Ups and Downs: An Analysis of Oregon's Relationship with the National Economy

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This thesis analyzes the interaction between Oregon's economy and those of the other 49 states which comprise the national economy. The author uses three empirical methods to investigate these relationships. Persistence of employment growth rates among the states is analyzed, and found to decrease over the last three decades. The Beta framework from finance is applied to the 50 states, and Oregon is found to have the 4th highest correlated volatility. A Granger Causality test is used to classify the states according to their predictive power of the national economy: Oregon is shown to be a leading indicator. Finally, this thesis estimates 50 state-specific Vector Autoregression models, and uses Impulse Response Functions to measure differential responses to a common shock. Oregon is shown to be the 3rd most sensitive state to a shock to fuel prices. The results of the thesis are discussed in terms of their relevance to Oregon policymakers, businesses, and consumers.

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INTRODUCTION

My interest in state economies began during my first years at the University of Oregon, when I would contrast the economic news I read in national newspapers such as *The Wall Street Journal* and *New York Times* with the stories I read in local newspapers. The incongruities were readily apparent: expansions and contractions did not seem to affect each state with the same force. While I thought it was interesting that Oregon's and the nation's economies did not seem to move perfectly in sync (or with the same relative magnitude), I had no way of investigating the question. Fortunately during the winter term of my Junior year I learned some ways of approaching the issue. I was taking both an economic forecasting course, taught by professor Tim Duy of the economics department, and a financial theory course, taught by professor Avinash Verma in the College of Business. This thesis explores the overlap between the two courses, and attempts to leverage the insights of both disciplines' methodologies in order to thoroughly analyze Oregon's relationship with the national economy.

As part of the finance course we learned about the capital asset pricing model. This model prices assets (e.g., stocks) based on their risk: the riskier an asset, the more an investor will demand to be compensated (i.e., riskier stocks will require a higher expected rate of return). This model interested me not for its predictive power but for its decomposition of **risk**[1] (i.e., **volatility**), into different parts, diversifiable (uncorrelated with the market) and undiversifiable (correlated with the market). I wondered if this same type of thinking could be applied to the states in the U.S., with Oregon as a particular asset, and the national economy serving as the market.

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[1] Definitions for words in **bold** are available in the glossary at the end of the thesis

Meanwhile, as a part of the economic forecasting course we learned about different methods for predicting values in a series of data. Using models ranging from simple **ordinary least squares** (**OLS**) regressions to those containing **autoregressive** and moving average terms, we tried to predict the future. Forecasting involves building a mathematical model that is a simplified representation of some system (e.g., Oregon's economy), and then letting it run future time values. The process is difficult, because of the rigorous mathematics, the inherent uncertainty in the future, and the inevitable oversimplification of the relationships affecting the variable one is attempting to forecast. The models we learned about in this course can be used to estimate the historical relationships between different variables, but instead of using the models for forecasting, I wanted to use them to analyze Oregon's link with the national economy.

Another motivation for this thesis is the Oregon fiscal budget process. In the realm of state politics, Oregon is unique in its "kicker checks." Oregon voters implemented a law in 1979 that requires excess revenue collected by the state government to be returned to taxpayers in the form of "kicker checks." Excess revenue is calculated through comparison of the state economist's forecast at the end of the regular Legislative session, adjusted in May, to the actual revenue that the state collects during the biennium (Legislative Review Office, 2007). If the amount collected is more than 2% greater than the amount forecasted, the total amount in excess of the forecast is returned in the form of mailed checks. The 2% threshold is calculated separately for personal income taxpayers and corporate income taxpayers; citizens and/or corporations can receive kicker checks. This law became popular with Oregonians and in 2000 was adopted into the state constitution (Cain 2006). However, some critics of the kicker checks claim that they are **procyclical**. While this thesis will not delve into the political issues, it will investigate the sensitivity of Oregon's economy. In this sense it will provide evidence of the extent to which a stabilization fund (in contrast to a kicker check) would be necessary for Oregon (as opposed to other states). Broadly speaking, determining the extent of Oregon's sensitivity to changes in economic conditions will also be relevant to citizens and businesspeople: if Oregon's economy is sensitive, one could help smooth consumption (or investment) by increasing personal savings during expansions.

The first part of this thesis will present a brief overview of Oregon's economy using descriptive statistics; the first section will familiarize the reader with the basics of Oregon's economy. Next, this paper will provide a comprehensive literature review, first covering the Capital Asset Pricing Model and discussing its relevance to state economies, then analyzing findings from economists on both regional and state economies within the U.S. The methodology section will describe **Vector Autoregression** (**VAR**) models and **Impulse Response Functions** (**IRF**). In the next section, the author will empirically analyze Oregon's economy using both the Beta framework and state-level VAR models and IRFs. The thesis will conclude with a summation of results and a discussion of their implications. The overall goal of this thesis is to illuminate Oregon's relationship with the national economy by comparing and contrasting it with the other states' relationships.

OVERVIEW OF OREGON'S ECONOMY

This section will present a brief description of Oregon's economy and will contrast it to the other states in the U.S. Oregon has an economy that, on a broad industry level, closely mirrors that of the nation as a whole. The Bureau of Labor Statistics provides data on the extent to which employment is concentrated in various industries; the results (with author's calculations) presented in Table 1 are with data from 2008, the most recent available. Oregon's workers are allocated among the

Table 1: Industry Composition

Industry	Workforce Employed By Industry		
	U.S.	Oregon	Difference
Natural Resources and Mining	1.7%	3.5%	1.9%
Construction	6.3%	6.5%	0.2%
Manufacturing	11.8%	13.6%	1.7%
Trade, Transportation, and Utilities	23.1%	23.1%	0%
Information	2.6%	2.5%	-0.1%
Financial Activities	7.0%	6.0%	-1.0%
Professional and Business Services	15.6%	13.6%	-2.0%
Education and Health Services	15.9%	14.8%	-1.0%
Leisure and Hospitality	11.8%	12.0%	0.2%
Other Services	4.0%	4.4%	0.4%

industries in a similar manner to the national economy: the biggest differences are that Natural Resources and Mining are a more important aspect of Oregon's economy, while Professional and Business Services play a relatively larger role in the national economy.

The size of Oregon, as measured by its **Gross Domestic Product** (**GDP**) output, is also about average for a state in the U.S. Comparing Oregon to the other 49 states in the U.S. allows the analysis of different factors to have a common basis for comparison.

In 2008, according to the author's calculations with data from the Bureau of Economic Analysis (BEA) and U.S. Department of Commerce, Oregon ranked 26th out of the 50 states, and produced 1.14% of the nation's GDP. Oregon might seem smaller than it actually is because of its neighbor to the south: California is far and away the largest state, producing 13% of the national output. Oregon's citizens rank slightly lower than average in terms of their income: Oregon's per-capita personal income of $36,365 is 30th among the states (Bureau of Economic Analysis 2008). There are about 3.8 million people living in Oregon (Census estimate 2009), and in the last 10 years, its population has grown by 11.8%, compared to 9.1% for the U.S. as a whole. Oregonians are slightly more educated than the average American: Oregon ranks 24th among the states, with just over 25% of its population holding a bachelor's degree or higher. Oregonians are more likely to be living below the poverty line: Oregon ranks 19th among the states in terms of this metric, with 14% of its population living below the poverty line (American Community Survey 2004).

These descriptive statistics help situate Oregon among the other 49 states in the country. After discovering that Oregon's economy is fairly average in its basic measurements, it's necessary to dig deeper in order to investigate its relationship with the national economy as a whole. In order to accomplish this objective, the next section delves into both the financial and economics literature with the goal of obtaining useful information about state economies (specifically Oregon's).

REVIEW OF LITERATURE

Finance Literature: Beta and Alternative Beta

This section will describe a methodology from finance which later in the thesis will be used to compare state economies within the U.S. A widely used model in finance is the Capital Asset Pricing Model (CAPM), which attempts to make explicit the relationship between the riskiness of an asset and the expected price of that asset. After making a series of assumptions- perfect information, identical time horizons, efficient capital markets, and diversified portfolios- Sharpe (1964) develops the framework for the CAPM as an **equilibrium** model where the market clearing rates are always achieved (Ho and Lee 2004). A key input into the model (in order to determine an asset's price) is the asset's Beta.

In the context of investing, Beta attempts to capture the sensitivity of an asset's returns to changes in the general market's returns. The term Beta comes from estimating the following equation:

$$R_a = R_f + \beta_a R_m$$

Where R_a is equal to the (historical) rate of return of a particular asset, R_f is a constant representing the risk-free rate, β_a is the estimated coefficient, and R_m, is the (historical) return of the market as a whole. The total risk of a portfolio is measured by the standard deviation of its returns: riskier portfolios' returns fluctuate more. However, the simple risk of an individual stock is not the relevant input into the capital asset pricing model: what matters is the undiversifiable (correlated) risk, i.e., the risk that cannot be eliminated by holding a mixture of unrelated stocks. The Capital Asset Pricing model uses the estimated Beta (β_a), multiplied by the risk premium of the market, and adds the current risk-free rate (e.g., the rate of return on U.S. Treasuries) to produce an *expected* future return for a particular asset, which leads to an appropriate price. Independent of the pricing function of the model, the Beta coefficient provides useful information by providing a measure of sensitivity to changes in the overall market. In adapting this model to state and national economies, the pricing function (and risk-free rate) can be ignored, while the Beta coefficient can be estimated and compared for each of the 50 states.

While Beta is widely used in finance, there are several critiques of its methodology. There is no standardized way to measure it: its value depends on the time interval chosen for calculating returns (e.g., daily, weekly, monthly) and the time period (e.g., last two years, last ten years). Beta incorporates two separate measurements, which can lead to misinterpretation. It can also be calculated as:

$$\beta_a = \frac{\sigma^2{}_{R_a, R_m}}{\sigma^2{}_{R_m}}$$

Where $\sigma^2{}_{RA,\ RM}$ is the **covariance** between the returns of the individual asset and those of the market, and $\sigma^2{}_{RM}$ is the **variance** of the market's returns. Tofallis

(2008) notes that many investors (and even some financial economics textbooks) misinterpret the Beta coefficient as the simple relative volatility of an asset. In reality it elucidates a particular aspect of relative volatility: that which is correlated with the market as a whole. Tofallis proposes a simple measure of total relative volatility: the ratio of the standard deviation in the returns of a particular asset (σ_a) with that of the standard deviation in the returns of the market as a whole (σ_m), multiplied by only the sign (*not* the degree) of their **correlation** ($\rho_{a,m}$). He calls this measurement Alternative Beta (β*).

$$\beta_a * = (sign\ of\ \rho_{a,m}) \times \frac{\sigma_a}{\sigma_m}$$

This measurement only describes the volatility of an asset with regards to the market as a whole; it does not decompose the volatility. In the context of state economies, Alternative Beta can provide a measurement to compare the *total* relative volatility of each of the 50 states.

Two measures of relative volatility used in finance, Beta and Alternative Beta, each could provide useful information in the context of state economies. Beta elucidates the correlated volatility; in Oregon's case: how sensitive is Oregon to movements in the national economy? Alternative Beta demonstrates a broader measure of relative volatility: how volatile is Oregon compared to the national economy? While these two metrics will elucidate the statistical relationship between each state and the nation, they do not investigate the underlying factors. The next part of the literature review, covering relevant economics literature, will probe more deeply into the factors driving state-level economic relationships.

Economics Literature: Regional Differences

Economists have studied both the national economy and its constituent parts. The most common delineation is between the nation, regions, and states. The regions are either those defined by the U.S. Census (using its nine divisions) or the Bureau of Economic Analysis (BEA), which defines eight regions in the U.S. This section will review studies on variation between regions in the United States; the next will cover state differences. Grouping the states into artificial geographic regions is useful for several reasons. It can help uncover patterns among states in a region, and if no such patterns exist, the regional effects will be insignificant; the significance of regional grouping can be tested. More practically, grouping the 50 states into eight regions allows an economist to more easily build econometric models and analyze the results: dealing with eight variables keeps more degrees of freedom available, and also makes mathematical modeling and analysis less onerous.

Clark (2001) investigates the extent to which industry mix explains region-level employment fluctuations. This paper sets up **Structural Vector Auto Regression (VAR)** models such that "the observed innovation for any region or industry variable is a function of an unobserved national **shock** and a set of unobserved region- and industry- specific shocks." (204) By analyzing the VAR models' **residuals**, the author is able to estimate the relative importance of national, industry, and regional shocks. The analysis finds that about 40% of a region's **cyclical** employment volatility ("the variance of the cyclical innovation of a region's growth rate") is due to regional shocks, 40% to national shocks, while only 20% can be explained by industry shocks. This paper argues that the relative decline of manufacturing across all regions has further increased the importance of region-specific (as opposed to industry-specific) shocks, which grew in importance (45% from 35%) in the latter part of the time series. The author's main point is that differences in industry concentration between the regions in the U.S. did not account for much (only 20%) of the variation in their cyclical employment; this result contrasts with the (according to Clark) popular notion among economists that differences in employment among regions are linked primarily to differences in industry composition. The Pacific region, in which Oregon resides, was found to be the least responsive to national shocks, which were only responsible for 10% of its forecast error variance, and most responsive to its own regional shocks, which accounted for over 50% of its forecast error variance.

Carlino and Defina (1998a) address the impact of monetary policy: could the Federal Reserve's actions impact the different states and regions of the United States in different ways? This analysis finds that the answer is "yes." The authors use structural VAR models to analyze the effects of a change in monetary policy on different regions and include "feedback effects among regions." (574) Their analysis uses (BEA) regional quarterly real personal income data, the federal funds rate, and an energy price proxy as the variables. After running their model the authors classify the regions into two broad categories, "core" and "non-core," with five of the eight regions (New England, Mideast, Plains, Southeast, Far West) being designated "core" due to their average response to monetary policy changes. The Great Lakes region was much more sensitive to changes in monetary policy, while the Southwest and Rocky Mountain regions were much less sensitive than any of the core regions.

After demonstrating significant variability among some of the regions in their response to monetary policy, the authors model state responses, and find significant heterogeneity among the states (although they do not present their state-level empirical results in this paper). The authors then attempt to explain this variation through a cross-state regression, using industry mix and financial variables. Without using regional dummy variables, the authors explain only about 16% of the variation in states' responses to monetary shocks; the inclusion of regional dummy variables increases the $\mathbf{R^2}$ to about 0.4 (so the new regression explains 40% of state variation). The change in explanatory power from 16% to 40% demonstrates that grouping states by region helps to explain about 24% of their variability in response to changes in monetary policy. However, the result also shows that while regions differ in their sensitivity to changes in monetary policy, there is also significant variation within regions (i.e., at the state-level), some of which can be explained by differences in industry mix, but the majority (60%) of which this paper was unable to explain.

