnitude, and wars in the Gulf, are thankfully relatively rare occurrences, but even under more normal circumstances, expectations can shift quite rapidly over a few months. Since the beginning of 1992, for example, consensus forecasts for growth in Japanese industrial production have declined

Figure I

Consensus Forecasts for U.K. Growth

1991



from an average of +1.3 percent to the −3.0 percent now being predicted (early June 1992). Such developments highlight the need for a reliable stream of regularly updated forecasts and the close monitoring of shifts in expectations. In such circumstances a flexible approach to reviewing established plans outside the normal six months or one year cycle and a willingness on the part of business economists to raise the red flag are clearly important. It should at least be possible to draw the attention of others involved in later stages of the planning process to such developments, even if a full scale review is impractical. In view of the difficulties that may be involved in disrupting the planning process in this way, however, it is important that the forecasts used to trigger such changes derive from a consistent and credible source. The choice of this source is therefore an important decision.

THE FORECAST SOURCE

The choice of forecast source is complicated by the large number and wide diversity of economic forecasting operations. These may be large international consultancy-type firms specializing in economic forecasting and analysis, government or semigovernment institutions such as the OECD, university research units, divisions of major banks or securities firms, or the in-house economic units of large industrial companies. Our company surveys over 180 economic forecasters based in the G-7 countries and Australia every month (of which about 25 are in the United States), and this is by no means an exhaustive list of the available sources. Blue Chip Economic Indicators covers about 50 U.S. forecasters in its principal American panel.

Comparing forecasters' track records is made more complicated by the fact that forecast errors vary in type and can have different consequences for the forecast user. For example, forecasters may correctly predict the direction of change in a series, but get the magnitude wrong (under or overpredicting investment growth, for example). This kind of forecasting error is, however, probably less damaging to the forecast user than a prediction that gets the direction of change wrong (forecasting a rise when the series in fact falls). From the users' point of view, a forecaster who accurately predicts trends but fails to spot turning points may well deserve a lower rating than another who correctly predicts turning points but has a poorer track record at other times. More generally, a good track record does not guarantee consistent success. The fact that a forecaster performed well in predicting economic developments for one or two years does not mean that he or she will continue to do so. Indeed, some of the more recent evidence from studies of forecasting accuracy (reviewed below) indicates that past success is no guarantee of future accuracy. The problem is compounded when forecasts for a range of different variables are considered. One forecaster may have a better track record on production growth, but a poor record on inflation. These results might be combined or weighted in some way, but how is a percentage error in forecasting inflation to be rated vis-a-vis an absolute error in volume terms in a forecast for housing starts, for example? The relative importance of the different variables will vary from user to user.

THE CONSENSUS APPROACH

All of this suggests that successfully differentiating among the large number of different forecasts available is a complex and challenging task. One possible solution to this problem of "picking winners" is to use aggregated or consensus forecasts, combining the predictions of a number of different forecasters into a single, mean forecast. The idea of using consensus projections is fairly well established in a number of countries, notably in the United States, where surveys of forecasters have been running for some time. Aside from reducing some of the problems of choice and weighting discussed above, the use of a consensus projection also appeals to many users because it does not rest on one particular view of the way an economy functions, but attempts to capture the information implicit in a range of forecasts. The results of these surveys have also attracted a good deal of academic interest and analysis, and several studies of the merits of consensus forecasting as an approach have been conducted.

Much of this work has concentrated on forecasts produced by various time series methods of extrapolation for individual series, although there have also been other studies comparing econometric and/or judgmental forecasts with the consensus. Most of these studies are based on data for the United States, where a long run of consistent back data is available from the surveys published in Blue Chip Economic Indicators over the past fourteen years.

As regards the accuracy of the consensus, the verdict of most of the academic work in this area has generally been favourable. In his study covering forecasts for seven variables made by twenty-two forecasters over nine years (1978 through 1986) Stephen McNees[1] concluded that "only four of the twenty-two individual forecasters were more accurate than the consensus in more than half their forecasts." For all seven variables weighted equally,

[1]See footnote at end of text.

the consensus forecasts ranked 6 (out of 23, including the consensus) on the basis of the RMSE (root mean squared error) criterion.

In addition, McNees noted that:

> "For any particular variable, the Blue Chip consensus was more accurate than most individual forecasters but less accurate than a minority of varying size depending on the predicted variable . . . Every forecaster, [except one], was more accurate than the consensus for at least one variable but none of the forecasters outperformed the consensus for all seven variables."[2]

Another study[3] comparing seventy-nine individual forecasts of six macroeconomic variables with the group mean found that, on average, the consensus was more accurate than around three-quarters of the individual forecasts, although again this proportion varied depending on the variable considered. On the basis of this evidence, which is broadly consistent with our own experience, it seems reasonable to assume that for some variables some of the individual forecasts making up the consensus will prove to be more accurate than the group mean when the results become known. However, the problem for a user of external forecasts remains how to determine *in advance* which individual forecasters will be more accurate. This would be a relatively simple task if some forecasters were clearly superior to the others and consistently achieved better results.

In fact, the evidence on this question is rather mixed. Victor Zarnowitz[4] examined forecasts submitted to the survey conducted by the American Statistical Association (ASA) and the National Bureau of Economic Research (NBER) from 1968 to 1979, and concluded (by comparing rank correlations of relative RMSEs across variables and forecast horizons) that "a small number of the more regular participants in the ASA-NBER surveys did perform better in most respects than the composite forecasts from the same surveys."

On the other hand a later analysis conducted by Roy Batchelor of the City University Business School[5] in London concluded that there were "no significant differences in the accuracy rankings of individual forecasters." This conclusion supports the argument that, without the benefit of hindsight, it is extremely difficult to pick out an individual forecaster who is likely to outperform the consensus across a range of variables and time horizons. As noted above, however, for certain variables considered in isolation the evidence does suggest that selected forecasters can perform consistently well.

THE MARKET FOR FORECASTS

There are a number of problems involved with the use of consensus forecasts. One is the choice of which forecasters to include in the consensus. However, given the competitive nature of the forecasting business (large numbers of suppliers, fairly standardized products, very low or nonexistent barriers to entry, etc.) inaccurate forecasters, or those lacking professional credentials, might be expected to be driven out of business, leaving a group of forecasters producing work of a similar quality. This is supported by the Batchelor study, which finds no evidence of significant differences in forecasters' track records. In a separate study,[6] Batchelor also finds that, perhaps because of this high level of competition in the forecasting business, some forecasters may attempt to differentiate their work by deliberately adopting a stance that is either pessimistic or optimistic in relation to their peers. Far from moving towards the consensus, some forecasters display "variety seeking" behaviour and attempt to distance themselves from the middle ground to some extent. Those that are determinedly optimistic year after year will almost certainly, at some stage, be proved correct when the outcome is better than the consensus predicted. Intuitively, this also ties in with the results showing that few forecasters beat the consensus consistently; neither the optimists nor the pessimists can always be right. This kind of behaviour probably reflects the fact that forecasts, like other types of information, are themselves a marketable commodity. From some perspectives, the middle ground may appear less valuable or interesting and thus more difficult to sell commercially. Thus accuracy may not always be the only consideration for the forecast producer, given that he is operating in a competitive market.

This leads to another caveat regarding the interpretation of consensus projections. The range or spread of different forecasts, which is often measured by the standard deviation of the sample, is frequently used as a measure of the "risk" or uncertainty attached to a consensus forecast. Clustering around the mean might, however, produce a range of forecasts that considerably understates the wide dispersion of likely outcomes, with the result that the deviation in the sample is considerably lower than the "risk" inherent in the forecast. This is reflected in the fact that the actual outcome for a particular variable is frequently outside the range of forecasts. In our experience, we have noted that the dispersion of forecasts may also vary widely from country to country. For example, the forecasts for the French economy produced (on a monthly basis) by a group of around sixteen French-based forecasters over the past two years have typically been much more closely grouped around the mean than those produced by a similar group of United States forecasters looking at the American economy. This may reflect structural differences between the two economies (the French economy may be more predictable, for example) or it may reflect more widespread attempts at product differentiation in the U.S. forecasting industry. So caution should be exercised when using forecast ranges to assess the uncertainty attached to the consensus. As always with a table of comparative forecasts, moreover, the astute analyst will endeavour to look past the numbers at the reasoning that lies behind them.

FOOTNOTES

[1]Stephen McNees, "The Tyranny of the Majority," New England Economic Review, Federal Reserve Bank of Boston, Nov/Dec 1987.

[2]Ibid.

[3]Victor Zarnowitz, "The Accuracy of Individual and Group Forecasts from Business Outlook Surveys," Journal of Forecasting, Vol 3 (Jan-March 1984).

[4]Ibid, pp. 23-24.

[5]Roy A. Batchelor, "All Forecasters Are Equal," Journal of Business and Economic Statistics, 1990.

[6]Roy Batchelor and Pami Dua "Conservatism and Consensus-Seeking Among Economic Forecasters," Paper presented to the Ninth International Symposium on Forecasting, Vancouver, June 1989.

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Appendix B

Global Insight Background Data

October 2009
Long-Range Forecast
Prepared by IHS GLOBAL INSIGHT

Washoe County, NV

PREFACE

This analysis accompanies a forecast prepared by IHS GLOBAL INSIGHT for the Washoe County Office of the County Manager. The forecast pertains to Washoe County, which comprises the cities of Reno and Sparks and the unincorporated remainder of the county. Some sections of this document will refer to the Reno-Sparks Metropolitan area, using it as an approximation of activity in Washoe County. These sections will be clearly marked using the notation Reno MSA.

RECENT PERFORMANCE

Washoe County continues to slow due to the impact of a weaker housing and construction market. Steady growth in the service sectors is being offset by declines in construction.

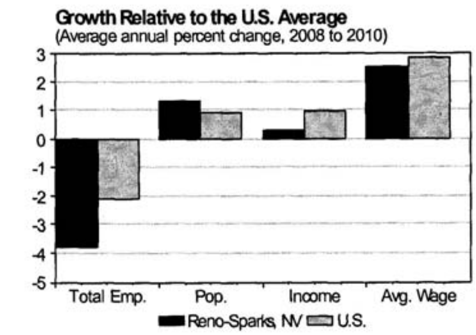
In 2008, Washoe County registered an employment decline of 4.5% year-over-year (y/y), and this year has not been kind either. The Reno metropolitan area, of which Washoe County is a part, posted a y/y decline of 8.4% in August 2009, continuing a trend of job losses that began in late 2007. The construction sector continues to see significant y/y declines due to the bust in the housing markets and the foreclosure crisis that has impacted nearly all areas of the nation. The unemployment rate in the metro area increased quite significantly to 13.8% in August, from 12.1% in the previous month; this was nearly double the 7.4% rate posted just a year ago in August 2008.

- **Personal Income:** Personal income in Washoe County increased by 5.0% in 2007, according to the Bureau of Economic Analysis, the latest data available. It is expected to increase at a much slower pace in 2008, and to fall in 2009 due to recessionary conditions, according to IHS Global Insight analysis.

- **Housing:** The combined construction and mining employment sector in Washoe County declined at a rate of 21.2% y/y in 2008, losing more than 4,000 jobs. Between August 2008 and August 2009, the Reno MSA saw a drop of more than 5,000 jobs (or 33.6% y/y), which suggests a slowing of the rate of decline, but still a negative trend. Employment in this sector has been declining since the end of 2006, and job levels are now more than 50% below their peak in early 2006, at levels not seen since early 1995. Through August 2009, the number of permits issued year to date in the Reno MSA was 57% lower than in the same period in 2008. In the second quarter of 2009, housing starts in the Reno MSA were down by 72.4% from one year earlier, according to IHS Global Insight.

- **Services:** Leisure and hospitality employment, which includes accommodations and eating and drinking establishments, is the second largest employment sector in Washoe County and in the Reno MSA, accounting for close to 18% of total employment. This sector saw employment growth decline from 2001 through to its lowest point in 2005. Thereafter, a strong national economy helped growth turn positive, and it remained strong through 2007, before turning down again beginning in 2008. In the Reno MSA, employment in leisure and hospitality declined by 4,600 jobs y/y in August 2009. Losses in this sector are a direct result of weaker economic conditions and restrained consumer spending. The professional and business services sector has also been hit by the weak economy, after having been the strong point in the economy for several years The education and health services sector, accounting for 10.0% of total employment, was the last of the employment sectors to be pulled down by the recession, declining by 1.6% in August. This sector was the last to lose jobs, as there is still a demand to meet the medical and educational needs of the metro area.

- **Trade, Transportation, and Utilities:** This sector, which is the largest in the Washoe County economy (at 22% of employment), was healthy through 2007, but posted a decline of 2.1% in 2008. Things have gotten worse this year; in the Reno MSA, this sector registered an August decline of 3.1% y/y.
- **Manufacturing:** This sector accounts for 6.5% of total employment in Washoe County, and had flat to positive growth between 2003 and 2007 – indeed, the Reno MSA is one of the few metro areas in the nation that did not see significant declines in manufacturing through the early years of this decade, slowing only during 2002. Employment levels increased each year through 2007, but then in 2008 felt the impacts of the recession, leading to a loss in payrolls that year. Declines in the Reno MSA have continued into 2009, and August saw a y/y loss of 1,300 jobs, the largest since the sector began its decline in 2008.



The local gaming market needs to invest in upgrades and expansions in order to remain competitive with the Las Vegas and California tribal gaming.

As mentioned above, leisure and hospitality employment is the second-largest sector in the Reno MSA, accounting for 18% of all jobs. This sector was dealt some major blows early in the decade, with the events of September 11, 2001, which affected tourism nationwide, and the increase in tribal gaming across the border in California. Both served to reduce tourism to the metro area. The area recovered, however, and through 2006 saw growth in gaming revenue. The numbers for 2007 and 2008 were down as the state and national economies began to contract and consumers pulled back their spending on non-essential things like travel. For the calendar year 2009, gaming win is down by 13.5% through the end of June, a decline that is close to that for the state as a whole.

It has been noted that for Reno to keep up, many of its properties will need to invest in upgrades and expansions in order to remain competitive.

The Legends at Sparks Marina development began opening stores late in 2008, and celebrated the opening of Phase I of the project in mid-2009. Future phases of the project include an arena, an upscale casino resort, and other entertainment and dining venues. Olympia Gaming, owner of the Casino Fandango located in Carson City, and Red Development are the project owners.

The Burning Man Festival, held annually in the Black Rock Desert, received a five-year permit from the Bureau of Land Management, keeping the festival going until at least 2010. The festival brings nearly 40,000 attendees to the area.

DEMOGRAPHICS AND LABOR FORCE

Population continues to grow in Washoe County, adding to the available pool of workers. As the population ages, this continued growth will keep a viable workforce.

The Census Bureau estimated Washoe County's population on July 1, 2008 to be 410,443 residents, up from the estimate for July 1, 2007 of 404,710 persons, confirming that population in the county continues to grow. The annual population growth rate between 2007 and 2008 was 1.4%, ranking 6th out of the counties in the state. Growth rates in the Las Vegas metro area, Nevada, and the United States over the same period were 2.1%, 1.8%, and 0.9%, respectively.

Recently released population data from the Census Bureau on cities and towns in the United States show that the city of Reno's population increased over the year by 2,854 to reach a total of 217,016 as of July 1, 2008 – a growth rate of 1.3%. Since April 1, 2000, the city of Reno has seen population growth of 18.4%, which places it 47th out of 273 areas with populations of more than 100,000. For the period between April 1, 2000 and July 1, 2008, North Las Vegas City saw an increase in population of 88.0% and Henderson City saw an increase of 43.8%, ranking them 3rd and 14th in the nation. The Las Vegas MSA was ranked 54th, with population growth of 16.3%. When looking at all incorporated cities in the state of Nevada, North Las Vegas City was the fastest growing over the eight-year period, with growth of 88.0%. Sparks posted growth of 33.5% since April 1, 2000 and increased by 2.0% between 2007 and 2008.

The total number of households in Washoe County, a primary indicator of growing demand for housing units, infrastructure, and government services, rose from 132,084 in 2000 to 155,857 in 2008 (American Community Survey data). Average household size in Washoe County increased slightly from 2.53 persons in 2000 to 2.59 persons in 2008. In 2000, 70.9% of the population were 21 years and older, while 10.5% were 65 years and older; by 2008, these proportions had risen to 71.3% and 11.9%, respectively.

Washoe County's population density increased from 53.5 persons per square mile in 2000 to 64.7 persons per square mile in 2008. By comparison, Nevada's population density in 2008 was only 23.7 persons per square mile, while the U.S. figure was 86.0 persons per square mile.

In the Reno MSA, the seasonally adjusted unemployment rate was 13.8% in August 2009; by comparison, the rates for Nevada and the United States were 13.2% and 9.7%, respectively, in August. Reno's unemployment rate has risen more quickly as a result of weaker economic conditions.

Fueled by strong population growth, the Reno MSA's total labor force has seen continued growth. The metro area labor force reached a total of 230,027 persons in August 2009, an increase of 0.4% from August 2008. Looking at the annual rates, labor force growth has been cyclical through this decade. Early on, growth slowed with the attacks in 2001, and then picked up, reaching 3.2% in 2006. Growth has since slowed again with 2008 showing an increase of 2.0%, and year-to-date through August 2009, the numbers are showing an increase of 0.5%.

INCOME AND WAGES

Per Capita income in the Reno MSA continues to be among the tops in the nation.

According to the Bureau of Economic Analysis, in 2008 per capita personal income in the Reno MSA was $45,424, the 29th highest in the United States, and well above the Nevada and U.S. figures of $41,182 and $39,582, respectively. The Reno MSA's 2008 per capita personal income was up 0.2% over 2007, compared to increases of 0.1% in Nevada and 2.5% for the United States. The weakness in per capita personal income growth can be attributed to the lag in the local economy as it weathers the current downturn. According to the BLS, in the first quarter of 2009, the average weekly wage in Washoe County was $785, down 1.4% from first quarter 2008, and ranking 206 among 335 of the largest counties. The average weekly wage in Clark County (Las Vegas) was higher, at $814, while the figure for the United States was $882.

The State of Nevada has released the following average weekly wage data for industries in Washoe County and Nevada for 2008:

Average Weekly Wages, Annual 2008

Sector	Washoe County	Nevada
Natural Resources and Mining	$1,194	$1,333
Construction	955	1,108
Manufacturing	1,037	956
Trade, Trans, & Utilities	720	708
Information	973	1,014
Financial Activities	1,005	944
Professional & Business Svcs	967	1,019
Education & Health Services	939	893
Leisure & Hospitality	429	577
Other Services	599	603
Public Administration	1,124	1,138
Total, All Industries	811	827

ECONOMIC STRUCTURE

Washoe County's 20 largest employers are listed below (as reported by the state of Nevada for the first quarter of 2009).

- Washoe County School District, elementary and secondary schools, 8,500 to 8,999 employees
- University of Nevada-Reno, colleges and universities, 4,000 to 4,499 employees
- Washoe County Comptroller, executive and legislative combined, 2,500 to 2,999 employees
- International Game and Technology, misc. manufacturing, 2,500 to 2,999 employees

- Renown Regional Medical Center, general medical and surgical hospitals, 2,000 to 2,499 employees
- Peppermill Hotel and Casino, casino hotels, 2,000 to 2,499 employees
- Silver Legacy Resort, casino hotels, 1,500 to 1,999 employees
- City of Reno, executive and legislative combined, 1,500 to 1,999 employees
- St. Mary's Hospitals, general medical and surgical hospitals, 1,500 to 1,999 employees
- Atlantis Casino Resort, casino hotels, 1,500 to 1,999 employees
- Grand Sierra Resort and Casino, casino hotels, 1,000 to 1,499 employees
- Eldorado Hotel and Casino, casino hotels, 1,000 to 1,499 employees
- Sparks Nugget, casino hotels, 1,000 to 1,499 employees
- Circus Circus Casinos - Reno, casino hotels, 1,000 to 1,499 employees
- Harrah's Reno, casino hotels, 1,000 to 1,499 employees
- Veteran's Administration Hospital, general medical and surgical hospitals, 1,000 to 1,499 employees
- Truckee Meadows Community College, junior colleges, 1,000 to 1,499 employees
- United Parcel Service, couriers, 1,000 to 1,499 employees
- Hire Dynamics, LLC, Temporary Help Services, 700 to 799 employees
- City of Sparks, executive and legislative combined, 700 to 799 employees

Of the MSA's 20 largest employers, eight are casinos. Because of the large presence of the casino industry, Washoe County has a unique economic structure compared to the U.S. economy. For example, the leisure and hospitality sector, which includes accommodations and eating and drinking establishments, accounted for 17.9% of Washoe County's total employment in 2008, compared to 9.8% for the U.S. economy. Because of the large declines in the construction industry in recent years, the combined construction and mining sector accounted for only 7.8% of Washoe County's total employment in 2008, down from 10.8% in 2006. The manufacturing sector accounted for 6.5% of Washoe County's 2008 employment, compared to 9.8% in the United States.

Reno's economy is heavily dependent on the leisure and hospitality sector, which is nearly twice as large as the national average.

The following table compares employment distribution by major sector for Washoe County, Nevada; the Mountain Census region (i.e., AZ, CO, ID, MT, NV, NM, UT, and WY); and the United States. The table confirms the importance of the leisure and hospitality sector in both Washoe County and in Nevada, and shows clearly how much the structure of their economies varies from the rest of the Mountain region states and from the United States.

Employment by Sector, Annual 2008 (NAICS) Sector

	Washoe County	Nevada	Mountain	US
Construction and Mining	7.8%	10.2%	8.7%	5.8%
Manufacturing	6.5%	3.8%	6.4%	9.8%
Trade, Transportation, and Utilities	21.9%	18.3%	19.0%	19.3%
Information	1.3%	1.2%	2.1%	2.2%
Financial Activities	4.6%	4.91%	5.8%	5.9%
Professional and Business Services	12.8%	12.1%	13.4%	13.0%
Educational and Health Services	9.9%	7.5%	11.2%	13.8%
Leisure and Hospitality	17.9%	26.3%	12.7%	9.8%
Other Services	3.3%	2.9%	3.6%	4.0%
Government	14.0%	12.8%	17.1%	16.5%

To gain even great insight in to the local economy, IHS Global Insight conducted a shift-share analysis to identify the changes in Washoe County's economic structure during the last 18 years. The change in economic structure, as measured by the distribution of employment by three-digit NAICs code in the private sector, was compared to the employment changes that occurred in the United States over the same period. The purpose of the analysis was to identify four types of economic sectors.

Type D: Competitive advantage and specialized. Competitive advantage means that an individual sector's employment growth rate in Washoe County over the last 18 years was higher than its employment growth rate at the U.S. level over the same period. Specialized means that the same sector's percent share of total Washoe County employment is higher than the sector's percent share of total U.S. employment (i.e., its location quotient is >1.0). Sectors in this category are major sources of growth in a regional economy, as they have both above-average shares of regional activity, and above-average growth rates. Higher growth rates for these sectors presumably occur because of competitive advantages (e.g., labor costs, agglomeration effects, skilled labor, proximity to market, lower cost of living, etc.) that attracted them into a region in the first place. Approximately 57.1% of Washoe County's 2008 employment, or 103,094 workers, are in sectors classified as type D. The top-five sectors in this category, based on total employment, are:

- Administrative and Support Services (NAICS 561)
- Food Services & Drinking Places (NAICS 722)
- Special Trade Contractors (NAICS 238)
- Ambulatory Healthcare Services (NAICS 621)
- Hospitals (NAICS 622)

While this analysis excluded the government sector, both the federal and local government sectors are definable as type D sectors.

Type C: Competitive advantage but not specialized. This type consists of sectors whose employment growth rate in Washoe County over the 18 years was higher than the sector's growth rate at the U.S. level, but also where the current shares of total county employment are less than their shares of total U.S. employment. Economic sectors classified as type C present targets of opportunity, as Washoe County may have competitive advantages that enable these sectors to achieve above-average growth rates. Approximately 19.9% of Washoe County's 2008 employment is classified as type C. The top-five private sectors in this category, based on total employment, are:

- Professional, Scientific, and Tech Services (NAICS 541)
- Retail Trade – Food & Beverage (NAICS 445)
- Credit Intermediaries and Related Services (NAICS 522)
- Religious, Civic, and Professional Organizations (NAICS 813)
- Management of Companies & Enterprises (NAICS 551)

Type B: Competitive disadvantage but specialized. This type is comprised of sectors whose employment growth rates in Washoe County over the last 17 years were below their employment growth rates at the U.S. level, but whose share of total Washoe County employment is higher than their shares of U.S. employment. Type B sectors often comprise major parts of a region's economy, but their boom years are in the past. Approximately 21.7% of Washoe County's

2008 employment is classified as type B. The top five private sectors in this category, based on total employment, are:

- Accommodations (NAICS 721)
- Amusement, Gambling and Recreation (NAICS 713)
- Social Assistance (NAICS 624)
- Warehousing & Storage (NAICS 493)
- Real Estate (NAICS 531)

Type A: Competitive disadvantage and not specialized. This type is comprised of sectors whose employment growth rates in Washoe County over the last 18 years were below their employment growth rates at the U.S. level and whose share of total Washoe County employment is less than their shares of U.S. employment. Type A economic sectors make little contribution to new regional economic growth, and sectors in this class comprised only 1.3% of Washoe County's total employment in 2008. The top-five sectors in this class are:

- Telecommunications (NAICS 517)
- Securities & Other Financial Investments (NAICS 523)
- Transit & Ground Passenger Transportation (NAICS 485)
- Motion Picture & Sound Recording Industry (NAICS 512)
- ISP's, Web Search Portals, & Data Processing (NAICS 518)

An IHS Global Insight analysis also estimated that the high-technology sector (NAICS definition) accounted for 3.3% of the Reno MSA's total non-agricultural employment in 2008, well below the average share of 6.1% for the United States.

Reno's economy is more diverse than the state, making it less vulnerable to changes in certain sectors.

Finally, IHS Global Insight also calculated the Hachmann Index of structure diversity for the Reno MSA for 2008. The purpose of this index is to compare the economic structure of a MSA or state to the structure of the U.S. economy to show how similar or different it is. The closer the index value is to 1.0, the more similar the structure of a MSA or state economy is to the structure of the U.S. economy. In general, larger economies such as those for big states and MSAs tend to be more economically diverse and have higher index values than the economies of smaller states and MSAs that may specialize in certain industries based on their competitive advantages. Economic structure is measured by the distribution of an economic indicator by NAICS code, such as employment, income, output, or business establishments. IHS Global Insight used employment at the three-digit NAICS code as obtained from our Business Demographics Navigator database, which includes estimates for self-employed workers, so they are larger than employment data from the Bureau of Labor Statistics' current employment survey. Consideration of self-employed workers is important in regional economies dependent on tourism because these economies usually have larger proportions of self-employed workers and sole proprietors in the retail and services sectors.

Given its dependence on the tourism and gaming industry, it was expected that the Reno MSA's index of structural diversity would be relatively low, meaning that the structure of its economy is much different than the structure of the U.S. economy. Not surprisingly, in 2008, the index of structural diversity for the Reno MSA was 0.617. By comparison, however, the structure index value for the State of Nevada was only 0.343 in 2008, the lowest value among all the states (excluding Washington, DC). These results show that Reno's economy is less diverse than the nation, on average, but far more diverse than the state economy. As a basis of comparison with its neighbors, the structural index value for the

State of California was 0.936 in 2008, the third highest value among all the states; in Utah the index was 0.905 in 2008, the 14th highest in the nation; and in Arizona the index was 0.915, the 9th highest.

REGIONAL ECONOMIC OUTLOOK

In 2008 and 2009, the Mountain region has seen economic growth that was a reversal of the boom of the previous years. A national slowdown, largely driven by a downturn in the housing sector – both in construction and finance – has impacted all areas of the regional economy.

Western States

The nation's top three growth states are located in this region—Utah, Wyoming, and Montana—while Colorado and Idaho rank 6th and 10th, respectively.

Once a growth leader, the Mountain region posted an employment decline of 5.4% year-over-year (y/y) in August 2009, ranking eighth among the nine census regions. The East North Central region posted the largest decline, at 5.6%, while the West South Central region saw the smallest decline, at 2.6%. In the Mountain region, all states posted declines, with Montana posting the smallest loss, at 0.7% y/y. The worst-performing states were Arizona (down 7.4%) and Nevada (down 6.5%). These two states were also among the worst performing in the nation, with only Michigan (down 7.9%) behind them.

The strongest growth sector of the regional economy continues to be educational and health services, which was up 1.7% y/y. The government sector was the only other sector to not show a decline, and it has been slowing due to tight fiscal restraint by states as they experience lower tax revenues. The main drag on the regional economy continues to be the housing market and its related employment sectors. Construction employment in the region was down 19.8% y/y, the largest decline among all employment sectors. All states posted construction payroll drops that were greater than 12% y/y, with Arizona and Nevada seeing declines of more than 25%. The natural resources and mining sector has also been experiencing deep job cuts, after posting large gains in 2008. There are a few states that are still seeing growth in this sector, although the gains in Utah (up 0.8%), and Nevada (up 0.8%) could not offset losses elsewhere in the region.

The Mountain region has seen the economic pain spread to nearly all sectors of its economy. The professional and business services sector and the trade, transportation, and utility sector, which together account for more than one-third of total jobs, continue to see employment declines. The leisure and hospitality sector accounts for 12.7% of the regional economy, the largest share among the nine regions, and well above the national average of 9.9%. This sector has been hit as consumers are spending less on travel and luxuries such as eating out. In August, the Mountain region posted a 4.8% y/y drop in leisure/hospitality employment, much more significant than the 0.3% contraction during 2008 and a far cry from the 2.1% gain in 2007. The losses in the Mountain region were far greater than anywhere else in the country, as the Pacific region saw a 2.9% drop and the South Atlantic region posted a 2.5% drop.

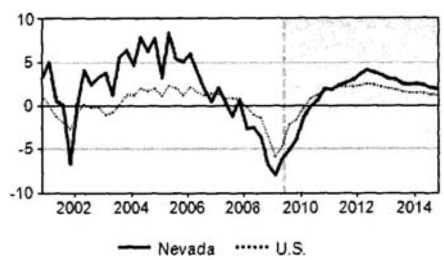
Total employment in the Mountain region declined by 0.5% in 2008 compared with 2007. Job creation in natural resources and mining and in educational and health services was offset by losses in construction, manufacturing, and finance. Economic conditions weakened significantly in 2008, bringing down growth across the nation. The Mountain region is made up of states that were at the forefront of the housing boom, and have thus been affected by the bust more so than other areas. Construction employment in the region declined by more than 81,000 jobs during 2008. Arizona fared the worst, posting a loss of nearly 37,000 construction jobs. The region is also home to states that benefited from elevated prices for natural resources. These states have weathered the economic downturn fairly well so far. Wyoming, Colorado, and Montana were the best performing in the region in 2008.

