GDP, PERSONAL INCOME AND GROWTH

PART 1: IMPACT OF NATIONAL AND OTHER STATE GROWTH ON NEVADA GDP

INTRODUCTION

Nevada has been heavily hit by the recession, with unemployment rates of 13.4% as of October 2011, lost sales tax revenue and gaming revenue, declining population, and reductions in visitors (DETR 2011). While other states have also been impacted by the recession, Nevada leads the way in unemployment and foreclosure rates (Bloomberg 2011).

There are many reasons why Nevada's economy has been impacted so heavily, its housing bubble created a high demand for construction-related employment, much of which was lost when the bubble burst and construction decreased. The State's dependence of tourism has also been impacted by competition from other gaming locations and reduction in tourism due to the declining economic conditions and high gas prices.

Assuming GDP[1], which measures output of the economy, is a good indicator of the health of the economy, we would expect an increasing GDP growth to indicate a growing and healthy economy, and a declining GDP growth to indicate potential problems. Figure 1 below shows a comparison of GDP growth between the United States and State of Nevada.

Figure 1
Comparison of Annual Growth Percentage
Real GDP-US and Nevada
1964-2010 (BEA)

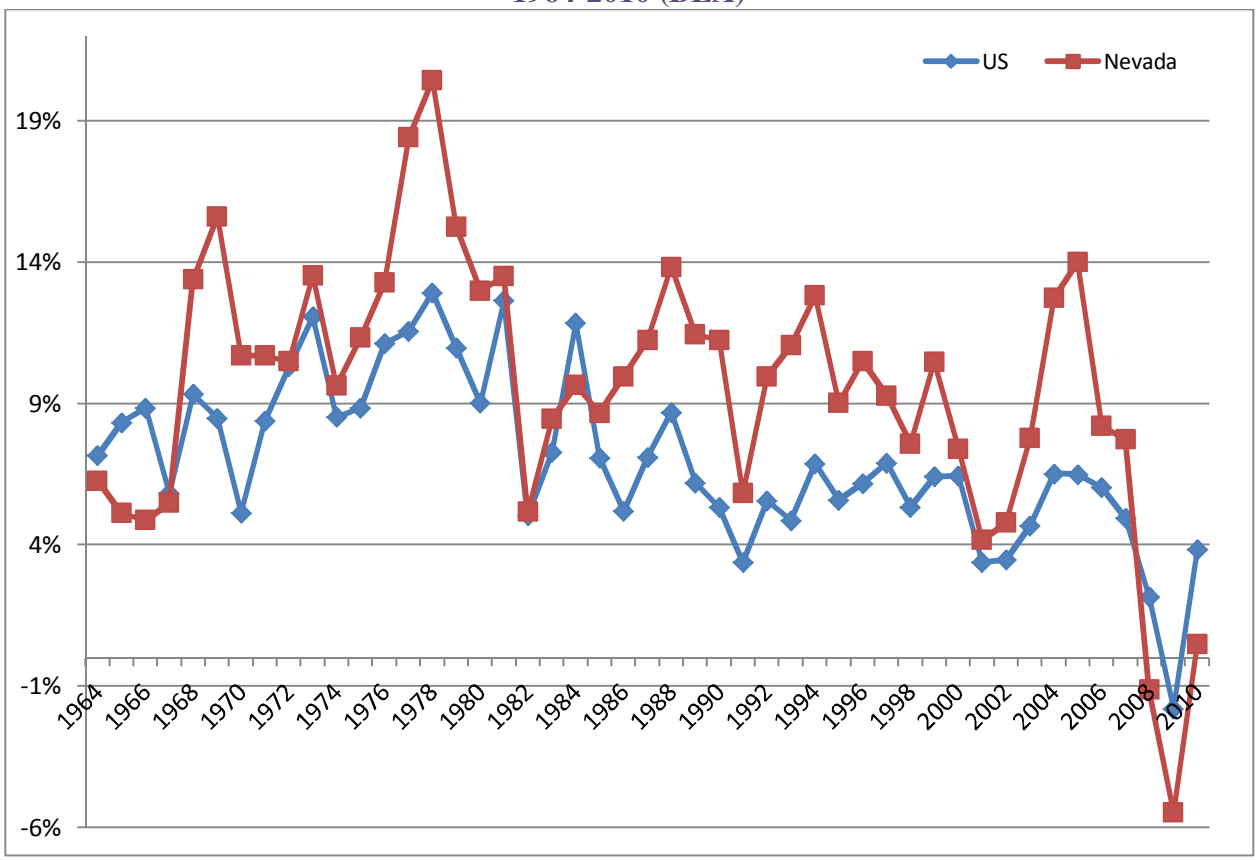

Figure 1 shows that starting in the late 1960's, Nevada experienced higher levels of GDP growth than the US as a whole. However, Nevada's economic decline, starting in 2008 is also more extreme than the national level.

[1] GDP-Gross Domestic Product. Unless otherwise indicated, the analysis uses real GDP, data adjusted for inflation, which allows for easier comparison between years by eliminating changes in data due to inflation.

Nevada's biggest neighbor to the West, California, is an important source of employment and trade for Nevada due to its large size and proximity. For example, in 2007, California residents made up 48% of visitors to the Reno-Sparks area (RSCVA 2008) and 31% of visitors to the Las Vegas area (LVCVA 2010). These visitors generate significant amounts of gaming revenue, sales tax revenue, room tax revenue and help create and support local jobs through their various expenditures.

California's GDP when compared to Nevada's, shows a similar pattern as the comparison of US GDP to Nevada's, as shown in Figure 2 below.

Figure 2
Comparison of Annual Growth Percentage
Real GDP-California and Nevada
1964-2010 (BEA)