Instead of analyzing one variable's differential effects on each region by analyzing the regions in one model, Carlino and Sill (2001) study each region individually (i.e., with its own model) and then compare the results. This paper decomposes volatility in regional output into cyclical and trend components. It uses region-by-region regression models: for each of the eight BEA regions the paper runs a separate regression generating region-specific coefficients for each of the explanatory variables. The model uses quarterly real per capita personal income data from 1956 to

1995, deflated by changes in each regional consumer price index (aggregated price indices from the major cities in each area) as its independent variable. There are several explanatory variables. The first is industrial structure, estimated using the percentage of a region's output that is accounted for by manufacturing. Next, the model adds the differential effects of monetary policy (i.e., the same change in national monetary policy affecting each region differently), represented through an index meant to quantify monetary policy from most restrictive (i.e., high interest rates) to most expansive (i.e., low interest rates). The degree of defense spending (the percentage of a state's income that is military spending) is also included, as Davis, Lougani, and Mahidhara (1997) showed that it can affect regional differences in employment cycles. The authors also add the relative price of oil as a final explanatory variable, to measure the effect of supply shocks (as energy is an unavoidable cost for many businesses).

Since the authors ran separate regressions for each region, their results are region-specific (as opposed to explanatory variable-specific). For example, their models showed that "an acceleration in the share of a region's income originating in manufacturing significantly increased the relative cyclical component in the New England region while lowering it in the Mideast region." This result is difficult to interpret; why does percent of manufacturing have opposite coeffiecients in two regions? The authors do not suggest an answer, although it could relate to the different levels of manufacturing at the beginning of the sample: changes in the (low initial) level of manufacturing in the New England region have different effects than the changes in the (high initial) level of manufacturing in the Mideast region.

The analysis did find a result that translated across regions: “considerable divergence of regional business cycles from national cycles” (455). There was much comovement between all of the regions except for the Far West region (in which Oregon resides); the “Wild West” appeared to chart its own path.

Economists have found that geographic regions provide a useful grouping mechanism for studying differences within the United State. Regional effects exist for growth rates, sensitivity to changes in monetary policy, and the degree of comovement with the national economy. However, regional analysis has its problems: Oregon is nearly always grouped with Washington and California, which presents a dilemma because California is much larger than Oregon and Washington combined. The Far West region is devoid of much meaning for Oregon: it mostly is representative of California. There is also significant variation within some regions, which renders the results more relevant to only certain states in the region. Due to these issues, it is beneficial to disassemble the U.S. economy into its 50 constituent parts. The large number of variables makes analysis more complicated, but there have been several economic studies that have nevertheless produced meaningful results.

Economics Literature: State Differences

Owyang, Rapach and Wall (2008) use a dynamic factor model (in contrast to the previously discussed VAR models) to find common factors that drive state-level fluctuations in personal income and employment growth. Their analysis excludes Alaska and Hawaii, as their economies are distinct from the contiguous states. The dynamic factor model, instead of modeling historical relationships among variables (as a VAR does) attempts to unconver underlying factors which are the true drivers of the movement. The model suggests that there are three common factors underlying the fluctuations: a “business-cycle” factor that is correlated to the national real GDP growth; a “dissonance” factor that is negatively correlated with employment growth; and an “inflation” or “financial” factor that is related to the inflation rate and nominal financial returns. The authors then found the load factors for each state/factor combination, for both personal income and employment growth. Essentially, they were attempting to determine the extent to which changes in each of the factors effect change in each state’s economy. The differences in state factor loadings are important because they represent the strength of the links between states and underlying forces that drive the national (itself an aggregate of the states) economy. Oregon was one of the states that followed the national economic cycle closely: its factor loadings were high for the business cycle factor (7th and 21st among the states for personal income and employment, respectively). Oregon’s employment also tracked the dissonance factor very strongly: its loading of 0.544 was the 2nd highest among the states. This result indicates that when an underlying negative factor affects the U.S. economy (e.g., something causes a recession) employment growth in Oregon is affected more severely than every other state in the U.S. except for Utah.

Their results show that there is much variation in the third factor’s effects: the “inflation” factor produced 22 negative coefficients among the states and 26 positive coefficients. This result suggests that increases in this particular factor affect nearly half the country in one way (i.e., negatively) and the other half the opposite way (i.e., positively). Oregon’s coefficients were not significantly different than zero. This result highlights the heterogeneity among the states in the U.S.

Carlino and Defina (1998b) add to their regional analysis of the differential effects of monetary policy by explicitly examining state-level differences. This paper shares a very similar methodology to Carlino and Defina (1998a); this discussion will focus mainly on its results. Using Structural VAR models and **Impulse Response Functions**, the authors demonstrate the variability of state responses to monetary policy shocks: they quantify this through the eight quarter cumulative responses (of real personal income) to a one-percentage point federal funds rate increase. Oregon ranked as the 5th most sensitive state in their data (1958-1992): its real personal income would be expected to decline by 1.72% cumulatively over the two years following a one percentage point increase (“shock”) to the Federal Funds rate.

Schunk (2004) also examines the state-level differences in the impacts of monetary policy (which is set on the national level by the Federal Reserve) and thus analyzes a similar issue to that which Carlino and Defina (1998b) explored. The paper first finds that the U.S. economy has shifted over the last few decades from manufacturing-focused to more service-based. Furthermore, “the degree of capital intensity and the variation across states has been declining over time.” (128) That is, the U.S. in total has become much less reliant on manufacturing and construction for generating personal income, and the states vary less in their industry mixes (of manufacturing and construction).

The author uses structural VAR models with quarterly regional data to examine the impact of changes in the federal funds rate on state economies. Consistent with his initial hypothesis, “the evidence indicates that the magnitude and differences in the state responses to monetary shocks have decreased over time.” (134) He tests this proposition by estimating the 48 state-level VAR models using three different time periods: the full time span (1959-2003), the first half of the data (1959-1980), and the second half of the data (1981-2003). The author is then able to compare state-level impulse response functions of the latter two VAR models (earlier period against the later time period) and show that the results (i.e., average state response) were significantly different. A shock (one percentage point increase) to the federal funds rate produced a -1.67% average state response (cumulative effect on state personal income growth after eight quarters) in the first section of the data while the same shock created only a -0.29% response in the second half of the data set.

Although the author does not make note of it, his results were extremely relevant to Oregon: it ranked as the 5th most sensitive state to Fed funds rate increases in the full time sample, and ranked as the 2nd most sensitive state in the latter half (1981-2003). His results were thus generally consistent with Carlino and Defina (1998b): the relative ordering of the states was similar, but the actual cumulative response estimates were lower in this paper. The interpretation for the post- 1981 data is that Oregon’s personal income growth would be expected to decrease by -0.69% (cumulatively over a two year time span) in response to a one percentage point shock to the Federal Funds rate. This result highlights the importance of state-specific analysis: even though the region in which Oregon is classified (Far West) was found to be the least sensitive to changes in monetary policy in Carlino and Defina (1998a), a closer examination reveals the extreme variation within that region. With the post- 1981 data, the response of

California's personal income to a Fed Funds rate increase was not statistically different from zero; this result reconciles the apparent incongruity between the regional and state analyses.

One potential reason for the decrease in differences between states' responses to monetary policy is increased bank integration. Morgan, Rime and Strahan (2004) analyze the relationship of increased bank integration with volatility and convergence of business cycles among the states. The authors find that increased integration of banking across state borders has reduced volatility and has increased the degree to which states' economies move together (i.e., convergence). The study found that Oregon had an average interstate asset ratio, which the authors define as "the percent of bank assets in a state held by out-of-state bank holding companies." (1556)

Owyang, Piger and Wall (2005) take a different approach to investigating state economies. They use a Markov regime-switching model to estimate each state's economic history. The model separates each state's economic history (represented by a monthly series of state coincident economic indicators) into periods of expansion and contraction that are specifically calculated for each state. This distinction of state-level recessions and expansions allows the authors to demonstrate the extent to which individual states are out of sync with the movements of the national economy. Both the growth and contraction rates varied significantly between the states. Oregon's monthly growth rate of 0.449% and its recession growth rate of -.330% showed that Oregon is volatile in comparison to other states: its expansion growth rate was the 13th highest, and its recession rate was the 14th lowest. Furthermore, its expansions and recessions were persistent: Oregon's expansions last on average 77 months, 6th longest among the states; Oregon's recession last on average 21 months, 16th longest among the states.

The authors attempt to explain this variation among states (in regards to expansion and recession growth rates) using a regression model. Their model includes industry mix, demographic, and state tax variables. Due to their regime-switching model, they can differentiate between variables that affect recession growth rates and those that affect expansion growth rates: recession growth rates were (only) significantly affected by industry composition, while expansion growth rates were related to demographic differences, but not industry composition. These growth rates refer to the regime that the state, not the national economy, is experiencing. For example, a state's percent of manufacturing can help predict its growth rate when it's in a recession (as compared to its historical growth rates) but not necessarily when the national economy is in a recession.

The authors also use Harding and Pagan's (2004) measure of concordance- the amount of time for which two economies (i.e., the state and national) are simultaneously in either an expansion or contraction- and input the paper's regime data to produce new estimates of each state's linkage to the national economy.   Oregon was in the same regime (i.e., expansion or recession) as the national economy 90.7% of the time, which makes it the 10th most concordant state: Oregon's economy is in synch with the nation's.

Instead of investigating comovement between each state and the national economy, Carlino and Defina (2004) analyze comovement between sectors within each state. The authors thus provide a measure of the degree to which the industries in each state move together. Two of the paper's more general findings are: levels of cohesion between industries within the various state are "widely dispersed but generally positive" and "state/sector cohesion has risen over time." (Carlino and Defina 2004, 299) This second result is a separate conclusion from that discussed previously (the increasing comovement between state economies): this result indicates that the degree to which different industries *within* each state move together has also increased over time. The authors calculate a cohesion index for each state: it consists of the "weighted averages of the bivariate cohesions for the eight sectors within each state." (307) The index thus provides a single, comparable measure of the industry cohesion within each of the 50 states. Oregon has the 7th highest cohesion, with an index value slightly greater than 0.4. This metric indicates that Oregon's industries move together about 30% more than the average state (median cohesion of 0.31): both failure and success appear to be contagious for Oregon businesses.

Blanchard and Katz (1992) provide a broad analysis of both regional and state differences within the U.S. Although their paper, "Regional Evolutions," was not in a peer-reviewed journal (it was published by the Brookings Institute[2]), the paper is highly regarded and widely cited: Google Scholar indicates that 1,378 articles have cited it. The authors first provide descriptive analysis of differences in state employment growth, which they find is persistent. Blanchard and Katz find that state differences in average growth rates persist over time, "with shocks having largely permanent effects." (11) A simple OLS regression is used to test the hypothesis of persistent growth rates:

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[2] The Brookings Institute is a nonpartisan, nonprofit think tank located in Washington, D.C., www.brookings.edu

average nonfarm employment growth from 1950-1970 (for each state) is plotted against average nonfarm employment growth from 1970-1990 (for each state) and the regression line has a slope of 0.7 and an R^2 of 0.75. This R^2 means that 75% of the variation in average state employment growth rates for the twenty years after 1970 can be explained by their average employment growth rate in the twenty years preceding 1970.

"Regional Evolutions" estimates the extent to which state employment growth can be explained by national employment growth by running a regression with the logged difference of state employment growth as the dependent variable, and a constant term and a coefficient multiplied by the logged difference of national employment as the independent variable. These regressions produced a Beta (coefficient in front of the national employment value) and an R^2 for each state: the coefficient describes the strength of the effect from the national economy while the R^2 shows how much of the changes in state employment growth rates are explained by changes in the national employment growth rates. The average adjusted R^2 was 0.66, which indicates about two-thirds of changes in each state's employment growth can be explained by (the estimated equation using) changes in the national employment growth rate. Oregon's R^2 was 0.72. The authors also determined that the relationship between states and the nation was relatively stable; they split the data in half (1950-1970 and 1971-1990) and compared the averages: they weren't significantly different. Their analysis also showed that there was significant variation within regions (whether Census divisions or BEA regions), so analyzing state-level data was beneficial. State-level variation was responsible for twice as much of the difference in employment growth as was regional variation (after accounting for the amount explained by national variation).

Blanchard and Katz find that, in contrast to the (apparent) stability of state differences in employment growth rates is the instability of state unemployment rates relative to the national average: "unemployment patterns present an image of vacillating state fortunes as states move from above to below the national unemployment rate, and vice versa" (2) While a shock produces permanent effects for employment (and output) growth rates, the effect on the unemployment rate fades out. Thus "a state typically returns to normal after an adverse shock not because employment picks up, but because workers leave the state." (3)

"Regional Evolutions" also develops a theoretical economic model to explain its empirical results. The model consists of states that produce different bundles of goods, which are then sold on a national market. Workers and firms are both free to move between states, and the states each offer different amenities. While the model is consistent with most of the authors' results, it does have some strong assumptions, such as constant returns to production and time-invariant state amenities. State amenities could change for a variety of reasons, such as technological advances that could affect the attractiveness of certain areas, e.g., air conditioning and Southern states.

Economists have found that there are significant differences between the U.S. states that manifest themselves in a variety of ways: differential responses to monetary policy, different expansion and recession growth rates, differential timing and duration of expansions and recessions, and persistently different employment growth rates (although the next section will provide a counter example to this finding). Some of the variation between states can be explained by geographic (i.e., regional) grouping, demographic, and differences in industry composition, but much of the underlying reasons for the interstate differences remains unresolved. This uncertainty is unsurprising: each state is affected by a nearly infinite number of local economies, which are each driven by many different factors. However, economists have established a solid base of understanding regarding the individual states in the U.S.

The economics literature has also provided valuable insights into Oregon's relationship with the national economy. Regional studies should be cautiously interpreted, as Oregon's grouping with California limits the relevance of empirical results about the Far West region. State-level studies produced several significant results for Oregon. Oregon tracks the national business cycle very closely: Oregon's economy moves with the nation's. Two independent studies found that Oregon is very sensitive to changes in monetary policy; this sensitivity could be due in part to the demonstrated high cohesiveness of Oregon's industries. One manifestation of this sensitivity is that Oregon's recessions and expansions are relatively strong (magnitude) and persistent (length) compared to the other states in the U.S. Taken together, the economics literature shows Oregon to be a tightly-knit state that is especially sensitive to changes in the overall economy. The next section will review an **econometric** methodology, vector autoregression modeling, that is used in several studies in the economics literature, and which will be used in the empirical portion of the thesis.