Employment is expected to decline in 2009, with a 4.7% rate of decrease projected; growth will turn around in 2011 and will average 2.4% annually through 2015. Educational and health services will continue to see strong growth in 2009, while most other sectors will see declines. Construction employment will see a decline again this year as the housing market in the region, as well as nationally, continues to work through an excess of inventory that resulted from too much building during the boom and the subsequent foreclosure crisis. Employment in professional and business services is expected to decline by 7.6% during 2009, as it remains affected by the contraction in the housing market and slower general economic conditions. Manufacturing payrolls, which saw a loss in 2008 (3.0%), will decline further in 2009, also a result of a national downturn. Job growth over the next five years will moderate across the regional economy. The strongest sector will be professional and business services, with annual growth of 5.0%.

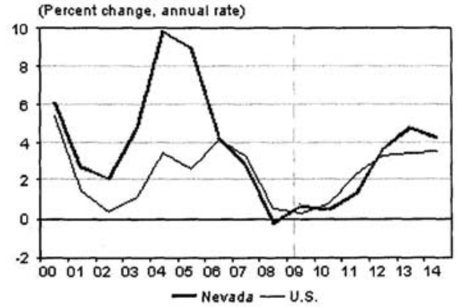
Nevada

Employment in 2009: Total employment in Nevada will decline further this year, as its economy continues to be heavily affected by the housing and mortgage crises. Construction losses will be a major drag on growth, but job declines will be seen across just about every sector of the state economy. Personal income growth will be sluggish, as consumers and businesses rein in spending over the near term. Nevada's population growth, after slowing in 2008, will bounce back, though, helping to push employment and housing growth back into positive territory by 2011.

Total Employment
(Percent change from a year earlier)

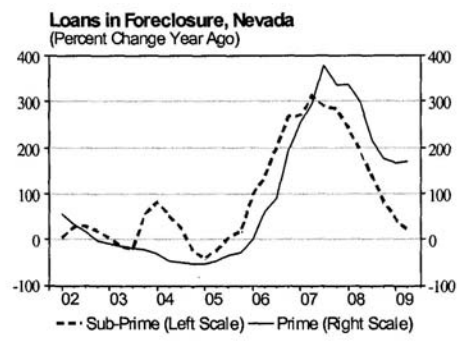


Employment through the Next Five Years: Nevada has been one of the fastest-growing states in the nation for most of the last two decades, and will continue to see strong growth, after a 2010 rebound, averaging 2.0% per year from 2010 through 2015. Population gains will drive employment expansion, and fill new positions at several resorts opening over the next few years. The strongest sectors over the forecast period will be professional and business services and construction. Personal income growth will slow in the near term, before bouncing back along with the rest of the economy.



Housing: The housing market in Nevada, and especially in Las Vegas, is currently falling at a rate that is almost as fast as it grew in recent years. Fueled by high employment growth, high population growth, and a low-interest-rate environment, housing prices in the state posted substantial increases beginning in 2004. Price increases were also boosted by investor activity in the market. As 2006 ended, home sales were slowing, and price growth was nearly flat. Through 2007, prices began to decline in reaction to an excess supply of homes for sale—homes that need to be absorbed before growth can begin again. The declining housing market is affecting several aspects of the state economy. Construction employment is declining, because inventory needs to be absorbed and therefore few new homes are being built. The state is experiencing a high number of mortgage defaults related to investor activity, which was one of the main sources of the housing boom in the state.

According to the Federal Housing Finance Authority (formerly known as the Office of Federal Housing Enterprise Oversight), home prices in Nevada decreased 28.1% in the second quarter of 2009, from their year-earlier levels, and declined from the previous quarter by 3.5%. In a ranking of states, Nevada ranked last in terms of price appreciation when looking at the 50 states and Washington, D.C.

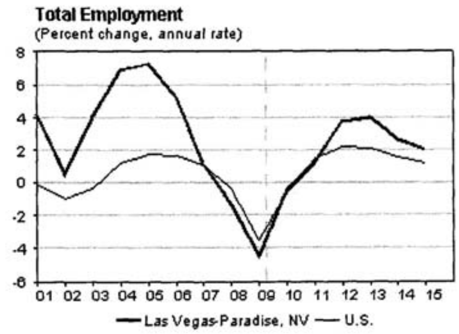


IHS Global Insight, Inc. – 2009

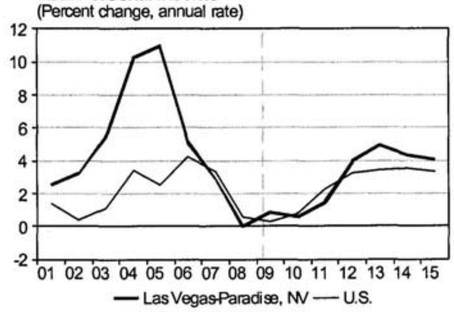
10

Las Vegas

Employment in 2009: Total employment in Las Vegas will decline this year, as the economy retrenches from the housing and mortgage crises. Construction losses will exert the greatest downward pull on growth, but job declines will be seen across nearly every sector of the economy. Personal income growth will be much slower, as consumers and businesses rein in spending over the near term. Strong population growth will help nudge employment and housing growth upward beginning in 2011.



Employment through the Next Five Years: Las Vegas has, in recent history, been one of the faster growing metro areas in the nation, and population growth is expected to average 2.2% per year over the next five years. These strong population gains will give momentum to the expansion of employment, and fill the new positions at several resorts opening over the next few years. With several new resorts scheduled to open during this time, the tourism sector needs to bounce back from the current down-cycle. Employment in the leisure and hospitality sector will grow at an average annual rate of 2.1% through 2015. Total employment will expand 2.2% annually over this time, with the strongest gainers being professional and business services and educational and health services. Personal income growth will slow in the near term, before bouncing back along with the economy.



Housing: Real estate has been the hot topic of late, and Las Vegas is no exception. Currently, the metro area is in the midst of a housing slump, with excess inventory and declining prices. According to the Federal Housing Finance Authority (FHFA) (formerly the Office of Federal Housing Enterprise Oversight (OFHEO)), home prices in the Las Vegas metro area declined 26.2% in the second quarter of 2009 compared with the same period one year earlier, ranking Las Vegas 295 out of 296 areas nationwide. FHFA estimates that prices declined by 4.8% from the previous quarter. The housing boom left the metro area with an excess inventory of housing that will need to be burned off before the market can return to a positive growth trend. The metro area was also a "hotspot" for speculative activity, and as these investors pulled out of the market, the inventory buildup occurred. Foreclosure activity, which has soared in the state, has also left many homes on the market. As a result of the excess supply of homes, construction activity has slowed significantly, with housing starts down by more than 43% in the second quarter of 2009.

This is not to say that there is not still residential activity going on in the metro area. Some 80 miles north of Las Vegas, in Mesquite, Pulte Homes, one of the nation's largest homebuilders, has broken ground on a master-planned community that will have more than 4,000 homes when completed. The first was ready for residents in early 2008, with the entire community planned for completion by 2013. Focus Property Group also has several planned communities in the works: one in Henderson at Inspirada, and one in Las Vegas called Kyle Canyon Gateway. For Inspirada, infrastructure should be ready in 2009, while other aspects will be ready in 2010. Also in Henderson, Plise Development & Construction broke ground on its $2-billion City Crossing project. The mixed-use project will have office space, retail, hotels, residential units, and outdoor areas spread over 126 acres.

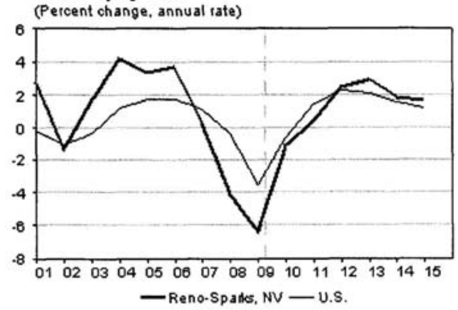
As residential construction cools off, nonresidential construction picked up some of the slack. With many hotel and casino projects in progress or being planned (see the section on leisure and hospitality), this sector should help the construction industry as a whole recover quickly from its current slump.

FORECAST SUMMARY

Employment growth in the Reno MSA will slow in the near-term as the local, and national, economies weather a housing storm.

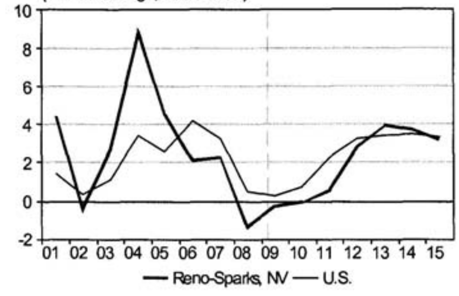
Employment in 2009: Total employment in the Reno-Sparks metropolitan area will continue to decline in the next year, as the economy retrenches from the housing and mortgage crises. Construction losses will be the largest drag on growth, but job declines will also be seen in many other service sectors due to sluggish economic conditions. Personal income growth will be weak as consumers and businesses rein in spending over the near term. Growth is expected to turn back into positive territory sometime in 2010 as the economy begins to show signs of recovering.

Total Employment
(Percent change, annual rate)



Employment through the Next Five Years: Population in the Reno-Sparks metropolitan area is expected to grow at an average annual rate of 1.8% over the next five years, above the 1.4% rate seen in the five years ending 2008. This healthy rate of growth will provide the impetus for continued gains in the service sector. Growth will be led by the professional and business services sector. The education and health services sector will also see strong growth as it keeps up with a population that is progressively getting older. Leisure and hospitality, which is a large component of the metro economy, will see growth remain at relatively the same level. Personal income will see slower growth as the economy settles into a stable growth trend.

Real Personal Income
(Percent change, annual rate)



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Housing: The residential housing market in Reno has been hit hard by the housing downturn, along with the housing markets in many other metro areas in the nation. At issue is an excess supply of housing that needs to be absorbed before the market can see any equalization between supply and demand. During the boom, demand was much higher than supply, leading to accelerated rates of price appreciation (27.5% in 2005). As demand has fallen off, and the overall economy has seen slower growth, price appreciation has taken a turn for the worse. In the second quarter of 2009, prices declined 17.4% on a year-over-year (y/y) basis, and were down 6.2% from the previous quarter. Among 296 metro areas, Reno ranked 279 in terms of y/y price appreciation in the quarter.

LONG-TERM OUTLOOK

Table 1 shows that we forecast employment growth in Washoe County to decline at an average rate of 0.5% between 2008 and 2013, with employment growth remaining stable after 2018, when it will grow at an annual rate of 1.5%. The highest long-term employment growth will be seen in the service sectors. The personal income growth rate will remain steady over the 25-year forecast horizon at about 4.3%, although it could rise if economic development policies are able to attract additional high-paying jobs to the region. Finally, we forecast that real gross county-level product will grow at an annual rate of 0.9% over the next five years. By comparison, the growth rate for Nevada's real GSP over the next five years will be 3.3%, one of the highest rates in United States over this period.

Table 2 presents a special population forecast prepared by IHS Global Insight for 2008 through 2033. Over the next five years, we forecast an annual population growth rate of 1.4%, which, while still an above-average growth rate, will be lower than the 2.7% annual growth rate recorded between 1990 and 2008. Over the longer term, we forecast that total population will grow at an annual rate of 1.6% over the next 10 years, and just under 1.9% over the25-year period between 2008 and 2033. We forecast that the population growth rate will decline after 2018 to an annual rate of 2.1%, due in large part to uncertainty about the capacity of the region's infrastructure, especially water, to continue to support high population growth. The fastest-growing age cohorts over the next 25 years will be the over 85 years old, 80 to 84 years old, 75 to 79 years old, and 70 to 74 years old cohorts. By contrast, annual population growth rates in the cohorts containing working age population between the ages of 25 and 55 will be much lower, with the highest growth rates in the 50 to 54 years old, and 60 to 64 years old cohorts.

As shown in Table 2, over the 25-year forecast period, we forecast that Reno's annual household growth rate will be 1.9%, on par with the population growth rate over the same period. However, between 2008 and 2013, the differential between the household and population growth rates will be greatest, with households growing at 1.3% during this period compared to annual population growth of 1.4%. This differential suggests that there will be increasing demands for local government services and infrastructure required by the older working-age cohorts through 2013; after this time the annual population and household growth rates will decline noticeably to under 2.0% as in-migration, especially of working age adults, declines in relative importance, and as the existing residents age. After 2018, we forecast an average annual household growth rate of just 2.1%, with the largest growth rates occurring in the 55 to 64 and 65 years and older cohorts.

Appendix C

Chapter 2. Technical Description of the Woods & Poole Economics, Inc. 2010 Regional Projections and Database

Note: this file does not have the highlighting, emphasized text, tables, graphs, and charts included in the printed chapter. Therefore some of the text included in this file may be out of context. It is important to refer to the printed chapter that is was enclosed with this CD-ROM, or PDF file on this CD-ROM, for a more complete description of the data sources, data definitions and projection methods.

Introduction

The Woods & Poole Economics, Inc. database contains more than 900 economic and demographic variables for every county in the United States for every year from 1970 to 2040. This comprehensive database includes detailed population data by age, sex, and race; employment and earnings by major industry; personal income by source of income; retail sales by kind of business; and data on the number of households, their size, and their income. All of these variables are projected for each year through 2040. In total, there are over 200 million statistics in the regional database. The regional model that produces the projection component of this database was developed by Woods & Poole. The regional projection methods are revised somewhat year to year to reflect new computational techniques and new sources of regional economic and demographic information. Each year, a new projection is produced based on an updated historical database and revised assumptions.

The fact that the proprietary Woods & Poole economic and demographic projections rely on a very detailed database, makes them one of the most comprehensive county-level projections available. A description of some characteristics of the database and projection model is contained in this chapter.

Overview of the Projection Methods

The strength of Woods & Poole's economic and demographic projections stems from the comprehensive historical county database and the integrated nature of the projection model. The projection for each county in the United States is done simultaneously so that changes in one county will affect growth or decline in other counties. For example, growth in employment and population in Houston will affect growth in other metropolitan areas, such as Cleveland. This reflects the flow of economic activity around the country as new industries emerge or relocate in growing areas and as people migrate, in part because of job opportunities. The county projections are developed within the framework of the United States projection made by Woods &

Poole. The U.S. projection is the control total for the 2010 regional projections and is described in the "Overview of the 2010 Projections" chapter included in Woods & Poole publications.

The regional projection technique used by Woods & Poole - linking the counties together to capture regional flows and constraining the results to a previously determined United States total - avoids a common pitfall in regional projections. Regional projections are sometimes made for a city or county without regard for potential growth in surrounding areas or other areas in the country. Such projections may be simple extrapolations of recent historical trends and, as a result, may be too optimistic or pessimistic. If these county projections were added together, the total might differ considerably from any conceivable national forecast scenario; this is the result of each regional projection being generated independently without interactive procedures and without being integrated into a consistent national projection.

The methods used by Woods & Poole to generate the county projections proceed in four stages. First, forecasts to 2040 of total United States personal income, earnings by industry, employment by industry, population, inflation, and other variables are made. In the 2010 Woods & Poole model the U.S. forecast included an estimate of the 2008-09 recession using preliminary employment data for 2008 and 2009 from the Bureau of Labor Statistics. Second, the country is divided into 179 Economic Areas (EAs) as defined by the U.S. Department of Commerce, Bureau of Economic Analysis (BEA). The EAs are aggregates of contiguous counties that attempt to measure cohesive economic regions in the United States (a list of all EAs and their component counties can be found in Appendix 6 following this chapter); in the 2010 Woods & Poole model, EA definitions released by the BEA in May 2007 are used. For each EA, a projection is made for employment, using an "export-base" approach; in some cases, the employment projections are adjusted to reflect the results of individual EA models or exogenous information about the EA economy. The employment projection for each EA is then used to estimate earnings in each EA. The employment and earnings projections then become the principal explanatory variables used to estimate population and number of households in each EA.
The third stage is to project population by age, sex, and race for each EA on the basis of net migration rates projected from employment opportunities. For stages two and three, the U.S. projection is the control total for the EA projections. The fourth stage replicates stages two and three except that it is performed at the county level, using the EAs as the control total for the county projections.

The "Export-Base" Approach

The specific economic projection technique used by Woods & Poole to generate the employment, earnings, and income estimates for each county in the United States generally follow a standard economic "export-base" approach. This relatively simple approach to regional employment projections is one that has been used by a number of researchers (see [5] and [9]). Although this approach has been criticized by several empirical studies (e.g., [8]), given the availability of regional data it remains one of the most feasible methodologies.

Certain industrial sectors at the regional level are considered "basic." This means that these sectors produce output that is not consumed locally but is "exported" out of the region for national or international consumption. This assumption allows these sectors to be linked closely to the national economy, and hence follow national trends in productivity and output growth. Normally, the "basic" sectors are mining, agriculture, manufacturing, and the Federal government. In contrast, "non-basic" sectors are those such as retail trade, utilities, real estate, and construction, the output of which is usually consumed locally. The growth of the "non-basic" sectors depends largely on the growth of the "basic" sectors that form the basis of the region's economy.

Intuitively, this approach has great appeal and there are numerous examples that seem to support the "export-base" theory. Automobile production in Detroit, for instance, is obviously much more sensitive to national and international price and demand for transportation equipment than to local demand. In Texas, oil and natural gas exploration and production are tied closely to the worldwide demand and supply of petroleum resources and not tied primarily to energy consumption in Texas.

Although the theory is appealing, some shortcomings do exist in the "export-base" approach. For example, some "basic" commodities produced locally are consumed locally. Producers of durable equipment used in other manufacturing processes are often affected not by the national demand for their product but by the regional demand. Machine tool makers that supply the local automobile industry in Detroit will prosper to the extent Detroit's automobile producers prosper. In Houston, the strength of the local oil industry will affect the demand and production of equipment for oil and natural gas production and exploration. In both of these instances, some durable manufacturing industries exist to serve local, not national, markets.

However, despite the shortcomings, the availability of relatively clean data for sub-national geographic areas makes the "export-base" approach very useful. The analytical framework for projections using the "export-base" approach entails estimating either demand equations or calculating historical growth rate differentials for output by sector. The principal explanatory variable, or the comparative data series for growth rate differentials, is the national demand for the output of that sector. Employment-by-sector data are often used as a surrogate variable since county output-by-sector data are not available; employment-by-sector data is used by Woods & Poole. Earnings projections are then obtained by using earnings-per-employee data either estimated as part of the model or imposed exogenously on the system. The complementary relationship could also be estimated, i.e., using an earnings forecast to derive employment based on earnings-per-employee data; this procedure has been used previously in some Woods & Poole regional models.

A modification of the "export-base" approach is used by Woods & Poole to account for regional variants to normal "basic"/"non-basic" industry definitions. Some "non-basic" sectors can be more appropriately modeled as "basic" sectors in certain regional economies. The finance and insurance sector or wholesale trade sector in New York City, for example, and the accommodation and food services sector in Las Vegas, are cases in which traditionally "non-basic" sectors are really "basic." New York is a worldwide financial and trade center and thus "exports" these services outside of the region; Las Vegas, as a vacation and entertainment center, similarly "exports" the output of its accommodation and food services sector to other parts of the country. Activity in these sectors, in these specific geographic areas, is therefore linked more closely to the performance of these same sectors in the surrounding regions and the nation as a whole than to the other "basic" industries in the region.

A list of Economic Areas that have traditionally "non-basic" sectors modeled as "basic" sectors is presented in Table 1. Areas with "non-basic" sectors modeled as "basic" are those areas with a proportion of "non-basic" sector employment relative to total employment greater than 1.5 standard deviations above the national mean for a specific sector. With the exception of two sectors that are always considered "non-basic," construction and state and local government, all "non-basic" sectors are evaluated for each EA using this method (see [5]).

Table 1. Economic Area "Non-Basic" Sectors Considered as "Basic" in the 2010 Woods & Poole Regional Model

UTILITIES
- Birmingham-Hoover-Cullman, AL
- Bismarck, ND
- Casper, WY
- Clarksburg, WV + Morgantown, WV
- Duluth, MN-WI
- Farmington, NM
- Gulfport-Biloxi-Pascagoula, MS
- Wichita Falls, TX

WHOLESALE TRADE
- Atlanta-Sandy Springs-Gainesville, GA-AL
- Charlotte-Gastonia-Salisbury, NC-SC
- Chicago-Naperville-Michigan City, IL-IN-WI
- Cincinnati-Middletown-Wilmington, OH-KY-IN
- Dallas-Fort Worth, TX
- Fargo-Wahpeton, ND-MN
- Houston-Baytown-Huntsville, TX
- Idaho Falls-Blackfoot, ID
- Kansas City-Overland Park-Kansas City, MO-KS
- Memphis, TN-MS-AR
- New York-Newark-Bridgeport, NY-NJ-CT-PA

RETAIL TRADE
- Alpena, MI
- Cape Girardeau-Jackson, MO-IL
- Duluth, MN-WI
- Erie, PA
- Eugene-Springfield, OR
- Marinette, WI-MI
- McAllen-Edinburg-Pharr, TX
- Missoula, MT
- Sarasota-Bradenton-Venice, FL

Tampa-St. Petersburg-Clearwater, FL

TRANSPORTATION and WAREHOUSING

Anchorage, AK
Fayetteville-Springdale-Rogers, AR-MO
Jacksonville, FL
Joplin, MO
Kearney, NE
Memphis, TN-MS-AR
New Orleans-Metairie-Bogalusa, LA
Pendleton-Hermiston, OR
Redding, CA
Scotts Bluff, NE
State College, PA

INFORMATION

Atlanta-Sandy Springs-Gainesville, GA-AL
Boston-Worcester-Manchester, MA-NH
Cedar Rapids, IA
Colorado Springs, CO
Columbus-Auburn-Opelika, GA-AL
Dallas-Fort Worth, TX
Denver-Aurora-Boulder, CO
Kansas City-Overland Park-Kansas City, MO-KS
Los Angeles-Long Beach-Riverside, CA
New York-Newark-Bridgeport, NY-NJ-CT-PA
Omaha-Council Bluffs-Fremont, NE-IA
San Angelo, TX
San Jose-San Francisco-Oakland, CA
Seattle-Tacoma-Olympia, WA
Tampa-St. Petersburg-Clearwater, FL
Washington-Baltimore-Northern Virginia, DC-MD-VA-WV

FINANCE and INSURANCE

Chicago-Naperville-Michigan City, IL-IN-WI
Dallas-Fort Worth, TX
Denver-Aurora-Boulder, CO
Des Moines-Newton-Pella, IA
Hartford-West Hartford-Willimantic, CT
Jacksonville, FL
Kansas City-Overland Park-Kansas City, MO-KS
New York-Newark-Bridgeport, NY-NJ-CT-PA
Omaha-Council Bluffs-Fremont, NE-IA
Philadelphia-Camden-Vineland, PA-NJ-DE-MD
Phoenix-Mesa-Scottsdale, AZ
San Antonio, TX
Sioux Falls, SD
Tampa-St. Petersburg-Clearwater, FL

REAL ESTATE and RENTAL and LEASING

Austin-Round Rock, TX
Bend-Prineville, OR
Denver-Aurora-Boulder, CO
Honolulu, HI
Las Vegas-Paradise-Pahrump, NV
Los Angeles-Long Beach-Riverside, CA
Miami-Fort Lauderdale-Miami Beach, FL

Orlando-The Villages, FL
Pensacola-Ferry Pass-Brent, FL
Phoenix-Mesa-Scottsdale, AZ
Reno-Sparks, NV
San Diego-Carlsbad-San Marcos, CA
Sarasota-Bradenton-Venice, FL
Tucson, AZ

PROFESSIONAL and TECHNICAL SERVICES
Albuquerque, NM
Austin-Round Rock, TX
Boston-Worcester-Manchester, MA-NH
Chicago-Naperville-Michigan City, IL-IN-WI
Denver-Aurora-Boulder, CO
Detroit-Warren-Flint, MI
Houston-Baytown-Huntsville, TX
Idaho Falls-Blackfoot, ID
Los Angeles-Long Beach-Riverside, CA
Miami-Fort Lauderdale-Miami Beach, FL
New York-Newark-Bridgeport, NY-NJ-CT-PA
Philadelphia-Camden-Vineland, PA-NJ-DE-MD
San Diego-Carlsbad-San Marcos, CA
San Jose-San Francisco-Oakland, CA
Santa Fe-Espanola, NM
Washington-Baltimore-Northern Virginia, DC-MD-VA-WV

MANAGEMENT of COMPANIES and ENTERPRISES
Atlanta-Sandy Springs-Gainesville, GA-AL
Boise City-Nampa, ID
Cincinnati-Middletown-Wilmington, OH-KY-IN
Columbus-Auburn-Opelika, GA-AL
Fayetteville-Springdale-Rogers, AR-MO
Minneapolis-St. Paul-St. Cloud, MN-WI
Richmond, VA
Roanoke, VA
St. Louis-St. Charles-Farmington, MO-IL

ADMINISTRATIVE and WASTE SERVICES
Augusta-Richmond County, GA-SC
Los Angeles-Long Beach-Riverside, CA
Miami-Fort Lauderdale-Miami Beach, FL
Orlando-The Villages, FL
Phoenix-Mesa-Scottsdale, AZ
Sarasota-Bradenton-Venice, FL
Tampa-St. Petersburg-Clearwater, FL

EDUCATIONAL SERVICES
Albany-Schenectady-Amsterdam, NY
Boston-Worcester-Manchester, MA-NH
Burlington-South Burlington, VT
Hartford-West Hartford-Willimantic, CT
New Orleans-Metairie-Bogalusa, LA
New York-Newark-Bridgeport, NY-NJ-CT-PA
Philadelphia-Camden-Vineland, PA-NJ-DE-MD
Pittsburgh-New Castle, PA
Rochester-Batavia-Seneca Falls, NY
Salt Lake City-Ogden-Clearfield, UT

Scranton--Wilkes-Barre, PA
South Bend-Mishawaka, IN-MI
St. Louis-St. Charles-Farmington, MO-IL
Syracuse-Auburn, NY
Washington-Baltimore-Northern Virginia, DC-MD-VA-WV

HEALTH CARE and SOCIAL ASSISTANCE
Albany-Schenectady-Amsterdam, NY
Bangor, ME
Bismarck, ND
Boston-Worcester-Manchester, MA-NH
Cape Girardeau-Jackson, MO-IL
Duluth, MN-WI
Fargo-Wahpeton, ND-MN
McAllen-Edinburg-Pharr, TX
Pittsburgh-New Castle, PA
Pueblo, CO
Scranton--Wilkes-Barre, PA
Springfield, IL

ARTS, ENTERTAINMENT, and RECREATION
Flagstaff, AZ
Gulfport-Biloxi-Pascagoula, MS
Helena, MT
Las Vegas-Paradise-Pahrump, NV
Los Angeles-Long Beach-Riverside, CA
Missoula, MT
Orlando-The Villages, FL
Reno-Sparks, NV
Santa Fe-Espanola, NM
Sarasota-Bradenton-Venice, FL
Shreveport-Bossier City-Minden, LA

ACCOMMODATION and FOOD SERVICES
Alpena, MI
Flagstaff, AZ
Honolulu, HI
Las Vegas-Paradise-Pahrump, NV
Reno-Sparks, NV

OTHER SERVICES, EXCEPT PUBLIC ADMIN.
Abilene, TX
Alpena, MI
Amarillo, TX
Beaumont-Port Arthur, TX
Corpus Christi-Kingsville, TX
Lubbock-Levelland, TX
McAllen-Edinburg-Pharr, TX
Miami-Fort Lauderdale-Miami Beach, FL
Midland-Odessa, TX
Mobile-Daphne-Fairhope, AL
Monroe-Bastrop, LA
Montgomery-Alexander City, AL
San Angelo, TX
Wichita Falls, TX

FEDERAL CIVILIAN GOVERNMENT

Anchorage, AK
Charleston-North Charleston, SC
El Paso, TX
Flagstaff, AZ
Gulfport-Biloxi-Pascagoula, MS
Honolulu, HI
Huntsville-Decatur, AL
Macon-Warner Robins-Fort Valley, GA
Pensacola-Ferry Pass-Brent, FL
San Antonio, TX
Texarkana, TX-Texarkana, AR
Virginia Beach-Norfolk-Newport News, VA-NC
Washington-Baltimore-Northern Virginia, DC-MD-VA-WV

In addition to following an "export-base" approach, Woods & Poole uses exogenous information about EA economies as well as some individual EA models to make projections. Although almost all EAs are not modeled individually, since most are assumed to fit a normative structure, certain EAs that have interesting features can be modeled separately. Areas that have had rapid growth (such as Houston) or severe economic recessions as in some heavy-industry EAs (such as Cleveland) lend themselves to individual models. These regional economies, at least in part, can be modeled separately. This is a simple "bottom-up" approach that can take into account the idiosyncrasies of individual areas (see [2], [3], [7]).

An example of the "bottom-up" approach is shown with the equations for Cleveland, Houston, Sioux City IA, and Seattle, presented in Table 2. The Cleveland-Akron-Elyria OH-PA Economic Area is defined as Ashland, Ashtabula, Carroll, Columbiana, Crawford, Cuyahoga, Erie, Geauga, Harrison, Holmes, Huron, Lake, Lorain, Mahoning, Medina, Portage, Richland, Stark, Summit, Trumbull, Tuscarawas, and Wayne counties in Ohio; and Mercer county in Pennsylvania. The Houston-Baytown-Huntsville TX Economic Area is defined as Angelina, Austin, Brazoria, Brazos, Burleson, Calhoun, Chambers, Colorado, DeWitt, Fayette, Fort Bend, Galveston, Goliad, Grimes, Harris, Houston, Jackson, Lavaca, Leon, Liberty, Madison, Matagorda, Montgomery, Nacogdoches, Polk, Robertson, Sabine, San Augustine, San Jacinto, Shelby, Trinity, Victoria, Walker, Waller, Washington, and Wharton counties. The Sioux City-Vermillion IA-NE-SD Economic Area is defined as Monona, O'Brien, Osceloa, Plymouth, Sioux, and Woodbury counties in Iowa; Antelope, Boyd, Cedar, Dakota, Dixon, Holt, Knox, Madison, Pierce, Stanton, Thurston, Wayne, and Wheeler counties in Nebraska; and Bon Homme, Clay, Union and Yankton counties in South Dakota. The Seattle-Tacoma-Olympia WA Economic Area is defined as Clallam, Grays Harbor, Island, Jefferson, King, Kitsap, Kittitas, Lewis, Mason, Pacific, Pierce, San Juan, Skagit, Snohomish, Thurston, and Whatcom counties.

The following discussion of these equations illustrates some of the logic and assumptions that go into the Woods & Poole model. The historical data used in the model equations is defined and explained in a later section of this chapter. Figure 1 illustrates graphically the degree of fit for several of the equations.

In equation (1) Cleveland manufacturing employment is a function of total U.S. manufacturing employment, the wages of Cleveland manufacturing workers relative to manufacturing workers for the U.S. as a whole, and a lagged dependent variable. All the coefficients are significant at a 95% confidence level, and together clearly explain historical manufacturing in Cleveland. It is interesting to note that the coefficient for relative wages is significant and negative. The ratio of earnings per manufacturing worker in Cleveland to U.S. earnings per manufacturing worker (this is the definition of relative wages) historically has always been greater than one, with a mean of 1.10 for the period 1970 to 2007. Relatively high wages explain, in part, the decline in manufacturing employment in areas such as Cleveland. Faced with relatively high wages, manufacturers have an incentive to increase the productivity of existing plants and save labor, move plants to other areas where wages are lower, or close plants permanently because of competition from other facilities able to produce the same goods more efficiently.