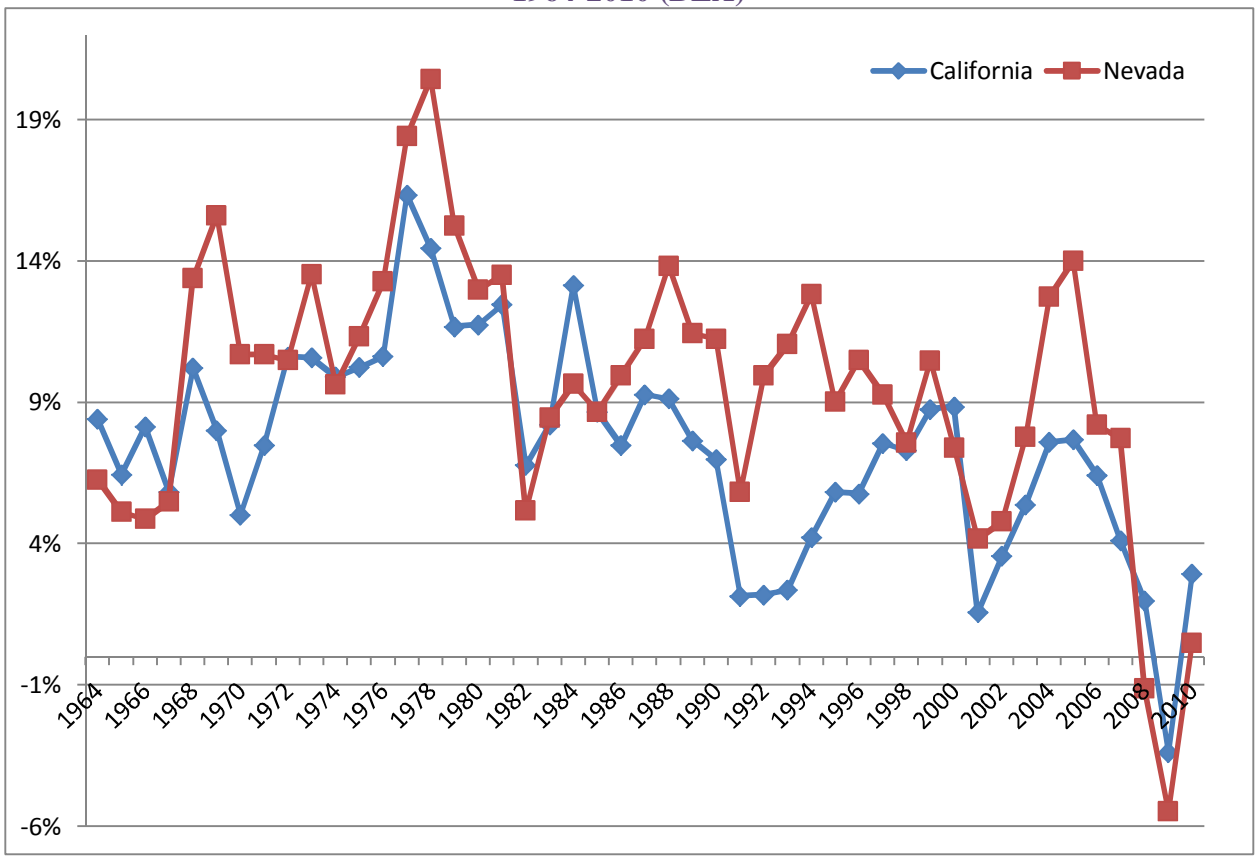

Figure 2 shows that Nevada experienced higher levels of growth during the boom periods and a higher level of decline once the recession began.

It is likely that events that caused the growth and decline in the US and California economies impacted the Nevada economy due to their shared trading and employment channels. However, it is likely that Nevada's economic growth and decline was also impacted by internal forces, the impact on Nevada growth of one of these forces, changes in personal income components, is discussed in Part 2 of this analysis. This paper focuses on the impacts of national and neighboring state forces on Nevada GDP.

METHODOLOGY

The purpose of this project is to determine State of Nevada's ability to withstand economic cycles, to determine whether changes in California GDP impact Nevada's GDP. Overall, the purpose is to see whether Nevada's GDP is sensitive to national growth/decline and whether it is sensitive to neighboring growth decline (California).

The first model is a simple comparison of Nevada GDP to national GDP between 1970 and 2009.[2] Real GDP data is used as it allows comparison of actual GDP growth without the impact of inflation. This data is collected from the Bureau of Economic Analysis, which provides GDP data at the national and state levels. Data is shown in percent annual change format, which is used as a proxy for economic growth on the assumption that the economy's output (GDP) growth represents overall growth of the economy. The model will take the form of:

$$\%\Delta NVGDP=\alpha+\beta\%\Delta USGDP \qquad (1)$$

The second model, similar to the above model, determines whether California GDP has an impact on Nevada GDP. In other words, we want to see whether California's cyclical growths and declines impact Nevada's economy. The model will take the following form:

[2] Real GDP data is available from the Bureau of Economic Analysis for the period between 1963 through 2010. However, personal income data also used in this report is available for the period between 1969 and 2009, so this period is used to be consistent. Because the analysis utilizes annual percent increase data calculated from this data, we cannot user 1969 data, so the analysis begins in 1970.

$$\%\Delta NVGDP=\alpha+\beta\%\Delta CAGDP \qquad (2)$$

The same analysis can be performed for all neighboring states, to determine whether proximity to other states impact Nevada's economic growth. For this analysis, California was selected as it is Nevada's largest neighbor and there are close economic relationships between the two states.

FINDINGS

National Impact

Since the model in equation (1) is based on time series data, variables within this study must be tested for stationarity, and if non-stationary, they should be cointegrated. Below are the tests for both. The Dickey-Fuller test for stationarity indicates that both variables in the model are non-stationary at all three levels of critical values.