METHODOLOGY

The classic way an economist represents the economy is through creating a structural model. The structural approach “attempts to use economic theory and historical data to recreate the structure of the economy as a system of equations.” (Anderson 1979, 2) Essentially, economists use existing theories to create a mathematical framework with restrictions on the relationships among the different variables (e.g., not allowing an increase in interest rates to have a positive effect on investment) and then use this model to predict the future under different situations. Anderson (1979) elucidates some issues economic forecasters have discovered using the traditional structural approach for regional economies. A major critique of this way of modeling the economy is that is cannot account for fundamental shifts. For example, structural models “did not predict and could not explain” (2) the high inflation and unemployment of the 1980s; the models were not sufficiently dynamic to allow for significant changes.

Another way in which to model the economy is through a vector auto regression (VAR) model. In its most basic form, it does not restrict its variables using relationships from theoretical economics. Instead, it “is a straightforward, powerful, statistical forecasting technique which can be applied to any set of historical data.” (3) The name *vector* refers to the simple data requirements (a collection of numbers) and *autoregression* explains that the VAR technique investigates relationships among the movements of all of the variables.

Stock and Watson (2001) further explore the history of the vector autoregression (VAR) and analyze its usefulness in addressing macroeconomic issues. While a univariate auto regression equation (a single-variable, single-equation model) explains values of a variable by its own lags (e.g., modeling output as a positive function of past output values) a vector autoregression incorporates multiple variables, each with multiple lags. The VAR "is an n-equation, n-variable linear model in which each variable is in turn explained by its own lagged values, plus current and past values of the remaining n-1 variables." (101) The unrestricted VAR is thus "a purely statistical tool" (102) with no roots in economic theory. It essentially tests for relationships among each of the variables (including past values) in the historical data; this method makes VAR models "powerful and reliable tools" (102) for describing patterns in data, but less effective in assigning causality to the demonstrated relationships.

There are three different types of VAR models: reduced form (or unrestricted), recursive, and structural. Reduced form VAR models do not impose any restrictions on the statistical analysis, and each equation uses ordinary least squares regression to estimate the coefficients. A drawback to this method is that if "the different variables are correlated with each other… then the error terms in the reduced form model will also be correlated across equations." (103) This correlation of error terms becomes an issue when using impulse response functions (IRF), discussed later.

Recursive VAR models improve upon reduced form VAR models by eliminating the problem of correlated error terms. Recursive VAR models ensure their error terms are uncorrelated through restricting the contemporary effects of the variables in the **Wold Causal Chain**. The ordering of the variables in the Wold causal chain is important: it dictates the order in which regressions are calculated and thus restricts the later variables (in the chain). Essentially, if there are three variables in a VAR model, and are ordered A,B,C in the Wold Causal Chain, then A can contemporaneously affect B and C, and B can contemporaneously affect C, but the other contemporaneous effects are restricted as zero. Therefore, “changing the order [of the variables in the VAR] changes the VAR equations, coefficients, and residuals.” (103) This shortcoming of recursive models can be remedied by recording and comparing results for different ordering of the variables: if the results are similar then the recursive VAR model provides a straightforward way of “fixing” the error terms of an unrestricted VAR model.

The last type of VAR model, structural, imposes restrictions on the relationships between the variables based on economic theory and decision-making behavior. This infusion of theoretical restrictions allows researchers to make causal claims based on their statistical results. Ostensibly, it provides a happy medium between the purely statistical realm of VARs and the theoretical economic relationships of traditional structural models. However, Stock and Watson are skeptical of this approach, suggesting that too often econometricians work backwards, developing superficial economic theories after finding results using unrestricted VAR models. Another critique of structural modeling is that the results of the analysis (including the impulse response function) are sensitive to the specific assumptions made.

Impulse responses functions (IRF) “trace out the responsiveness of the dependent variables in the VAR to shocks to each of the variables.” (Brooks 2002, 341) The responsiveness is based on the historical relationships between the two variables uncovered by the VAR estimation; the IRF allows the researcher to examine the magnitude and duration of one variable's effects on another. If the VAR system is stable, "the shock should gradually die away." (Brooks 2002, 341) Thus IRFs also provide a way of checking the validity of the system: if shocks produce results clearly at odds with economic theory, or the system is shown to be unstable, the researcher can re-examine the model. A critique of standard IRFs is that they make a strong assumption: that the error terms across each VAR equation are uncorrelated. This assumption does not hold for many series of macroeconomic and financial data. Orthogonalised impulse response functions (or the use of recursive/structural VAR models with restrictions) ameliorate this problem by using the ordering of the variables to attribute the common component of the errors to the first variable in the VAR (Brooks 2002). While this procedure emphasizes the ordering of the variables, this effect can be minimized by computing separate IRFs using opposite ordering schemes (if the results are similar then the researcher can be very confident in his/her results).

This thesis will use a recursive VAR model (with Wold causal chain ordering) to represent state economies and will use IRFs to analyze the differential effects of a shock to the national economy. The justification for the ordering of the variables will be provided in the next section, which will also include two additional types of empirical analysis. First, the author will update some of the analysis found in "Regional Evolutions," using more recent data. The paper will then apply the Beta framework to state economies, analyzing their sensitivity to national changes. Finally, the author will estimate state VAR models and compare cumulative IRF results.

EMPIRICAL ANALYSIS

State Employment: "Regional Evolutions" Update

Since "Regional Evolutions" was published nearly 20 years ago, this section will update some of its basic analysis with a more recent data set. First, this section will attempt to address the persistence of employment growth. Instead of comparing average employment growth for the twenty years preceding 1970 with that of the twenty years following 1970 (as the original paper did), the year 1990 is used as the middle point. This section obtained data on nonfarm employment growth (from the Bureau of Labor Statistics) for each state from 1950-2009, and was able to duplicate the original paper's results (using its time period); this procedure ensures that the methodologies for calculation and regression are the same. Each state's average employment growth during the first time period (Jan. 1970-Dec. 1989) was used to predict the average rate of employment growth during the second time period (Jan. 1990- Dec. 2009). Figure 1 shows the strong persistence of employment growth found in the original paper, while Figure 2 shows less persistence in the more recent time period. Oregon is highlighted in red in each of these figures; a black line is also shown, representing the "best fit" of the OLS regression. Employment growth rates were not nearly as persistent during the last 40 years as they were from 1950-1990. The R^2 of .544 indicates that about 54% of the variation in average growth rates in state nonfarm payrolls during the second time period can be explained by differences in growth rates during the first time period. The same regression equation explains 22% less of the variation with the most recent data than it did in the original paper.

The results begin to contrast even more strongly if, instead of using 20 year time periods, 10 year time periods are used. The calculations are identical, except that there are now fewer (half) values for each state. Figure 3 shows the results for the beginning of the time period used by Blanchard and Katz: 1950-1969. The persistence of growth rates during these two decades was very strong. Figure 4 contrasts these results by using the most recent twenty years; there was very little persistence in state employment growth rates from the 1990s to the 2000s. Table 2 shows the results for this same method using consecutive decades from 1950 until 2009. The results suggest that there has been much less persistence in employment growth rates during the last 30 years than in the previous 20. This difference might be due to a structural change in the economy, or a change in states' reactions to employment shocks. Regardless of the reason, these results demonstrate the importance of using contemporary data: if analysis stretches back too far it risks identifying patterns that are no longer relevant.

Table 2: Persistence of Employment Growth Rates Over Time

Explanatory Variable: Average employment growth in 1st time period	Dependent Variable: Average employment growth in 2nd time period	R^2
1950-1959	1960-1969	.54
1960-1969	1970-1979	.35
1970-1979	1980-1989	.13
1980-1989	1990-1999	.06
1990-1999	2000-2009	.17