Equation (2) explains Houston manufacturing employment as a function of total U.S. mining earnings times a dummy variable for the years 1971 to 1985, U.S. manufacturing earnings, and a lagged dependent variable. U.S. mining earnings measures the expansion of domestic mining activity as oil and natural gas prices increased during the 1970s. Historically the largest manufacturing sectors in the Houston Economic Area were the production of equipment used in the exploration and extraction of petroleum resources and the production of refined fuels and chemicals from oil; both of these manufacturing sectors were dependent on the output of the mining sector for the U.S. as a whole. As the price of oil increased during the 1970s, demand for new extraction and exploration increased. Similarly, as prices fell in the 1980s, demand for new exploration waned. Both of these phenomena have affected Houston's manufacturing employment base.

Equation (3) measures Houston mining employment as a function of U.S. mining earnings and the dependent variable lagged one year. Mining employment in Houston, another "basic" sector, depends on total demand for domestic mining output. As the price of oil rises, marginal U.S. reserves, which are relatively more expensive to produce or refine, become competitive, and Houston (and U.S.) production increases. In addition, increased mining revenues allow more capital to be used in the production of oil when prices are high. When prices are low, Houston (and U.S.) production declines and imports generally rise.

In equation (4) Sioux City IA farm employment is a function of U.S. farm employment, the dependent variable lagged one year, and an intercept term. Farming, the largest "basic" sector in Sioux City, has experienced significant employment declines in recent years. Sioux City farm employment is related to U.S. farm employment in this equation because the reasons for job losses in Sioux City are related to nationwide changes in agriculture. In every decade this century, farm employment in the U.S. has declined as farm productivity has increased. The experience of Sioux City is like that of most other farming areas: employment has declined as output has remained steady or increased. The national projections of agricultural productivity growth are important to expected farm employment in Sioux City.

Equation (5) explains Sioux "non-basic" employment as a function of Sioux City "basic" employment, the dependent variable lagged one year, and an intercept term. This equation illustrates the relationship between "basic" employment losses and subsequent "non-basic" employment losses. As the population declined in Sioux City, so did "non-basic" employment.

In equation (6) Seattle manufacturing employment is a function of an intercept term, the U.S. unemployment rate, a dummy variable for 1970 to 1972, and a lagged dependent variable. The largest manufacturing sectors in Seattle - aircraft, lumber, and wood products - are sensitive to U.S. business cycles. U.S. business cycles are measured by the civilian unemployment rate, which has a negative coefficient in equation (6). The negative coefficient of the dummy variable for 1970 to 1972 adjusts the specification of the equation for the severe regional recession during that time.

Equation (7) explains Seattle "non-basic" employment as a function of an intercept term, Seattle population, a dummy variable for the 1970-72 regional recession, and the U.S. unemployment rate. The unemployment rate measures the sensitivity of Seattle employment to U.S. business cycles. "Non-basic" employment is also a function of the population of the region; as the population of Seattle has grown, the demand for "non-basic" sector employment has also increased. It is interesting that population is contemporaneous with the dependent variable, "non-basic" employment, in equation (7) but lagged in equation (5). In rapidly growing areas, such as Seattle, population increases have an immediate effect on employment growth in "non-basic" industries. In some very rapidly growing areas of Texas in the late 1970s, population growth actually preceded "non-basic" employment growth. This is analogous to "boom towns" of the Old West as the economy catches up to the demand created by the new population growth and new businesses locate in the fast-growing area. However, in areas losing population, "non-basic" employment does not decline in step with population losses. Many "non-basic" businesses in a declining area will hang on as long as possible in anticipation of an upturn in the region's economy. This reflects the local nature of most "non-basic" businesses and the desire of firms to protect their capital investment in a specific site.

The Demographic Model

The demographic portion of the regional model follows a traditional cohort-component analysis based on calculated fertility and mortality in each county or EA. The "demand" for total population is estimated from the economic model: if the demand for labor is forecast to rise for a particular county or EA, then either the labor force participation rate will rise or population in-migration will be positive. The inverse is true for counties and EAs with projected declines in employment. Therefore, future EA and county migration patterns for population by age, sex, and race are based on employment opportunities. Individuals and families are assumed to migrate, at least in part, in response to employment opportunities (see [1], [4], and [6]) with two exceptions: for population aged 65 and over and for college or military-aged population, migration patterns over the forecast period are based on historical net migration and not economic conditions. The integration of economic and demographic regional analysis is a significant strength of the Woods & Poole approach.

The age, sex, and race distribution of the population is projected by aging the population by single year of age by sex and by race for each year through 2040 based on county or EA specific mortality, fertility, and migration rates estimated from historical data. In the Woods & Poole model, projected net mortality and migration are estimated based on the historical net change in population by age, race, and sex for a particular county or EA. Similarly, projected net births and migration of age zero population by race are estimated based on the historical change in age zero population by race per female population age 15 to 44 by race for a particular county or EA.

The United States population by age, sex, and race projections, 2009-2040, are based on Bureau of the Census population estimates for 2000 through 2008. Woods & Poole forecasts these U.S. estimates with a cohort-component model based on the year to year change in U.S. population by single year of age, race, and sex. Forecast fertility, mortality, and international migration are estimated from the Census population estimates and are applied exogenously to the Woods & Poole U.S. projections. Woods & Poole produces only a "middle" U.S. population forecast - this forecast is similar to the Census "middle" forecast scenario for the U.S. population. The U.S. population by age, sex, and race forecast is the control total for the EA projections. Each EA projection serves as the control totals for the county projections.

The Accuracy of the Projections

Unlike other sciences, economics and demographics cannot rely on experimentation to test theories and verify hypotheses. Rather, historical data are analyzed and theories are developed that explain the historical data. The resulting models are then used to make a projection. Woods & Poole projections, like all economic and demographic projections, utilizes this approach: analyzing historical data to make estimates of future data. There are, of course, inherent limitations to projections, and the Woods & Poole projections should never be interpreted as an infallible prediction of the future; future data may differ significantly from Woods & Poole projections and Woods & Poole does not guarantee the accuracy of the projections. In all Woods & Poole publications, the word "forecast" is used as a synonym for "projection" and refers to Woods & Poole estimated data for any year from 2008 to 2040 (2009 to 2040 for population); in Woods & Poole publications "projections", or "forecasts", both mean estimates of future data (2008 to 2040, or 2009 to 2040 for population).

One key limitation to all projections, and Woods & Poole projections in particular, is that the future is never known with any certainty. The model on which the projections are based may not accurately reflect future events. In addition, there is always the possibility of an unanticipated shock to the economy, or of some other event that was not foreseen based on an analysis of historical data. For instance, a local government may enact a new industrial policy that has an unexpected, beneficial effect on employment growth. Or an abrupt economic change, although anticipated, may occur with much greater intensity or in a shorter time period than expected. For example, the projection may assume an increase in the price of a commodity, such as oil, over a five-year period, but an embargo may raise the price to that level in only one year. In addition, the projections may not be accurate because historical data is revised; or because the projection model does not accurately reflect demographic or economic phenomena; or because the projections contain errors; or because the smooth growth path of the long-term projections inaccurately reflects important variance in economic or demographic growth for particular regions; or because assumptions about national or regional growth, upon which the projections are based, turn out to be incorrect. In addition, there are many other types of economic and demographic events that could create outcomes far different from Woods & Poole's projections.

Another limitation results from doing forecasts for small geographic areas for small data series. Statistically, models are more reliable the larger the area and/or the series being studied. Small area forecasts, such as county population for White men age 84, are subject to more error because of the small sample size. This error can be reduced, although never eliminated, by constraining the small area forecasts to the forecast totals for a larger area or series; this is the method used by Woods & Poole.

One way to evaluate the effectiveness of a projection method is to compare previous projections to current data; although such a comparison does not indicate the potential accuracy of current or future projections, it can be useful to measure the magnitude of error of previous projections. Table 3 illustrates how well Woods & Poole regional models projected employment, population, and personal income over a 1-year to 10-year forecast horizon for various geographies.

One statistic used to evaluate the projections is the Average Absolute Percent Error (AAPE), which is the average of the absolute values of the percent difference from the projected data to the actual data. The lower the AAPE, the more accurate the projection (e.g., Woods & Poole's 3-year population projections have been accurate within +/-1.8% for states and +/-3.2% for counties). All Woods & Poole projections are evaluated for each projection horizon; thus, the AAPE for 1-year projections is calculated based on all Woods & Poole one-year projections (there have been twenty-two 1-year projections and fourteen 10-year projections). Changes to historical data are not adjusted when calculating the AAPEs. Thus, if a projection was made using historical data that were subsequently revised, the AAPE is calculated based on the revised data, probably inflating the AAPE, particularly for short-term projections. For example, projections of 1993 employment done in 1984 were made using a different definition of employment; in the 1984 forecast, U.S. total employment in 1980 was estimated to be 106.4 million jobs. However, since then, the definition of employment has been revised several times by the Department of Commerce and now U.S. total employment in 1980 is estimated to be 114.2 million jobs; therefore, the AAPEs are calculated based on revised data so they incorporate not only forecast error but definitional changes as well, probably inflating the AAPEs.

The longer the forecast horizon, the larger the AAPE. Thus for all Metropolitan Statistical Areas (MSAs), 1-year population projections have been accurate within +/-1.3% compared to +/-5.7% for the 10-year projection. In addition, population projections, the most stable series and the data least subject to historical revision, have the lowest AAPEs.

Personal income has the highest AAPE for all geographies because, in addition to projecting the level of personal income, there is an implicit price inflation forecast built into the income projections. In the early 1980s after a period of rapid inflation, the Woods & Poole personal income projections had relatively high AAPEs (the 10-year personal income forecast had an AAPE of +/-15.9% for counties). As inflation mitigated in the 1980s, the AAPEs for personal income dropped sharply; the 5-year AAPE dropped to +/-9.7% for counties.

Generally, the smaller the geography, the larger the AAPEs for all variables. For all counties, the AAPE for 8-year population projections was +/-7.0%. However, for counties with population under 50,000 in 2000, the 8-year projection AAPE was +/-7.5%. Similarly, for larger geographies, the AAPEs are usually lower. The AAPE for counties with 2000 population between 50,000 and 100,000 was +/-ñ6.0%; for counties with population over 100,000 the AAPE was +/-5.8%. AAPEs for smaller variables tend to be higher than AAPEs for larger variables. Thus, the AAPE for retail trade employment would probably be higher than the AAPE for total employment, holding geographic area size and forecast horizon constant.

The accuracy of Woods & Poole's projections has been comparable to the accuracy of other regional forecasting programs. Figure 2 compares Woods & Poole's projections to Department of Commerce Bureau of Economic Analysis (BEA) and Census Bureau projections over comparable forecast horizons. The Woods & Poole 8-year forecast AAPEs for states for the year 1990 for employment and personal income were slightly below the BEA AAPEs, and slightly above the BEA for population. Similarly, the Woods & Poole 1-year to 5-year population projections AAPE for states were slightly below the Census AAPEs.

Other statistics are sometimes used to evaluate forecasts. The AAPE is most commonly used as a measure of accuracy for projections when the units being compared are of different sizes (e.g., county population, the base of which can range from 100 for Loving, TX to 8 million for Los Angeles, CA). It has the advantage of being able to compare units of different sizes equally. In some models, the Root Mean Squared Error (RMSE) is used to measure accuracy. The RMSE has the disadvantage of giving modest errors for large units a greater weight than modest errors for small units (i.e., an error of 10,000 on a base of 2 million is given greater weight than an error of 1,000 on a base of 20,000, just the opposite of the AAPE).

Another useful statistic in evaluating forecasts is the simple average of all the percent errors: the Average Percent Error (APE). This measures the bias of the forecast. In Woods & Poole projections, employment for counties have always had a downward bias (the APE has been negative). The APE for all 5-year Woods & Poole county employment projections is -1.5% with a standard deviation of 11.8% (see Table 3). In contrast, the county population projections have always had an upward bias (the APE has been positive). The APE for all 5-year Woods & Poole county population projections is +0.6% with a standard deviation of 7.3%.

Historical Data

Much of the historical economic data in the Woods & Poole regional databases are obtained from the Bureau of Economic Analysis (BEA) of the Department of Commerce. The historical data from the BEA include county-level data for each year 1969 through 2007 for employment and earnings by one-digit Standard Industrial Classification (SIC) code (1969 to 2000) and by one-digit North American Industry Classification System (NAICS) code (2001 to 2007), and personal income by source of income. Other sources of data include the 1970, 1980, 1990, and 2000 Censuses and post-Censal reports for population and household data, and the quinquennial Census of Retail Trade for retail sales data. Woods & Poole generally accepts the government data as given unless indicated otherwise in this chapter. The discussion which follows, of the historical data used by Woods & Poole, is not intended to be a complete explanation of the historical data; the user should consult the government sources of the historical data for a complete explanation. Some of the sources of government data used by Woods & Poole have technical explanations of how the historical data is collected, how the data can be used, and limitations to the data; the documentation may contain important information on the applicability of the data for particular applications and should be reviewed by users of the historical data; the documentation can be obtained from the U.S. Dept. of Commerce, the Government Printing Office or many public libraries. All data for the years 2008-2040 (2009-2040 for population) are projected by Woods & Poole.

Historical data are subject to revision from time to time. Historical employment and income data from the Bureau of Economic Analysis are revised on a regular basis. For example, historical data released by the Bureau of Economic Analysis in 1984 showed total employment for the United States in 1980 to be 106.4 million jobs; the current estimate of 1980 U.S. total employment is 114.2 million jobs. When using the historical data, it is important to use the current revision and not combine this data with previous versions since there may be definitional changes in the data.

Gross Domestic Product by State

Gross Domestic Product by State, formerly Gross State Product (GSP), is called Gross Regional Product (GRP) in the Woods & Poole database. GRP is historical for the United States total, regions, and states for the years 1969-2007 from the Bureau of Economic Analysis Gross Domestic Product by State series. All county, and metropolitan area, historical GRP data, 1969-2007, is estimated by Woods & Poole by allocating state GRP in a particular year to counties within the state based on the proportion of total state earnings of employees originating in a particular county. County GRP estimates are constrained to state totals for the years 1969-2007. All GRP data is establishment based.

Employment

The employment data in the Woods & Poole database are a complete measure of the number of full- and part-time jobs by place of work. Historical data, 1969-2007, are from the U.S. Department of Commerce, Bureau of Economic Analysis. The employment data include wage and salary workers, proprietors, private household employees, and miscellaneous workers. Wage and salary employment data are based on an establishment survey in which employers are asked the number of full- and part-time workers at a given establishment. Because part-time workers are included, a person holding two part-time jobs would be counted twice. Also, since the wage and salary employment data are based on an establishment survey, jobs are counted by place of work and not place of residence of the worker; thus, a job in the New York Metropolitan Area is counted in the New York Metropolitan Area regardless of where the worker lives. The 2010 Woods & Poole model included an estimate of the 2008-09 recession using preliminary employment data for 2008 and 2009 from the Bureau of Labor Statistics.

Data on proprietors include farm and non-farm proprietors by sector. Proprietors include not only those people who devote the majority of their time to their proprietorship, but people who devote any time at all to a proprietorship. Thus, a person who has a full-time wage and salary job and on nights and weekends runs a small business legally defined as a proprietorship would be counted twice. The employment data therefore include full- and part-time proprietors.

Private household employment data include persons employed by a household on the premises, such as full-time baby-sitters, housekeepers, gardeners, and butlers. Miscellaneous employment data include judges and all elected officials, persons working only on commission in sectors such as real estate and insurance, students employed by the colleges or universities in which they are enrolled, and unincorporated subcontractors in sectors such as construction.

The employment data used by Woods & Poole comprise the most complete definition of the number of jobs by county. Woods & Poole data may be higher than that from other sources because they measure more kinds of employment. There are three other commonly used government sources for employment data: the Bureau of Labor Statistics (BLS), the Bureau of the Census, and the National Income and Product Accounts (NIPA). These sources of employment data differ from the data used by Woods & Poole. The BLS establishment data are generally much lower than the Woods & Poole data because agricultural workers, the military, proprietors, households, and miscellaneous employment are not included; the exclusion of proprietors from the BLS data is the most significant difference. Data from the Census (and some survey data from the BLS) are based on employment by place of residence and differ fundamentally in concept from the Woods & Poole employment data by place of work; Census employment data are generally lower than Woods & Poole data, but not always. Since Census data are based on a household survey, persons holding two jobs would be counted only once, and, therefore, the data would be lower than Woods & Poole. However, Census survey data for counties that have a large number of commuters and relatively few jobs within the county could yield employment data higher than Woods & Poole. Employment data in the National Income and Product Accounts are close to Woods & Poole data, except that part-time proprietors and certain miscellaneous employees are excluded; therefore, these data are usually lower.

Employment by Sector

The employment data is by two-digit North American Industry Classification System (NAICS) industry. The two-digit industries are defined in the 1997 North American Industry Classification System Manual. The employment data in the Woods & Poole 2010 database is no longer based on the Standard Industrial Classification (SIC) system definitions. For the years 1969-2000 BEA provided employment industry data by SIC rather than by NAICS; Woods & Poole has estimated the NAICS industry data for 1969-2000 from the BEA SIC 1969-2000 employment industry data and the NAICS employment industry data for the years 2001-2007.

As a rule, employment is classified in a given industry depending on the primary activity of the establishment. For example, employees of a large oil company are classified in many different sectors depending on the specific establishment in which they worked, even though the company as a whole would be considered a mining company: employees at a refinery are in manufacturing; employees at the company headquarters are in management; pipeline operators are in transportation; and oil field workers are in mining. If a given establishment is engaged in activities in different sectors, all employees are classified according to the primary activity of the establishment regardless of their actual occupations; thus, a secretary for a trucking company is a transportation worker and an accountant at a small plumbing company is a construction worker. The main exception to this rule is the classification of government workers in the Woods & Poole database: all government employees are classified in Federal civilian, Federal military, or state and local government employment, regardless of the usual classification of the establishment in which they work. Definitions for each sector, based on NAICS industries, in the Woods & Poole database are as follows:

Farming includes establishments such as farms, orchards, greenhouses, and nurseries primarily engaged in the production of crops, plants, vines, trees (excluding forestry operations), and specialties such as Christmas trees, sod, bulbs, and flower seed. It also includes establishments such as ranches, dairies, feedlots, egg production facilities, and poultry hatcheries primarily engaged in the keeping, grazing, or feeding of cattle, hogs, sheep, goats, poultry of all kinds, and special animals such as horses, bees, pets, fish farming, and animals raised for fur.

Forestry, fishing, related activities, and other includes establishments primarily engaged in harvesting timber, and harvesting fish and other animals from their natural habitats. The sector also includes agricultural support establishments that perform one or more activities associated with farm operation, such as soil preparation, planting, harvesting, and management, on a contract or fee basis. Excluded are establishments primarily engaged in agricultural research and establishments primarily engaged in administering programs for regulating and conserving land, mineral, wildlife, and forest use. Other consists of jobs held by U.S. residents who are employed by international organizations and by foreign embassies and consulates in the United States.

Mining includes establishments that extract naturally occurring mineral solids (e.g. coal and ores), liquid minerals (e.g. crude petroleum), and gases (e.g. natural gas.) Mining includes quarrying, well operations, beneficiating (e.g., crushing, screening, washing, and flotation), and other preparation customarily performed at the mine site, or as a part of mining activity.

Utilities includes establishments engaged in the provision of electric power, natural gas, steam supply, water supply, and sewage removal. Utilities include electric power generation, electric power transmission, electric power distribution, natural gas distribution, steam supply provision, steam supply distribution, water treatment, water distribution, sewage collection, sewage treatment, and disposal of waste through sewer systems and sewage treatment facilities. Excluded from this sector are establishments primarily engaged in waste management services that collect, treat, and dispose of waste materials but do not use sewer systems or sewage treatment facilities. Also excluded from this sector are federal or state or local government operated establishments.

Construction includes establishments primarily engaged in building new structures and roads, alterations, additions, reconstruction, installations, and repairs. It includes general contractors engaged in building residential and nonresidential structures; contractors engaged in heavy construction, such as bridges, roads, tunnels, and pipelines; and special trade contracting, such as plumbing, electrical work, masonry, and carpentry. Construction includes establishments primarily engaged in the preparation of sites for new construction, including demolition, and establishments primarily engaged in subdividing land for sale as building sites. Construction work done may include new work, additions, alterations, or maintenance and repairs.

Manufacturing includes establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. The assembling of component parts of manufactured products is considered manufacturing, except in cases where the component parts are associated with structures. Manufacturing establishments can be plants, factories, or mills as well as bakeries, candy stores, and custom tailors. Manufacturing establishments may either process materials or may contract with other establishments to process their materials for them. Broadly defined, manufacturing industries include the following: food processing, such as canning, baking, meat processing, and beverages; tobacco products; textile mill products, such as fabric, carpets and rugs; apparel; wood products, including logging, sawmills, prefabricated homes, and mobile homes; furniture; paper; printing; chemicals, such as plastics, paints, and drugs; petroleum refining; rubber and plastics; leather products; stone, clay, and glass; primary metals, such as steel, copper, aluminum, and including finished products such as wire, beams, and pipe; fabricated metals, such as cans, sheet metal, cutlery, and ordnance; industrial machinery, including computers, office equipment, and engines; electronics and electrical equipment; transportation equipment, such as cars, trucks, ships, and airplanes; instruments; and miscellaneous industries, such as jewelry, musical instruments, and toys. Excluded from manufacturing is publishing of printed materials.

Wholesale trade includes establishments engaged in wholesaling merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. The merchandise described in this sector includes the outputs of agriculture, mining, manufacturing, and certain information industries, such as publishing. Wholesale establishments are primarily engaged in selling merchandise to retailers; or to industrial, commercial, institutional, farm, construction contractors; or to professional business users; or to other wholesalers or brokers. The merchandise sold by wholesalers includes all goods used by institutions, such as schools and hospitals, as well as virtually all goods sold at the retail level. Wholesalers can be merchant wholesalers who purchase goods from manufacturers or other wholesalers and sell them; sales branches of manufacturing, mining, or farm companies engaged in marketing the products of the company to retail establishments; or agents, merchandise or commodity brokers, and commission merchants.

Retail trade includes establishments engaged in retailing merchandise, generally without transformation, and rendering services incidental to the sale of merchandise. Retail trade includes store retailers such as motor vehicle and parts dealers including automobile, motorcycle and boat dealers as well as tire and automobile parts stores; furniture and home furnishing stores; electronics and appliance stores; food and beverage stores, including supermarkets, convenience stores, butchers, and bakeries; health and personal care stores such as pharmacies and optical goods stores; gasoline stations; clothing and clothing accessory stores; sporting goods, hobby, book and music stores; department stores; and miscellaneous establishments, including office supply stores, mobile home dealers, thrift shops, florists, tobacco stores, and pet shops. Retail trade also includes nonstore retailers such as Internet and catalog sellers, as well as home delivery establishments such as heating oil dealers. Retail trade excludes eating and drinking places, including restaurants, bars, and take-out stands.

Transportation and warehousing includes industries providing transportation of passengers and cargo and warehousing and storage for goods. Establishments in these industries use transportation equipment or transportation related facilities as a productive asset. Transportation includes railroads, highway passenger transportation, trucking, shipping, air transportation, pipelines, and transportation services. Transportation also includes private postal services, and courier services but excludes the U.S. Postal Service. Warehousing includes refrigerated storage and grain elevators.

Information includes establishments engaged in producing and distributing information and cultural products; providing the means to transmit or distribute these products as well as data or communications; and processing data. The main components of this sector are the publishing industries, including software publishing, and both traditional publishing and publishing exclusively on the Internet; the motion picture and sound recording industries; movie theaters; the broadcasting industries, including traditional broadcasting and those broadcasting exclusively over the Internet; the telecommunications industries; the industries known as Internet service providers and Web search portals; data processing industries; and the information services industries.

Finance and insurance includes establishments primarily either engaged in or facilitating financial transactions (e.g. transactions involving the creation, liquidation, or change in ownership of financial assets.) Establishments include depository institutions, such as commercial banks, credit unions savings and loans, and foreign banks; credit institutions; credit card processing; investment companies; brokers and dealers in securities and commodity contracts; security and commodity exchanges; carriers of all types of insurance; insurance agents and insurance brokers. Also included are central banks and monetary authorities charged with monetary control.

Real estate and rental and leasing includes establishments primarily engaged in renting, leasing, or otherwise allowing the use of tangible or intangible assets, and establishments providing related services. Real estate includes real estate leasing establishments, real estate agencies and brokerages, property management establishments, appraisals establishments, and escrow agencies. Rental and leasing includes car and truck rental, consumer goods rentals such as video stores and and formal wear rental stores, and commercial equipment renting and leasing construction, transportation, office and farm equipment. Also included are establishments that lease nonfinancial and noncopyrighted intangible assets such are patents and trademarks.

Professional and technical services includes establishments that specialize in performing professional, scientific, and technical activities for others. These activities include legal advice and representation; accounting, bookkeeping, and payroll services; architectural, engineering, and specialized design services; computer services; consulting services; research services; advertising services; photographic services; translation and interpretation services; veterinary services; and other professional, scientific, and technical services. Excluded are establishments primarily engaged in providing office administrative services, such as financial planning, billing and recordkeeping, personnel, and physical distribution and logistics.

Management of companies and enterprises includes bank holding establishments, other holding establishments, corporate management establishments as well as regional and subsidiary management establishments. Company or enterprise headquarters are included.

Administrative and waste management includes establishments engaged in office administration, hiring and placing of personnel, document preparation and similar clerical services, solicitation, collection, security and surveillance services, cleaning, and waste disposal services. Among many other establishments administrative includes call centers, tele-marketers, janitorial services, armored cars, temporary employment agencies, locksmiths, landscaping, and travel agencies. Waste management includes, among other establishments, solid waste collections and disposal, landfill operations and septic tank maintenance. Excluded from administrative and waste management are establishments involved in administering, overseeing, and managing other establishments of the company or enterprise. Also excluded are government establishments engaged in administering, overseeing, and managing governmental programs.

Educational services includes private elementary schools, junior colleges, colleges, universities, and professional schools. Also included are trade and vocational schools, business and secretarial schools, computer training services, language schools, fine arts training, sports training establishments, driving schools, flight schools and establishments that provide test preparation and tutoring. Educational services may be provided imparted in educational institutions, the workplace, or the home through correspondence, television, or other means. Public schools, including colleges and universities, are excluded from educational services.

Health care and social assistance includes establishments providing health care and social assistance for individuals. Health care establishments include ambulatory care services (e.g. physician offices, dentists, specialists, HMOs, dialysis centers, blood banks, ambulance services), hospitals, and nursing and residential care facilities. Social assistance establishments include individual and family services (e.g. adoption agencies and youth centers) and community services such as food banks and homeless shelters. Excluded from this sector are aerobic classes and nonmedical diet and weight reducing centers. Also excluded are public hospitals and clinics.

Arts, entertainment, and recreation includes establishments that are involved in producing, promoting, or participating in live performances, events, or exhibits intended for public viewing; establishments that preserve and exhibit objects and sites of historical, cultural, or educational interest; and establishments that operate facilities or provide services that enable patrons to participate in recreational activities or pursue amusement, hobby, and leisure time interests. The sector includes establishments engaged in the performing arts, sporting events, museums, zoos, amusement and theme parks, golf courses, marinas, casinos, and gambling establishments. Excluded are movie theaters.

Accommodation and food services includes hotels, motels, casino hotels, bed and breakfasts, campgrounds and recreational vehicle parks and other lodging places as well as eating and drinking places, including restaurants, bars, and take-out stands. Also included are caterers and food service contractors.

Other services, except public administration includes churches and establishments engaged in equipment and machinery repairing, promoting or administering religious activities, grantmaking, advocacy, and establishments providing drycleaning and laundry services, personal care services, death care services, pet care services, photofinishing services, temporary parking services, and dating services. Private households that engage in employing workers on or about the premises in activities primarily concerned with the operation of the household are included in this sector.

Federal civilian includes all Federal government workers regardless of their establishment classification. Federal civilian employment includes executive offices and legislative bodies; courts; public order and safety; correctional institutions; taxation; administration and delivery of human resource programs, such as health, education, and public assistance services; housing and urban development programs; environmental programs; regulators, including air traffic controllers and public service commissions; the U.S.

Postal Service; and other Federal government agencies.

Federal military includes Air Force, Army, Coast Guard, Marine Corps, Merchant Marine, National Guard, and Navy. Personnel deployed abroad are counted in their home base or port. Reserves who receive regular training are included. Civilians working on a military base are classified in the sector appropriate to their occupation.

State and local government is defined the same as Federal civilian except that the activities are run by state and local governments. At the local level, this includes all public schools as well as police and fire departments; at the state level, it includes all public junior colleges, colleges, and universities.

Earnings

Earnings of employees is the sum of wages and salaries, other labor income, and proprietors' income. Earnings also includes personal contributions for social insurance, but does not include residence adjustment; each of these components is defined in the discussion of total personal income that follows. As with employment, the historical earnings data (1969-2007) are from the U.S. Department of Commerce, Bureau of Economic Analysis. Also, like employment, earnings data are by place of work, so that earnings of an employee who works in one county but resides in another are counted in the county where the job is.

The two-digit NAICS sectors for earnings are defined the same as for employment in the preceding section. The two-digit industries are defined in the 1997 North American Industry Classification System Manual.   As with employment, earnings data in the Woods & Poole 2010 database is no longer based on the Standard Industrial Classification (SIC) system definitions. For the years 1969-2000 BEA provided earnings industry data by SIC rather than by NAICS; Woods & Poole has estimated the NAICS industry data for 1969-2000 from the BEA SIC 1969-2000 earnings industry data and the NAICS earnings industry data for the years 2001-2007.

Earnings relates to workers' compensation and is not a measure of company earnings or profits. Earnings-by-sector data are sometimes used as a surrogate variable for output by sector at the regional level where output data are not generally available.

Personal Income

The historical data (1969-2007) for total personal income are from the U.S. Department of Commerce, Bureau of Economic Analysis. Total personal income is the income received by persons from all sources, that is, from participation in production, from both government and business transfer payments, and from government interest, which is treated like a transfer payment. Persons consist of individuals, nonprofit institutions serving individuals, private uninsured welfare funds, and private trust funds. Personal income is the sum of wages and salaries, other labor income, proprietors' income, rental income of persons, dividend income, personal interest income, and transfer payments less personal contributions for social insurance. Definitions for the sources of personal income follow:

Wages and salaries consists of monetary remuneration of employees, including compensation of corporate officers; commissions, tips, and bonuses; and receipts-in-kind that represent income to the recipients.

Other labor income consists of employer payments to private and government employee retirement plans, private group health and life insurance plans, privately administered workers' compensation plans, and supplemental unemployment benefit plans.