			Critical Value (tc)				
	t	**p**	**1%**	**5%**	**10%**	**Result**	**Conclusion**
NVGDP	-1.295	0.6313	-3.655	-2.961	-2.613	|t|<|tc|, p>5%	do not reject Ho
USGDP	-1.971	0.2995	-3.655	-2.961	-2.613	|t|<|tc|, p>5%	do not reject Ho

The test assumes that data is non-stationary (Ho), because we do not reject the null hypothesis, both variables are non-stationary. Because these variables are non-stationary, they must be cointegrated in order to proceed with the analysis, otherwise they are unrelated variables and the result of the regression will not be accurate. To test whether these variables are cointegrated, the analysis estimates residuals of the regression model and then conducts the Dickey-Fuller test on the residuals. The results of this test are shown below:

```
Dickey-Fuller test for unit root                    Number of obs   =        39

                                    ———— Interpolated Dickey-Fuller ————
                 Test         1% Critical       5% Critical      10% Critical
               Statistic         Value             Value            Value
——————————————————————————————————————————————————————————————————————————
 Z(t)          -3.163           -3.655            -2.961           -2.613
——————————————————————————————————————————————————————————————————————————
MacKinnon approximate p-value for Z(t) = 0.0222
```

|t|>|tc| for the 5% and 10% critical values, reject H_0 that variables are not cointegrated at these levels, p=0.02<0.05, reject H_0 that residuals are not cointegrated.

This means that even though the variables are non-stationary, they are cointegrated and therefore can be used in this model. Another problem that faces a time series regression equation is serial correlation. The Breusch-Godfrey test can test for this as follows:

Breusch-Godfrey LM test for autocorrelation

lags(p)	chi2	df	Prob > chi2
1	**10.840**	**1**	**0.0010**

H0: no serial correlation

P=0.001<0.05, reject null that no serial correlation exists. This test shows that serial correlation exists and must be corrected. Serial correlation can be fixed using the Prais-Winston technique, but only if we can show that this technique is appropriate. To do so, we must create a new model with lag variables, as follows:

$$\%\Delta\text{NVGDP}=\alpha+\beta_1\%\Delta\text{USGDP}+\beta_2\%\Delta\text{NVGD}P_{t-1}+\beta_3\%\Delta\text{USGD}P_{t-1}$$

If we can show that the coefficients of this model have the following relationship β_1=-($\beta_2 * \beta_3$), we can use the Prais-Winston technique to solve our serial correlation. If the relationship does not exist, we must use a dynamic model to show the relationship between US and Nevada GDP. The below test shows that the relationship does exist, since the p value of this test=0.700>0.05, we do not reject H_0 that β_1=-($\beta_2 * \beta_3$).

```
(1)  _b[l1.usgdp] = -_b[l1.nvgdp]*_b[usgdp]

           F(1, 35) =        0.15
           Prob > F =        0.7000
```

Using the Prais-Winston technique, we can finally arrive at the model predicting the relationship between US GDP and Nevada GDP:[3]

$$\%\Delta NVGDP = 0.0207192 + 1.113511\%\Delta USGDP \qquad r^2 = 0.6132$$
$$(0.01264) \qquad (0.14876)^{***}$$

This model predicts approximately 61% of the annual change in Nevada GDP. It shows that given a 1% increase in US GDP will increase NV GDP by 1.11%. This means that US economic growth will cause Nevada growth to increase at a higher rate. The coefficient of USGDP is highly significant, while the coefficient of the constant is not significant at any significance level.

There, however, may be another problem with this data, this one dealing with causality. It is unclear if changes in US GDP cause changes in Nevada GDP, or because NV GDP is a component of US GDP, it causes changes in the national GDP. We can use the Granger Causality test to help resolve this issue. The test will not tell us whether one variable causes the change in the other, rather it will tell us which variable came first, which is as good of an answer as we can get in this case.

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
nvgdp	usgdp	**18.021**	**4**	**0.001**
nvgdp	ALL	**18.021**	**4**	**0.001**
usgdp	nvgdp	**20.548**	**4**	**0.000**
usgdp	ALL	**20.548**	**4**	**0.000**

Because the null hypothesis of this test is that the first variable does not cause the second variable, we would reject the null, which means both variables Granger-cause the other variable.

[3] Values in parenthesis are standard errors associated with above coefficients. Asterisks following each standard deviation number represent the significance of the coefficient at the level of significance of 10%-*, 5%-**, and 1%-***.