Figure 1: Persistence of Employment Growth Rates 1950-1989

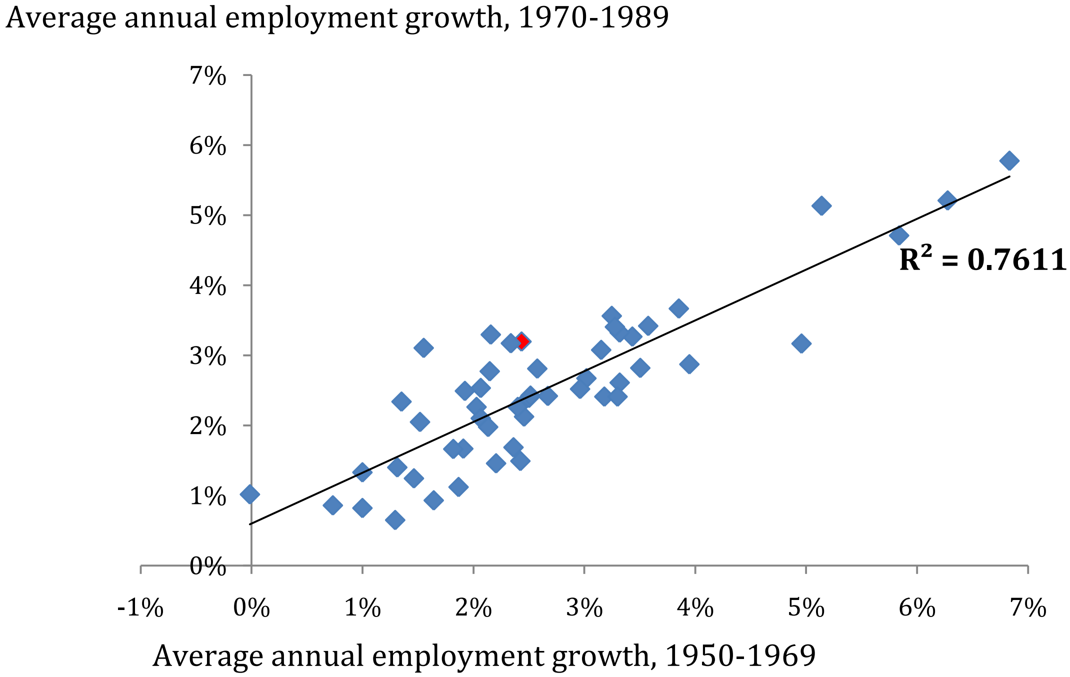


Figure 2: Persistence of Employment Growth Rates 1970-2009

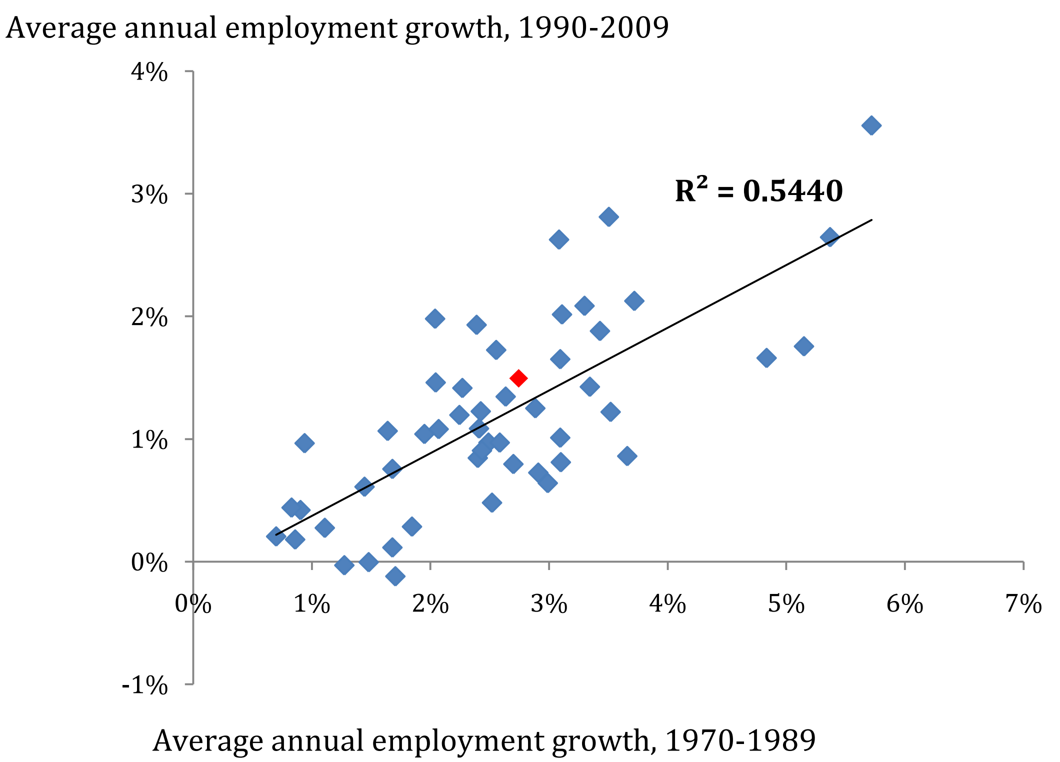


Figure 3: Persistence of Employment Growth Rates 1950-1969

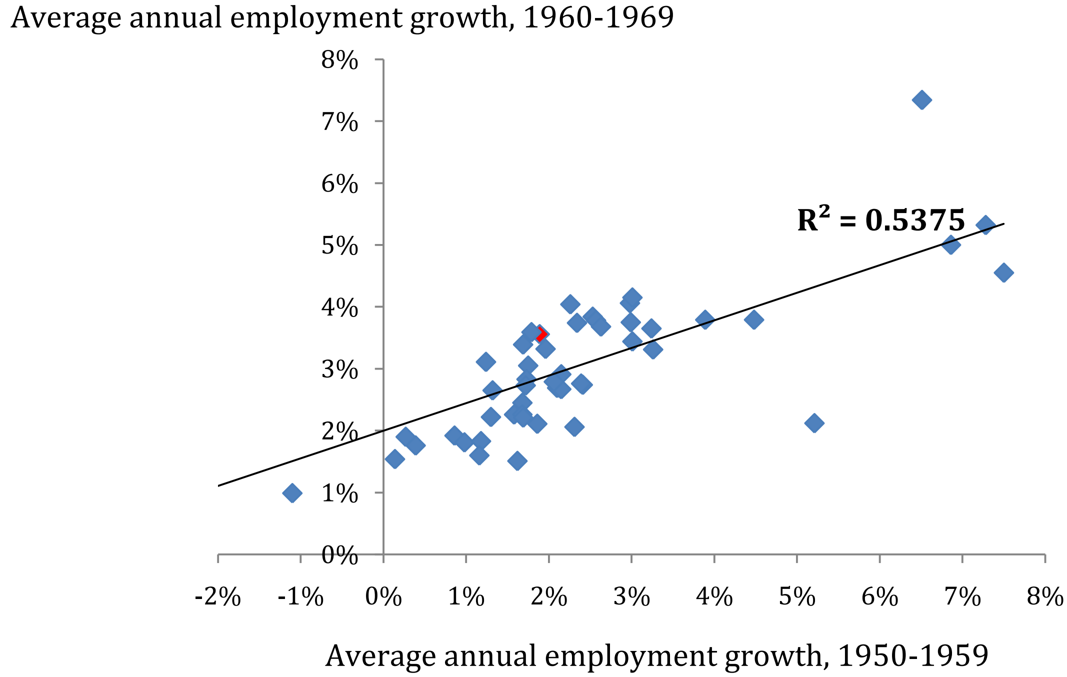
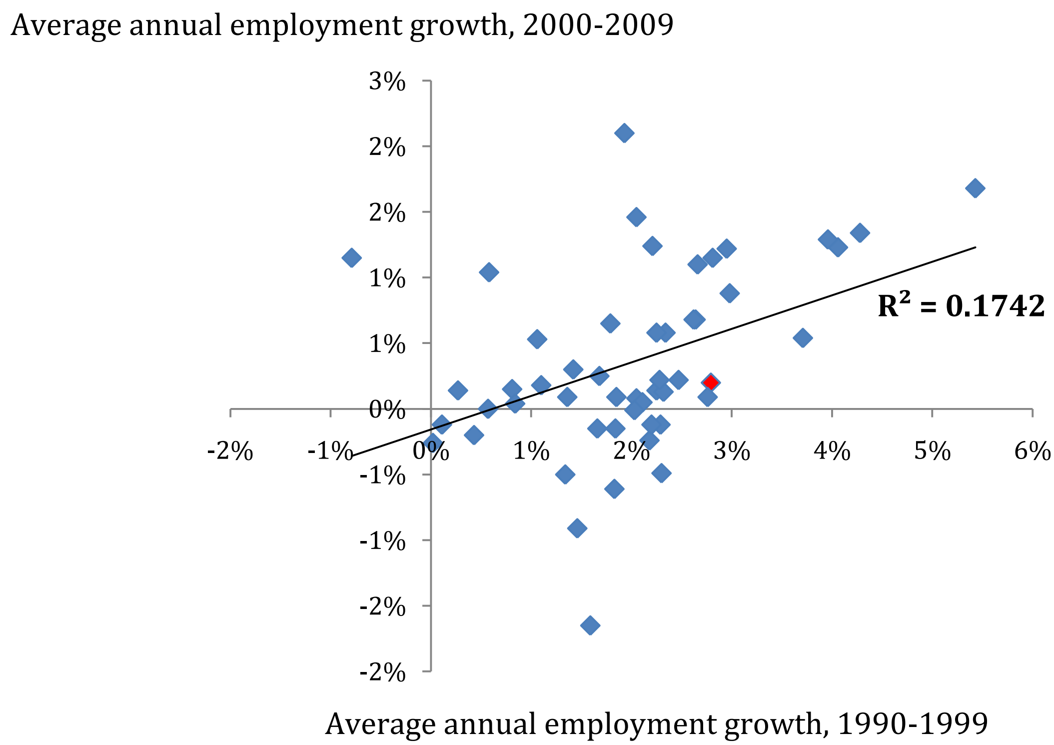
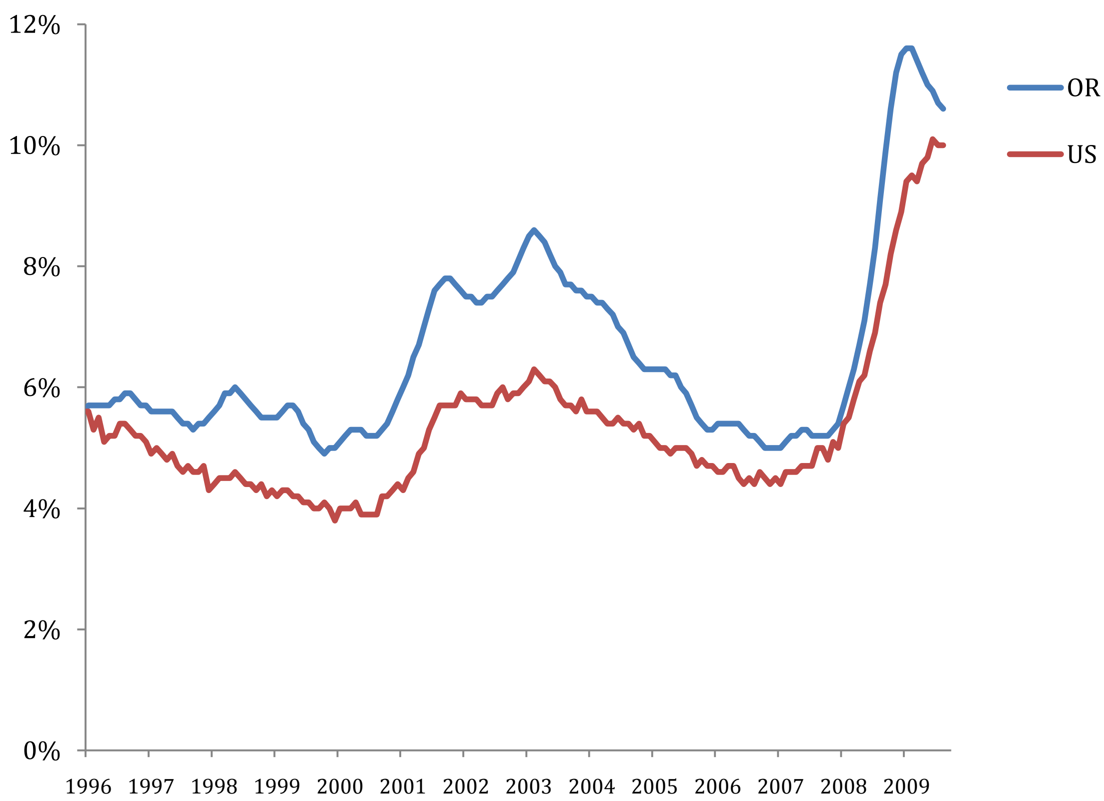


Figure 4: Persistence of Employment Growth Rates 1990-2009



The second claim this section will consider is that of vacillating state fortunes, i.e., the impermanence of state-level differences from the national unemployment rate. This analysis considers only Oregon's unemployment rates, and again takes advantage of more recent data than were available to Blanchard and Katz. In fact, in examining recent unemployment numbers for Oregon in relation to the national economy, one is struck by the regularity of a pattern: Oregon's unemployment rates have been higher than the nation's for many months in a row. Figure 5 demonstrates the extent of this phenomenon: while Oregon's relative unemployment has historically vacillated (as described by the authors) for many years prior to the middle of the 1990's, the last

Figure 5: Persistence of Oregon's High Unemployment 1996-2010



fifteen years have been rough for Oregon's workers. In fact, since May 1996, every single month has produced a higher unemployment rate for Oregon than for the national economy. Without delving too deep into a complex issue, this result might be due to differences in the structural rate of unemployment: potentially due to the decline of once important industries such as timber, Oregon has a larger number of workers with skills which are no longer demanded in the labor market. Regardless of the underlying reason, Oregon's relatively high unemployment over the last 15 years is a significant development.

Updating some of the analysis of Regional Evolutions demonstrated that state differences in employment growth levels have been much less persistent over the last thirty years than they were over the twenty years prior to that. The magnitude of the difference suggests that there was some structural change in state economies. The author also found that Oregon's relative unemployment rate, in contrast to the general findings in "Regional Evolutions," has been persistently above the national average. The next section will provide more analysis, but instead of focusing on employment will use a broader measure of a state's economy within the Beta framework.

State Economies: Financial Analysis

This analysis will use the Beta framework described in the review of financial literature. The equation which will be estimated for each state is:

$$G_i = \alpha_0 + \beta_i G_n$$

Where G_i is equal to each state's historical monthly growth rate, α_0 is the estimated constant, β_i is the estimated Beta coefficient, and G_n is the historical monthly growth rate for the national economy. Using ordinary least squares (OLS) regression to estimate Beta for each state produces a measure of each state's undiversifiable (or correlated) risk, which is risk that is directly due to the degree of sensitivity to changes in the national economy's growth rate.

In order to produce a monthly growth rate for states and the nation, this analysis uses a coincident economic index developed by Crone & Clayton-Matthews (2005)[3]. An economic model originally developed by Stock and Watson in the late 1980's produced a coincident index for the national economy; Crone and Clayton-Matthews further refine this model and apply it to state-level data. Their model incorporates information from four separate data series, thus presenting a relatively complete picture of a state's economy in one number. The variables included are: nonfarm payroll employment, average hours worked in manufacturing, the unemployment rate, and real wage and salary disbursements (which is also a component of personal income). The model has five significant equations: one for each of the variables; "and one equation for an underlying (latent) factor that is reflected in each of the indicator (input) variables. The underlying factor represents the state coincident index." (Crone & Clayton-Matthews, 2005) The data are preferable to the traditional real gross state product because they are available monthly instead of annually and have a shorter lag

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[3] The data were obtained from: http://www.philadelphiafed.org/research-and-data/regional-economy/indexes/coincident/

time. Real state personal income is often used in state-level economic analysis, however these coincident indicators fluctuate more with the business cycle than personal income (Owyang, Piger, and Wall, 2005); this fluctuation will facilitate analysis by highlighting differences in growth rates.

The author converted the data from the original index numbers into month over month percentage changes. As a result, these data approximate the economic growth each state experienced (in percentage terms) in every month from January 1990 through December 2009.

Using the last twenty years of data, Oregon had the 7th most correlated risk among the states, with a Beta of 1.23. During the 1990s (Jan. 1990-Dec. 1999) Oregon had a Beta of 0.68, and was the median state in the U.S. (in terms of its correlated risk). However, during the last ten years (Jan. 2000-Dec. 2009) Oregon's Beta increases to 1.48, which is the 4th highest Beta among the states during that time. This statistic means that (over the last ten years) if the national economy grew (or contracted) by 10% in a given month, Oregon would be expected to grow (or contract), on average, by 14.8%. A full table of calculated Betas for each state is presented in the Appendix, with estimates for the entire twenty year time period and estimates for each ten year time period. These results empirically suggest that during the last ten years Oregon has been among the most sensitive states to changes in the national economy.

Another interesting metric the Beta measurement produces is the R^2 of the regression. The R^2 answers the question: how much of a given state's current growth is explained by the national economy's current growth (multiplied by a coefficient). The Beta demonstrates the *intensity* of the national economy's effect, but not the extent to which changes in a state's economy can be explained solely using the national economy: the latter is measured by the R^2. In this data series there appeared to be a significant change between the 1990's and the 2000's. The average R^2 for the states in the first half of the data set was 0.37, in the second half it was 0.67. The standard deviation was 0.18. Oregon's R^2 increased in both an absolute and relative sense from the first time period to the second: its R^2 went from 0.42 to 0.79, and its rank among the states jumped from 26th to 10th. This result suggests that during the past ten years Oregon's economy has behaved in a very predictable way in relation to the national economy.

In the last twenty years, the monthly growth of Oregon's economy had an Alternative Beta (compared to the national economy) of 1.44, 12th among the states: Oregon's rate of growth fluctuated about 44% more than did the national economy's. In the last ten years, Oregon's Alternative Beta was 1.54, 8th among the states. A full table of calculated Alternative Betas for each state is presented in the Appendix. The difference between Beta and alternative Beta becomes readily apparent with the case of Hawaii's estimates (using the whole time period): its Beta is the lowest, because its risk (volatility) is not primarily driven by the national economy; it does not have very much correlated risk. However, Hawaii's Alternative Beta was more towards the middle (34th) because its *total* risk was not very different from that of an average state. The correlation for each state (with the national economy) was positive over both the 20 year and 10 year time periods, so the sign of the correlation did not affect the calculations.

In order to further investigate the relationship between state and national economies, this section calculated the simple correlation of each state's monthly growth to that of the national economy: it produced a ranking of the degree to which states' fortunes move with those of the national economy. Using the time period beginning January 1990, Oregon's monthly growth was correlated with the nation's at a level of 0.85, 8th among the states. During the last ten years (starting January 2000) Oregon's correlation was 0.90, 5th among the states. These results are consistent with the previously mentioned observation that Oregon's mixture of industries closely mirrors that of the nation as a whole, as well as Owyang, Piger and Wall's (2005) finding that Oregon's economy is very concordant with the nation's.

Through the use of calculations and statistical techniques primarily applied in the field of finance to evaluate stock prices, this section has analyzed Oregon's relationship with the national economy. Using monthly growth rates derived from a coincident index, this analysis has shown that over the last 20 years (and especially over the last 10 years) Oregon has experienced a high degree of correlation with the national economy, and has furthermore exhibited a strong sensitivity to changes in the national economy. Table 3 presents a summary of these metrics.

In order to dig deeper into the underlying relationship between state and national economies, the next section develops an econometric model for state economies. While this section provided a broad overview of differences among state economies, focusing on Oregon, the next section will consider specific economic drivers of these differences.

Table 3: Summary of Oregon's Financial Metrics

Metric	Value and Rank (1990-1999)		Value and Rank (2000-2009)	
β	0.68	25th	1.48	4th
R^2	0.42	26th	0.79	10th
β^*	1.44	12th	1.54	8th
ρ	0.85	8th	0.90	5th

State Economies: Econometric Analysis

In order to further investigate the interaction between the state and national coincident indexes Oregon and the national economy, this section first uses **Granger Causality tests**. Next, it develops a more comprehensive picture of the interaction by estimating a recursive VAR model representing state economies. This model will then be subject to a "shock," an impulse that changes one of the variables (by one standard deviation) in the model in order to observe its effects on the other variables. The results from the impulse response functions will be analyzed and discussed in terms of their relevance to Oregon's economy.

Before analyzing the indexes, one must determine whether or not there is a **unit root** in the data. Using the Augmented Dickey-Fuller Test, this analysis found that, using logged levels for each of the data series, one cannot reject the initial hypothesis of a unit root. After first differencing the logged data, the hypothesis of a unit root can be rejected for all of the indexes. Oregon's index could not reject a unit root for log levels, but once the data were first differenced the unit root could be rejected at the 99%

confidence level. Since the data are part of a constructed index that is set to each state's long-term growth (state GDP) trend, logging the data was not crucial, but will make the interpretation of results more straightforward.

This analysis uses a Granger Causality test to investigate the interaction between the state and national indexes. This test's initial hypothesis (H_o) is that variable B does not "Granger Cause" variable A. In order to test this assertion, a univariate autoregressive equation is run for variable A's past values, and then another equation is run including variable B's past values and the autoregressive term of variable A. In order to disprove the initial hypothesis, variable B's past values must significantly contribute to the explanation of variable A's past values beyond the explanation provided by the autoregressive term. An F-Test provides the means for making this judgment. The equation below shows the relationship in mathematical terms.