Proprietors' income includes inventory valuation and capital consumption adjustments and is defined as the income, including income-in-kind, of proprietorships and partnerships, and of tax-exempt cooperatives. Inventory valuation adjustment is the difference between the cost of inventory withdrawals as valued in determining profits before tax, and the cost of withdrawals valued at current replacement costs. Capital consumption adjustment is depreciation and damage to a proprietor's fixed capital less the value of the current services of the fixed capital assets owned by and used by the proprietor.

Dividend income consists of the payments in cash or other assets, excluding the corporation's own stock, made by corporations located in the United States or abroad to persons who are U.S. residents; it excludes that portion of dividends paid by regulated investment companies (mutual funds) related to capital gains distributions. Interest is the interest income (monetary and imputed) of persons from all sources. Rental income is the net income of persons from the rental of real property except for the income of persons primarily engaged in the real estate business; the imputed net rental income of the owner-occupants of nonfarm dwellings; and the royalties received from patents, copyrights, and the right to natural resources.

Transfer payments to persons are payments to persons for which no current services are performed. They consist of payments to individuals by Federal, state, and local governments and by businesses. Government payments to individuals include retirement and disability insurance benefits, medical payments (mainly Medicare and Medicaid), income maintenance benefits, unemployment insurance benefits, veterans benefits, and Federal grants and loans to students. Business payments to persons consists primarily of liability payments for personal injury.

Personal social insurance contributions are subtracted in the calculation of personal income and consist of the contributions, or payments, by employees, by the self-employed, and by other individuals who participate in the following government programs: Old-age, survivors, and disability insurance (social security); hospital insurance; supplementary medical insurance; unemployment insurance; railroad retirement; veterans life insurance; and temporary disability insurance. These contributions are excluded from personal income by definition, but the components of personal income upon which these contributions are based-mainly wage and salary disbursements and proprietors' income-are presented gross of these contributions.

Residence adjustment is the net amount of personal income of persons residing in a specific geographic area but receiving the income outside that geographic area. For example, a person who earns income in one county but lives in a different county would have that income counted under residence adjustment; the county in which the person lives would have a positive residence adjustment and the county in which the person works would have a negative adjustment. Residence adjustment adjusts the earned component of personal income, which is establishment-based by place of work, to population, which is by place of residence. When total personal income is adjusted this way, personal income per capita can be calculated. Residence adjustment is a net number for a given county; if it is negative, it means that there is net commuting into the county; if it is positive, it means that there is net commuting out of the county.

As with employment, the definition of total personal income used by Woods & Poole is the most comprehensive one available. Another commonly used measure of income is money income of persons. Money income is the concept used by the Bureau of the Census and is widely used in other sources. When Woods & Poole's income data are higher than data from another source, once inflation adjustments are taken into account, it is probably because the other source uses money income base data. Total personal income includes all of money income plus the exclusions to money income. Money income excludes payments-in-kind such as food stamps, agricultural payments-in-kind, and the value of in-kind medical payments; the imputed rental value of owner-occupied housing; the imputed value of certain interest payments such as the value to consumers of free non-interest bearing checking accounts; all other labor income; capital consumption adjustments for proprietors; inventory valuation adjustments, although sometimes this is negative; and lump-sum payments such as liability judgments and consumer defaults on debts to businesses. For the U.S. as a whole, money income is about 25% less than total personal income; at the regional level, the difference varies depending on the specific composition of total personal income.

Another commonly used measure of income is disposable income, which is defined as total personal income less personal tax and non-tax payments. Disposable income is the income available to persons for spending or saving. Tax payments are payments, net of refunds, made by persons to the government; it includes taxes such as income, estate and gift, and personal property taxes, but it excludes personal contributions to social insurance. Non-tax payments include tuition and fees paid to schools and hospitals operated mainly by the government, donations to such institutions, passport fees, and fines and penalties.

Retail Sales and Food Services Sales

Data for retail sales by kind of business are from the 1972, 1977, 1982, 1987, 1992, 1997, 2002 Census of Retail Trade (U.S. Department of Commerce, Bureau of the Census). Retail sales data for 1972, 1977, 1982, 1987, 1992, and 1997 has been changed by Woods & Poole from SIC classifications to estimated NAICS kind of business classifications to be consistent with 2002 Census of Retail Trade data. The intervening historical data for the years 1969-71, 1973-76, 1978-81, 1983-86, 1988-91, 1993-96, and 1998-2001 are also estimated by Woods & Poole.

These estimates are made by interpolating retail sales by kind of business per capita for the intervening years (e.g., 1973-76). These proportions are then multiplied by population for the intervening years to estimate retail sales by kind of business. The estimates are then constrained to U.S. retail sales by kind of business for the intervening years. U.S. retail sales data for 1969-2002 are from the Bureau of Economic Analysis but are revised by Woods & Poole to be consistent with the sum of the county retail sales data for the Census years. Therefore, retail sales data for the U.S. are the sum of county retail sales as published in the Census of Retail Trade and differ from the U.S. data published monthly by the Department of Commerce.

Some county data from the Census of Retail Trade are withheld because of Federal information disclosure policies. All withheld data have been estimated by Woods & Poole; the techniques used to make these estimates are described below in the section titled "Estimation of Missing Historical Data."

In the 2010 Woods & Poole database total retail sales are modified to include food services and drinking places sales (NAICS 722). The inclusion of food services and drinking places sales makes total retail sales more consistent with the SIC definition.

Retail sales are counted, as are employment and earnings, on an establishment basis. Mail-order sales are counted at the point from which the merchandise is sent and not at the point at which it is received. Retail sales are classified by kind of business according to the principal lines of commodities sold (e.g., groceries or hardware) or the usual trade designation (e.g., drug store or cigar store). In some cases, an establishment sells goods in several different business groups, such as a convenience store with gasoline pumps. In these cases, all the establishment's sales are classified in the business group that is the primary activity of the establishment; therefore, the retail sales data by kind of business does not reflect retail sales by merchandise line. The specific kinds of business, on an NAICS basis, are described as follows:

Motor vehicle and parts dealers include establishments selling new and used cars and trucks, boats, recreational vehicles, utility trailers, aircraft, snowmobiles, motorcycles, snowmobiles, and mopeds. It also includes dealers selling new automobile parts and accessories, such as tires, as well as automobile repair shops maintained by establishments engaged in the sale of new automobiles. Establishments selling medium and heavy-duty trucks are generally excluded.

Furniture and home furnishings stores include establishments primarily selling new furniture, floor coverings, draperies and window treatments, glassware and china. Bath, linen, matress and lamp stores are included. Used furniture, appliance, and electronics stores are excluded.

Electronics and appliance stores include establishments selling new consumer electronics, televisions, radios, home appliances, computers, cameras and photography supplies.

Building material and garden equipment and supplies dealers include retail establishments primarily engaged in selling lumber and other building materials; paint, glass, and wallpaper; hardware; nursery stock; lawn and garden supplies; and outdoor power equipment. It includes lumber and other building materials dealers, and paint, glass, and wallpaper stores selling to the general public, even if sales to contractors account for a larger proportion of total sales. Dealers selling mobile homes are excluded.

Food and beverage stores include establishments primarily engaged in selling for home preparation and consumption. Food stores include grocery stores, such as supermarkets and convenience stores; meat and fish markets; fruit and vegetable markets; candy, nut, and confectionery stores; dairy product stores; retail bakers; and miscellaneous stores such as beer, wine and liquor stores, health food stores, and coffee and tea stores.

Health and personal care stores include pharmacies and drug stores; cosmetic, beauty supplies and perfume stores; optical goods stores; health supplement stores; and convalescent supply stores.

Gasoline stations include establishments primarily selling gasoline and automotive lubricants. These establishments frequently sell other merchandise, such as tires, batteries, accessories, and other automobile parts, or perform minor repair work. Establishments called garages but deriving more than half of their receipts from the sale of gasoline and automotive lubricants are included. Gasoline stations combined with other activities such as convenience stores or car washes are classified by their primary activity as determined by sales.

Clothing and clothing accessories include retail stores primarily engaged in selling clothing of all kinds and related articles for personal wear and adornment. These establishments include men's, boys', women's, infants' and girls' clothing stores; shoe stores; and specialty stores, such as swimwear, wigs, lingerie, luggage and handbags. Establishments that meet the diversity criterion for department stores are not included. Excluded are custom tailors and athletic uniform stores

Sporting goods, hobby, book, and music stores include sporting good stores (including bicycle stores, golf pro shops, exercise equipment stores and gun shops); hobby, toy and game stores; sewing and needlework stores; musical instrument and supply stores; book stores, newsstands, and music stores. Excluded are used book stores.

General merchandise stores include department stores, general discount stores, variety stores, warehouse clubs, and miscellaneous general merchandise stores. These stores all sell a number of lines of merchandise, such as dry goods, apparel and accessories, furniture and home furnishings, small wares, hardware, and food in one establishment.

Miscellaneous retail stores include florists; office supply, stationery and gift stores; used merchandise stores such as thrift stores, used book stores, and antique shops; pet shops; art dealers; mobile home dealers; swimming pool stores; and tobacco stores.

Nonstore retailers include Internet sellers; mail order and catalog sellers; television and infomercial sellers; door-to-door sellers; vending machine operators; and direct selling establishments such as heating oil dealers, bottled gas dealers, newspaper delivery, and bottled water providers.

Food services and drinking places includes establishments selling prepared food and drinks for consumption on the premises; it also includes lunch counters and refreshment stands selling prepared foods and drinks for immediate consumption. These establishments include restaurants and lunchrooms; social caterers; cafeterias; refreshment places, such as take-out hamburger and chicken stands; contract feeding, such as institutional food service; ice cream and frozen yogurt stands; and drinking places, such as bars and lounges.

Constant and Current Dollars

All earnings, personal income, and retail sales data in the Woods & Poole database are presented in 2004 dollars. These are called "constant" dollars and are used to measure the "real" change in earnings and income when inflation is taken into account. For example, it would be incorrect to assume that Americans were more than twice as wealthy in 1980 as in 1970 even though income per capita increased from $4,081 to $10,114; during those ten years the general price level increased more than 97%, and $10,114 in 1980 could not buy as much as $10,114 could in 1970. When adjusted for the rate of inflation by making income per capita "constant" in 2004 dollars, the increase from 1970 to 1980 was only 26% ($16,725 to $21,052).

In the Woods & Poole database, the personal consumption expenditure deflator is used to convert current dollars into constant dollars; the chain-type deflator, revised by the BEA in 2000, is used by Woods & Poole. The personal consumption expenditure deflator for each year from 1969 to 2040 is listed in Table 4. To convert current dollar data to 2004 dollars, divide the current dollars by the deflator for the appropriate year in Table 4 divided by 100. To convert constant 2004 dollar data into current dollars, multiply the constant dollars by the deflator for the appropriate year in Table 4 divided by 100. The formulas in the side-bar box on the facing page outline the procedure to convert constant dollars to current dollars and vice versa. The same deflator is used for the U.S. and all counties in the Woods & Poole database; hence, the rate of inflation (the percent difference year to year in the deflator) is assumed to be constant for all parts of the country.

Table 4. Personal Consumption Expenditure Deflator (2004 = 100)

1969	23.30
1970	24.40
1971	25.44
1972	26.32
1973	27.75
1974	30.62
1975	33.17
1976	35.01
1977	37.28

1978	39.90
1979	43.42
1980	48.05
1981	52.33
1982	55.22
1983	57.60
1984	59.78
1985	61.75
1986	63.26
1987	65.45
1988	68.04
1989	71.01
1990	74.27
1991	76.96
1992	79.18
1993	81.01
1994	82.71
1995	84.49
1996	86.30
1997	87.76
1998	88.55
1999	90.02
2000	92.26
2001	94.19
2002	95.53
2003	97.42
2004	100.00
2005	102.94
2006	105.80
2007	108.55
2008	112.18
2009	114.55
2010	117.42
2011	120.96
2012	124.72
2013	128.66
2014	132.79
2015	137.12
2016	141.66
2017	146.42
2018	151.41
2019	156.65
2020	162.15
2021	167.92
2022	173.98
2023	180.35
2024	187.04
2025	194.08

2026	201.39
2027	209.00
2028	216.93
2029	225.17
2030	233.75
2031	242.68
2032	251.97
2033	261.65
2034	271.72
2035	282.21
2036	293.10
2037	304.42
2038	316.17
2039	328.37
2040	341.05

Note: Chain-type deflator; historical data, 1969-2008, from U.S. Dept. of Commerce; projected data, 2009-2040, from Woods & Poole Economics, Inc.

Population

The historical population data for the years 1969 to 2008 is from the U.S. Department of Commerce, Bureau of the Census. The historical population data in the 2010 Woods & Poole database includes 2000 Census results. The historical county total population and population by single year of age by race and sex for the years 1991-1999 and 2001-2008 was estimated by Woods & Poole using 1990 and 2000 Census results and Bureau of the Census intercensal and postcensal estimates. The historical county population by single year of age by race and sex for the years 1971-1979 and 1981-1989 is estimated by using single year of age data from the 1970, 1980, and 1990 Census of Population for counties, and U.S. annual population by single year of age by race and sex.

Population is defined as July 1 residential population and includes: civilian population; military population except personnel stationed overseas; college residents; institutional populations, such as prison inmates and residents of mental institutions, nursing homes, and hospitals; and estimates of undocumented aliens. Excluded are persons residing in Puerto Rico, U.S. territories and possessions, and U.S. citizens living abroad.

For the years 1990 to 2040 the population data is broken down by five race/ethnic groups: White not including Hispanic or Latino (i.e. Non-Hispanic), Black Non-Hispanic, Native American or American Indian Non-Hispanic, Asian American and Pacific Islanders Non-Hispanic, and Hispanic or Latino. Population by race as defined by the Census Bureau reflects self-identification by respondents and does not denote any clear-cut scientific definition of biological stock. White population includes people who identify themselves as White and people who do not identify themselves by any race but identify themselves by nationality, such as Canadian, German, Italian, Arab, Lebanese, Near Eastern, or

Polish. Black population includes people who identify themselves as Black and people who do not identify themselves by any race but identify themselves by nationality, such as African American, Afro-American, Black Puerto Rican, Jamaican, Nigerian, West Indian, or Haitian. Native American population includes people who identify themselves as Alaska Native or American Indian by Indian tribe or classify themselves as Canadian Indian, French American Indian, Spanish-American Indian, Eskimos, Aleuts, and Alaska Indians. Asian American and Pacific Islander population are people who identify themselves as having origins in any of the original peoples of the Far East, Southeast Asia,or the Indian subcontinent including, for example, Cambodia, China, India, Japan, Korea, Malaysia, Pakistan, the Philippine Islands, Thailand, Vietnam, Hawaii, Guam, Samoa, or other Pacific Islands.

Hispanic or Latino population are people whose origins are from Spain, the Spanish-speaking countries of Central or South America, the Dominican Republic, and who identify themselves generally as Spanish, Spanish-American, Hispanic, Hispano, Latino, and so on. Hispanic population is not a race group but rather a description of ethnic origin. Although Hispanics are part of the other four race groups they split out separately in the Woods & Poole database so that the four race groups plus Hispanic equals total population.

Hispanic data are historical for 1970, 1980, and 1990-2008 from the decennial censuses, adjusted to July 1, and from Census Bureau intercensal and postcensal population estimates. For counties with Hispanic population greater than 40,000, actual historical data for 1981-1985 from a special Census Bureau report are included. Census Bureau data are also included for the U.S. for 1969-1990, and for states for 1981-1985 and 1990. Hispanic data for all other years are estimated. The Woods & Poole Hispanic population data for 1980 differ significantly from the final 1980 Census for some states, e.g., Alabama and Mississippi; this is because of post-1980 Census Bureau revisions to the 1980 Census that are incorporated in the Woods & Poole data.

For the years 1970 to 1989 the population in the Woods & Poole database is available in three race groups which sum to total population: White, Black, and Other. All three of these race groups include Hispanic population. The Hispanic data for 1970 to 1989 is provided separately. Although the total Hispanic population and the population by age and gender for the years 1970 to 1989 are consistent with the data 1990 to 2040, the population by race data is not.

The Woods & Poole database includes 2000 Census population data, adjusted to July 1, for total population by single year of age, race and sex. However, the 2000 Census race classifications were adjusted to create a consistent time-series for the years 1990 to 2000. The 2000 Census classification Some Other Race was distributed as follows: of the 15.36 million people classifying themselves as Some Other Race, 14.89 million were Hispanic and were therefore added to Hispanic population; the remaining 468,000 were distributed to the other four race groups proportionally by age and gender. The 2000 Census classifications for Two or More Races were distributed as follows: of the 6.8 million people classifying themselves as Two or More Races, 2.22 million were Hispanic and were added to the Hispanic population; the remaining 4.60 million were distributed to the other four race groups proportionally by age and gender.

The population data in the Woods & Poole database are generally consistent with data from other sources, including the Census Bureau. The most significant difference between the Census Bureau data used by Woods & Poole and the actual 1970, 1980, 1990, and 2000 Census results is that Woods & Poole data are July 1-based and the decennial census data are April 1-based. Decennial census data were adjusted forward from April 1 to July 1 to make them consistent with population data for other years as well as with the employment and income data, which are also July 1-based.

Households

The data for households are from Census Bureau counts in 1970, 1980, 1990, and 2000 and Census Bureau estimates for 1985. As with population, the household data from the decennial censuses were adjusted from April 1 to July 1. The 1985 Census Bureau estimate was already July 1-based. All other years of county household data (i.e., 1969, 1971-1979, 1981-1984, 1986-1989, and 1991-1999) are estimates. Household data for the U.S. and states, 1969-2000, are based on Census Bureau data.

Household data for total number of households, group quarters population, and average size of households from the 1990 and 2000 Census, adjusted to a July-1 base, are included in the Woods & Poole database.

Households are defined as occupied housing units. A housing unit is a house, an apartment, a group of rooms, or a single room occupied as separate living quarters. The occupants of a housing unit may be a single family, one person living alone, two or more families living together, or any group of related or unrelated persons who share living quarters. All people are part of a household except those who reside in group quarters. Group quarters include living arrangements such as prisons, homes for the aged, rooming houses, college dormitories, and military barracks. The average size of households is defined as total population less group quarters population divided by the number of households. Mean household income is defined as total personal income less estimated income of group quarters population divided by the number of households.

Households by Income Bracket

The number of households by income bracket is historical only for 1990 and 2000 and is based on Census data for household income in the years 1989 and 1999, respectively. The income brackets are in 2000 dollars and since the brackets themselves are not adjusted over the projection horizon all brackets from 2001 to 2040 are also in 2000 dollars. The 2000 Census income brackets are retained for the projection years; as a result, in the Woods & Poole projections, there is a heaping of households into the higher income brackets because of projected real increases in total personal income. The projection of the number of households by income bracket is made simply by changing the median income for the years 2001 to 2040 in relation to projected mean household income, and retaining the income distribution around the 2000 median. The lack of historical time series data for county households by income bracket means that the projections are based on a single observation point; projections based on extrapolations from a single data point are less reliable that projections based on time-series data.

Woods & Poole Wealth Index

The Woods & Poole Wealth Index is a measure of relative total personal income per capita weighted by the source of income. The Wealth Index is the weighted average of regional income per capita divided by U.S. income per capita (80% of the index); plus the regional proportion of income from dividends/interest/rent divided by the U.S. proportion (10% of the index); plus the U.S. proportion of income from transfers divided by the regional proportion (10% of the index). Thus, relative income per capita is weighted positively for a relatively high proportion of income from dividends, interest, and rent, and negatively for a relatively high proportion of income from transfer payments. Because the imputed rent of owner-occupied homes is added to rental income of persons in calculating total personal income, some of the appreciated value of owner-occupied homes is included in rental income. Since dividends, interest, and rent income are a good indicator of assets, the Woods & Poole Wealth Index attempts to measure relative wealth.

Comparative Data

Some Woods & Poole statistical tables and data files contain summary data on unemployment, number of business establishments, and educational attainment. These data are provided for comparison purposes and are not part of the Woods & Poole forecasting model.

Labor force and unemployment data are from the Bureau of Labor Statistics. Data are provided for the civilian labor force, employment, unemployment, and the unemployment rate for 1998 to 2008. Employment is defined by the Bureau of Labor Statistics and excludes military employment and proprietors. Civilian labor force is defined as people who are either employed or who are unemployed and looking for work; civilian labor force is the sum of the employed and unemployed. The unemployment rate is the number of people unemployed divided by the civilian labor force. The monthly data are not seasonally adjusted. The labor force, employment, and unemployment data are all by place of residence and not by place of work.

Business establishments by size and industry is from the Bureau of the Census. Data are provided for the total number of business establishments and the number with fewer than fifty employees and the number with fifty or more employees by one-digit NAICS industries. The data are for March 2005 and March 2006 and are not an annual average. The number of business establishments excludes proprietors and government. The industry groups are based on 1997 North American Industry Classification System (NAICS) definitions. The data on the number of business establishments includes establishments by industry that are statewide and not part of any particular county. In the Woods

& Poole database, statewide establishments are distributed proportionally to counties within the state based on the number of establishments by industry within a particular county; therefore, Woods & Poole county data may differ from other published data.

Educational attainment data for the years 1970, 1980, 1990, and 2000 are from the Bureau of the Census. The percent of the population age 25 or more not completing high school, completing high school, and completing four or more years of college is reported. The educational attainment data are based on self-reporting by decennial Census respondents and are not matched to actual school enrollment or graduation data.

Land area is from the 2000 Census and is in square miles. The data are for all U.S. counties; the land area for geographic units larger than county (including the U.S. as a whole) is calculated by summing county land area.

Estimation of Missing Historical Data

Some historical earnings and employment data by sector was withheld by the Department of Commerce because of Federal information disclosure policies. Data are usually withheld in small sectors in a specific county; the reporting of this data would divulge confidential employment and earnings information about specific companies in that area. In order to make the database consistent, and facilitate the forecasting model, all missing data points were estimated by Woods & Poole. In sum, approximately 4% of all data in the historical database were withheld and had to be estimated.

The algorithms used to estimate the missing data were applied in two stages. First, a "best guess" of the missing data was obtained. For example, in the case of mining employment, missing data for a county were estimated by observing the relationship between that county's mining employment in reported years and statewide mining employment for the same years. This method took into account, when possible, fluctuations in a series because of business cycles during the historical period. When sufficient years in a series were reported to provide statistical reliability (this occurred in approximately 33% of the cases where data were withheld), business cycles were all estimated separately, thus enabling reliable estimates to be made of the missing data points. In other cases, where too many years in a series were withheld, business cycles were not taken into account, but the same method of observing the relationship between county series, in reported years, to the state series in the same years was used (this occurred in approximately 61% of the cases). In approximately 6% of the cases, the data for a county series, such as mining employment, were withheld for every year, and the relational method would not work. In these cases, the relationship between total economic activity in the county to the state, in a non-cyclical manner, was used to derive "best guess" results.

Once the "best guess" results were estimated, an iterative procedure was used to simultaneously constrain the "best guess" to the county control total, (i.e., total employment in the above example) and the state total for the series (i.e., state mining employment in the above example). This iterative procedure, beginning with the "best guess" solution, produced, for all missing data points, a convergence point that is used as historical data. However, since the data are truly withheld by the government, there is no mathematically tractable solution to the problem of missing data. Estimated withheld data are indicated for employment and earnings of employees in the Woods & Poole database printed tables with an "e" following the estimated data; estimated withheld data for retail sales by kind of business and other data series is not indicated in the Woods & Poole database.

Average Annual Rate of Growth

In some statistical tables in Woods & Poole publications, data are presented for the average annual rate of growth for a particular variable over a specified time period. The average annual rate of growth is the compounded growth of a variable over time. Thus, a 3.0% average annual rate of growth between 1970 and 1980 for population would mean that, on average, the population increased 3.0% each year between 1970 and 1980.

An average annual rate of growth can be calculated by dividing the data year t+n by data year t and calculating the nth root of the quotient (where n is the number of years between t and t+n). Subtract one and multiply by 100 to convert the growth into percent. A negative average annual rate of growth would mean a decline in the variable over time.

Rounding of Data

Data for the U.S., states, Metropolitan Statistical Areas (MSAs), Designated Market Areas (DMAs), and other regions are the sum of counties. Due to rounding, the subtotals in Woods & Poole data tables may not exactly equal the components. Special calculations in some data tables (e.g., population growth rates) also may not exactly equal the data because of rounding. Since the U.S. and state data are based on county estimates, they may differ from U.S. and state data available from other sources.

County Definitions

The county definitions and county-equivalent definitions used in the Woods & Poole database are defined by the BEA. In New England, counties were created by summing townships and creating county-equivalent areas. Parishes in Louisiana, Boroughs in Alaska, and Independent Cities in Maryland, Missouri, and Nevada are called counties in the Woods & Poole database. In some states, notably Virginia, counties exist with independent cities. In cases where boundaries between counties and independent cities (or counties and other counties) have changed since 1969, new county groups are created to maintain the consistency of the historical data. Table 5 lists all the special county groupings in the Woods & Poole database.

Broomfield County Colorado (FIPS 08014) is a new county created after the 2000 Census from portions of Boulder, Adams, Jefferson and Weld counties; it is not included separately in the 2010 Woods & Poole database.

Federal Information Processing Standards (FIPS) codes are defined by the National Institute of Standards and Technology to give numeric "names" to geographic areas such as states and counties. Each state has a two-digit FIPS code (Alabama is 01 and Wyoming is 56) and counties have five-digit codes with the first two digits being the state code: Autauga AL is 01001 and Weston WY is 56045.

Table 5. Woods & Poole Special County Definitions
(FIPS codes in Parentheses)

Northwest Arctic Borough, AK (02188)
- Kobuk, AK (02140)

Remainder of Alaska, AK (02999)
- Aleutian Islands, AK (02010)
- Aleutian Islands East Borough, AK (02013)
- Aleutian Islands West Census Area, AK (02016)
- Bethel Census Area, AK (02050)
- Denali Borough, AK (02068)
- Dillingham Census Area, AK (02070)
- Haines Borough, AK (02100)
- Kenai Peninsula Borough, AK (02122)
- Lake and Peninsula Borough, AK (02164)
- North Slope Borough, AK (02185)
- Prince of Wales-Outer Ketchikan, AK (02201)
- Sitka Borough, AK (02220)
- Skagway-Yukatat-Angoon, AK (02231)
- Skagway-Hoonah-Angoon Census Area, AK (02232)
- Southeast Fairbanks Census Area, AK (02240)
- Valdez-Cordova Census Area, AK (02261)
- Wrangell-Petersburg Census Area, AK (02280)
- Yakutat Borough, AK (02282)
- Yukon-Koyukuk, AK (02290)

Yuma + La Paz, AZ (04027)
- La Paz, AZ (04012)
- Yuma, AZ (04027)

Miami-Dade, FL (12086)
- Dade, FL (12025)

Maui + Kalawao, HI (15901)
- Kalawao, HI (15005)
- Maui, HI (15009)

Fremont, ID (16043)
- Fremont, ID (16043)
- Yellowstone Park, ID

Park, MT (30067)
- Park, MT (30067)
- Yellowstone Park, MT (30113)

Valencia + Cibola, NM (35061)

Cibola, NM (35006)
Valencia, NM (35061)

Halifax, VA (51083)
Halifax, VA (51083)
South Boston City, VA (51780)

Albemarle + Charlottesville, VA (51901)
Albemarle, VA (51003)
Charlottesville City, VA (51540)

Alleghany + Clifton Forge + Covington, VA (51903)
Alleghany, VA (51005)
Clifton Forge City, VA (51560)
Covington City, VA (51580)

Augusta + Staunton + Waynesboro, VA (51907)
Augusta, VA (51015)
Staunton City, VA (51790)
Waynesboro City, VA (51820)

Bedford + Bedford City, VA (51909)
Bedford, VA (51019)
Bedford City, VA (51515)

Campbell + Lynchburg, VA (51911)
Campbell, VA (51031)
Lynchburg City, VA (51680)

Carroll + Galax, VA (51913)
Carroll, VA (51035)
Galax City, VA (51640)

Dinwiddie + Colonial Heights + Petersburg, VA (51918)
Dinwiddie, VA (51053)
Colonial Heights City, VA (51570)
Petersburg City, VA (51730)

Fairfax + Fairfax City + Falls Church City, VA (51919)
Fairfax, VA (51059)
Fairfax City, VA (51600)
Falls Church City, VA (51610)

Frederick + Winchester, VA (51921)
Frederick, VA (51069)
Winchester City, VA (51840)

Greensville + Emporia, VA (51923)
Greensville, VA (51081)
Emporia City, VA (51595)

Henry + Martinsville, VA (51929)
Henry, VA (51089)
Martinsville City, VA (51690)

James City + Williamsburg, VA (51931)
James City County, VA (51095)

Williamsburg City, VA (51830)

Montgomery + Radford, VA (51933)
Montgomery, VA (51121)
Radford City, VA (51750)

Pittsylvania + Danville, VA (51939)
Pittsylvania, VA (51143)
Danville City, VA (51590)

Prince George + Hopewell, VA (51941)
Prince George, VA (51149)
Hopewell City, VA (51670)

Prince William + Manassas + Manassas Park, VA (51942)
Prince William, VA (51153)
Manassas City, VA (51683)
Manassas Park City, VA (51685)

Roanoke + Salem, VA (51944)
Roanoke, VA (51161)
Salem City, VA (51775)

Rockbridge + Buena Vista + Lexington, VA (51945)
Rockbridge, VA (51163)
Buena Vista City, VA (51530)
Lexington City, VA (51678)

Rockingham + Harrisonburg, VA (51947)
Rockingham, VA (51165)
Harrisonburg City, VA (51660)

Southampton + Franklin, VA (51949)
Southampton, VA (51175)
Franklin City, VA (51620)

Spotsylvania + Fredericksburg, VA (51951)
Spotsylvania, VA (51177)
Fredericksburg City, VA (51630)

Washington + Bristol, VA (51953)
Washington, VA (51191)
Bristol City, VA (51520)

Wise + Norton, VA (51955)
Wise, VA (51195)
Norton City, VA (51720)

York + Poquoson, VA (51958)
York, VA (51199)
Poquoson City, VA (51735)

Shawano (includes Menominee), WI (55901)
Menominee, WI (55078)
Shawano, WI (55115)

Metropolitan Area Definitions

Metropolitan Statistical Areas (MSAs), Combined Metropolitan Statistical Areas (CSAs), Micropolitan Statistical Areas (MICROs), and Metropolitan Divisions (MDIVs) in the Woods & Poole database are as defined in the November 2008, Office of Management and Budget (OMB BULLETIN NO. 09-01).

All Woods & Poole historical data back to 1969 is revised to reflect the new 2008 OMB Metropolitan Area (MSA, CSA, MICRO, and MDIV) definitions. There are 366 MSAs, 124 CSAs, 574 MICROs, and 29 MDIVs in the 2010 Woods & Poole database. A list of all CSAs, MSAs, MICROs, and MDIVs and their component counties can be found in Appendices 2, 3, 4 and 5, respectively. These Appendices follow this chapter and begin on page 40. Although CSAs can be defined in terms of MSAs and MICROs, in the Woods & Poole database, and in Appendix 2, they are defined in terms of counties.