A similar analysis can be conducted for the impact of growth in California on Nevada growth, as shown in equation (2). Since this is also time series data, we start with the Dickey Fuller test, results of which are below:

			Critical Value (tc)				
	t	**p**	**1%**	**5%**	**10%**	**Result**	**Conclusion**
NVGDP	-1.295	0.6313	-3.655	-2.961	-2.613	|t|<|tc|, p>5%	do not reject Ho
CAGDP	-1.453	0.5568	-3.655	-2.961	-2.613	|t|<|tc|, p>5%	do not reject Ho

Because we do not reject the null hypothesis, both variables are non-stationary. Because these variables are non-stationary we will conduct the Dickey-Fuller test on the residuals. The results of this test are shown below:

Dickey-Fuller test for unit root — Number of obs = **39**

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	**-3.072**	**-3.655**	**-2.961**	**-2.613**

MacKinnon approximate p-value for Z(t) = **0.0287**

|t|>|tc| for the 5% and 10% critical values, reject H_0 that variables are not cointegrated at these levels, p=0.03<0.05, reject H_0 that residuals are not cointegrated.

This means that even though the variables are non-stationary, they are cointegrated and therefore can be used in this model. Another problem that faces a time series regression equation is serial correlation. The Breusch-Godfrey test can test for this as follows:

Breusch-Godfrey LM test for autocorrelation

lags(*p*)	chi2	df	Prob > chi2
1	**11.088**	**1**	**0.0009**

H0: no serial correlation

P=0.009<0.05, reject null that no serial correlation exists. This test shows that serial correlation exists and must be corrected. Serial correlation can be fixed using the Prais-Winston technique, but only if we can show that this technique is appropriate. To do so, we must create a new model with lag variables, as follows:

$$\%\Delta NVGDP=\alpha+\beta_1\%\Delta CAGDP+\beta_2\%\Delta NVGDP_{t-1}+\beta_3\%\Delta CAGDP_{t-1}$$

The below test shows that β_1=-($\beta_2 * \beta_3$), since the p value of this test=0.99>0.05, so we can use Prais-Winston to correct for serial correlation:

```
(1)  _b[l1.cagdp] = -_b[l1.nvgdp]*_b[cagdp]

           F(1, 35) =        0.00
         Prob > F =        0.9886
```

Using the Prais-Winston technique, we can finally arrive at the model predicting the relationship between California GDP and Nevada GDP:

$$\%\Delta NVGDP=0.0322071+0.8863906\%\Delta CAGDP \qquad r^2=0.5321$$
$$(0.013061)^{**}\ (0.1404819)^{***}$$

This model predicts approximately 53% of the annual change in Nevada GDP. It shows that given a 1% increase in US GDP will increase NV GDP by 0.89%. This means that California economic growth will cause some Nevada growth, but at a lower rate. The coefficient of CAGDP and of the constant is significant at 5%.

Similar to the national impact analysis, we need to determine whether each variable causes the other. In this case the Granger Causality test shows that we cannot reject the null, so neither variable Granger-causes the other.

Granger causality Wald tests

Equation	Excluded	chi2	df	Prob > chi2
nvgdp	cagdp	5.4516	4	0.244
nvgdp	ALL	5.4516	4	0.244
cagdp	nvgdp	5.9172	4	0.205
cagdp	ALL	5.9172	4	0.205

CONCLUSION

There were few surprises in the analyses of the impact of national and California growth on the State of Nevada. It makes sense that the change in national GDP has a higher impact on the State than changes in California, since Nevada and the US are interrelated. Also not surprising are the low r-squared results of these models, since so many other variables predict the growth of Nevada's economy.

REFERENCES

"2007 Reno-Tahoe Visitor Profile Study." Reno Sparks Convention and Visitors Authority (RSCVA). February 2008.

"2010 Las Vegas Visitor Profile Study." Las Vegas Convention and Visitors Authority (LVCVA). 2011.

"GDP and Personal Income." Bureau of Economic Analysis. Real GDP data is available for the period between 1963 and 2010. Percentage annual growth is estimated using annual GDP data.