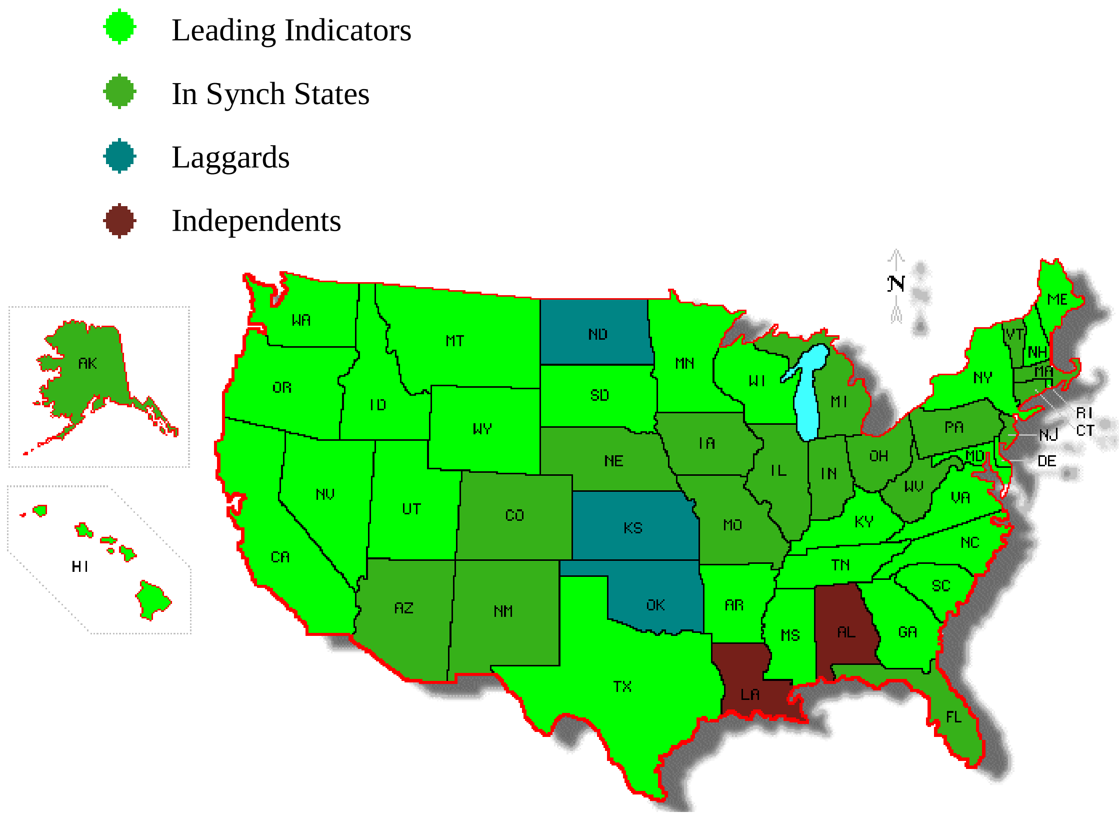
$$A_t = \alpha_0 + \alpha_1 A_{t-1} + \alpha_2 A_{t-2} + \alpha_3 B_{t-1} + \alpha_4 B_{t-2} + ...\alpha_n A_{t-n} + \alpha_{n+1} B_{t-n}$$

In order for variable B to Granger Cause variable A in this example (using two lags, so t=2), α_3 and α_4 must be significantly different than zero and contribute to the model's explanatory power. While this procedure is rigorous, it does not assign causality in the strict sense: if B Granger Causes A, it does not necessarily directly cause A, but it does help predict A's values in a significant way. A common counter-example to the usefulness of this test is that it would conclude that a rooster crowing

Granger Causes the sun to rise. In spite of this critique, the test provides a useful way of analyzing two sets of economic variables.

In order to analyze the statistical relationship between the state and national indexes, a Granger Causality test was run for the national (logged and differenced) index and each state's (logged and differenced) index. The results were interesting: the statistical relationships between states and the national economy (as measured by the index) had four possibilities, because the Granger Causality test was run for each state-national pair. The first of these was that changes in the state index Granger Caused changes in the national economy, but changes in the national economy did not Granger Cause changes in the state's economy. This section designated these 27 states (including Oregon) as “Leading Indicators” because they help to predict changes in the national index. The next group, 18 states, exhibited bi-directional Granger Causality: these are called “In Synch States” because their values interact with the nation's to help predict both sets of values. The third group, 3 states, did not Granger Cause changes in the national economy, but movement in the national economy Granger Caused changes in the states' economies: these are called “Laggards” because they tend to trail the national economy. The final group, 2 states (Louisiana and Alabama), exhibited no Granger Causality in either direction: these are called “Independents” because their movements are not predictable using the national economy, and their movements do not help predict changes in the national economy. Figure 6 presents a visual depiction of these results.

Figure 6: State Differences in Granger Causality Results



Having finished the examination of the statistical relationship between the lagged values of the state and national indexes, this section will now analyze their interaction in a more comprehensive manner by building a VAR model. The state and national index variables must be included in the VAR model (they form the fundamental relationship this model hopes to examine), but there are additional economic variables which might prove useful. Both individual states' economies and the national economy are affected by common macroeconomic variables. In the economics literature, differential responses to monetary policy were found on a state level. In order to account for this finding, the **Federal Funds Rate (Fed Funds)** will be included in the VAR model. This variable represents monetary policy, which is set by the Board of Governors of the Federal Reserve in order to stimulate the national economy during periods of contraction, and slow the economy during periods of high growth and inflation. A second macroeconomic variable to be considered is the **Fuel Producers Price Index (Fuel PPI)**, an index measuring the price of fuel, which is an input into the vast majority of American businesses. This variable provides additional information because it represents a more exogenous variable: American policymakers do not have direct control over the price of energy (e.g., oil). Furthermore, economists have studied the effects of a "shock" to oil prices and found significant results: a shock to oil prices affected production negatively in the U.S. and the U.K. in a VAR model. (Burbidge and Harrison 1984)

While there are a virtually unlimited number of economic variables, this VAR model incorporates the four previously described: a national coincident index, a state-level coincident index, the Fed Funds rate, and Fuel PPI. All of these data are available on a monthly basis, and the author (consulting his advisors) chose January 1984 as an appropriate starting point. There were thus more than 300 observations for each VAR model. The national indexes, state indexes, and Fuel PPI were logged and differenced (a unit root was found in the logged values) while the Fed Funds Rate was differenced. After selecting the variables, it becomes necessary to decide on the order in which they will be included in the recursive VAR model by way of a Wold causal chain.

The Wold causal chain requires restrictions on contemporaneous effects; the ordering of the variables is meaningful. One of the objectives of this VAR model is to compare the sensitivity of each state (through IRF results) to a national shock; placing the national index first in the ordering will facilitate this analysis. Although it does not appear to be consistent with the Granger Causality results for several states (especially as Oregon appears to be a leading indicator of the nation) placing the state index after the national index can be logically consistent: although several states help to predict changes in the national economy, it is not necessarily true (and in fact seems very unlikely) that changes in a leading indicator state (e.g., Oregon) actually *cause* changes in the entire national economy: most are simply too small. Thus the first two variables are the national index and the state index. In deciding the order of the next two variables, the idea of a contemporaneous response is crucial. While Fuel PPI is a mostly exogenous variable, the Fed Funds rate is not: the Board of Governors uses every available piece of information available (e.g., state and national indicators, fuel prices) before making its decision. The Fed Funds rate is thus a logical choice for the last variable in the Wold causal chain; all other variables can affect it, but changes in the rate will take (a reasonable assumption) at least a month for their effects to be felt. The ordering for the Wold causal chain is:

National Index ⟶ **State Index** ⟶ **Fuel PPI** ⟶ **Fed Funds Rate**

After the recursive VAR models' data series, transformations, and ordering of variables has been chosen, the appropriate number of lags can be determined. The Akaike Information Criterion (AIC) and the Schwarz Information Criterion (SIC) provide useful numbers for model selection: they each aim to combat the problem of "over fitting the data" by assessing a numerical penalty for each additional parameter in a model. “Adding… an additional lag to a model will have two competing effects on the information criteria: the residual sum of squares will fall but the value of the penalty term will increase.” (Brooks 2002, 257) Essentially, they balance the added explanatory power of another parameter (in this case, another lagged value) against the lost degree of freedom. The SIC’s penalty term is harsher than that of the AIC: all else equal, the AIC will permit more lags in a model. The researcher’s objective is to minimize each information criterion: if it increases in value when another lag is added, the growth in the penalty term overpowered the increased explanatory power, and the lag should not be included in the model. After comparing the AIC and SIC for lag lengths of 2-12 months across several state models, the author decided on a lag length of 10 months: it was the lowest value in most cases (or was nearly identical to that of 6 months). Oregon’s AIC table is presented in Table 4.

Table 4: VAR Model Lag Selection

Number of Lags	AIC
2	-27.16
4	-27.34
6	-27.37
8	-27.30
10	**-27.36**
12	-27.29

The author estimated VAR models for each of the 50 states by using the same variables, ordering, and lags for each state’s model: each state’s VAR model had its own estimated coefficients, but everything else about the model was identical. VAR results are notoriously difficult to interpret: each state's model contains 160 estimated coefficients (4 variables and 10 lags each), making comparison and analysis virtually impossible (Oregon's estimated VAR model is presented in the Appendix). However, as discussed in the Methodology section, Impulse Response Functions provide a standardized way to compare different estimated VAR models. In the context of state economies within the U.S., two IRF results are of interest: each state's response to a shock to the national coincident index, and each state's response to a shock to fuel prices (which also functions as a type of shock to the national economy). Cumulative IRFs measure the extent to which the effects of a shock accumulate over time. These will be used to compare the responses of each state to a shock to the national index and the Fuel PPI, respectively. It is necessary to choose a time period for the cumulative IRF: the author chose two years as an appropriate time length. This time period was chosen because two years was used several times for cumulative IRFs in the literature review (e.g., Carlino and Defina 2004, Schunk 2005) and qualitative observations confirmed that this was a reasonable length; it was generally the peak of the IRFs, after which the shock gradually died out.

The results from the Beta framework suggest that Oregon is highly sensitive to a shock to the nation: the VAR model and IRF allow this proposition to be tested. The results for the cumulative IRFs for each state in response to a shock to the national index are presented in Table 5. In contrast to the Beta results, Oregon's response was about average, ranking 20th among the states. This result is not surprising after accounting for the Granger Causality results: because Oregon is a leading indicator, changes to the national index have not historically predicted movements in Oregon's economy. Thus a shock to the national index did not affect Oregon as much as might be expected from the Beta results. The Beta framework does not account for lags of variables, and thus presents a more basic picture of the relationship between the states and the national economy. By including time series data, the VAR models allow the researcher to investigate multiple factors within the same model.

The next set of IRFs involved a shock to Fuel PPI. In these results, a potential cause of Oregon's sensitivity was found: Oregon's cumulative response was the 3rd highest among the 50 states. A shock to Fuel PPI caused Oregon's index to decrease .8% over two years; Oregon's cumulative response to an oil price shock is twice as strong (-0.8%) as that of an average state (-0.4%). The results for the cumulative IRFs for a Fuel PPI shock are presented in Table 6. Instead of being sensitive to changes in the national index (representing the national economy), Oregon is instead sensitive to changes (i.e., fuel prices) that occur for every state (and thus the national economy) simultaneously. While an energy price shock would *occur* simultaneously for each state, the results of the IRF and earlier Granger Causality test suggest that the *effect* on each state's economy differs in both magnitude and timing: an energy price shock does not appear to immediately propagate its effects uniformly across all states. Instead, the shock might first affect certain states (the Leading Indicators, which includes Oregon) and then its effects would spread throughout the country.

The fuel price shocks produced stronger results from the states (average response of -0.4%) than did a shock to the national index (average response of + 0.33%) although the standard errors are too large to say anything with certainty. Oregon's impulse responses (non-cumulative) to a shock from each of the variables in its VAR model are presented graphically in Figure 7, which also shows five years of time elapsing. This longer time span was chosen in order to illustrate the appropriateness of the two year cumulative impulse response data: the effect of a Fuel PPI shock becomes statistically equivalent (because of the standard errors) to zero after two and a half years. The red dotted lines represent a two standard error “cushion” on each side of the estimated responses, which are in blue. It is surprising that a shock to the federal funds rate did not significantly affect Oregon’s economy; the interest rate is a powerful tool for stimulating or slowing the economy. However, the focus of these VAR models was to examine the differential response of states to a national shock, not a monetary policy decision, so this result was not of particular interest to this thesis.

The national index’s impulse responses in Oregon’s VAR model are presented in Figure 8. Its IRFs look similar to the majority of the states’. Its two year cumulative response to a shock to Fuel PPI was -.46% indicating that the sensitivity of the aggregate economy is roughly in the middle of the state-level responses. This result is consistent with expectations: the national economy is simply an aggregate of the state economies. Once again it was surprising to see that a shock to the Fed Funds rate did not produce significant effects for the national index. It is also initially surprising to see that a shock to Oregon’s economy, which makes up about 1.14% of the national economy’s output, produces a significant positive effect on the national economy. However, this result is consistent with the Granger Causality results: changes in Oregon’s economy Granger Cause changes in the national economy. The author cautions that Granger Causality is not equivalent to actual causation; it simply indicates significant (and in excess of autoregressive terms) predictive power. The IRF results indicate that when Oregon's economy experiences a positive (or negative) shock (based on the historical statistical relationships uncovered by the VAR) the national economy will later experience the effects of this positive (or negative) shock.