New England City and Town Areas (NECTAs) and Combined New England City and Town Areas (CNECTAs) are not in the Woods & Poole database because they are defined with geographic units smaller than counties. The 19 MSAs, CSAs, and MICROs in Puerto Rico are also not included in the Woods & Poole database.

MSAs, as defined by the OMB, have at least one urbanized area of 50,000 or more population, plus adjacent territory that has a high degree of social and economic integration with the core as measured by commuting ties. Micropolitan Statistical Areas - a new set of statistical areas - have at least one urban cluster of at least 10,000 but less than 50,000 population, plus adjacent territory that has a high degree of social and economic integration with the core as measured by commuting ties. The central cities that form the basis on MSAs and MICROs are generally included in their titles, as well as the name of each state into which the MSA or MICRO extends. MSAs and MICROs are defined in terms of whole counties (or equivalent entities), including in the six New England States. If the specified criteria are met, a MSA containing a single core with a population of 2.5 million or more may be subdivided to form smaller groupings of counties referred to as Metropolitan Divisions. MDIVs are not comparable to either MSAs or MICROs and should not be ranked together.

According to the OMB if specified criteria are met, adjacent MSAs and MICROs, in various combinations, may become the components of a new set of areas called Combined Statistical Areas. For instance, a CSA may comprise two or more MSAs, a MSA and a MICRO, two or more MICROs, or multiple MSAs and MICROs. In the Woods & Poole database CSAs are defined in terms of counties. According to the OMB combinations for adjacent areas with an employment interchange of 25 or more are automatic. Combinations for adjacent areas with an employment interchange of at least 15 but less than 25 are based on local opinion as expressed through the Congressional delegations.

Regions

The eight regions in the Woods & Poole database are aggregates of states and are defined by the Bureau of Economic Analysis. A list of all BEA regions and their component states can be found in Appendix 1 following this chapter. The BEA regions used by Woods & Poole differ from the nine regions defined by the Census Bureau and used in their publications.

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Appendix D

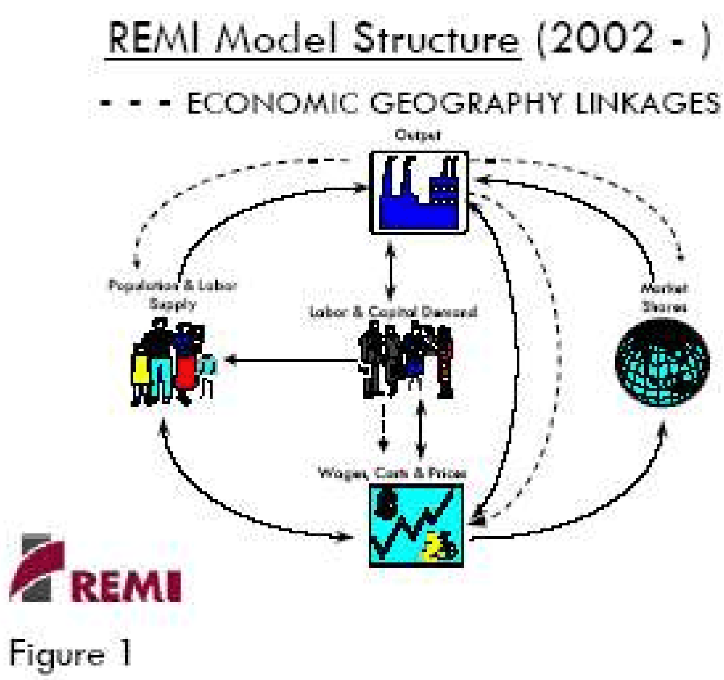
The Nevada State Demographer's projections are developed using the Regional Economic Models, Incorporated (REMI) model through 2028.

The REMI model is a comprehensive model that encompasses a wide range of demographic and economic activity. It relates a region or set of regions to each other and the nation as whole. It also comes with differing levels of industrial detail. The model is used by the Nevada Commission on Economic Development, the Nevada Department of Administration, and the University of Nevada, Las Vegas. The model used in producing these projections is a 17 region model with a breakdown into 23 industrial sectors. Documentation about the model can be found at http://www.remi.com/support/documents.shtml.

The overall linkages of the REMI model are shown in Figure 1.

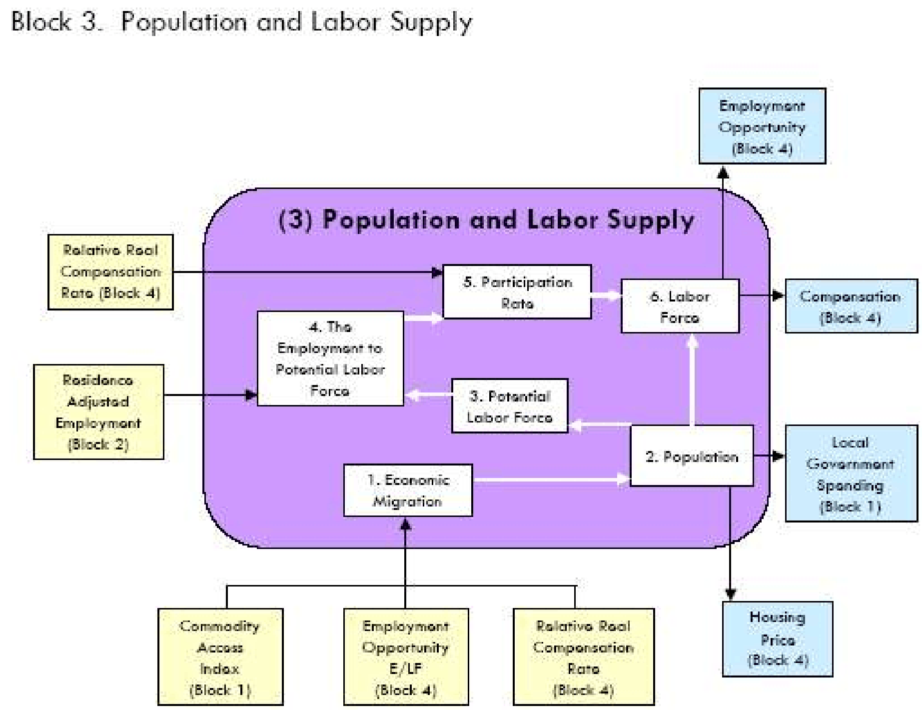
The REMI model comes with a baseline forecast, what has come to be referred to as an out of the box projection (see Appendix pages). The user can do things such as update employment for all sectors and by specific sectors through what are called policy variables. For the most part, those kinds of changes were made to the model in producing the projections. One area of concern in looking at the model was the performance of the Population and Labor Supply Block which is illustrated in Figure 2.

Figure 1: REMI Model Overall Linkages



Source: Regional Economic Models, Inc.; REMI Policy Insight 8.0 User Guide; 2006; p.6.

Figure 2: Population and Labor Supply



Source: Regional Economic Models, Inc.; REMI Policy Insight 8.0 User Guide; 2006; p.16.

LIMITATIONS TO THE PROJECTIONS

REMI has a number of strengths. The model is under constant research and has been available for over 25 years. It has been examined and reviewed through peer-reviewed articles. The User Guide and other information is available to anyone with a computer, that is much of the detail of their methodology is publicly available. One of the major limitations with the model is that there is currently limited historic data from which it is built. This is because of the change from the Standard Industrial Classification (SIC) to the North American Industrial Classification System (NAICS) in 2001. Limited history limits the amount of information that a model can be constructed from for portraying the area that is being modeled. Another limit is that Nevada has a number of small counties as well as areas with limited numbers of employees or employers in various economic sectors. This leads to missing information through data suppression which REMI and this office has to then estimate values to substitute for that missing information.

Also, REMI is built on federal data including the annual estimates that are done by the Census Bureau. So any projections done within the model have to be re-based off of Nevada's generated estimates.

Appendix E

TMWA Background Data

TRUCKEE MEADOWS WATER AUTHORITY
www.tmh2o.com

Memorandum

1355 Capital Blvd. • PO Box 30013 • Reno, NV 89520-3013
775.834.8080 • 775.834.8003

TO: File

FROM: **Shawn Stoddard, Ph.D. Senior Resource Economist**

DATE: August 3, 2009

SUBJ: TPEM Series No. 1: Washoe County Population Projection 2009 to 2050

Findings

- State Demographer reports 2008 population as 423,833 persons.
- Current economic conditions are unprecedented and are thus not easily modeled by traditional population/employment models.
- Washoe County population from 1950 to 2008 is well modeled by a logistic curve.
- Population projection using logistic curve is statistically similar to State Demographer's 2008 population projection for Washoe County.
- Population projections for 2010 to 2030:

Year	Population	Year	Population
2010	440,081	2021	519,876
2011	448,038	2022	526,185
2012	455,872	2023	532,324
2013	463,577	2024	538,291
2014	471,146	2025	544,088
2015	478,572	2026	549,713
2016	485,851	2027	555,166
2017	492,977	2028	560,450
2018	499,946	2029	565,564
2019	506,754	2030	570,511
2020	513,398		

- Logistic curve model can and should be updated annually.

Discussion

To date TMWA has developed two population/employment models, TMWA Population Employment Models, TPEM 2002 and TPEM 2006. TPEM 2002 model projected total population as a function of employment in various economic sectors and projected employment in various sectors as a function of employment and population. This model resulted in increasing population and employment indefinitely through time (i.e. no resource or economic constraints). This model was then constrained by extrapolating land use patterns and utilization rates thus limiting the growth in population to rate that new dwelling units were currently being constructed. The 2002 model had the benefit of detailed employment data by sector from 1969

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to 2000, the 2000 census population data, and detailed land use. In 2002 it was a reasonable expectation that future land utilization rates and patterns will be similar to past patterns.

TPEM 2006 was a reconstruction of the logic used in the 2002 model. However, the modeling effort was plagued by difficulties caused by changes in the way the U.S. government reports labor statistics. In 2001 there was a change in the industrial classification system from SIC codes (Standard Industry Classification) to NAICS codes (North America Industry Classification System). This resulted in a break in the time series for all employment data, making time series analysis difficult at best and data series short for any meaningful analysis. BLS (Bureau of Labor Statistics) published a limited amount of reconstructed employment data for the years 1990 to 2001 that allowed for the development of a population/employment model that was based only on population and total employment for Washoe County. Thus, the 2006 model had less detail and information than the 2002 model but used the same logic for the land use analysis. While the 2006 model performed well, it was based on limited data and was very time consuming to develop and only provided limited information.

This memorandum, the first in a series, relating to the development of TPEM 2009 describes the analysis and projection total population for Washoe County. This total population will serve as a key data input for estimating and projecting residential dwelling units and total employment as required for future water demand projections.

Much of the technical discussion on population projection methods is taken either in part or in whole from "*State and Local Population Projection – Methodology and Analysis*" by Stanley K. Smith, Jeff Tayman, and David A. Swanson, published 2001 Kluwer Academic / Plenum Publisher.

Population Analysis Process

There are many different methods of projecting populations. These models range from the simple with minimum data requirement to the very complex with large complex data requirements. The State Demographer uses the Regional Economics Model, Inc. (REMI) model which is a very complex data model that produces very detailed outputs in excess of TMWA's planning needs. The State Demographer last published population projections in October 2008 using the REMI model and data from 2007.

The goal of this analysis is to develop a population projection that captures the most current population trends, considers the natural constraints on growth, has value when compared with other current and recent population projections, and can be easily updated on an annual basis.

Since the 2008 Demographer's projection is the most current projection published and is based on a full economic model, it will serve as a comparison / baseline projection. For a new / updated projection to be useful it should meet these requirements:

1. Project a long-run model of population, i.e. beyond year 2030.
2. Use data that is part of a very long time series, and is not likely to change in the near future e.g., Census and Demographer's certified annual population estimates.
3. Produce a projection that is statistically comparable to results produced by more complicated structural models.

4. Produce results that reasonably include or project current regional economic and population expectation.

The logistic curve model (LCM) used for projecting population in this report was selected based on the results from a model evaluation, testing, and comparison process documented in Appendix A: Population Projection Notes. The LCM described below meets all of the selection criteria defined. LCMs are generally used for long-term population projections, thus this model is able to project population beyond the year 2030. The model is estimated using 59 years of Washoe County population from 1950 to 2008. The resulting model contains the Demographer's projection with-in the 95% confidence interval. Last, the model projections are reasonable given current economic conditions.

Logistic Curve Model

Population for Washoe County is defined as:

$$Pop_t = \alpha / \left(1 + \beta 1 * e^{-\beta 2 * t}\right) + calib$$

Where t is time, Pop_t is population in time t, α is population ceiling, $\beta 1$ and $\beta 2$ are shape parameters, and *calib* is an adjustment factor so the population modeled in 2008 will equal the observed population.

Estimation results:

$$Pop_t = 676{,}985 / \left(1 + 12.93262 * e^{-0.0513267 * t}\right) + calib$$

Where t is time in years starting at $t = 1$ for 1950 and $calib = 7{,}464$ is an adjustment to make the projection equal observed population in 2008. The $R^2 = 0.9997$ shows that this model is a very good fit to the historic data.

This model is restricted to the lower 95% confidence boundary to capture the current effect of the current economic downturn. The estimation process for selecting the lower boundary requires some explanation. Three models are estimated using the population data. First, an unrestricted model (Model 1) that estimates α, $\beta 1$, and $\beta 2$ for the population data. Model 1 provides an unrestricted estimate of the population ceiling α as 731,313 persons with a 95% confidence interval of 676,985 and 785,641 persons. Second two restricted models are estimated, Model 2, restricts α to 676,985 persons, providing the lower 95% confidence boundary. Model 3, restricts α to 785,641 persons providing the upper 95% confidence boundary. The full estimation results are reported in Appendix A.

Figure 1, provides a graphical comparison of the three models with the historic population from 1950 to 2008. As can be seen all three models plot well with the historic population. All three models fit the data equally well as judge by the R^2 =0.9997 for all models.

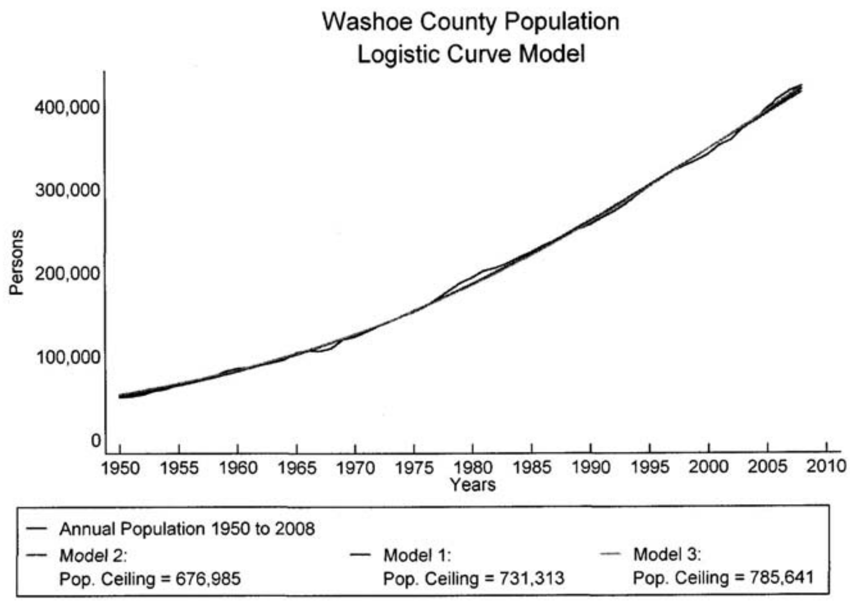

Figure 1: Logistic curves and historic population for Washoe County.

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Figure 2, shows the three LCMs calibrated to 2008 estimated population. Through the year 2015 all projections are essentially the same and can be used for planning. However, Model 2 is preferred as the economy is still in period of decline and this has the effect of slowing population growth. Through the year 2020 the Demographer's projection tracks very well with Model 1 and then trends towards Model 2. On this basis Models 1 and 2 are favored for projecting population.

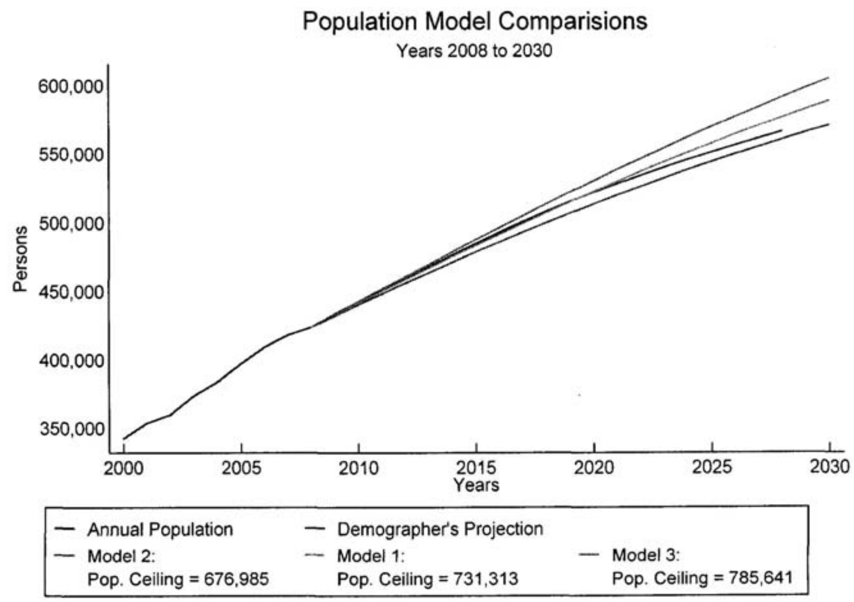

Figure 2: Compare Models 1 to 3 and Demographer's projections.

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Figure 3, shows the long-run properties of each of the models. From this graph, Model 3 seems to be the least likely out come, it has a population ceiling of 785,641 persons and given current conditions and the overall trend between the years 2000 and 2030, this model is rejected. While Model 1 is plausible it is rejected in favor of Model 2. The primary reason for selecting Model 2 is the continued slowing economy, which generally results in slow population growth. Model 2 also tracks best with the REMI model projections published by the State Demographer. This is a conservative population projection in that it expects slower growth, but the projection through 2020 from all models are statistically equal.

This model should be updated annually as certified population and/or projections are published.

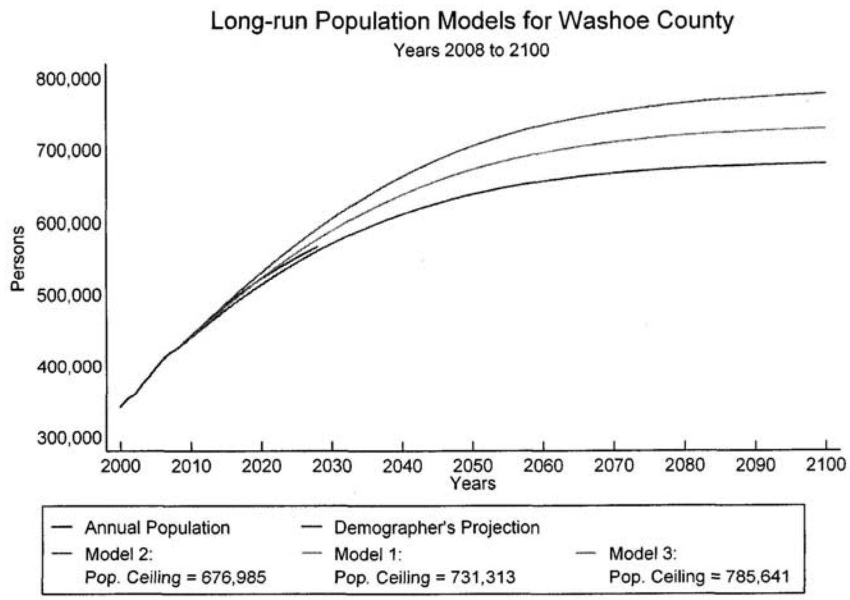

Figure 3: Compare models long-run projections through 2100.

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Figure 4 graphs the complete population and population projections from 1950 to 2100. The LCM fits the long-run trend well. The long-run graph shows the Demographer's projection tracking as a section of the overall trend. Thus, the graphical analysis supports the selection of Model 2 as a reasonable model to project population values.

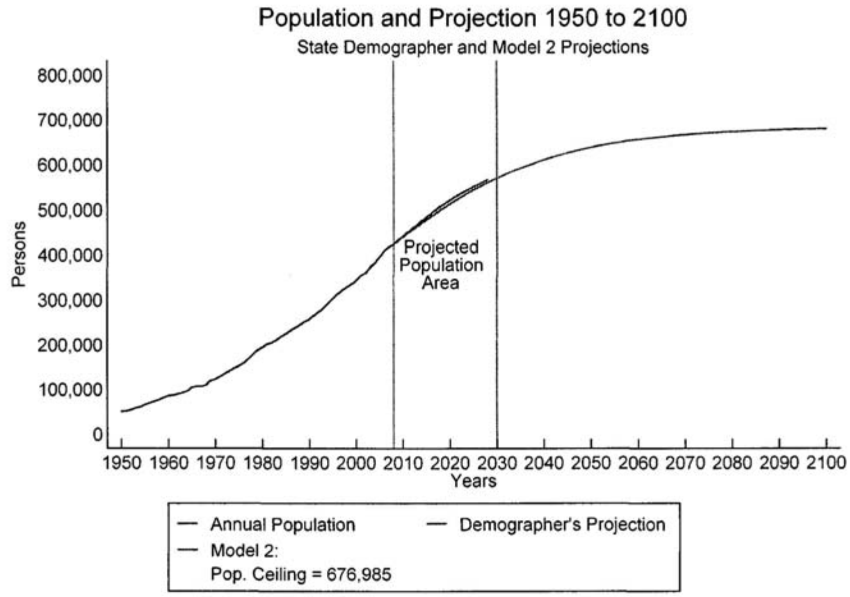

Figure 4: Population, Demographer's and Model 2 Projections 1950 to 2100.

Appendix B lists all the data, model output, historic population, and the Demographer projection used in this analysis.

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TPEM Population Projection Appendixes

Appendix A: Population Projection Research Notes. These notes document the analysis process, testing results of various population projection methods and the logic used to select the model to be used for projecting Washoe County Population.

Appendix B: Source Data, documents the data used in the analysis, where to obtain updates to the data, and a listing of the data in the form of tables.

Appendix C: Stata Program Code, To enable others to replicate and or review the analysis in detail all project code is listed and documented. Included are instruction for creating the file folder structure necessary to run the provided code.

Appendix A: Population Projection Research Notes

Current Population and Demographic Data

There are only two sources of population data for the State of Nevada and Washoe County; United States Census Bureau and the State Demographer's Office. The Census Bureau compiles and estimate a wide range of demographic variables for each of Nevade's counties. The State of Nevada Demographer is responsible for estimating population for each county and the State for State Department of Taxation. It is the Demographer's population estimates that must be used for the allocation of state funds. The population used is described in Appendix B.

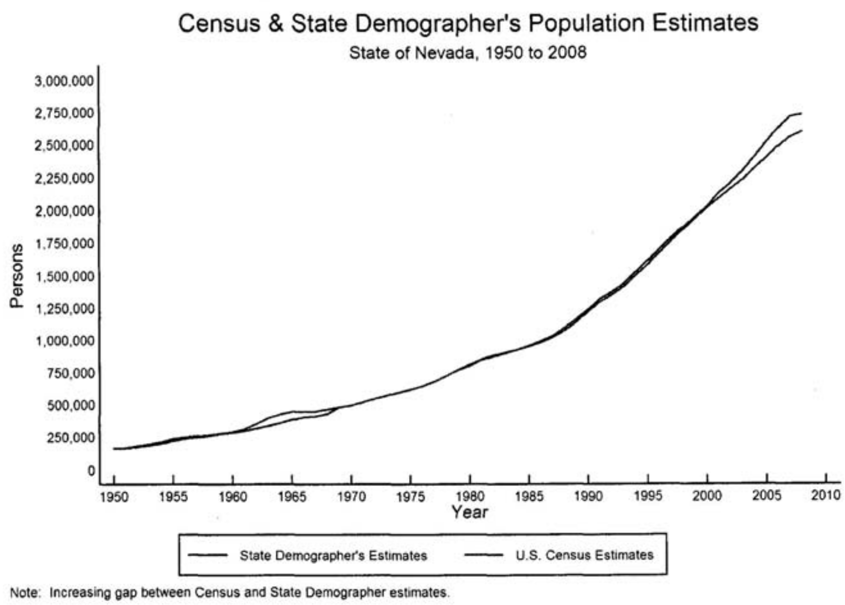

Figure A - 1: Compare Nevada population between Census and Demographer.

The demographer's population and the Census population for most of the years since 1950 are in close agreement (Figure A - 1). The exception to this trend starts with the year 2000 where the estimates provided by the Demographer are increasingly higher than the Census estimates. Also noted is a sharp decrease in population growth starting in 2007. This trend requires the use of Demographer's estimates in population for recent and current years.

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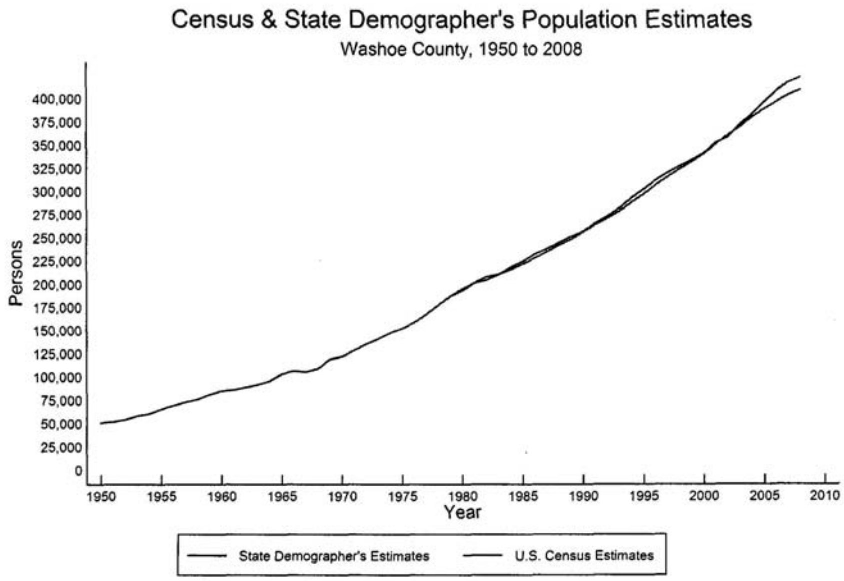

Note: Increasing gap between Census and State Demographer estimates.

Figure A - 2: Compare Washoe County population between Census and Demographer.

Figure A - 2, shows result similar to the Nevada trends. There is also an increasing gap between Demographer's estimates and the Census estimates. Because the Demographer is working with direct data from local agencies, utilities, and other sources. It will be assumed for modeling purposes that the Demographer's data is a better estimate of population and will be used in all models.

Recent Population Projections

Since the year 2000 there have been various population projections or forecasts published for Washoe County from various local agencies. Summarized here is a graphical comparison of these projections. Each projection is graphed with the Demographer's estimated population for 2000 to 2008 to provide a comparison of each projection's performance.

Projections published since 2000 include:

- TMWA's TPEM 2002
- Washoe County Consensus Forecast 2003
- TMWA's TPEM 2006
- State Demographer Projection 2006
- Washoe County Consensus Forecast 2008
- State Demographer Projection 2008

A graphical analysis is performed to provide insight on which methods have performed best in the past and to assess what could be a reasonable projection give current economic conditions.

Consensus Forecast 2003 and 2008

The Consensus Forecast (CF), published by Washoe County, uses the recent published data from the State Demographer, Woods & Poole, Global Insight, NPA Data Sources and Truckee Meadows Water Authority (TMWA). The CF is in general an averaging of the various published projections with the intent of reducing forecast error over any one forecast or projection.

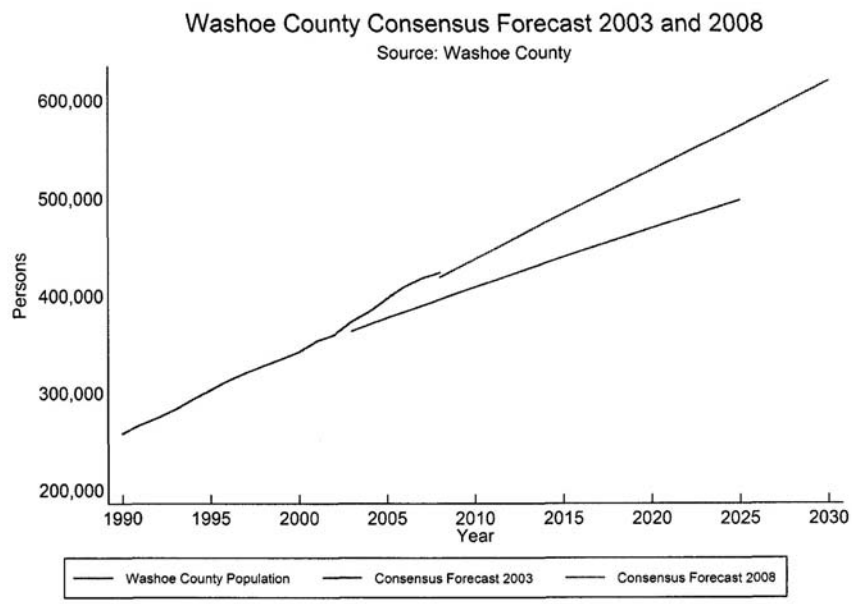

Figure A - 3: Washoe County Consensus Forecast for 2003 and 2008.

Figure A - 3, shows that each of the consensus forecast have the practical effect of a linear extrapolation of the recent population trends at the time of the forecast is published. The 2003 forecast was a reasonable trend using population up to the year 2000, but clearly under estimated the population growth at occurred. The 2008 forecast is reasonable given the population trend form 2000 to 2008, however, this trend show high levels of growth and does not include the recent and current economic conditions. This is to be expected given that most of the projections are based on 2006 data.

The 2008 Consensus Forecast is not suitable for current planning because it based on data at the peak of the growth cycle and the data is two years out of date.

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State Demographer's Population Projections

There are two recent population projections from the State Demographer's office, 2006 and 2008. The State Demographer (SD) uses the Regional Economics Model, Inc. (REMI) model for Nevada's 17 counties. The model has a 25-yar history of development and economic theory and is used by a variety of public and private sector users across the county as a tool for conducting projections as well as looking at the economic impacts of specific projects. The REMI model allows the user to look at how regional economics interact with each other and with the nation as a whole. The current model was created with federal data beginning in 2001 using the North American Industrial Classification System (which was implemented at that time). This short history coincides with some of Nevada's counties having had record population growth and mining has recovered from the down cycle of the late 1990's. This history of strong growth is the foundation for the projections and limits the ability to model recent shocks to the economy.

With the above discussion from the SD and the current continuation of the economic downturn, one should expect that the SD 2008 projection is likely to over project population growth for Nevada and the counties. Below, the SD projections are compared with population from 1990 to 2008.