Table 5: Cumulative IRFs for Shock to National Index

Cumulative Response to a One SD shock to Dlog(US)			
State	Rank	2 Year Cumulative Response	Standard Error
WV	1	1.19%	(0.26%)
SC	2	0.92%	(0.35%)
OH	3	0.86%	(0.27%)
OK	4	0.83%	(0.27%)
MI	5	0.81%	(0.45%)
IL	6	0.79%	(0.24%)
KS	7	0.76%	(0.20%)
CO	8	0.74%	(0.26%)
PA	9	0.72%	(0.22%)
NE	10	0.65%	(0.18%)
MO	11	0.64%	(0.29%)
ND	12	0.62%	(0.23%)
MS	13	0.59%	(0.21%)
NM	14	0.56%	(0.21%)
CA	15	0.56%	(0.18%)
WI	16	0.46%	(0.19%)
LA	17	0.41%	(0.26%)
WY	18	0.41%	(0.33%)
IA	19	0.40%	(0.20%)
OR	**20**	**0.38%**	**(0.28%)**
IN	21	0.36%	(0.24%)
AL	22	0.35%	(0.25%)
VA	23	0.34%	(0.20%)
SD	24	0.33%	(0.17%)
AR	25	0.33%	(0.19%)
RI	26	0.32%	(0.31%)
NC	27	0.31%	(0.27%)
NY	28	0.31%	(0.16%)
CT	29	0.29%	(0.22%)
MA	30	0.29%	(0.28%)
AK	31	0.26%	(0.33%)
WA	32	0.23%	(0.23%)
VT	33	0.23%	(0.27%)
HI	34	0.23%	(0.25%)
TX	35	0.19%	(0.19%)
MT	36	0.14%	(0.23%)
ME	37	0.13%	(0.44%)
MN	38	0.13%	(0.18%)
NJ	39	0.06%	(0.20%)
AZ	40	0.05%	(0.26%)
DE	41	0.05%	(0.25%)
KY	42	-0.01%	(0.25%)
NV	43	-0.05%	(0.39%)
FL	44	-0.08%	(0.24%)
UT	45	-0.10%	(0.21%)
TN	46	-0.11%	(0.20%)
GA	47	-0.15%	(0.23%)
MD	48	-0.19%	(0.23%)
ID	49	-0.30%	(0.33%)
NH	50	-0.46%	(0.28%)

Table 6: Cumulative IRFs for Shock to Fuel PPI

Cumulative Response to a One SD shock to Dlog(Fuel PPI)			
State	Rank	2 Year CumulativeResponse	Standard Error
NV	1	-1.15%	(0.35%)
MI	2	-1.01%	(0.41%)
OR	**3**	**-0.79%**	**(0.26%)**
SC	4	-0.72%	(0.29%)
HI	5	-0.71%	(0.22%)
UT	6	-0.67%	(0.20%)
KY	7	-0.65%	(0.22%)
WA	8	-0.64%	(0.22%)
NC	9	-0.58%	(0.23%)
ID	10	-0.58%	(0.30%)
IN	11	-0.58%	(0.22%)
WV	12	-0.58%	(0.26%)
AL	13	-0.55%	(0.22%)
MN	14	-0.53%	(0.16%)
DE	15	-0.53%	(0.21%)
MD	16	-0.52%	(0.20%)
OH	17	-0.52%	(0.25%)
GA	18	-0.52%	(0.20%)
CO	19	-0.51%	(0.24%)
MO	20	-0.49%	(0.26%)
FL	21	-0.48%	(0.20%)
TN	22	-0.42%	(0.17%)
WI	23	-0.40%	(0.18%)
PA	24	-0.40%	(0.20%)
NH	25	-0.39%	(0.26%)
ME	26	-0.38%	(0.37%)
VA	27	-0.38%	(0.17%)
TX	28	-0.36%	(0.18%)
CA	29	-0.36%	(0.17%)
MA	30	-0.35%	(0.24%)
NJ	31	-0.35%	(0.18%)
NY	32	-0.35%	(0.15%)
IA	33	-0.32%	(0.17%)
AR	34	-0.31%	(0.17%)
IL	35	-0.31%	(0.20%)
CT	36	-0.29%	(0.19%)
VT	37	-0.28%	(0.23%)
KS	38	-0.25%	(0.19%)
AZ	39	-0.25%	(0.22%)
NE	40	-0.22%	(0.15%)
SD	41	-0.19%	(0.14%)
MS	42	-0.18%	(0.19%)
MT	43	-0.18%	(0.20%)
NM	44	-0.17%	(0.19%)
ND	45	-0.13%	(0.19%)
RI	46	-0.05%	(0.27%)
OK	47	-0.02%	(0.23%)
AK	48	0.26%	(0.29%)
LA	49	0.32%	(0.23%)
WY	50	0.49%	(0.29%)

Figure 7: Oregon Impulse Response Functions

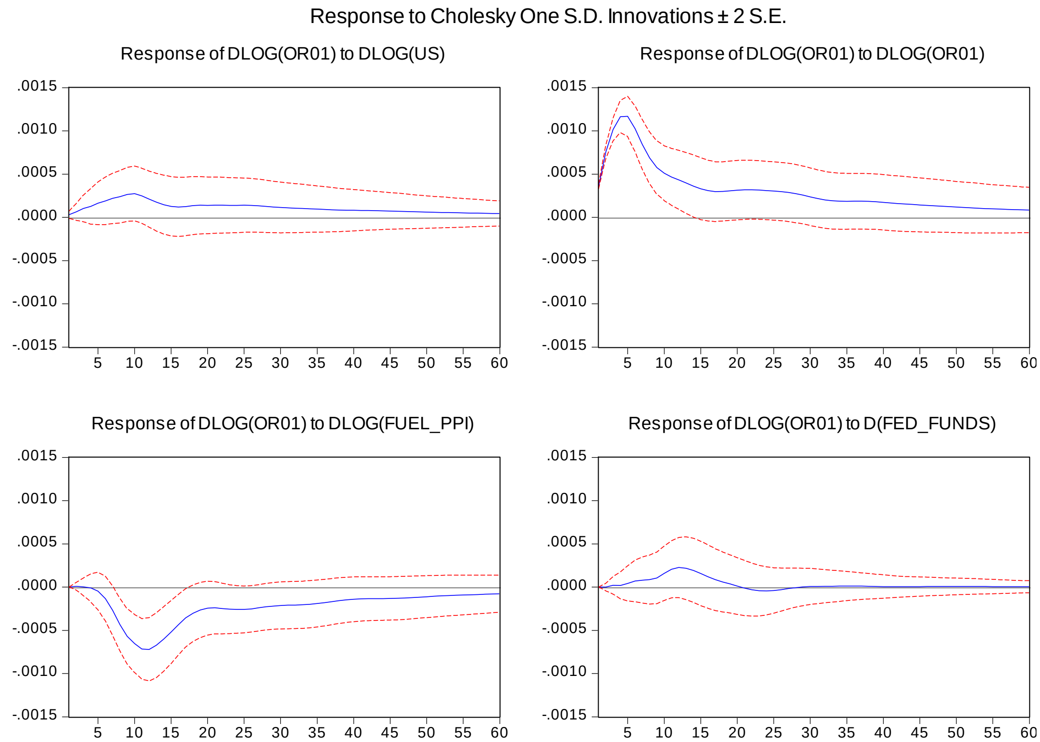
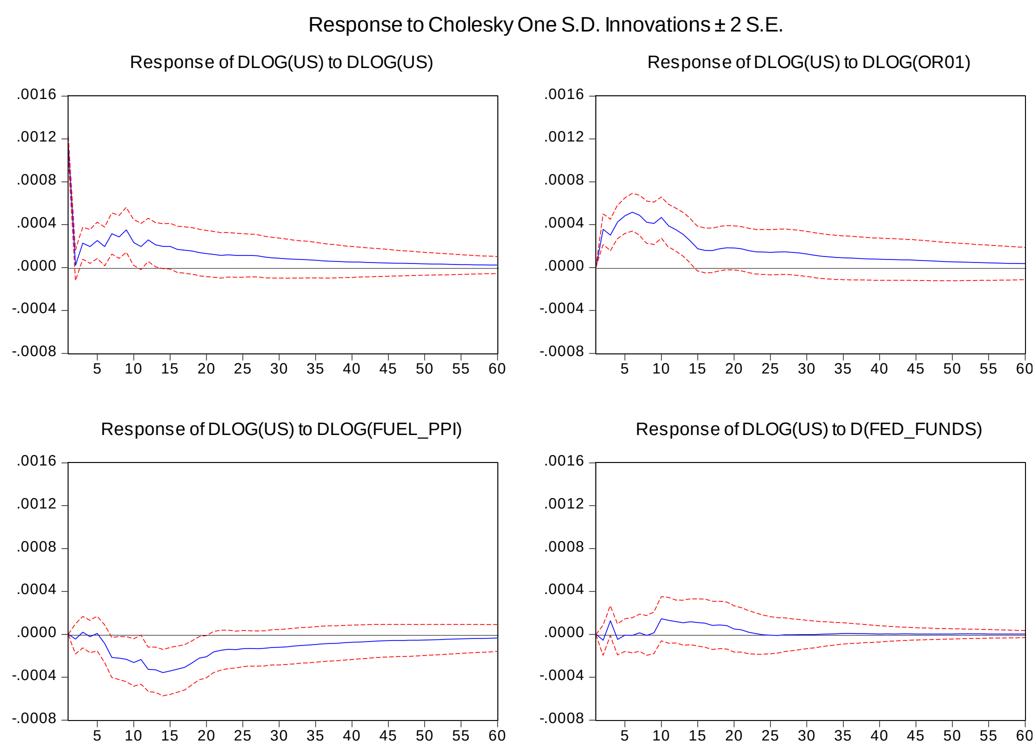


Figure 8: National Impulse Response Functions



SUMMARY OF FINDINGS AND CONCLUSIONS

Major Findings

This thesis has analyzed the relationship between Oregon's and the national economy in the context of the other 49 states. In the first section, descriptive statistics were used to situate Oregon's economy among the states. The industry composition of Oregon mirrors that of the nation, and Oregon is in the middle of the states in terms of output, poverty levels, and educational attainment. The next section examined the economics literature, which produced several significant findings for Oregon. Oregon's economy is cohesive, both with the national economy and with itself: its industries grow and contract together. Shocks to monetary policy severely affect Oregon, which is another potential reason (in addition to the cohesiveness of its industries) that both its recessions and expansions are lengthy and potent.

The author empirically analyzed the states in the US using the Beta framework from finance and found that Oregon has the 4th highest measure of correlated volatility over the last 10 years. Additionally, Oregon's total volatility has been the 8th highest, and its correlation with the national economy the 4th highest during the last ten years. Using Granger Causality tests with state and national indexes allowed the predictive power of the states to be compared. Oregon appears to be a leading indicator of the national economy; changes in Oregon's economy Granger Cause changes in the national index. The final section of the thesis built a VAR model for each state and ran IRFs for a shock to the national index and a shock to Fuel PPI. While Oregon was not particularly responsive to a shock to the national index, it was the 3rd most sensitive state to a shock to Fuel PPI. The IRF results, coupled with the Granger Causality results, suggest that when a common shock occurs, the effect on Oregon’s economy is strong and sudden.

The mixture of methodologies from finance and economics produced interesting and relevant results. The Beta results suggested an issue (sensitivity to changes in the national economy) for the econometric model to investigate; the Granger Causality tests, VAR models, and IRF then went more in-depth and uncovered additional information about the underlying relationships between state economies.

Relevance for Oregonians

The results of this thesis have several implications. The most important is that decision-makers in Oregon, whether in government, business, or academia, must account for the demonstrated sensitivity of Oregon’s economy. More specifically, these findings call into question the appropriateness of the “kicker checks.” In stark contrast to the kicker checks’ popularity is their usefulness to Oregonians; they exemplify procyclical policy and likely make a sensitive economy even more so.

For example, if the national economy grows 2% more than expected in a given year, Oregon’s economy would (based on its historical Beta) grows 3% more than expected. Tax revenue (nearly all of which is linked to income) would rise concurrently, and Oregonians would, in addition to receiving expected government services, get a nice gift in the mail- the kicker check (Esteve, 2009). This “bonus” will increase everyone’s incomes, and since the economy (in this hypothetical) is growing faster than expected, it is likely more people are employed than expected, and the environment is ripe for consumer spending (as opposed to saving). Spending the kicker checks further stimulates businesses- they earn more revenue and invest in new equipment or hire more employees- and the happy cycle continues.

Unfortunately, this **procyclical** process also applies to the inverse situation. When the national economy experiences a severe recession (e.g., 2008) Oregon's economy contracts much more than expected, taxpayers earn less income, and thus pay less taxes. State governments cannot run deficits: either taxes will increase, or Oregonians will receive fewer services than they were expecting. Both of these government actions are unattractive in a recession; a **budget stabilization fund** (**BSF**) can smooth these transitions.

Oregon has recently implemented a temporary BSF, with the passage in 2007 of Oregon Revenue Statute 293.144. (Thatcher). During the BSF's first year of existence in Oregon, lawmakers suspended the corporate kicker check (for that year only) and gave the fund a $300 million head start (Esteve). However, the current economic uncertainty highlights the fundamental opposition of the two laws. Since they are both based on differences between actual and projected revenues, as opposed to revenue growth, there is a strong reliance on accurate economic forecasting. "If [the state economist] sets a low figure [for the upcoming biennia]—which makes sense this year given the current economic conditions—and then the economy rebounds, the state could end up sending millions of dollars back to taxpayers at the same time it is making deep cuts to services." (Esteve) Additionally, contributions to Oregon's pseudo BSF are capped at 1% of general fund appropriations per biennium and are severely limited by the primacy of the kicker check (Thatcher 2008, Appendix A).

Economists and political scientists have found some budget stabilization funds to be more successful than others. Wagner and Elder (2005) determined that "states may reduce the cyclical variability of expenditures by 20 percent from adopting a BSF, but only if the BSF is governed by both strict deposit and strict withdrawal rules." (459) Thus the lesson for Oregon's legislature is twofold: if any state should have a BSF, Oregon should (due to its economy's demonstrated sensitivity), and this BSF needs to have both an automatic deposit rule and a limiting withdrawal rule. Mainly due to the political issues involved (i.e., the kicker checks are very popular) Governor Kulongoski's recently (January 2010) proposed plan for a comprehensive budget stabilization fund was rejected by the state Senate (Esteve 2010). It is also instructive that he was only willing to propose the initiative during his final year in office. The results of this thesis could be used as objective evidence for the necessity of a BSF for Oregon.

In addition to state policymakers, the findings of this thesis could have implications for Oregon businesses and consumers. Businesses could benefit from knowing that Oregon is especially sensitive to economic shocks: Oregon businesses should slow investment growth during expansions in order to provide a buffer for the severe downturns. Oregon consumers should behave similarly, saving more during expansions than the average American, because they will be more significantly affected by economic downturns. Forecasters should note the differential timing of the state economies: Oregon and other leading indicators can be used to help predict economic movement on a national level.

Suggestions for Future Studies

This thesis investigated the issue of state-level differential responses to economic shocks, but did not attempt to explain the variation. What, besides the cohesiveness of its industries, makes Oregon sensitive to national shocks? Why do the leading indicator states help predict changes in the national economy? Is there a better way to group the states for purposes of economic analysis (other than by geographic region)? Another possible extension of this research is applying some of the same analytical tools (e.g., Beta, differential cumulative IRFs) to countries within the European Union (EU). Focusing on more disaggregated segments of national economies can provide useful insight; one could also extend this type of analysis to cities within particular states.

GLOSSARY

Bivariate: Concerning only two variables.

Budget Stabilization Fund (BSF): Mechanism by which state governments can accumulate savings in periods of expansion and then spend their reserves during times of economic contraction. A BSF is colloquially referred to as a "rainy day fund."

Correlation: Similar to covariance in that it also measures the degree to which two variables "move together" over a measured time horizon, however its lower bound is -1 and its upper bound is 1: it provides a standardized, comparable measurement.

Covariance: The degree to which two variables "move together" over the measured time horizon.

Cyclical: In economics, this term is related to the business cycle: that which is cyclical is related to the particular state (recession or expansion) of the current economy.

Econometric: Using both economic principles and theories (econo) along with rigorous mathematical/statistical techniques (metric).