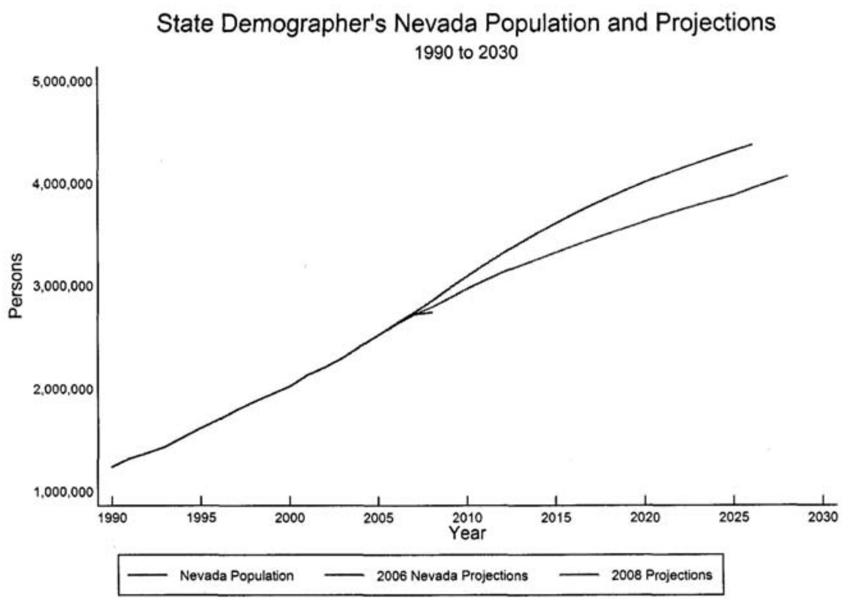

Figure A - 4: Compare State Demographer's Nevada population and projections.

Figure A - 4, the projections for 2008 shows a slowing of grows as when compared to 2006 projections. This is the result of capturing the start of the downturn in the economy that has resulted in a sharp decline in population growth. The 2008 projection is based on 2007 data and thus is missing part of the population change at the state level. As the downturn is continuing as of July 2009, the decline in growth can be expected to continue through 2009 and possibly into 2010.

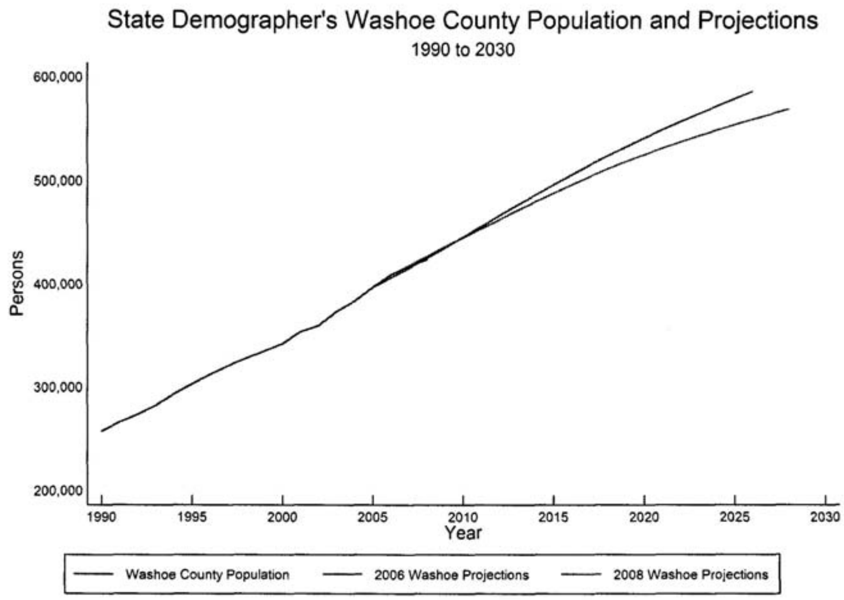

Figure A - 5: Compare State Demographer's Washoe County population and projections.

Figure A - 5 and Figure A - 6 examine the SD's projections for Washoe County. Figure A - 5 looks at a longer-trend from 1990 to 2030 and compares both the 2006 and 2008 projections. We see that both projections fit the trend well and that the 2008 projection is showing a slowing of growth beyond 2010. This fits well with the current conditions and expectations. Figure A - 6, is the same data, just look at the selection of years from 2000 to 2015. What we see here is that both of these projects perform well when compared with the data, the 2008 projection is starting to capture the economic slowdown.

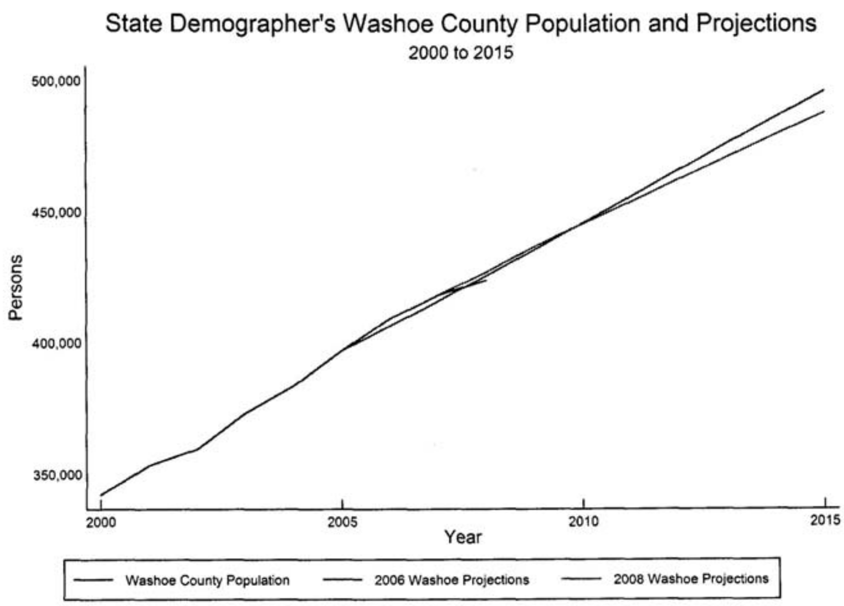

Figure A - 6: State Demographer's Washoe County population and projections, years 2000 to 2015.

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TMWA's Projections

TMWA's projections are from its population and employment model. The model first projects both population and employment as if there are no constraints on future growth. As a second stage the population and employment was then constrained base on recent land utilization rates and was then extrapolated to the available buildable land. This approach is very labor intensive and requires several months to perform. The past model created projections that are reasonable with the population trends (Figure A - 7).

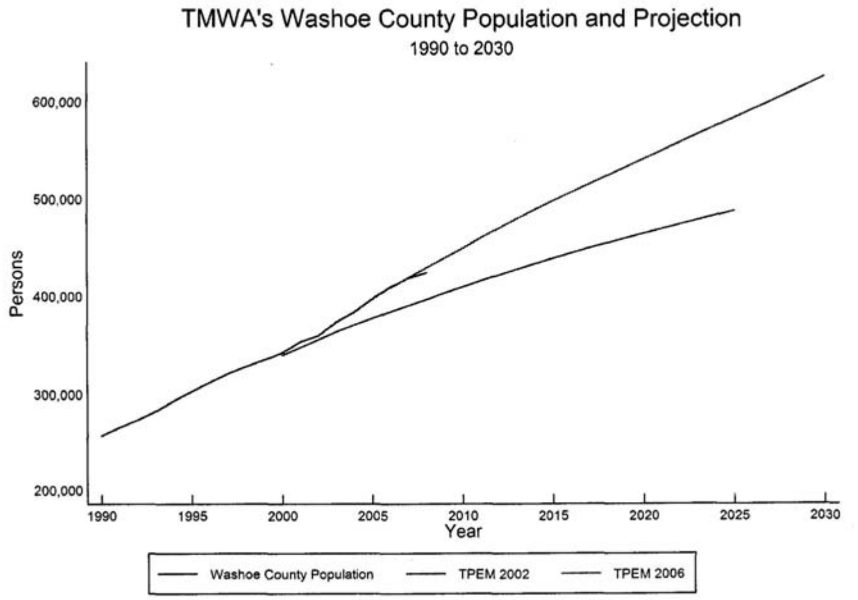

Figure A - 7: Compare TMWA's projections with population for 1990 to 2030.

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Graphically compare all recent projections
As can be seen above the 2002 and 2003 projections under estimated the population growth and will not be compared here. This comparison will focus on TPEM 2006, CF 2008, and SD 2008.

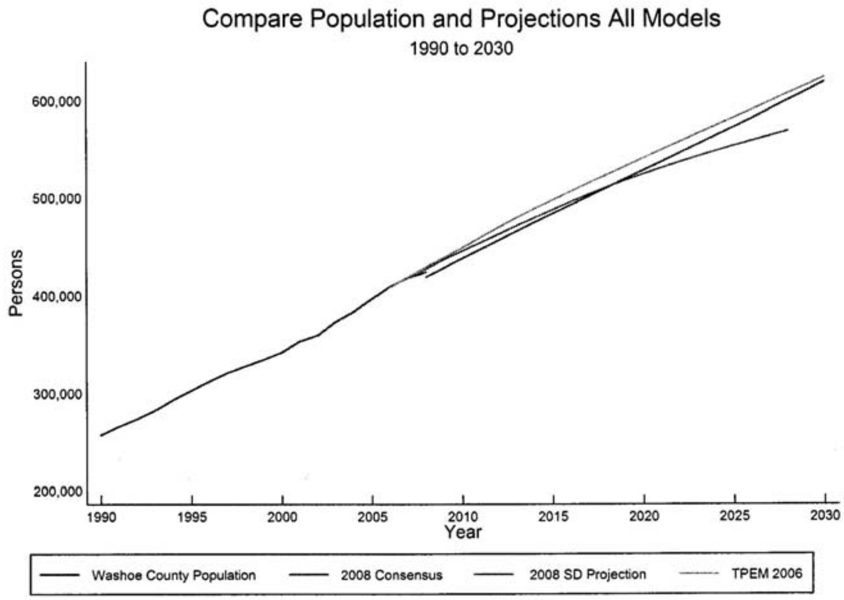

Figure A - 8: Compare the three most recent projections, 1990 to 2030.

Figure A - 8, shows the three most recent projections. The SD model which is the most recent, show the effect of the economic slowdown and how that compounds in the future years.

The 2008 SD model will be calibrated to match 2008 observed population and the used as a comparison with potential models to be used for providing an updated long-run population projection for Washoe County.

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State Demographer Adjusted Projections for Nevada and Washoe County

The next two graphs show the adjustments to State Demographer projections. The adjustment is only a shifting of the line to match the currently published population estimates.

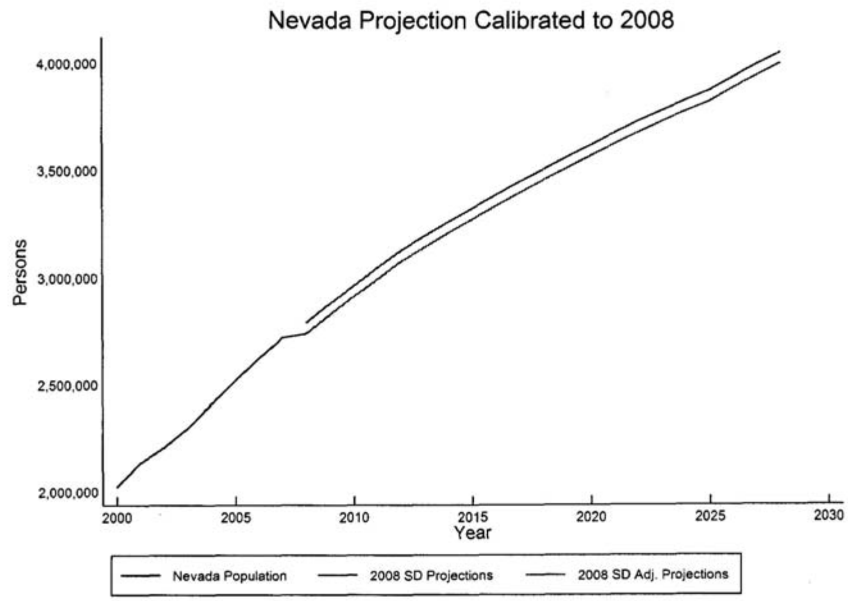

Figure A - 9: Adjusted State Demographer's Nevada Population Projections.

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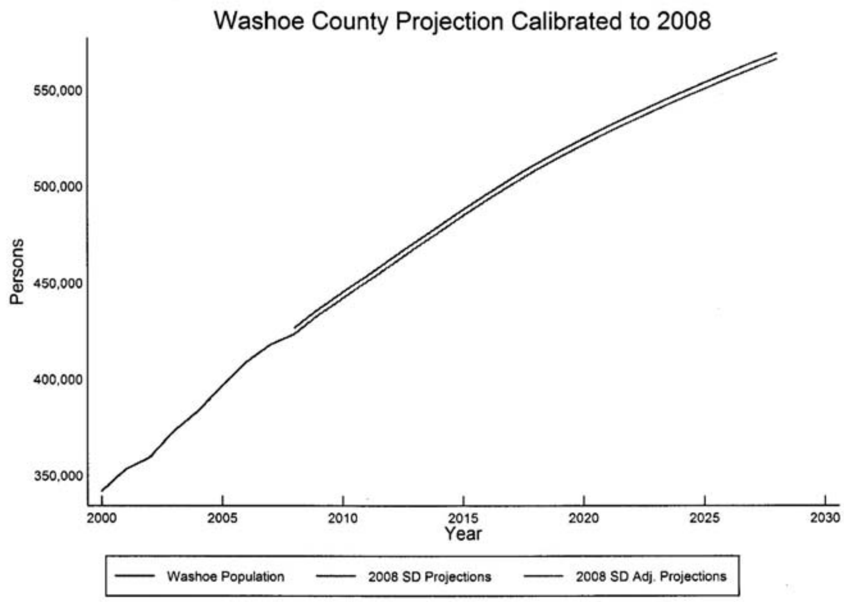

Figure A - 10: Adjusted State Demographer's Washoe County Population Projections.

Population Projection Models

There are many different methods of projecting populations. These model range from the simple with minimum data requirement to the vary complex with large complex data requirements. The goal of this report is to develop a population projection that seek to use more recently published data than that included in the State Demographer's REMI model. The model required by TMWA needs to project both the county population and county employment. The projection also needs to have sufficient detail that it can be disaggregated to smaller sub-county area.

The model search process will start with very simple demographic models and then advance to more complex model. The goal is to find a good working model that will provide a long-run projection of population that improves on the SD model by providing an update for current economic conditions.

Model Search

Simple Trend Extrapolation Models

Linear (LINE)

The linear extrapolation method (LINE) assumes that the population will increase (decrease) by the same number of persons in each future year as the average increase (decrease) observed over the base period. Average annual absolute change is computed as

$$AAAC = (P_l - P_b)/y$$

where P_l is the population in launch year (2008), P_b

This procedure may be used to compute different $AAAC_{base}$ just by changing the base year. The AAAC is computed for base years 1960, 1970, 1980, 1990, and 2000.

Give the AAAC the population projection is expressed as

$$P_t = P_l + z(AAAC)$$

Where z is the number of years in the projection horizon.

Base Year	AAAC	SD 2028 Adj Proj	AAAC 2028
1960	6,915	566,238	562,137
1970	7,725	566,238	578,324
1980	7,938	566,238	582,598
1990	8,774	566,238	599,320
2000	9,100	566,238	605,828

As can be seen in the above table the longest base period results in a tend of 6,915 person per year. As the base period changes to focus on the more recent years the rate of growth increases. The $AAAC_{1960}$ which is the closest to the long-term results in a projection similar to the Demographer's projection. This method does provide reasonable projection of the total population.

Geometric (GEO) and Exponential (EXPO)

The geometric extrapolation method (GEO) and the Exponential (EXPO) methods, both assumes that the population will increase (decrease) at the same percentage rate during the projection horizon as during the base period. The GEO models assumes an annual percentage rate while the EXPO method assumes continuous compounding. Both of these models will produce nearly identical projections for this reason only the exponential method is applied.

The exponential growth rate *r* is computed as

$$r = [(P_l / P_b)]/y$$

Given this formula for the exponential rate, a population projection can be expressed as

$$P_t = P_l e^{rz}$$

The exponential growth rate is calculated for each of the following base periods: 1960, 1970, 1980, 1990, and 2000 to 2008.

Base Year	EXPO Model Rate	SD 2028 Adj Proj	EXPO 2028
1960	3.28%	566,238	816,631
1970	3.18%	566,238	800,756
1980	2.70%	566,238	727,514
1990	2.63%	566,238	717,262
2000	2.39%	566,238	682,998

These models can lead to very high projection in a region that has had periods of high growth. The table above clearly show projections that are unreasonable and assume no limits on growth, such as economic conditions.

Complex Trend Extrapolation Models

Complex extrapolation methods differ for the simple methods in several ways. They use data from a number of points in time, have more complex mathematical structures and require an algorithm for estimating the each methods parameters. Because these methods use more data, they may provide a more complete picture of the historical pattern of population change than the simple extrapolation methods. Their more complex mathematical structures provide a wider range of possibilities regarding population trends than the simpler methods. In addition, the application of statistical algorithms to estimate the model's parameters provides a basis for constructing prediction intervals. However, these methods are more difficult to implement than the simple trend or ratio extrapolation methods. There is discussion as to whether the complex extrapolation provide more accurate forecasts than the simpler methods.

The process of projecting population using a complex extrapolation method has three basic steps:

1. assemble historical population data at equal time intervals between a base year and launch year. The data must be based on consistently defined geographic boundaries for each point in time, i.e. county or state boundaries. Since city boundaries change over time, these methods should not be used for sub-county regions.
2. Select a mathematical model and estimate its parameters through a curve fitting process. The choice of the model should reflect the analyst's judgment regarding the nature of population change and the most likely future population trend. While graphs, statistical correlation measures, and the analysis of residuals are used evaluate how well the model

fits the historical data; however, a close fit does not guarantee an accurate or even a reasonable projection.

3. Use the mathematical model and estimate parameters to prepare the population projections. In this step four methods will be applied to the historic Washoe County data: linear trend, polynomial curve fitting, logistic curve fitting, and ARIMA time series model.

Each of these models will be estimated using STATA statistical software version 10. Each model will be described along with the estimated parameters.

Linear Trend (OLS)

The linear trend model is the simplest of the complex trend extrapolation methods. It is based on the assumption that the population will increase or decrease by a constant numerical amount, as determined by historical population change. This assumption is identical to the assumption underlying the LINE method discussed above. However, it is operationally applied differently. The linear trend model is based on the equation for a straight line:

$$Y = \alpha + \beta X$$

Where Y is the dependent variable (population); X is the independent variable (time); α is a constant or intercept term; and β is the slope of the line. The terms X and Y are the model variables or data used in estimating the model and take on values that vary with each observation. The terms α and β are the model's parameters. The parameters represent the statistical relation between the models independent and dependent variables. They take on values that remain constant for any particular application of the model but will vary from one application to another.

The linear trend model is estimated using ordinary least squares (OLS) regression. The model for Washoe County is:

$$Pop_t = \alpha + \beta_1 t + calib$$

Where population is annual population for Washoe County from 1950 to 2008. Time *t* is 1 for the year 1950 and 59 for the year 2008; *calib* is an adjustment factor.

The adjustment factor is required since any curve fitting procedure is unlikely to produce an estimate for the launch year that is equal to the observed value for the launch year. The adjustment factor is calculated by subtracting the estimated population from the observed population for the launch year. This adjustment produces a parallel shift in the trend line that makes it pass directly through the launch-year population.

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STATA results for the OLS estimation of the linear trend model.

Table A - 1: Results of linear model estimation.

```
regress washoe t;

      Source |       SS       df       MS              Number of obs =      59
-------------+------------------------------           F(  1,    57) = 2176.38
       Model |  7.1958e+11     1  7.1958e+11           Prob > F      =  0.0000
    Residual |  1.8846e+10    57   330632934           R-squared     =  0.9745
-------------+------------------------------           Adj R-squared =  0.9740
       Total |  7.3843e+11    58  1.2732e+10           Root MSE      =   18183

------------------------------------------------------------------------------
      washoe |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
           t |   6485.086   139.0106    46.65   0.000     6206.722     6763.45
       _cons |    5411.15   4795.363     1.13   0.264      -4191.4     15013.7
------------------------------------------------------------------------------
```

Regression analysis results in the following model:

$$\text{Population} = 5411.15 + 6485.086{*}t + 35{,}801$$

$$R^2 = 0.97$$

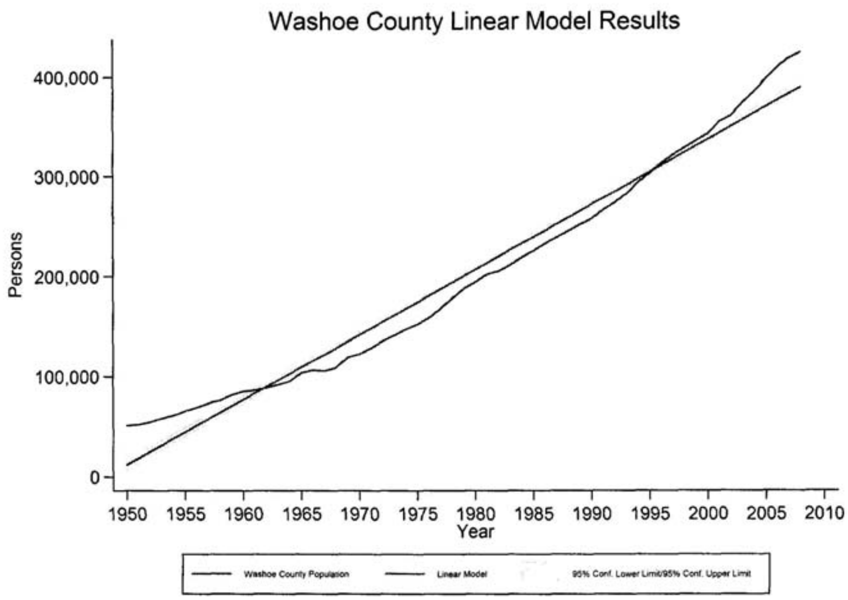

Figure A - 11: Linear Regression Model of population.

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Note: while most observations are not within the 95% confidence interval and the R^2 shows that the model explains 97% of the variation(Figure A - 11). This model would not provide a very accurate forecast in most years unless the model is calibrated for a recent launch year. After calibrating the model for 2008 (Figure A - 12), the calibrated models provides a good projection when compared with the State Demographer's 2008 projection. The Demographer's projection is contained in the upper 95% confidence interval of the projection.

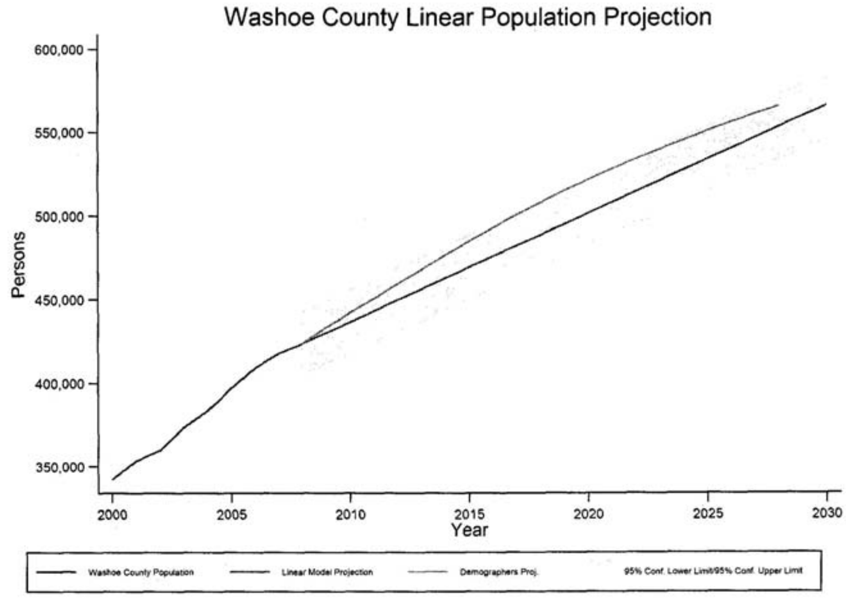

Figure A - 12: Compare linear trend model with Demographer's projections.

A limitation of the linear model is the lack of constraint on future growth that could from resource limitation. The nature of the linear model is the assumption the future will be similar to the past.

In light of the current economic condition the projection could be considered an improvement for total population. As the economic decline continues, this can be expected to result in slower or declining population growth. The linear predicts an average growth 6,485 persons per year.

This is a reasonable short term improvement to the State Demographer's projection, in that it provides a lower but statistically equal projection. Might not be a good long-term projection model.

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Polynomial Curve Fitting

Polynomial curve fitting is useful for basing projections on nonlinear patterns (i.e., patterns in which annual population change is not a constant numerical value). The general formula for a polynomial curve is

$$Y = \alpha + \beta_1 X + \beta_2 X^2 + \beta_3 X^3 + \ldots + \beta_n X^n$$

Where Y is population as defined in the linear trend model, X is time. This model differs from the linear model in that powers of time are used as independent variables.

This model is estimated using OLS by first creating variable for each power of time that is desired. Models with only the squared term are called quadratic functions. The highest exponent in the exponent in the equation is the degree of the polynomial.

The quadratic function was estimated as:

$$\text{Population}_t = 46{,}725 + 2{,}421t + 67.72t^2 - 1516$$
$$R^2 = 0.9991 \text{ Root MSE} = 3{,}415.9$$

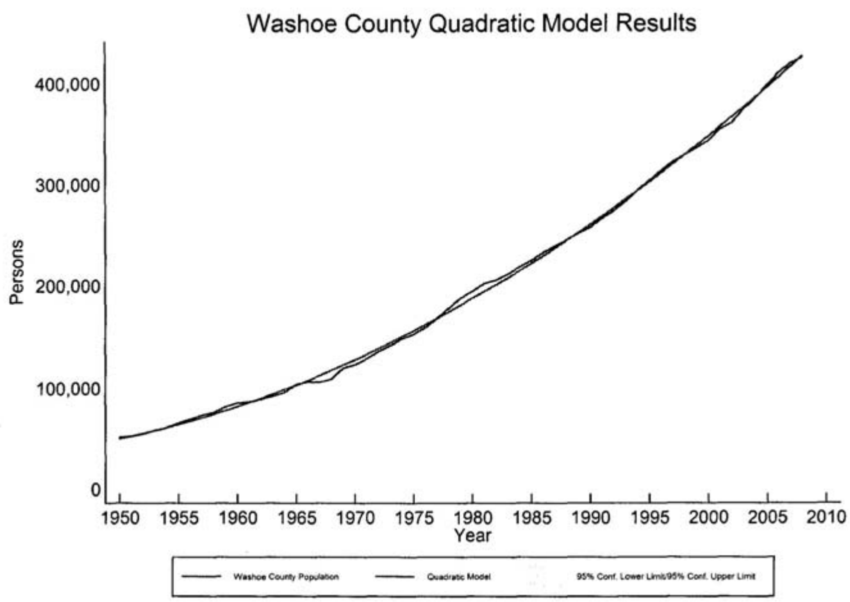

Figure A - 13: Washoe County quadratic model results.

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As seen in Figure A - 13, the non-linear model fits the data very well. Because the model fits so well, the 95% confidence interval is to small to be seen on the chart. Figure A - 14 compares the quadratic model with the Demographer's projection. The quadratic model show population growing at an increasing rate. The quadratic does not look to be a reasonable projection.

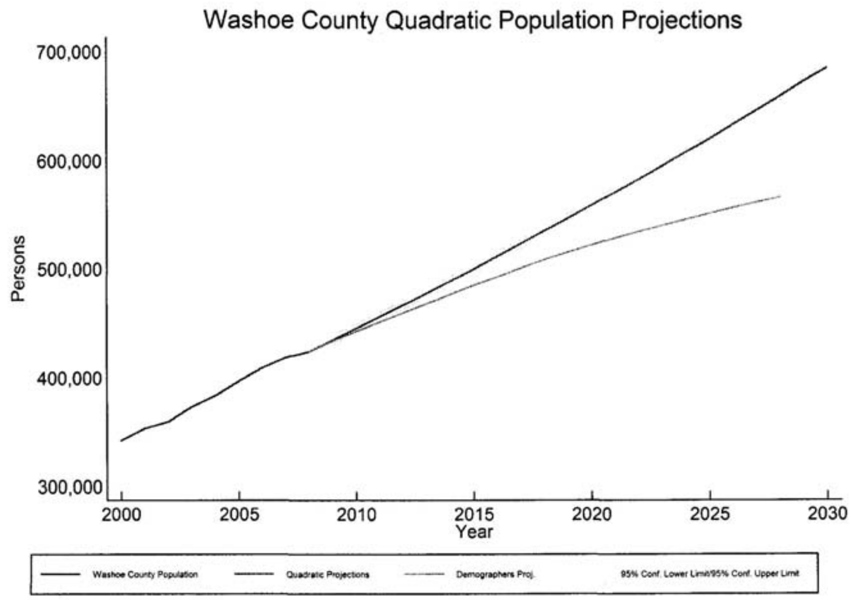

Figure A - 14: Quadratic model population projection.

The cubic function was estimated as:

$$\text{Population}_t = 48{,}663 + 2{,}049t + 83.10t^2 - .1708t^3 - 65.625$$
$$R^2 = 0.9992 \text{ Root MSE} = 3{,}377.9$$

Both of these function provide very good fits to the historic data as can be seen by R^2 and the Root Mean Squared Error (MSE) values being low. The cubic function provides a marginally better fit having the lowest MSE.

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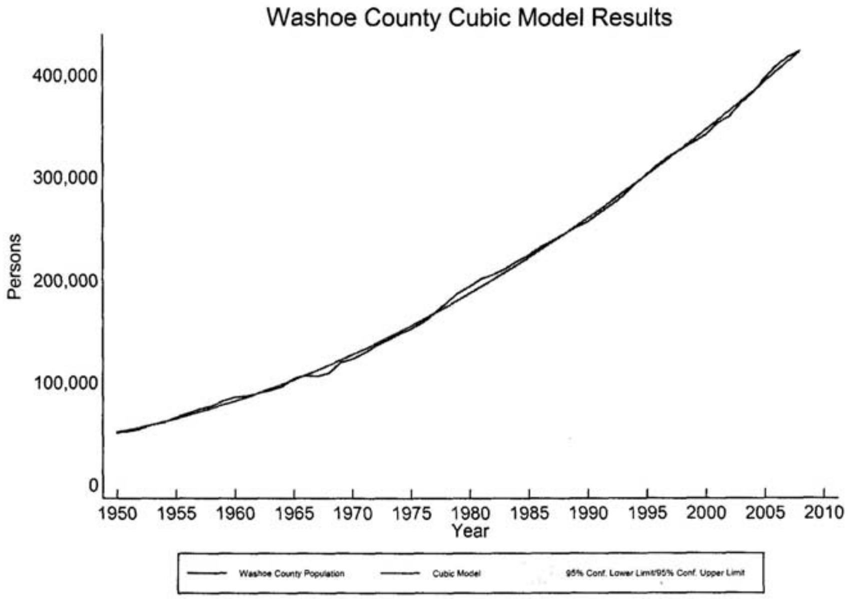

Figure A - 15: Washoe County cubic model results.

Figure A - 15 and Figure A - 16 both show the cubic model results and projects. The fit is about the same as the quadratic model, but with a slower rate of growth.

However, both of these functions suffer from the same issues as the exponential methods. The projections tends to work well in the short-run, but shows population growing at an increasing rate that implies no future limits on growth and growth will continue to increase at an increasing rate. The cubed term in the model has the effect of slowing down the rate of growth resulting in a model that grows slower than the quadratic but still to fast for current economic conditions.

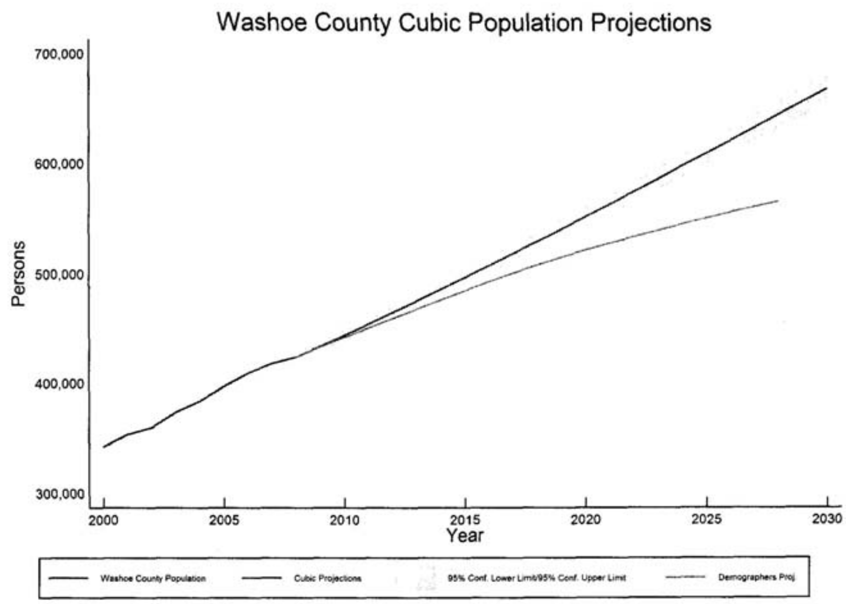

Figure A - 16: Cubic model population projection.

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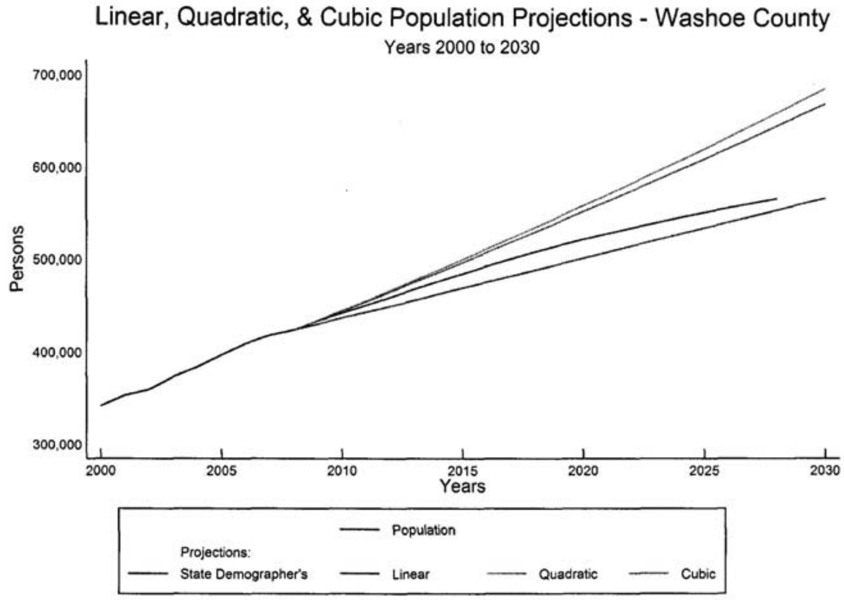

Figure A - 17: Compare linear, quadratic, and cubic population projection models.

Figure A - 17 shows a the results of the three models the polynomial models fit the historic data best, however, as the applied linear projection might be the best of these three models.

When comparing the three projections with the Demographer's projection. The quadratic and cubic project growth that is not economically consistent with current conditions. The linear model projects growth that is reasonable given current conditions. The Demographer's projection based on the REMI economic is a good model that a bias upwards given the limited economic data included since 2001. However, it would reasonable to adopt the linear trend model at this time.

Logistic Curve Fitting

All of the extrapolation methods examined so far are not constrained by any limits on growth. In the above methods, population growth (or decline) can go on forever. In many cases, this will not be a reasonable assumption. In particular, the non-linear models can lead to very high population projections if the projection is used for too long of a planning horizon.

The logistic curve, one of the best-known growth curves in demography, solves this problem by including an explicit ceiling on population. It is a symmetric sigmoid shape (S-shape) curve that has an initial period of slow growth, followed by increasing growth rate, followed by a declining growth rates that eventually approach zero as population size levels off at it upper limit. The idea of limits on growth is intuitively plausible and is consistent with Malthusian theories of population growth, geographic impediments such as public lands and unbuildable terrain, growth constraints created by water resources and government policies, and filling up of empty residential sites.

The logistic curve was a popular projection method in the early decades of the twentieth century. While its usefulness for projections have been questions, studies have shown that logistic curves often provide reasonably accurate population forecasts. There are other curves that contain asymptotic ceilings on population size include modified exponential and Gompertz models.

In Smith 2000 on pg 171, provides the descriptions of logistic curve fitting. Keyfitz(1968) formula for a three-parameter logistic curve is provided as:

$$Y = \alpha \Big/ \left(1 + \beta_1 e^{-\beta_2 x}\right)$$

where Y is population, X is time, α is the upper asymptote or population ceiling, β_1 and β_2 are parameters that define the shape of the logistic curve. Stata is able to estimate this non-linear function.

The Keyfitz (1968) model is estimated as:

```
Nonlinear regression                              Number of obs =         59
                                                  R-squared     =     0.9997
                                                  Adj R-squared =     0.9997
                                                  Root MSE      =   3938.771
                                                  Res. dev.     =   1141.233
```

washoe	Coef.	Robust HC2 Std. Err.	t	P>|t|	[95% Conf.	Interval]
/a	731313.3	27120.04	26.97	0.000	676985.4	785641.3
/b	13.57627	.4349354	31.21	0.000	12.70499	14.44755
/c	.0492867	.0007863	62.68	0.000	.0477115	.0508619

The population ceiling is estimated as 731,313 persons, β_1 and β_2 are curve shape parameters. This model results in a $R^2 = 0.9997$, Root MSE = 3938.771, this model is the best fit to the historic population data. All parameters are statistically significant. The population ceiling has a 95% confidence interval of 676,985 to 785,641 persons. This implies that in the long-run the population of Washoe County can be expected to mature to some stable level between 676,985 and 785,641. Therefore to estimate an approximate 95% confidence population range the model is re-estimated holding α equal to the 95% interval. The results are display below:

```
Nonlinear regression                              Number of obs =         59
Lower population ceiling                          R-squared     =     0.9997
                                                  Adj R-squared =     0.9997
                                                  Root MSE      =   4111.782
                                                  Res. dev.     =    1147.35

------------------------------------------------------------------------------
             |             Robust HC2
      washoe |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          /b |   12.93262   .1609521    80.35   0.000     12.61031    13.25492
          /c |   .0513267   .0003517   145.94   0.000     .0506224     .052031
------------------------------------------------------------------------------


Nonlinear regression                              Number of obs =         59
Upper Population Ceiling                          R-squared     =     0.9997
                                                  Adj R-squared =     0.9997
                                                  Root MSE      =   4039.966
                                                  Res. dev.     =   1145.271

------------------------------------------------------------------------------
             |             Robust HC2
      washoe |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
          /b |   14.26106   .1633092    87.33   0.000     13.93404    14.58808
          /c |   .0476456   .0002577   184.92   0.000     .0471297    .0481616
------------------------------------------------------------------------------
```

The logistic curve to be used for the Washoe County population is defined as:

$$Population_t = 676{,}985/(1 + 12.93262*e^{-0.0513267*t})$$

Where t is time in years starting at t = 1 for 1950.

A likelihood-ratio test was done to test if model 2 is nested in model 1 and if model 3 is nested in model 1. The models were found to be nested and the restrictions on population ceiling are statistically within the unrestricted population model.

The graph shows the logistic curves compared with the Demographer's projection. Given the current economic conditions one can expect the population to trend closer to the lower bounds of the Logistic curves.

Figure 1, Figure 2, Figure 3, and Figure 4 in the memo above show the results of the logistic curve fitting. The logistic curve is best fit to the data and provides the most reasonable population projection given current data and staff resources.

Other statistical models were tested such as autoregressive and vector autoregressive model. However, the results at this time suggest the a considerable amount of staff time and resources would be required to fully develop this type of model. The initial result did not suggest that these model would provide equal results. Perhaps the econometric model effort could be reconsidered at a future time when additional data can be developed.

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Appendix B: Source Data

Table 1: Historic and projected populations, 1950 to 2100.

Time	Year	Population	Demographer	Model 2	Model 1	Model 3
1	1950	50,484		58,421	56,333	54,731
2	1951	51,600		60,893	58,787	57,170
3	1952	54,000		63,474	61,346	59,710
4	1953	58,100		66,168	64,013	62,354
5	1954	60,500		68,978	66,793	65,108
6	1955	65,200		71,910	69,689	67,973
7	1956	68,900		74,966	72,703	70,954
8	1957	73,000		78,149	75,841	74,054
9	1958	76,000		81,465	79,106	77,276
10	1959	81,300		84,917	82,500	80,625
11	1960	84,988		88,508	86,029	84,103
12	1961	85,969		92,241	89,695	87,714
13	1962	88,648		96,122	93,502	91,461
14	1963	91,705		100,152	97,453	95,349
15	1964	95,289		104,335	101,552	99,380
16	1965	103,420		108,674	105,802	103,557
17	1966	106,356		113,172	110,205	107,884
18	1967	105,541		117,831	114,764	112,364
19	1968	108,776		122,655	119,483	116,999
20	1969	119,192		127,645	124,364	121,792
21	1970	122,574		132,803	129,409	126,746
22	1971	128,600		138,130	134,619	131,863
23	1972	135,400		143,627	139,997	137,145
24	1973	141,000		149,296	145,544	142,595
25	1974	147,400		155,136	151,261	148,212
26	1975	152,200		161,148	157,149	154,000
27	1976	158,700		167,331	163,207	159,958
28	1977	167,800		173,683	169,436	166,088
29	1978	177,600		180,204	175,836	172,389
30	1979	187,200		186,890	182,404	178,861
31	1980	193,623		193,740	189,141	185,505
32	1981	201,680		200,749	196,043	192,318
33	1982	205,130		207,915	203,108	199,300
34	1983	210,990		215,232	210,333	206,448
35	1984	218,320		222,696	217,715	213,761
36	1985	224,580		230,300	225,250	221,235
37	1986	232,270		238,039	232,932	228,867
38	1987	238,360		245,905	240,757	236,653
39	1988	244,890		253,892	248,719	244,589
40	1989	251,580		261,991	256,812	252,669
41	1990	257,120		270,194	265,028	260,889
42	1991	265,762		278,491	273,361	269,243
43	1992	273,178		286,874	281,803	277,724
44	1993	282,214		295,332	290,345	286,324
45	1994	293,141		303,856	298,978	295,038
46	1995	302,748		312,434	307,694	303,856
47	1996	312,366		321,055	316,483	312,772
48	1997	320,828		329,710	325,334	321,775

49	1998	327,899		338,385	334,239	330,857
50	1999	334,601		347,071	343,185	340,008
51	2000	341,935		355,755	352,164	349,219
52	2001	353,271		364,426	361,163	358,481
53	2002	359,423		373,073	370,173	367,782
54	2003	373,233		381,685	379,182	377,112
55	2004	383,453		390,250	388,179	386,461
56	2005	396,844		398,757	397,153	395,818
57	2006	409,085		407,197	406,094	405,173
58	2007	418,061	414,928	415,559	414,991	414,515
59	2008	423,833	423,833	423,833	423,833	423,833
60	2009		433,643	432,010	432,611	433,117
61	2010		442,196	440,081	441,314	442,358
62	2011		450,742	448,038	449,934	451,544
63	2012		459,381	455,872	458,461	460,665
64	2013		467,999	463,577	466,886	469,713
65	2014		476,448	471,146	475,201	478,678
66	2015		484,803	478,572	483,398	487,551
67	2016		492,986	485,851	491,471	496,324
68	2017		500,807	492,977	499,412	504,988
69	2018		508,233	499,946	507,215	513,536
70	2019		515,218	506,754	514,874	521,961
71	2020		521,811	513,398	522,385	530,256
72	2021		528,071	519,876	529,743	538,415
73	2022		534,137	526,185	536,943	546,431
74	2023		539,954	532,324	543,983	554,301
75	2024		545,576	538,291	550,859	562,019
76	2025		551,001	544,088	557,569	569,581
77	2026		556,240	549,713	564,111	576,983
78	2027		561,315	555,166	570,484	584,223
79	2028		566,238	560,450	576,687	591,297
80	2029			565,564	582,718	598,204
81	2030			570,511	588,579	604,942
82	2031			575,293	594,269	611,509
83	2032			579,911	599,789	617,905
84	2033			584,368	605,141	624,130
85	2034			588,667	610,325	630,183
86	2035			592,810	615,344	636,065
87	2036			596,801	620,199	641,777
88	2037			600,644	624,893	647,319
89	2038			604,340	629,428	652,694
90	2039			607,895	633,807	657,902
91	2040			611,312	638,032	662,946
92	2041			614,593	642,108	667,828
93	2042			617,744	646,036	672,551
94	2043			620,767	649,820	677,116
95	2044			623,667	653,465	681,527
96	2045			626,448	656,972	685,787
97	2046			629,112	660,346	689,899
98	2047			631,665	663,591	693,865
99	2048			634,110	666,709	697,690
100	2049			636,450	669,705	701,377

101	2050	638,689	672,582	704,928
102	2051	640,831	675,343	708,348
103	2052	642,879	677,994	711,639
104	2053	644,837	680,536	714,807
105	2054	646,709	682,974	717,853
106	2055	648,497	685,311	720,782
107	2056	650,204	687,551	723,597
108	2057	651,835	689,696	726,301
109	2058	653,392	691,751	728,899
110	2059	654,878	693,719	731,393
111	2060	656,296	695,603	733,787
112	2061	657,649	697,405	736,085
113	2062	658,939	699,130	738,289
114	2063	660,170	700,779	740,402
115	2064	661,343	702,357	742,429
116	2065	662,461	703,865	744,372
117	2066	663,528	705,307	746,234
118	2067	664,544	706,685	748,018
119	2068	665,512	708,002	749,727
120	2069	666,434	709,260	751,363
121	2070	667,312	710,462	752,930
122	2071	668,149	711,610	754,431
123	2072	668,946	712,706	755,867
124	2073	669,705	713,753	757,242
125	2074	670,427	714,752	758,557
126	2075	671,115	715,705	759,815
127	2076	671,770	716,615	761,019
128	2077	672,393	717,484	762,170
129	2078	672,986	718,313	763,271
130	2079	673,550	719,103	764,323
131	2080	674,087	719,858	765,330
132	2081	674,598	720,577	766,292
133	2082	675,084	721,263	767,211
134	2083	675,546	721,918	768,090
135	2084	675,986	722,542	768,930
136	2085	676,405	723,137	769,732
137	2086	676,802	723,704	770,499
138	2087	677,181	724,245	771,231
139	2088	677,541	724,761	771,931
140	2089	677,883	725,253	772,599
141	2090	678,209	725,721	773,237
142	2091	678,518	726,168	773,847
143	2092	678,812	726,593	774,429
144	2093	679,092	726,999	774,984
145	2094	679,358	727,385	775,515
146	2095	679,611	727,754	776,022
147	2096	679,852	728,105	776,505
148	2097	680,080	728,439	776,967
149	2098	680,297	728,758	777,408
150	2099	680,504	729,061	777,829
151	2100	680,700	729,350	778,230

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Appendix C: Stata Source Code

```
/*       1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
*  Program Name:   PopProjWashoe_Master.do
*  Created by:     Shawn Stoddard
*  Created on:     7/23/2009
*  Abstract:
*
*
*
********************************************************************************/
#delimit;
clear;
set more off;
capture log close;

local logpath logs\ ;
local filename PopProjWashoe_Master ;
local logfile = "`logpath'" + "`filename'" ;
clear;
do PopProjWashoe_01;
do PopProjWashoe_02;
do PopProjWashoe_03;

exit;
********************************************************************************
```

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```
/*       1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
* Program Name:   PopProjWashoe_01.do
* Created by:     Shawn Stoddard
* Created on:     7/20/2009
* Updated on:     7/31/2009
* Abstract:       Performs a complete graphical analysis of recent projections
*   and start the population models search process.
********************************************************************************/
#delimit;
pause on;
clear;
set more off;
capture log close;
set linesize 90;
local logpath logs\ ;
local filename PopProjWashoe_01 ;
local logfile = "`logpath'" + "`filename'" ;
log using "`logfile'", replace text;
set memory 500m;
/* Washoe County data filename is */;
local datafile data\\WashoeDataAll_01 ;

/* Start with population from State Demographer's reports ********************/;
use data\populationdata;
keep year nevada washoe;
label var nevada "SD Nv Pop";
label var washoe "SD Washoe Pop";
save `datafile', replace;

/* Get Census population from REIS files */;
use data\reis_ca04_all, clear;
keep fips table year CA04ln_0020;
label var year "Year";
rename CA04ln_0020 ReisPop;
label var ReisPop "Population";

/* Filter the entire data REIS data and keep only the following areas        */;
/* State of Nevada and Washoe County                                          */;
generate keep = 0 /* flag variable for filtering data */;
replace  keep = 1 if fips == "32000" /* Nevada, NV */;
replace  keep = 1 if substr(fips,1,2) == "32" /* Nevada Counties */;
keep if keep == 1 /* delete all records not flagged with 1 */;
drop keep;
compress;

reshape wide ReisPop, i(table year) j(fips) string;
tsset year, yearly;
keep year ReisPop32000 ReisPop32031 /* keep only Nv & Washoe */;
rename ReisPop32000 CenNv;
rename ReisPop32031 CenWas;
label var CenNv "Census Nv Pop";
label var CenWas "Census Washoe Pop";
tempfile rpop;
save `rpop';

use `datafile', clear;
merge year using `rpop';
drop _merge;

/*update 2008 census population from Census web site */;
replace CenNv = 2600167 if year == 2008;
replace CenWas = 410443 if year == 2008;
tsset year, yearly;
save `datafile', replace;

/* Update Nevada Census population from 1950 to 1969 using Census data *********/;
/* this is census data that was collected as part of the 2003 resource plan    */;
merge year using data\CensusPopulation, sort keep(CenNv) update;
drop _merge;
drop if year < 1950;
tsset year, yearly;
save `datafile', replace;
```

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```
/* all the possible employment data for whatever years possible ****************/;
/* start with DETR Labor force data - this is the State's source of data  ******/;
/* reported to BLS */;
use data\detrlabforyearly, clear;
keep if fips == "32000";
drop area fips;
rename lf lf_nv;
rename emp emp_nv;
rename uemp uemp_nv;
rename uempr uempr_nv;
label var lf_nv "DETR Nv LF";
label var emp_nv "DETR Nv Emp";
label var uemp_nv "DETR Nv UEmp";
label var uempr_nv "DETR Nv UE Rate";
tempfile emp;
save `emp', replace;

use `datafile', clear;
merge year using `emp', sort;
drop _merge;
save `datafile', replace;

use data\detrlabforyearly, clear;
keep if fips == "32031";
drop area fips;
rename lf lf_was;
rename emp emp_was;
rename uemp uemp_was;
rename uempr uempr_was;
label var lf_was "DETR Was LF";
label var emp_was "DETR Was Emp";
label var uemp_was "DETR Was UEmp";
label var uempr_was "DETR Was UE Rate";
tempfile emp;
save `emp', replace;
use `datafile', clear;
merge year using `emp', sort;
drop _merge;
save `datafile', replace;

/* Get the REIS Total Employment, Wage & Salary, and Proprietors ***************/;
use data\REIS_CA04_all, clear;
keep fips year CA04ln_7010 CA04ln_7020 CA04ln_7040;
keep if fips == "32000" ;
drop fips;
rename CA04ln_7010 bea_temp_nv;
rename CA04ln_7020 bea_wemp_nv;
rename CA04ln_7040 bea_pemp_nv;
label var bea_temp "BEA Total Emp Nv";
label var bea_wemp "BEA Wage Emp Nv";
label var bea_pemp "BEA Proprietors Nv";
save `emp', replace;
use `datafile', clear;
merge year using `emp', sort;
drop _merge;
save `datafile', replace;

use data\REIS_CA04_all, clear;
keep fips year CA04ln_7010 CA04ln_7020 CA04ln_7040;
keep if fips == "32031" ;
drop fips;
rename CA04ln_7010 bea_temp_was;
rename CA04ln_7020 bea_wemp_was;
rename CA04ln_7040 bea_pemp_was;
label var bea_temp_was "BEA Total Emp Was";
label var bea_wemp_was "BEA Wage Emp Was";
label var bea_pemp_was "BEA Proprietors Was";
save `emp', replace;
use `datafile', clear;
merge year using `emp', sort;
drop _merge;
save `datafile', replace;
```

```
/* merge in population project data for graphical analysis ********************/;
merge year using data\PopulationProjectionsAll, sort;
drop sdnvpop sdwapop;
drop _merge;
/* add a variable t for use in time analysis */;
generate t = _n;
order t year;
tsset year, yearly;
save `datafile', replace;

/* Start graphical review and analysis of population data                    */;
/* Create graphs for TPEM Series No. 1 - Appendix A                          */;
/* Figure A-1:  Historic Nevada Population - Census & Demographer *************/;
tsline nevada CenNv if tin(1950,2010),
  title("Census & State Demographer's Population Estimates", color(black) size(medium))
  subtitle("State of Nevada, 1950 to 2008", color(black) size(small))
  graphregion(color(white))
  ytitle("Persons", color(black) size(small))
  xtitle("Year", color(black) size(small))
  ylabel(0(250000)3000000, noticks labsize(vsmall) angle(horizontal) format(%10.0fc))
  xlabel(1950(5)2010 , ticks tposition(inside) labsize(vsmall))
  legend(on lcolor(black) cols(2) size(vsmall) symxsize(6) rowgap(.5)
         span
         order(1 "State Demographer's Estimates"
               2 "U.S. Census Estimates"))
  note("Note:  Increasing gap between Census and State Demographer estimates.",
       color(black) size(vsmall) span);
graph export graphs\TPEMFig_A-01.png, width(3600) replace;
graph export graphs\TPEMFig_A-01.emf, replace;

/* Figure A-2:  Historic Washoe County Popuation - Census & Demographer *********/;
tsline washoe CenWas if tin(1950,2010),
  title("Census & State Demographer's Population Estimates", color(black) size(medium))
  subtitle("Washoe County, 1950 to 2008", color(black) size(small))
  graphregion(color(white))
  ytitle("Persons", color(black) size(small))
  xtitle("Year", color(black) size(small))
  ylabel(0(25000)400000, noticks labsize(vsmall) angle(horizontal) format(%10.0fc))
  xlabel(1950(5)2010 , ticks tposition(inside) labsize(vsmall))
  legend(on lcolor(black) cols(2) size(vsmall) symxsize(6) rowgap(.5)
         span
         order(1 "State Demographer's Estimates"
               2 "U.S. Census Estimates"))
  note("Note:  Increasing gap between Census and State Demographer estimates.",
       color(black) size(vsmall) span);
graph export graphs\TPEMFig_A-02.png, width(3600) replace;
graph export graphs\TPEMFig_A-02.emf, replace;

/* Figure A-3: Compare Consensus 2003 and 2008 Forecast with Population      */;
tsline washoe wcf2003 wcf2008 if tin(1990,2030),
  title("Washoe County Consensus Forecast 2003 and 2008", color(black) size(medium))
  subtitle("Source: Washoe County", color(black) size(small))
  graphregion(color(white))
  ytitle("Persons", color(black) size(small))
  xtitle("Year", color(black) size(small))
  ylabel(, noticks labsize(vsmall) angle(horizontal) format(%12.0fc))
  xlabel(1990(5)2030, ticks tposition(inside) labsize(vsmall))
  legend(on lcolor(black) cols(3) size(vsmall) symxsize(6) rowgap(*.5)
         span
         order(1 "Washoe County Population" 2 "Consensus Forecast 2003"
               3 "Consensus Forecast 2008"));
graph export graphs\TPEMFig_A-03.png, width(3600) replace;
graph export graphs\TPEMFig_A-03.emf, replace;

/* Figure A-4: Nevada population & Demographer's projections ********************/;
tsline nevada sdfnv2006 sdfnv2008 if tin(1990,2030),
  title("State Demographer's Nevada Population and Projections", color(black) size(medium))
  subtitle("1990 to 2030", color(black) size(small))
  graphregion(color(white))
  ytitle("Persons", color(black) size(small))
  xtitle("Year", color(black) size(small))
  ylabel(, noticks labsize(vsmall) angle(horizontal) format(%12.0fc))
  xlabel(1990(5)2030, ticks tposition(inside) labsize(vsmall))
  legend(on lcolor(black) cols(3) size(vsmall) symxsize(6) rowgap(*.5)
```

```
        span
        order(1 "Nevada Population" 2 "2006 Nevada Projections"
             3 "2008 Projections"));
graph export graphs\TPEMFig_A-04.png, width(3600) replace;
graph export graphs\TPEMFig_A-04.emf, replace;

/* Figure A-5: Washoe County population & Demographer's projections          */;
tsline washoe sdfwa2006 sdfwa2008 if tin(1990,2030),
  title("State Demographer's Washoe County Population and Projections",
       color(black) size(medium))
  subtitle("1990 to 2030", color(black) size(small))
  graphregion(color(white))
  ytitle("Persons", color(black) size(small))
  xtitle("Year", color(black) size(small))
  ylabel(,noticks labsize(vsmall) angle(horizontal) format(%12.0fc))
  xlabel(1990(5)2030, ticks tposition(inside) labsize(vsmall))
  legend(on lcolor(black) cols(3) size(vsmall) symxsize(6) rowgap(*.5)
        span
        order(1 "Washoe County Population" 2 "2006 Washoe Projections"
             3 "2008 Washoe Projections"));
graph export graphs\TPEMFig_A-05.png, width(3600) replace;
graph export graphs\TPEMFig_A-05.emf, replace;

/* Figure A-6: Washoe County population & Demographer's projections          */;
tsline washoe sdfwa2006 sdfwa2008 if tin(2000,2015),
  title("State Demographer's Washoe County Population and Projections",
       color(black) size(medium))
  subtitle("2000 to 2015", color(black) size(small))
  graphregion(color(white))
  ytitle("Persons", color(black) size(small))
  xtitle("Year", color(black) size(small))
  ylabel(,noticks labsize(vsmall) angle(horizontal) format(%12.0fc))
  xlabel(2000(5)2015, ticks tposition(inside) labsize(vsmall))
  legend(on lcolor(black) cols(3) size(vsmall) symxsize(6) rowgap(*.5)
        span
        order(1 "Washoe County Population" 2 "2006 Washoe Projections"
             3 "2008 Washoe Projections"));
graph export graphs\TPEMFig_A-06.png, width(3600) replace;
graph export graphs\TPEMFig_A-06.emf, replace;

/* Figure A-7: TMWA's Washoe County Projections                              */;
tsline washoe tmwac2002 tmwac2006 if tin(1990,2030),
  title("TMWA's Washoe County Population and Projection", color(black) size(medium))
  subtitle("1990 to 2030", color(black) size(small))
  graphregion(color(white))
  ytitle("Persons", color(black) size(small))
  xtitle("Year", color(black) size(small))
  ylabel(,noticks labsize(vsmall) angle(horizontal) format(%12.0fc))
  xlabel(1990(5)2030, ticks tposition(inside) labsize(vsmall))
  legend(on lcolor(black) cols(3) size(vsmall) symxsize(6) rowgap(*.5)
        span
        order(1 "Washoe County Population"  2 "TPEM 2002" 3 "TPEM 2006"));
graph export graphs\TPEMFig_A-07.png, width(3600) replace;
graph export graphs\TPEMFig_A-07.emf, replace;

/* Figure A-8: Compare all recent projections                                */;
tsline washoe wcf2008 sdfwa2008 tmwac2006 if tin(1990,2030),
  title("Compare Population and Projections All Models", color(black) size(medium))
  subtitle("1990 to 2030", color(black) size(small))
  graphregion(color(white))
  ytitle("Persons", color(black) size(small))
  xtitle("Year", color(black) size(small))
  ylabel(,noticks labsize(vsmall) angle(horizontal) format(%12.0fc))
  xlabel(1990(5)2030, ticks tposition(inside) labsize(vsmall))
  legend(on lcolor(black) cols(4) size(vsmall) symxsize(6) rowgap(*.5)
        span
        order(1 "Washoe County Population"  2 "2008 Consensus"
             3 " 2008 SD Projection" 4 "TPEM 2006"));
graph export graphs\TPEMFig_A-08.png, width(3600) replace;
graph export graphs\TPEMFig_A-08.emf, replace;


/* adjust State Demographer 2008 projection to match 2008 population         */;
```

```
/* Figure A-9:  Adjusted SD projections SDFnv2008 to current population ********/;
quietly summarize nevada if year == 2008,detail;
local pop08 = `r(mean)';
quietly summarize sdfnv2008 if year == 2008, detail;
local fe2008 = `r(mean)' -`pop08';
display "Population forecase error for sefnv2008:  `fe2008'";
generate sdfnv2008adj = sdfnv2008 - `fe2008';
label var sdfnv2008adj "2008 Nv SD Adj Proj";
tsline  nevada if tin(2000, 2008)
  || tsline sdfnv2008 sdfnv2008adj if tin(2008,2030),
  title("Nevada Projection Calibrated to 2008", color(black) size(medium))
  graphregion(color(white))
  ytitle("Persons", color(black) size(small))
  xtitle("Year", color(black) size(small))
  ylabel(, noticks labsize(vsmall) angle(horizontal) format(%12.0fc))
  xlabel(2000(5)2030, ticks tposition(inside) labsize(vsmall))
  legend(on lcolor(black) cols(3) size(vsmall) symxsize(6) rowgap(*.5)
         span
         order(1 "Nevada Population" 2 "2008 SD Projections"
               3 "2008 SD Adj. Projections"));
graph export graphs\TPEMFig_A-09.png, width(3600) replace;
graph export graphs\TPEMFig_A-09.emf, replace;

/* Adjust Washoe County SDFwa2008 to current population ***********************/;
/* Figure A-10: Adjusted SD Projections SDFwa2008 to current population       */;
quietly summarize washoe if year == 2008,detail;
local pop08 = `r(mean)';
quietly summarize sdfwa2008 if year == 2008, detail;
local fe2008 = `r(mean)' -`pop08';
display "Washoe forecase error for sef2008:  `fe2008'";
generate sdfwa2008adj = sdfwa2008 - `fe2008';
label var sdfwa2008adj "2008 Washoe SD Adj Proj.";
tsline  washoe if tin(2000, 2008)
  || tsline sdfwa2008 sdfwa2008adj if tin(2008,2030),
  title("Washoe County Projection Calibrated to 2008", color(black) size(medium))
  graphregion(color(white))
  ytitle("Persons", color(black) size(small))
  xtitle("Year", color(black) size(small))
  ylabel(,noticks labsize(vsmall) angle(horizontal) format(%12.0fc))
  xlabel(2000(5)2030, ticks tposition(inside) labsize(vsmall))
  legend(on lcolor(black) cols(3) size(vsmall) symxsize(6) rowgap(*.5)
         span
         order(1 "Washoe Population" 2 "2008 SD Projections"
               3 "2008 SD Adj. Projections"));
graph export graphs\TPEMFig_A-10.png, width(3600) replace;
graph export graphs\TPEMFig_A-10.emf, replace;

/****************************************************************************/;
/* Begin a population projection model search                               */;
/****************************************************************************/;
/* Trend Extrapolation Models                                               */;
/****************************************************************************/;
/* Linear (LINE) model compute AAAC for washoe county                       */;
/* base row is 11 and launch row is 59  for base year 1960*/;
local brow = 11;
local lrow = 59;
local byear = year[`brow'];
local lyear = year[`lrow'];
count if tin(`byear',`lyear');
local y = `r(N)';
local pl = washoe[`lrow'];
local pb = washoe[`brow'];
local AAAC = (`pl' - `pb')/`y';
display "LINE Model for Washoe County: Base year   = `byear'";
display "                              Launch year = `lyear'";
display "                              Pl          = `pl'";
display "                              Pb          = `pb'";
display "                              y           = `y'";
display "                              AAAC        = `AAAC'";
/* project Washoe AAAC */;
gen wash_aaac_60 = .;
replace wash_aaac_60 = washoe if year == 2008;
replace wash_aaac_60 = wash_aaac_60[_n-1] + `AAAC' if year > 2008;
replace wash_aaac_60 = round(wash_aaac_60,0);
```