Equilibrium: State in a market in which all demand is fulfilled by the existing supply: the buyers and sellers end up at a "market-clearing price."

Federal Funds Rate (Fed Funds): Effective interest rate set by the Board of Governors of the Federal Reserve System. Low rates spur economic activity (and potentially inflation) while higher rates slow economic activity (and stifle inflation).

Fuel Producers Price Index (Fuel PPI): Index (maintained by the Bureau of Labor Statistics) that measures changes in fuel prices for businesses in the United States

Granger Causality Test: Series of equations (with time-series data) that tests whether a given variable's past values help to predict another variable's values

Gross Domestic Product: Amount (dollar value) produced in a given economy

Impulse Response Function: Test that can "trace out the responsiveness of the dependent variables in the Vector Auto regression to shocks to each of the variables." (Brooks 2002, 341) Asks the question: all else equal, if variable A is "shocked" so that it is higher than predicted (based on other variables' initial values) what is the effect on each of the other variables?

Ordinary Least Squares (OLS): A method for estimating a linear relationship between two (or more) variables. It consists of minimizing (least) the sum of the squared error terms (squares) between a fitted line and the actual data values.

Procyclical: Tending to strengthen (or move with) cycles of both recessions and expansions (i.e., grow during expansions and contract during recessions). The opposite is countercyclical, which would tend to oppose recessions and expansions (i.e., shrink during expansions and grow during recessions).

R^2: The amount of variation in the dependent variable that is explained by the researcher's estimated equation

Regression: A more general term (OLS is one specific regression technique) for estimating statistical relationships among variables.

Residuals/Errors: These are the “unexplained” or leftovers after a model has been estimated for explaining the relationship among different variables. The larger the residuals/errors, the less accurate the model.

Risk: In the context of finance, risk refers to the probability that an outcome (e.g., the price of a stock in a year) differs from the expectation. It is generally measured by calculating the standard deviation of the historical outcomes; more variability is analogous to more risk.

Shock: Change in the value of a variable in an equation. This change happens in the error term, and the variable’s value is thus higher than predicted based on the other variables’ values. It can be used to study the effect on other variables in an Impulse Response Function.

Standard Deviation: A statistic that is simply the square root of the variance. A higher standard deviation indicates more variation.

Stochastic: Non-deterministic process, in that the future state cannot be perfectly predicted with current information (hence the use of statistics and probability).

Structural VAR: A specific type of VAR that includes some restrictions on the relationships among the variables. These restrictions are generally grounded in economic theory, and allow the researcher to assign causality to his results.

Unit Root: Indicates that a linear stochastic process is non-stationary.

Variance: Statistical term measuring the amount of variation within the historical values of a particular variable (i.e., each value's distance from the average value). A higher variance indicates more variation.

Vector Auto Regression (VAR): A VAR is a series of equations (regressions) in which each variable is a function of its own and all of the other variables' past values.

Volatility: Generally refers to the variance (or standard deviation) or a particular series of data: the more variation in a data series, the more volatile it is. Advanced statistical techniques other than variance can also be used to quantify volatility.

Wold Causal Chain: An ordering of the variables in a VAR model (along with identifying restrictions) which eliminates the contemporaneous effects of the variable on the right side of another (e.g., if the ordering is A B C then A can affect B contemporaneously but B cannot affect A contemporaneously)

APPENDIX

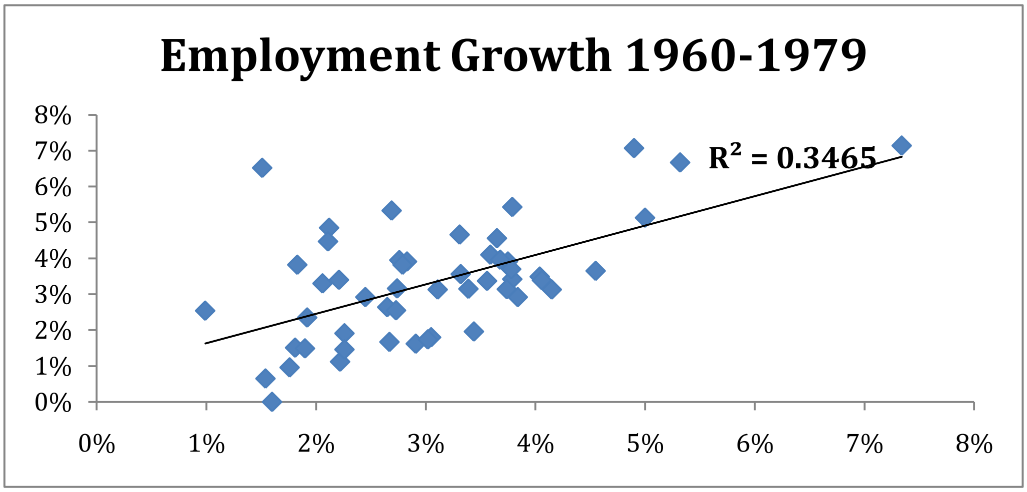
State	Jan 1990-Dec 2009			
	Beta	Rank	R2	Rank
AL	1.03	21	0.66	20
AK	0.04	50	0.00	50
AZ	1.27	9	0.75	3
AR	0.73	42	0.60	31
CA	0.77	38	0.65	23
CO	1.10	14	0.62	29
CT	0.83	32	0.64	26
DE	1.08	16	0.73	5
FL	1.06	18	0.70	14
GA	1.10	14	0.78	1
HI	0.47	49	0.18	48
ID	1.39	3	0.64	26
IL	0.97	26	0.73	5
IN	1.08	16	0.64	26
IA	0.72	43	0.67	18
KS	0.83	32	0.52	38
KY	1.06	18	0.72	9
LA	0.48	48	0.08	49
ME	1.36	4	0.52	38
MD	1.04	20	0.67	18
MA	0.98	24	0.54	35
MI	1.93	1	0.62	29
MN	0.75	40	0.73	5
MS	0.75	40	0.41	45
MO	1.29	8	0.66	20
MT	0.76	39	0.50	42
NE	0.72	43	0.54	35
NV	1.75	2	0.70	14
NH	1.15	11	0.56	33
NJ	0.84	30	0.69	17
NM	0.80	35	0.56	33
NY	0.66	45	0.59	32
NC	1.14	13	0.75	3
ND	0.87	28	0.28	46
OH	1.25	10	0.72	9
OK	0.84	30	0.52	38
OR	**1.31**	**7**	**0.71**	**12**
PA	0.98	24	0.72	9
RI	1.15	11	0.48	43
SC	1.32	5	0.73	5
SD	0.57	46	0.45	44
TN	0.87	28	0.71	12
TX	0.79	37	0.65	23
UT	0.99	23	0.65	23
VT	0.90	27	0.51	41
VA	0.80	35	0.76	2
WA	1.01	22	0.66	20
WI	0.81	34	0.70	14
WV	1.32	5	0.54	35
WY	0.56	47	0.23	47

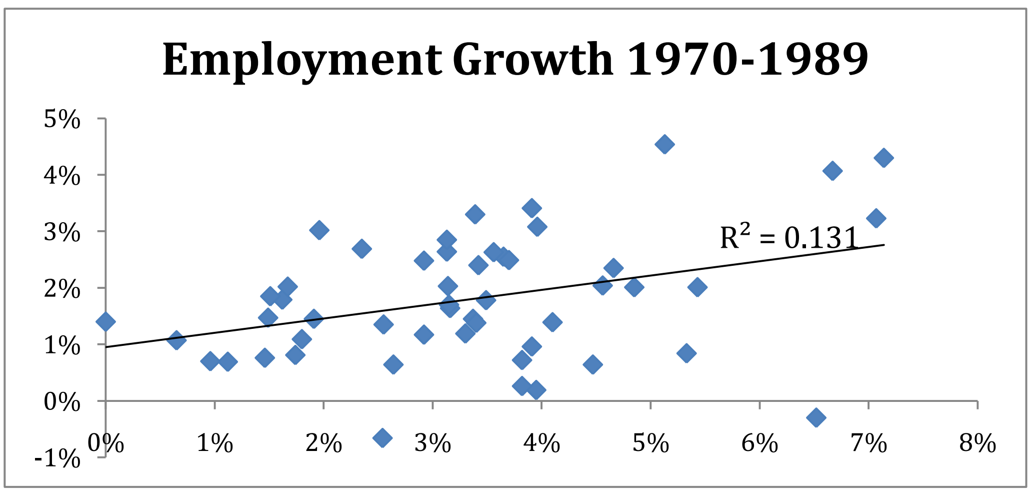
State	Jan 1990-Dec 1999					Jan 2000- Dec 2009			
	Beta	Rank	R2	Rank		Beta	Rank	R2	Rank
AL	0.37	40	0.23	36		1.23	8	0.79	10
AK	0.01	49	0.00	50		0.18	50	0.13	49
AZ	0.82	22	0.50	13		1.40	5	0.80	5
AR	0.32	44	0.17	41		0.73	43	0.75	23
CA	0.56	28	0.32	33		0.88	33	0.80	5
CO	0.52	30	0.34	31		1.10	18	0.67	33
CT	1.01	15	0.55	9		0.82	37	0.76	20
DE	1.01	15	0.56	7		1.00	22	0.75	23
FL	0.84	21	0.62	3		1.15	14	0.69	29
GA	0.89	18	0.58	6		1.04	19	0.85	1
HI	-0.24	50	0.05	46		1.04	19	0.66	34
ID	0.33	43	0.14	43		1.70	2	0.80	5
IL	0.69	24	0.51	12		0.95	27	0.77	18
IN	0.62	26	0.33	32		1.14	16	0.69	29
IA	0.38	39	0.40	28		0.71	44	0.74	26
KS	0.48	33	0.22	38		0.84	35	0.55	42
KY	0.57	27	0.46	20		1.11	17	0.79	10
LA	0.36	41	0.10	45		0.38	49	0.03	50
ME	1.90	1	0.48	17		1.15	14	0.61	38
MD	1.37	5	0.63	2		0.97	26	0.78	16
MA	1.35	6	0.50	13		0.81	38	0.61	38
MI	1.47	4	0.42	26		1.70	2	0.64	36
MN	0.36	41	0.47	19		0.79	39	0.84	2
MS	0.54	29	0.22	38		0.64	46	0.37	47
MO	1.07	10	0.45	21		1.21	10	0.70	28
MT	0.20	46	0.05	46		1.00	22	0.69	29
NE	0.50	31	0.29	34		0.67	45	0.55	42
NV	1.02	13	0.43	24		1.96	1	0.76	20
NH	1.60	3	0.48	17		0.91	31	0.76	20
NJ	1.08	9	0.62	3		0.78	40	0.79	10
NM	0.42	36	0.18	40		0.92	29	0.69	29
NY	0.95	17	0.62	3		0.62	47	0.71	27
NC	0.85	20	0.54	10		1.22	9	0.79	10
ND	0.79	23	0.14	43		0.90	32	0.33	48
OH	1.03	12	0.50	13		1.20	11	0.78	16
OK	0.43	35	0.23	36		1.01	21	0.58	40
OR	**0.68**	**25**	**0.42**	**26**		**1.48**	**4**	**0.79**	**10**
PA	1.02	13	0.56	7		0.99	24	0.80	5
RI	1.63	2	0.50	13		0.99	24	0.47	45
SC	1.04	11	0.54	10		1.37	6	0.75	23
SD	0.14	47	0.03	48		0.61	48	0.62	37
TN	0.50	31	0.35	30		0.92	29	0.81	3
TX	0.47	34	0.45	21		0.86	34	0.66	34
UT	0.27	45	0.15	42		1.16	12	0.81	3
VT	1.18	8	0.43	24		0.74	42	0.58	40
VA	0.86	19	0.65	1		0.77	41	0.80	5
WA	0.42	36	0.25	35		1.16	12	0.77	18
WI	0.41	38	0.39	29		0.84	35	0.79	10
WV	1.33	7	0.44	23		1.27	7	0.51	44
WY	0.14	47	0.03	48		0.94	28	0.41	46

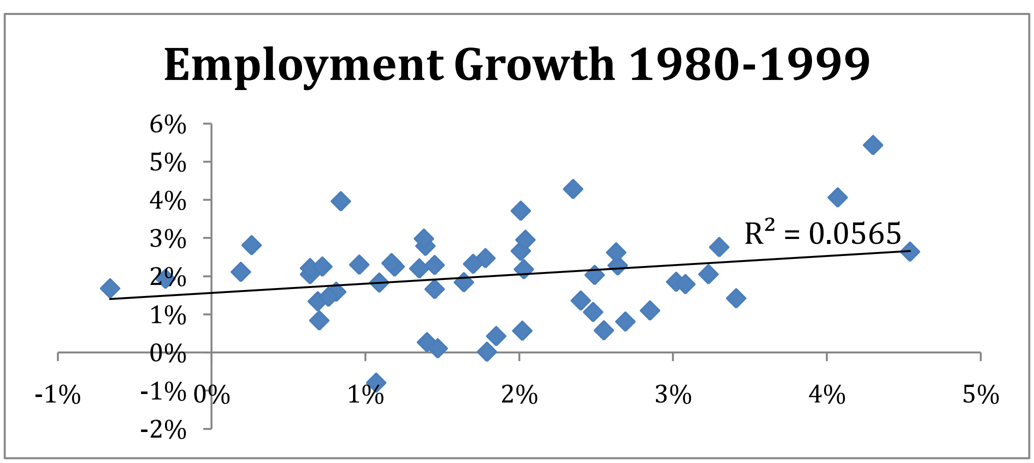
State	Correlation (Jan. 1990-Dec. 2009)	Rank
GA	0.8805	1
VA	0.8687	2
NC	0.8663	3
PA	0.8561	4
MN	0.8547	5
SC	0.8521	6
IL	0.8517	7
OR	**0.8510**	**8**
KY	0.8510	9
OH	0.8509	10
DE	0.8505	11
FL	0.8428	12
TN	0.8385	13
WI	0.8379	14
NJ	0.8339	15
IA	0.8192	16
MO	0.8181	17
MD	0.8173	18
AL	0.8141	19
WA	0.8106	20
CT	0.8099	21
CA	0.8068	22
TX	0.8051	23
UT	0.8035	24
IN	0.8021	25
ID	0.8011	26
MI	0.7882	27
CO	0.7874	28
NY	0.7718	29
AR	0.7694	30
NV	0.7631	31
NH	0.7545	32
NM	0.7495	33
WV	0.7472	34
NE	0.7446	35
MA	0.7377	36
AZ	0.7241	37
OK	0.7227	38
ME	0.7204	39
KS	0.7184	40
VT	0.7156	41
MT	0.7027	42
RI	0.6898	43
SD	0.6623	44
MS	0.6430	45
ND	0.5155	46
WY	0.4704	47
HI	0.4276	48
LA	0.2662	49
AK	0.0778	50