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```
/* base row is 21 and launch row is 59  for base year 1970*/;
local brow = 21;
local lrow = 59;
local byear = year[`brow'];
local lyear = year[`lrow'];
count if tin(`byear',`lyear');
local y = `r(N)';
local pl = washoe[`lrow'];
local pb = washoe[`brow'];
local AAAC = (`pl' - `pb')/`y';
display "LINE Model for Washoe County: Base year   = `byear'";
display "                              Launch year = `lyear'";
display "                              Pl          = `pl'";
display "                              Pb          = `pb'";
display "                              y           = `y'";
display "                              AAAC        = `AAAC'";
/* project Washoe AAAC */;
gen wash_aaac_70 = .;
replace wash_aaac_70 = washoe if year == 2008;
replace wash_aaac_70 = wash_aaac_70[_n-1] + `AAAC' if year > 2008;
replace wash_aaac_70 = round(wash_aaac_70,0);

/* base row is 31 and launch row is 59  for base year 1980*/;
local brow = 31;
local lrow = 59;
local byear = year[`brow'];
local lyear = year[`lrow'];
count if tin(`byear',`lyear');
local y = `r(N)';
local pl = washoe[`lrow'];
local pb = washoe[`brow'];
local AAAC = (`pl' - `pb')/`y';
display "LINE Model for Washoe County: Base year   = `byear'";
display "                              Launch year = `lyear'";
display "                              Pl          = `pl'";
display "                              Pb          = `pb'";
display "                              y           = `y'";
display "                              AAAC        = `AAAC'";
/* project Washoe AAAC */;
gen wash_aaac_80 = .;
replace wash_aaac_80 = washoe if year == 2008;
replace wash_aaac_80 = wash_aaac_80[_n-1] + `AAAC' if year > 2008;
replace wash_aaac_80 = round(wash_aaac_80,0);

/* base row is 41 and launch row is 59  for base year 1990*/;
local brow = 41;
local lrow = 59;
local byear = year[`brow'];
local lyear = year[`lrow'];
count if tin(`byear',`lyear');
local y = `r(N)';
local pl = washoe[`lrow'];
local pb = washoe[`brow'];
local AAAC = (`pl' - `pb')/`y';
display "LINE Model for Washoe County: Base year   = `byear'";
display "                              Launch year = `lyear'";
display "                              Pl          = `pl'";
display "                              Pb          = `pb'";
display "                              y           = `y'";
display "                              AAAC        = `AAAC'";
/* project Washoe AAAC */;
gen wash_aaac_90 = .;
replace wash_aaac_90 = washoe if year == 2008;
replace wash_aaac_90 = wash_aaac_90[_n-1] + `AAAC' if year > 2008;
replace wash_aaac_90 = round(wash_aaac_90,0);

/* base row is 51 and launch row is 59  for base year 2000*/;
local brow = 51;
local lrow = 59;
local byear = year[`brow'];
local lyear = year[`lrow'];
count if tin(`byear',`lyear');
local y = `r(N)';
```

```
local pl = washoe[`lrow'];
local pb = washoe[`brow'];
local AAAC = (`pl' - `pb')/`y';
display "LINE Model for Washoe County: Base year   = `byear'";
display "                              Launch year = `lyear'";
display "                              Pl          = `pl'";
display "                              Pb          = `pb'";
display "                              y           = `y'";
display "                              AAAC        = `AAAC'";
/* project Washoe AAAC */;
gen wash_aaac_00 = .;
replace wash_aaac_00 = washoe if year == 2008;
replace wash_aaac_00 = wash_aaac_00[_n-1] + `AAAC' if year > 2008;
replace wash_aaac_00 = round(wash_aaac_00,0);

/* Geometric Exponential (GEO and EXPO) methods                          */;
/* base row is 11 and launch row is 59  for base year 1960*/;
local brow = 11;
local lrow = 59;
local byear = year[`brow'];
local lyear = year[`lrow'];
count if tin(`byear',`lyear');
local y = `r(N)';
local pl = washoe[`lrow'];
local pb = washoe[`brow'];
local r = ln(`pl'/`pb')/`y';
display "EXPO Model for Washoe County: Base year   = `byear'";
display "                              Launch year = `lyear'";
display "                              Pl          = `pl'";
display "                              Pb          = `pb'";
display "                              y           = `y'";
display "                              r           = `r'";
/* project Washoe population */;
gen wash_expo_60 = .;
replace wash_expo_60 = washoe if year == `lyear';
replace wash_expo_60 = `pl'*exp(`r'*(year-`lyear')) if year > `lyear';
gen wash_expo_all_60 = .;
replace wash_expo_all_60 = washoe if year == `byear';
replace wash_expo_all_60 = washoe[`brow']*exp(`r'*(year-`byear')) if year > `byear';

/* base row is 21 and launch row is 59  for base year 1970*/;
local brow = 21;
local lrow = 59;
local byear = year[`brow'];
local lyear = year[`lrow'];
count if tin(`byear',`lyear');
local y = `r(N)';
local pl = washoe[`lrow'];
local pb = washoe[`brow'];
local r = ln(`pl'/`pb')/`y';
display "EXPO Model for Washoe County: Base year   = `byear'";
display "                              Launch year = `lyear'";
display "                              Pl          = `pl'";
display "                              Pb          = `pb'";
display "                              y           = `y'";
display "                              r           = `r'";
/* project Washoe population */;
gen wash_expo_70 = .;
replace wash_expo_70 = washoe if year == `lyear';
replace wash_expo_70 = `pl'*exp(`r'*(year-`lyear')) if year > `lyear';
gen wash_expo_all_70 = .;
replace wash_expo_all_70 = washoe if year == `byear';
replace wash_expo_all_70 = washoe[`brow']*exp(`r'*(year-`byear')) if year > `byear';

/* base row is 31 and launch row is 59  for base year 1980*/;
local brow = 31;
local lrow = 59;
local byear = year[`brow'];
local lyear = year[`lrow'];
count if tin(`byear',`lyear');
local y = `r(N)';
local pl = washoe[`lrow'];
local pb = washoe[`brow'];
local r = ln(`pl'/`pb')/`y';
```

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```
display "EXPO Model for Washoe County: Base year    = `byear'";
display "                              Launch year  = `lyear'";
display "                              Pl           = `pl'";
display "                              Pb           = `pb'";
display "                              y            = `y'";
display "                              r            = `r'";
/* project Washoe population */;
gen wash_expo_80 = .;
replace wash_expo_80 = washoe if year == `lyear';
replace wash_expo_80 = `pl'*exp(`r'*(year-`lyear')) if year > `lyear';
gen wash_expo_all_80 = .;
replace wash_expo_all_80 = washoe if year == `byear';
replace wash_expo_all_80 = washoe[`brow']*exp(`r'*(year-`byear')) if year > `byear';

/* base row is 41 and launch row is 59  for base year 1990*/;
local brow = 41;
local lrow = 59;
local byear = year[`brow'];
local lyear = year[`lrow'];
count if tin(`byear',`lyear');
local y = `r(N)';
local pl = washoe[`lrow'];
local pb = washoe[`brow'];
local r = ln(`pl'/`pb')/`y';
display "EXPO Model for Washoe County: Base year    = `byear'";
display "                              Launch year  = `lyear'";
display "                              Pl           = `pl'";
display "                              Pb           = `pb'";
display "                              y            = `y'";
display "                              r            = `r'";
/* project Washoe population */;
gen wash_expo_90 = .;
replace wash_expo_90 = washoe if year == `lyear';
replace wash_expo_90 = `pl'*exp(`r'*(year-`lyear')) if year > `lyear';
gen wash_expo_all_90 = .;
replace wash_expo_all_90 = washoe if year == `byear';
replace wash_expo_all_90 = washoe[`brow']*exp(`r'*(year-`byear')) if year > `byear';

/* base row is 51 and launch row is 59  for base year 2000*/;
local brow = 51;
local lrow = 59;
local byear = year[`brow'];
local lyear = year[`lrow'];
count if tin(`byear',`lyear');
local y = `r(N)';
local pl = washoe[`lrow'];
local pb = washoe[`brow'];
local r = ln(`pl'/`pb')/`y';
display "EXPO Model for Washoe County: Base year    = `byear'";
display "                              Launch year  = `lyear'";
display "                              Pl           = `pl'";
display "                              Pb           = `pb'";
display "                              y            = `y'";
display "                              r            = `r'";
/* project Washoe population */;
gen wash_expo_00 = .;
replace wash_expo_00 = washoe if year == `lyear';
replace wash_expo_00 = `pl'*exp(`r'*(year-`lyear')) if year > `lyear';
gen wash_expo_all_00 = .;
replace wash_expo_all_00 = washoe if year == `byear';
replace wash_expo_all_00 = washoe[`brow']*exp(`r'*(year-`byear')) if year > `byear';
/* drop all created variables because none of these models are useful         */;
drop wash_exp*;
save `datafile', replace;
graph drop _all;

log close;
exit;
```

```
/*       1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
*  Program Name:   PopProjWashoe_02.do
*  Created by:     Shawn Stoddard
*  Created on:     7/20/2009
*  Abstract:       All the projection attemps so far have provided very good
*    results.  This script is a go back to the drawing board and see if something
*    was missed.
*
********************************************************************************/
pause on
#delimit;

set more off;
capture log close;
set linesize 90;
local logpath logs\ ;
local filename PopProjWashoe_02 ;
local logfile = "`logpath'" + "`filename'" ;
log using "`logfile'", replace text;
/* Washoe County data filename is */;
local datafile data\\WashoeDataAll_01 ;
use `datafile', clear;
local datafile data\\WashoeDataAll_02 ;
/*****************************************************************************/;
/* Clean up the data a bit by dropping variables that are not required       */;
/*****************************************************************************/;
/* if we need any of these variables we can just undo this action            */;
drop CenNv CenWas sdfnv2006  sdfwa2006  wcf2003 wcf2008 tmwau2002 tmwac2002
     tmwau2006 tmwac2006 tmwau2008;
drop  wash_aaac_60 wash_aaac_70 wash_aaac_80 wash_aaac_90 wash_aaac_00;

/*****************************************************************************/;
/* Complex Trend Extapolation models                                         */;
/*****************************************************************************/;
/* Linear Trend model (OLS)                                                  */;
/*****************************************************************************/;
regress washoe t;
predict wash_ols01;
label var wash_ols01 "Predicted linear values";
predict wash_ols01e, stdp;
label var wash_ols01e "Standard Error of Prediction";
predict wash_ols01f, stdf;
label var wash_ols01f "Standard Error of Forecast";
generate wash_ols01l = wash_ols01 - wash_ols01e;
label var wash_ols01l "95% Conf. Lower Limit";
generate wash_ols01h = wash_ols01 + wash_ols01e;
label var wash_ols01h "95% Conf. Upper Limit";
local calib = washoe[59] - wash_ols01[59];
display "Calib = `calib'";

twoway rarea wash_ols01l wash_ols01h year if tin(1950,2008),
       sort bcolor(gs14) ||
       line washoe year if tin(1950,2008), ||
       line wash_ols01 year if tin(1950,2008),
       title("Washoe County Linear Model Results", color(black) size(medium))
       graphregion(color(white))
       ytitle("Persons", color(black) size(small))
       xtitle("Year", color(black) size(small))
       ylabel(, noticks labsize(small) angle(horizontal) format(%12.0fc))
       xlabel(1950(5)2010, ticks tposition(inside) labsize(small))
       legend(on lcolor(black) col(3) size(tiny) symxsize(6) rowgap(*.5)
       order(2 "Washoe County Population" 3 "Linear Model"  1));

graph export graphs\TPEMFig_A-11.png, width(3600) replace;  /* this line locks up STATA */
graph export graphs\TPEMFig_A-11.emf, replace; /* this line works */

/* Calibrated Projections                                                    */;
replace  wash_ols01  = wash_ols01 + `calib' if tin(2008,2030);
replace  wash_ols01l = wash_ols01 - wash_ols01f if tin(2008,2030);
replace  wash_ols01h = wash_ols01 + wash_ols01f if tin(2008,2030);
```

```
twoway rarea wash_ols01l wash_ols01h year if tin(2008,2030),
       sort bcolor(gs14) ||
       line washoe year if tin(2000,2008), ||
       line wash_ols01 sdfwa2008adj year if tin(2008,2030),
       title("Washoe County Linear Population Projection", color(black) size(medium))
       graphregion(color(white))
       ytitle("Persons", color(black) size(small))
       xtitle("Year", color(black) size(small))
       ylabel(, noticks labsize(vsmall) angle(horizontal) format(%12.0fc))
       xlabel(2000(5)2030, ticks tposition(inside) labsize(vsmall))
       legend(on lcolor(black) col(4) size(tiny) symxsize(6) rowgap(*.5)
              span
              order(2 "Washoe County Population" 3 "Linear Model Projection"
                    4 "Demographers Proj." 1));
graph export graphs\TPEMFig_A-12.png, width(3600) replace;
graph export graphs\TPEMFig_A-12.emf, replace;

/******************************************************************************/;
/* estimate Polynomial curve of degree 2 and degree 3                        */;
/******************************************************************************/;
/* generate time squared & time cubed                                        */;
gen t2 = t^2;
gen t3 = t^3;
/* estimate quadratic function*/;
regress washoe t t2;
predict wash_pcf01;
label var wash_pcf01 "Quadratic Function Model";
predict wash_pcf01e, stdp;
label var wash_pcf01e "Standard Error of Prediction";
predict wash_pcf01f, stdf;
label var wash_pcf01f "Standard Error of Forecast";
generate  wash_pcf01l = wash_pcf01 - wash_pcf01e;
label var wash_pcf01l "95% Conf. Lower Limit";
generate  wash_pcf01h = wash_pcf01 + wash_pcf01e;
label var wash_pcf01h "95% Conf. Upper Limit";
local calib = washoe[59] - wash_pcf01[59];
display "Calib = `calib'";

twoway rarea wash_pcf01l wash_pcf01h year if tin(1950,2008),
       sort bcolor(gs14) ||
       line washoe year if tin(1950,2008), ||
       line wash_pcf01 year if tin(1950,2008),
       title("Washoe County Quadratic Model Results", color(black) size(medium))
       graphregion(color(white))
       ytitle("Persons", color(black) size(small))
       xtitle("Year", color(black) size(small))
       ylabel(, noticks labsize(small) angle(horizontal) format(%12.0fc))
       xlabel(1950(5)2010, ticks tposition(inside) labsize(small))
       legend(on lcolor(black) col(3) size(tiny) symxsize(6) rowgap(*.5)
       order(2 "Washoe County Population" 3 "Quadratic Model"  1));
graph export graphs\TPEMFig_A-13.png, width(3600) replace;
graph export graphs\TPEMFig_A-13.emf, replace;

/* very good fit to the historic data */
replace  wash_pcf01  = wash_pcf01 + `calib'     if tin(2008,2030);
replace  wash_pcf01l = wash_pcf01 - wash_pcf01f if tin(2008,2030);
replace  wash_pcf01h = wash_pcf01 + wash_pcf01f if tin(2008,2030);

twoway rarea wash_pcf01l wash_pcf01h year if tin(2008,2030),
       sort bcolor(gs14) ||
       line washoe year if tin(2000,2008), ||
       line wash_pcf01 sdfwa2008adj year if tin(2008,2030),
       title("Washoe County Quadratic Population Projections", color(black) size(medium))
       graphregion(color(white))
       ytitle("Persons", color(black) size(small))
       xtitle("Year", color(black) size(small))
       ylabel(, noticks labsize(small) angle(horizontal) format(%12.0fc))
       xlabel(2000(5)2030, ticks tposition(inside) labsize(small))
       legend(on lcolor(black) col(4) size(tiny) symxsize(6) rowgap(*.5)
              span
              order(2 "Washoe County Population" 3 "Quadratic Projections"
                    4 "Demographers Proj." 1));
graph export graphs\TPEMFig_A-14.png, width(3600) replace;
graph export graphs\TPEMFig_A-14.emf, replace;
```

```
/* estimate cubic model                                                    */;
regress washoe t t2 t3;
predict wash_pcf02;
label var wash_pcf02 "Cubic Function Model";
predict wash_pcf02e, stdp;
label var wash_pcf02e "Standard Error of Prediction";
predict wash_pcf02f, stdf;
label var wash_pcf02f "Standard Error of Forecast";
generate  wash_pcf02l = wash_pcf02 - wash_pcf02e;
label var wash_pcf02l "95% Conf. Lower Limit";
generate  wash_pcf02h = wash_pcf02 + wash_pcf02e;
label var wash_pcf02h "95% Conf. Upper Limit";
local calib = washoe[59] - wash_pcf02[59];
display "Calib = `calib'";

twoway rarea wash_pcf02l wash_pcf02h year if tin(1950,2008),
       sort bcolor(gs14) ||
       line washoe year if tin(1950,2008), ||
       line wash_pcf02 year if tin(1950,2008),
       title("Washoe County Cubic Model Results", color(black) size(medium))
       graphregion(color(white))
       ytitle("Persons", color(black) size(small))
       xtitle("Year", color(black) size(small))
       ylabel(, noticks labsize(small) angle(horizontal) format(%12.0fc))
       xlabel(1950(5)2010, ticks tposition(inside) labsize(small))
       legend(on lcolor(black) col(3) size(tiny) symxsize(6) rowgap(*.5)
       order(2 "Washoe County Population" 3 "Cubic Model"  1));
graph export graphs\TPEMFig_A-15.png, width(3600) replace;
graph export graphs\TPEMFig_A-15.emf, replace;

/* very good fit to the historic data */
replace  wash_pcf02  = wash_pcf02 + `calib'     if tin(2008,2030);
replace  wash_pcf02l = wash_pcf02 - wash_pcf02f if tin(2008,2030);
replace  wash_pcf02h = wash_pcf02 + wash_pcf02f if tin(2008,2030);

twoway rarea wash_pcf02l wash_pcf02h year if tin(2008,2030),
       sort bcolor(gs14) ||
       line washoe year if tin(2000,2008), ||
       line wash_pcf02 sdfwa2008adj year if tin(2008,2030),
       title("Washoe County Cubic Population Projections", color(black) size(medium))
       graphregion(color(white))
       ytitle("Persons", color(black) size(small))
       xtitle("Year", color(black) size(small))
       ylabel(, noticks labsize(vsmall) angle(horizontal) format(%12.0fc))
       xlabel(2000(5)2030, ticks tposition(inside) labsize(vsmall))
       legend(on lcolor(black) col(4) size(tiny) symxsize(6) rowgap(*.5)
              span
              order(2 "Washoe County Population" 3 "Cubic Projections"
                    1 4 "Demographers Proj." ));
graph export graphs\TPEMFig_A-16.png, width(3600) replace;
graph export graphs\TPEMFig_A-16.emf, replace;

/* Graph the three models with demographer's projection                    */;
   tsline washoe if tin(2000,2008)
|| tsline sdfwa2008adj if tin(2008,2030)
|| tsline wash_ols01 wash_pcf01 wash_pcf02 if tin(2008,2030) ,
   title("Linear, Quadratic, & Cubic Population Projections - Washoe County",
         color(black) size(medium))
   subtitle("Years 2000 to 2030", color(black) size(small))
   graphregion(color(white))
   ytitle("Persons", color(black) size(small))
   xtitle("Years", color(black) size(small))
   ylabel(, noticks labsize(vsmall) angle(horizontal) format(%12.0fc))
   xlabel(2000(5)2030, ticks tposition(inside) labsize(vsmall))
   legend(on lcolor(black) col(4) size(vsmall) symxsize(6) rowgap(*.5)
          span
          order(- " " 1 "Population"  - " " - " "
                - "Projections:" - " " - " " - " "
                2 "State Demographer's" 3 "Linear" 4 "Quadratic" 5 "Cubic"));
graph export graphs\TPEMFig_A-17.png, width(3600) replace;
graph export graphs\TPEMFig_A-17.emf, replace;

save `datafile', replace;
```

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```
/*      1         2         3         4         5         6         7         8
12345678901234567890123456789012345678901234567890123456789012345678901234567890
********************************************************************************
* Program Name:   PopProjWashoe_03.do
* Created by:     Shawn Stoddard
* Created on:     7/27/2009
* Abstract:       Estimate an Logistic Curve
*
*
*
********************************************************************************/
#delimit;
clear;
set more off;
capture log close;
set linesize 90;
local logpath logs\ ;
local filename PopProjWashoe_03 ;
local logfile = "`logpath'" + "`filename'" ;
log using "`logfile'", replace text;
/* Washoe County data filename is */;
local datafile data\\WashoeDataAll_02 ;
use `datafile', clear;
local datafile data\\WashoeDataAll_03 ;
/*****************************************************************************/;
/* Complex Trend Extapolation models                                         */;
/*****************************************************************************/;
/*****************************************************************************/;
/* Logistic Curve Fitting                                                    */;
/*****************************************************************************/;
/* project to the year 2050                                                  */;
local newN = _N + 70;
set obs `newN';
replace t = _n if t == .;
replace year = t + 1949 if year == .;

nl (washoe = {a} / (1 + {b} * exp( -1* {c} * t) ) ),
    variables(washoe t) initial(a 400000 b 5.0 c .5) vce(hc2);
estimates store m1;

predict wash_lcf01;
label var wash_lcf01 "Keyfitz Logistic Model Estimated Ceiling";
local calib = washoe[59] - wash_lcf01[59];
display "Calib = `calib'";
generate wash_lcf01c = wash_lcf01 + `calib';
/* Compute the upper and lower population values based on the 95% conf.     */;
/* interval of b0 - the population ceiling                                  */;
/* change b0 to lower limit of b0 and re-estimate model (676985)            */;
/* change b0 to upper values of b0 and re-estimate model(785641)            */;

/* estimate lower curve                                                      */;
nl (washoe = 676985 / (1 + {b} * exp( -1* {c} * t) ) ),
    variables(washoe t) initial(b 5.0 c .5) vce(hc2);
estimates store m2;

predict wash_lcf02;
label var wash_lcf02 "Keyfitz Logistic Model b0 = 676,985";
local calib = washoe[59] - wash_lcf02[59];
display "Calib = `calib'";
generate wash_lcf02c = wash_lcf02 + `calib';
/* estimate upper curve                                                      */;
nl (washoe = 785641 / (1 + {b} * exp( -1* {c} * t) ) ),
    variables(washoe t) initial(b 5.0 c .5) vce(hc2);
estimates store m3;

predict wash_lcf03;
label var wash_lcf03 "Keyfitz Logistic Model b0 = 785,641";
local calib = washoe[59] - wash_lcf03[59];
display "Calib = `calib'";
generate wash_lcf03c = wash_lcf03 + `calib';


/* Create Graphs for the Population Memo                                     */;
```

```
/* Figure 1: logistic curve and population                                    */;
/* models with historic populaiton                                            */;
   tsline washoe wash_lcf01 wash_lcf02 wash_lcf03 if tin(1950,2008),
   title("Washoe County Population", color(black) size(medium))
   subtitle("Logistic Curve Model", color(black) size(medium))
   graphregion(color(white))
   ytitle("Persons", color(black) size(small))
   xtitle("Years", color(black) size(small))
   ylabel(, noticks labsize(small) angle(horizontal) format(%12.0fc))
   xlabel(1950(5)2010, ticks tposition(inside) labsize(small))
   legend(on lcolor(black) col(3) size(small) symxsize(3) rowgap(*.5)
          span
          order(1 "Annual Population 1950 to 2008"  - " " - " "
                3 "Model 2:" 2 "Model 1:" 4 "Model 3:"
                - "Pop. Ceiling = 676,985"
                - "Pop. Ceiling = 731,313"
                - "Pop. Ceiling = 785,641" ));

graph export graphs\TPEMFig_01.png, width(3600) replace;
graph export graphs\TPEMFig_01.emf, replace;

/* Figure 2:  Population projection models 2008 to 2030             */;
/* Graph 2030 projections                                           */;
   tsline washoe if tin(2000, 2008), lwidth(medium)
|| tsline sdfwa2008adj if tin(2008,2030)
|| tsline wash_lcf02c wash_lcf01c wash_lcf03c if tin(2008,2030),
   title("Population Model Comparisions", color(black) size(medium))
   subtitle("Years 2008 to 2030", color(black) size(small))
   graphregion(color(white))
   ytitle("Persons", color(black) size(small))
   xtitle("Years", color(black) size(small))
   ylabel(, noticks labsize(small) angle(horizontal) format(%12.0fc))
   xlabel(2000(5)2030, ticks tposition(inside) labsize(small))
   legend(on lcolor(black) col(3) size(small) symxsize(3) rowgap(*.5)
          span
          order(1 "Annual Population"  2 "Demographer's Projection" - " "
                3 "Model 2:" 4 "Model 1:" 5 "Model 3:"
                - "Pop. Ceiling = 676,985"
                - "Pop. Ceiling = 731,313"
                - "Pop. Ceiling = 785,641" ));
graph export graphs\TPEMFig_02.png, width(3600) replace;
graph export graphs\TPEMFig_02.emf, replace;

/* Findings:  Population projection model 2010 to 2030             */;

   tsline washoe if tin(2000, 2008), lwidth(medium)
|| tsline wash_lcf02c if tin(2008,2030),
   title("Population Projection 2009 to 2030", color(black) size(medium))
   graphregion(color(white))
   ytitle("Persons", color(black) size(small))
   xtitle("Years", color(black) size(small))
   ylabel(, noticks labsize(small) angle(horizontal) format(%12.0fc))
   xlabel(2000(5)2030, ticks tposition(inside) labsize(small))
   legend(on lcolor(black) col(1) size(small) symxsize(3) rowgap(*.5)
          span
          order(1 "Annual Population"
                2 "Model 2:  Pop. Ceiling = 676,985" ));
/* Figure 3: Compare models  1 to 3 through year 2100                         */;
/* Graph 2100 projections                                          */;
   tsline washoe if tin(2000, 2008), lwidth(medium)
|| tsline sdfwa2008adj if tin(2008,2030)
|| tsline wash_lcf02c wash_lcf01c wash_lcf03c if tin(2008,2100),
   title("Long-run Population Models for Washoe County", color(black) size(medium))
   subtitle("Years 2008 to 2100", color(black) size(small))
   graphregion(color(white))
   ytitle("Persons", color(black) size(small))
   xtitle("Years", color(black) size(small))
   ylabel(, noticks labsize(small) angle(horizontal) format(%12.0fc))
   xlabel(2000(10)2100, ticks tposition(inside) labsize(small))
   legend(on lcolor(black) col(3) size(small) symxsize(3) rowgap(*.5)
          span
          order(1 "Annual Population"  2 "Demographer's Projection" - " "
                3 "Model 2:" 4 "Model 1:" 5 "Model 3:"
                - "Pop. Ceiling = 676,985"
```

```
                - "Pop. Ceiling = 731,313"
                - "Pop. Ceiling = 785,641" ));

graph export graphs\TPEMFig_03.png, width(3600) replace;
graph export graphs\TPEMFig_03.emf, replace;

/* Figure 4: graph population & model 2 1950 to 2100                  */;
/* Graph 2100 projections                                       */;
   tsline washoe if tin(1950, 2008), lwidth(medium)
|| tsline sdfwa2008adj if tin(2008,2030)
|| tsline wash_lcf02c if tin(2008,2100),
   title("Population and Projection 1950 to 2100", color(black) size(medium))
   subtitle("State Demographer and Model 2 Projections", color(black) size(small))
   graphregion(color(white))
   xline(2008, lcolor(red)) xline(2030, lcolor(red))
   text(380000 2009 "Projected" "Population" "Area", place(e) size(small))
   ytitle("Persons", color(black) size(small))
   xtitle("Years", color(black) size(small))
   ylabel(0(100000)800000, noticks labsize(small) angle(horizontal) format(%12.0fc))
   xlabel(1950(10)2100, ticks tposition(inside) labsize(small))
   legend(on lcolor(black) col(2) size(small) symxsize(3) rowgap(*.5)
          span
          order(1 "Annual Population"  2 "Demographer's Projection"
                3 "Model 2:" - " "
                - "Pop. Ceiling = 676,985"
                ));
graph export graphs\TPEMFig_04.png, width(3600) replace;
graph export graphs\TPEMFig_04.emf, replace;
exit;


/* likelihood ratio test of models */;

/* estimate lower curve                                              */;

lrtest m1 m2, stats dir;
lrtest m1 m3, stats dir;


/* send the results to an Excel file for creating a report table     */;
outsheet t year washoe sdfwa2008adj wash_lcf02c wash_lcf01c wash_lcf03c
         using data\PopProjLCFmodel.csv, comma replace;
tsset year, yearly;
save `datafile', replace;
exit;
*******************************************************************************
Stata stops reading the file at the exit statement so
you can type whatever you want down here in the form of
comments.
```

W:\WaterResources\Projects_Population2009\Documentation\Reports\TPEM2009_No01\Memo_TPEM_No01_20090803.doc