State	Correlation (Jan. 2000-Dec. 2009)	Rank
GA	0.9193	1
MN	0.9164	2
PA	0.9042	3
TN	0.9021	4
OR	**0.8991**	**5**
UT	0.8987	6
KY	0.8970	7
WI	0.8948	8
CA	0.8924	9
ID	0.8922	10
NJ	0.8920	11
VA	0.8913	12
NC	0.8893	13
AL	0.8889	14
OH	0.8860	15
CT	0.8769	16
IL	0.8766	17
NH	0.8759	18
WA	0.8753	19
MD	0.8679	20
AR	0.8669	21
SC	0.8654	22
DE	0.8650	23
IA	0.8633	24
NV	0.8481	25
NY	0.8422	26
MO	0.8402	27
IN	0.8377	28
FL	0.8354	29
NM	0.8290	30
MT	0.8232	31
CO	0.8197	32
AZ	0.8143	33
TX	0.8141	34
HI	0.8122	35
MI	0.8010	36
SD	0.7877	37
MA	0.7838	38
ME	0.7805	39
OK	0.7642	40
VT	0.7617	41
NE	0.7616	42
WV	0.7377	43
KS	0.7335	44
RI	0.6885	45
WY	0.6381	46
MS	0.6051	47
ND	0.5441	48
AK	0.3664	49
LA	0.1838	50

State	Alternative Beta (Jan. 1990-Dec. 2009)	Rank		State	Alternative Beta (Jan. 2000-Dec. 2009)
MI	2.43	1		LA	2.18
WV	2.14	2		WV	2.13
ME	1.87	3		MI	2.10
AZ	1.78	4		ID	1.91
LA	1.75	5		NV	1.78
NV	1.74	6		AZ	1.77
ID	1.73	7		SC	1.56
RI	1.65	8		**OR**	**1.54**
SC	1.54	9		ME	1.45
MO	1.53	10		WY	1.44
NH	1.49	11		RI	1.42
OR	**1.44**	**12**		MO	1.40
CO	1.41	13		AL	1.38
OH	1.38	14		FL	1.36
IN	1.35	15		NC	1.36
MA	1.33	16		CO	1.36
ND	1.33	17		IN	1.34
NC	1.31	18		WA	1.33
MD	1.29	19		OK	1.32
DE	1.28	20		HI	1.29
GA	1.28	21		UT	1.28
WA	1.26	22		OH	1.24
AL	1.26	23		ND	1.24
VT	1.25	24		MT	1.21
FL	1.25	25		DE	1.17
UT	1.22	26		GA	1.15
OK	1.16	27		MD	1.14
MS	1.15	28		NM	1.11
WY	1.15	29		KS	1.11
KS	1.15	30		IL	1.09
IL	1.14	31		KY	1.09
PA	1.14	32		PA	1.07
KY	1.12	33		TX	1.06
HI	1.10	34		MS	1.05
MT	1.08	35		NH	1.03
NM	1.06	36		MA	1.03
NJ	1.05	37		TN	1.02
CT	1.05	38		CA	0.98
TN	1.04	39		VT	0.97
TX	0.98	40		CT	0.95
WI	0.97	41		WI	0.94
NE	0.96	42		NJ	0.91
CA	0.95	43		NE	0.85
AR	0.95	44		MN	0.84
MN	0.87	45		AR	0.84
IA	0.86	46		IA	0.81
NY	0.85	47		VA	0.75
SD	0.84	48		NY	0.74
VA	0.80	49		SD	0.72
AK	0.66	50		AK	0.51


Employment Growth 1960-1979
R² = 0.3465
8%
7%
6%
5%
4%
3%
2%
1%
0%
0%
1%
2%
3%
4%
5%
6%
7%
8%


Employment Growth 1970-1989
R² = 0.131
5%
4%
3%
2%
1%
0%
-1%
0%
1%
2%
3%
4%
5%
6%
7%
8%


Employment Growth 1980-1999
R² = 0.0565
6%
5%
4%
3%
2%
1%
0%
-1%
-2%
-1%
0%
1%
2%
3%
4%
5%

Vector Autoregression Estimates

Sample (adjusted): 1984M12 2009M12
Included observations: 301 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	DLOG(US)	DLOG(OR01)	DLOG(FUEL_ PPI)	D(FED_ FUNDS)
DLOG(US(-1))	-0.008846	-0.000204	1.987675	0.836900
	(0.06126)	(0.01938)	(2.17627)	(10.4527)
	[-0.14439]	[-0.01051]	[0.91334]	[0.08007]
DLOG(US(-2))	0.175008	0.014246	1.771733	6.693252
	(0.06072)	(0.01920)	(2.15679)	(10.3591)
	[2.88243]	[0.74190]	[0.82147]	[0.64612]
DLOG(US(-3))	0.134232	-0.007343	-4.251384	2.174349
	(0.06121)	(0.01936)	(2.17424)	(10.4430)
	[2.19309]	[-0.37934]	[-1.95534]	[0.20821]
DLOG(US(-4))	0.150144	0.024400	2.274407	-7.850418
	(0.06186)	(0.01956)	(2.19755)	(10.5549)
	[2.42703]	[1.24711]	[1.03497]	[-0.74377]
DLOG(US(-5))	0.047390	-0.005294	0.060364	8.019109
	(0.06237)	(0.01973)	(2.21562)	(10.6417)
	[0.75980]	[-0.26838]	[0.02724]	[0.75356]
DLOG(US(-6))	0.131251	0.014475	-0.046865	-6.984739
	(0.06206)	(0.01963)	(2.20466)	(10.5891)
	[2.11480]	[0.73744]	[-0.02126]	[-0.65962]
DLOG(US(-7))	0.084568	-0.008551	-1.326640	12.33231
	(0.06220)	(0.01967)	(2.20966)	(10.6131)
	[1.35953]	[-0.43468]	[-0.60038]	[1.16199]
DLOG(US(-8))	0.128089	0.017777	-0.188718	12.95672
	(0.06170)	(0.01951)	(2.19190)	(10.5278)
	[2.07586]	[0.91094]	[-0.08610]	[1.23071]
DLOG(US(-9))	-0.050574	-0.014992	-0.735030	4.299653
	(0.05971)	(0.01888)	(2.12090)	(10.1868)
	[-0.84706]	[-0.79398]	[-0.34656]	[0.42208]
DLOG(US(-10))	-0.089268	-0.026305	-0.915136	-18.21833
	(0.05894)	(0.01864)	(2.09372)	(10.0562)
	[-1.51456]	[-1.41119]	[-0.43709]	[-1.81165]
DLOG(OR01(-1))	1.008062	2.122991	9.721686	-24.58704
	(0.19552)	(0.06183)	(6.94526)	(33.3583)
	[5.15593]	[34.3337]	[1.39976]	[-0.73706]

DLOG(OR01(-2))	-1.297266	-1.656311	-23.35871	138.9004
	(0.46398)	(0.14674)	(16.4819)	(79.1634)
	[-2.79595]	[-11.2874]	[-1.41723]	[1.75461]
DLOG(OR01(-3))	0.955555	0.720102	24.03529	-224.0055
	(0.57883)	(0.18306)	(20.5619)	(98.7594)
	[1.65083]	[3.93362]	[1.16893]	[-2.26819]
DLOG(OR01(-4))	-0.592499	-0.487612	-18.26291	183.2786
	(0.60592)	(0.19163)	(21.5241)	(103.381)
	[-0.97785]	[-2.54455]	[-0.84849]	[1.77284]
DLOG(OR01(-5))	0.480712	0.301530	15.11271	-100.3527
	(0.61848)	(0.19560)	(21.9702)	(105.524)
	[0.77725]	[1.54155]	[0.68787]	[-0.95100]
DLOG(OR01(-6))	-0.299506	0.040318	-10.79807	51.79247
	(0.62133)	(0.19650)	(22.0716)	(106.011)
	[-0.48204]	[0.20518]	[-0.48923]	[0.48856]
DLOG(OR01(-7))	-0.116424	-0.067897	7.520382	-17.41283
	(0.61187)	(0.19351)	(21.7352)	(104.395)
	[-0.19028]	[-0.35087]	[0.34600]	[-0.16680]
DLOG(OR01(-8))	0.149566	-0.024900	6.742245	9.204456
	(0.58688)	(0.18561)	(20.8476)	(100.132)
	[0.25485]	[-0.13416]	[0.32341]	[0.09192]
DLOG(OR01(-9))	0.067574	-0.044946	-17.09797	-12.92030
	(0.48294)	(0.15274)	(17.1555)	(82.3985)
	[0.13992]	[-0.29427]	[-0.99665]	[-0.15680]
DLOG(OR01(-10))	-0.208772	0.073390	6.893131	-5.984260
	(0.21915)	(0.06931)	(7.78475)	(37.3904)
	[-0.95265]	[1.05889]	[0.88547]	[-0.16005]
DLOG(FUEL_PPI(-1))	-0.000872	0.000246	0.248124	-0.284730
	(0.00176)	(0.00056)	(0.06236)	(0.29951)
	[-0.49697]	[0.44249]	[3.97898]	[-0.95065]
DLOG(FUEL_PPI(-2))	-0.000108	-0.000589	-0.075236	0.445153
	(0.00181)	(0.00057)	(0.06418)	(0.30824)
	[-0.05986]	[-1.03060]	[-1.17236]	[1.44420]
DLOG(FUEL_PPI(-3))	0.000438	0.000307	0.037369	-0.271197
	(0.00181)	(0.00057)	(0.06439)	(0.30927)
	[0.24160]	[0.53619]	[0.58035]	[-0.87688]
DLOG(FUEL_PPI(-4))	-7.08E-05	-0.001007	0.077806	-0.563598
	(0.00182)	(0.00058)	(0.06462)	(0.31035)
	[-0.03890]	[-1.74986]	[1.20412]	[-1.81598]
DLOG(FUEL_PPI(-5))	-0.000782	-0.000864	-0.092146	-0.501739
	(0.00184)	(0.00058)	(0.06537)	(0.31399)
	[-0.42479]	[-1.48409]	[-1.40952]	[-1.59793]

DLOG(FUEL_PPI(-6))	-0.002988	-0.001145	-0.111016	-0.019762
	(0.00184)	(0.00058)	(0.06545)	(0.31435)
	[-1.62202]	[-1.96442]	[-1.69623]	[-0.06287]
DLOG(FUEL_PPI(-7))	-0.000752	-0.001118	0.021990	-0.052179
	(0.00187)	(0.00059)	(0.06653)	(0.31954)
	[-0.40159]	[-1.88762]	[0.33053]	[-0.16329]
DLOG(FUEL_PPI(-8))	0.000225	-7.62E-05	-0.051861	-0.025628
	(0.00185)	(0.00059)	(0.06573)	(0.31572)
	[0.12180]	[-0.13020]	[-0.78897]	[-0.08118]
DLOG(FUEL_PPI(-9))	0.000107	-0.000386	-0.105514	0.074593
	(0.00183)	(0.00058)	(0.06507)	(0.31251)
	[0.05858]	[-0.66605]	[-1.62166]	[0.23869]
DLOG(FUEL_PPI(-10))	0.002288	-0.000952	0.171669	-0.031859
	(0.00179)	(0.00057)	(0.06353)	(0.30513)
	[1.27926]	[-1.68325]	[2.70222]	[-0.10441]
D(FED_FUNDS(-1))	-0.000295	2.39E-06	0.017286	0.377968
	(0.00036)	(0.00012)	(0.01296)	(0.06227)
	[-0.80735]	[0.02070]	[1.33336]	[6.07023]
D(FED_FUNDS(-2))	0.000787	9.63E-05	0.008595	0.081254
	(0.00038)	(0.00012)	(0.01335)	(0.06410)
	[2.09506]	[0.81082]	[0.64406]	[1.26768]
D(FED_FUNDS(-3))	-0.000513	-0.000146	-0.012522	0.012752
	(0.00038)	(0.00012)	(0.01347)	(0.06469)
	[-1.35194]	[-1.21731]	[-0.92973]	[0.19713]
D(FED_FUNDS(-4))	-3.73E-05	0.000201	0.002018	-0.054129
	(0.00037)	(0.00012)	(0.01324)	(0.06358)
	[-0.10016]	[1.70666]	[0.15241]	[-0.85129]
D(FED_FUNDS(-5))	-0.000211	-2.35E-05	-0.003854	0.162003
	(0.00037)	(0.00012)	(0.01326)	(0.06367)
	[-0.56487]	[-0.19917]	[-0.29073]	[2.54456]
D(FED_FUNDS(-6))	7.64E-05	-3.50E-05	0.001738	0.054183
	(0.00037)	(0.00012)	(0.01297)	(0.06229)
	[0.20920]	[-0.30324]	[0.13402]	[0.86978]
D(FED_FUNDS(-7))	-9.31E-05	7.10E-05	0.000294	-0.066775
	(0.00036)	(0.00011)	(0.01261)	(0.06058)
	[-0.26214]	[0.63242]	[0.02333]	[-1.10223]
D(FED_FUNDS(-8))	-4.93E-05	9.93E-05	0.014546	0.035591
	(0.00035)	(0.00011)	(0.01253)	(0.06016)
	[-0.13983]	[0.89026]	[1.16131]	[0.59160]
D(FED_FUNDS(-9))	0.000699	0.000207	0.005233	0.063632
	(0.00035)	(0.00011)	(0.01252)	(0.06012)

	[1.98254]	[1.85429]	[0.41805]	[1.05845]
D(FED_FUNDS(-10))	-2.29E-05	-0.000157	0.005941	-0.058435
	(0.00033)	(0.00011)	(0.01187)	(0.05702)
	[-0.06865]	[-1.48690]	[0.50038]	[-1.02479]
C	0.000161	8.18E-05	0.004997	-0.030780
	(0.00014)	(4.3E-05)	(0.00488)	(0.02343)
	[1.16996]	[1.88287]	[1.02420]	[-1.31350]
R-squared	0.803088	0.991571	0.245452	0.391951
Adj. R-squared	0.772794	0.990274	0.129367	0.298405
Sum sq. resids	0.000332	3.32E-05	0.419037	9.666844
S.E. equation	0.001130	0.000357	0.040146	0.192822
F-statistic	26.50963	764.6645	2.114425	4.189932
Log likelihood	1637.347	1983.853	562.7238	90.37996
Akaike AIC	-10.60696	-12.90932	-3.466603	-0.328106
Schwarz SC	-10.10200	-12.40437	-2.961648	0.176849
Mean dependent	0.002288	0.003564	0.002015	-0.030930
S.D. dependent	0.002371	0.003624	0.043025	0.230204

Determinant resid covariance (dof adj.)	9.33E-18
Determinant resid covariance	5.19E-18
Log likelihood	4281.402
Akaike information criterion	-27.35816
Schwarz criterion	-25.33833

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