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An Analysis of Okun's Law, the Natural Rate, and Voting Preferences for the 50 States

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Abstract

In this paper we test Okun's Law for individuals states from 1990 through 2012. We find the relationship between output and unemployment becomes stronger following the 2007 Great Recession. For most states the impact of a change in output on unemployment has increased and in many cases the two-to-one relationship has shifted to a three-to-two relationship. Further, we also find for most states the natural rate of unemployment has increased. We use average employment ratios by major industries to explain differences in Okun's Law across states. We find a stronger Okun effect for states with relatively large employment in professional and business services, construction, and manufacturing. Finally, we find a significant correlation between states that lean more Democrat with a stronger Okun effect.

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1 Introduction

During the Great Recession unemployment rates rose sharply and have been slow in return to pre-recession levels. Okun's Law (from Okun (1962)) claims that a one-percent change in the output gap will cause an opposite change in unemployment of a third to a half percentage point.[1] Today many are questioning the stability of Okun's Law as evidence in support of a "jobless recovery".

According to the Congressional Budget Office the recessionary gap peaked at -7.5% of potential GDP in 2009 and has slowly improved to -5.7% by the end of 2012 (see figure 1). Assuming Okun's Law held we would have expected cyclical unemployment to increase by approximately 3.75% during the Great Recession. Figure 2 shows the divergence in predicted and actual unemployment rates. The predicted unemployment is calculated using Okun's two-to-one rule and a natural rate of unemployment of 4.8% prior to the Great Recession. If Okun's Law held the unemployment rate would have peaked at 8.4% in 2009q3.[2] The actual unemployment rate was significantly higher peaking at 10% in October of 2009. By the end of 2012 the predicted and actual unemployment rates were nearly equal. During the downturn and subsequent recovery there seems to be ample evidence suggesting a divergence in the relationship between output and unemployment in the short-run, but a constant long-run relationship.

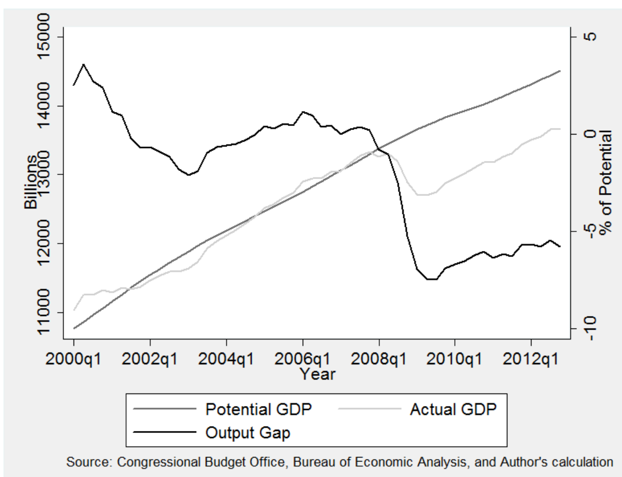

Figure 1: Actual and potential output

Most research explaining the divergence in Okun's Law focuses on increased worker productivity over time. Daly and Hobijn (2010) find stronger labor productivity growth during the Great Recession allowed firms to layoff a large numbers of workers while holding output relatively steady. The productivity gains have resulted in a nearly one for one relationship between deviations in output and unemployment. Owyang and Sekhposyan (2012) analyze how Okun's Law has changed over time with attention on the Great Recession. They find Okun's Law does differ when comparing across recessions and expansions. During normal

[1] see Mankiw (2010), Romer (2006), or Abel, Bernanke, and Croushore (2008) for textbook examples.
[2] For a summary of estimating the natural rate of unemployment see Weidner and Williams (2011).

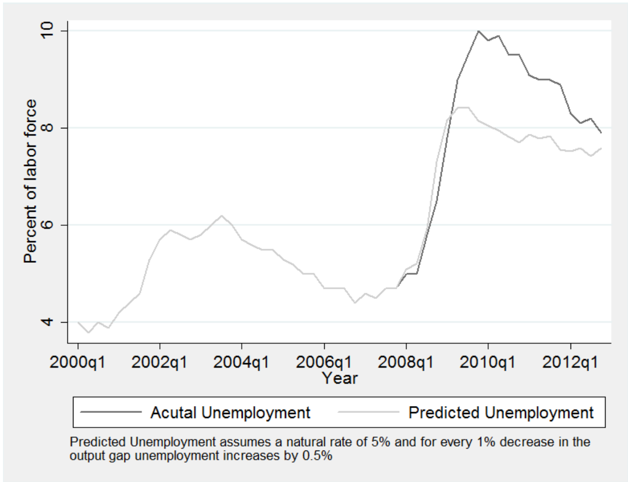

Figure 2: Actual and predicted levels of unemployment assuming Okun's Law holds

times they find the correlation between real output and unemployment to be approximately -0.4 but strengthens to -0.55 during recessions.

In this paper we model Okun's Law across states and use employment levels by industry to explain difference in Okun's Law. We find the relationship between unemployment and output has become stronger (i.e. unemployment rates have become more sensitive to changes in output) following the Great Recession for nearly all states. In particular the relationship is strongest for states with a larger share of employment in professional and business services, construction, and manufacturing sectors. States with a larger share of employment in government, financial services, and trade, transportation, and utilities tend to exhibit a weaker response in unemployment.

Additionally, we find a large degree of heterogeneity across states. States with the weakest relationship following the Great Recession are: North Dakota (-0.114), Louisiana (-0.208), Montana (-0.244), Nebraska (-0.278), and Maine (-0.284). The coefficients in parenthesis measure the change in unemployment following a one-percent change in output. States with the largest responsiveness to changes in output were Alabama (-0.669), Utah (-0.621), Virginia (-0.591), Missouri (-0.582), New York (-0.565), and Florida (-0.564).[3]

Using data for the United States we find evidence that the relationship between changes in output and unemployment to be more responsive following the Great Recession. Prior to the Great Recession the correlations between changes in output and unemployment were (-0.442) and (-0.496) from 1990-1999 and 2000-2007, respectively. From 2008 through 2012 the correlation strengthen to (-0.622). Despite the increased sensitivity this does not imply that the United States is experiencing a "jobless recovery". In fact one could argue just the opposite. The increased sensitivity contributed to much larger increases in unemployment immediately following the financial crisis but has also aided in the recovery.

For many states the strength of the relationship between output and unemployment tend to follow a distinct political divide. States with a strong Okun effect appear to lean more to the left compared to states with a weak Okun effect. We use Spearmen's rank correlation

[3]Estimates in parenthesis come from equation 1 from 2008q1 through 2012q4.

to estimate a cross-section correlation and find for 2008 through 2012 a significant positive correlation between left leaning states and a stronger Okun effect. We find no evidence of a link between state voting preference and the natural rates of unemployment.

The rest of this paper is organized as follows: Section 2 provides a short overview of Okun's Law, discusses some key issues estimating the relationship, and provides a brief review of the literature. Section 3 reviews the data construction for state level estimation. Section 4 reviews the results and regressions attempting to explain changes in Okun's Law using state level employment data. Finally, section 5 concludes.

2 Okun's Law

Okun (1962) analyzes the relationship between the change in the log real gross national product (RGNP) and the unemployment rate. To estimate this relationship Okun regressed the quarterly change in the log of RGNP on the change in unemployment from 1947q1 to 1960q4:

$$\Delta u_t = \alpha_d + \beta_d \Delta y_t + e_t \tag{1}$$

where u_t is the unemployment rate and y_t is the log of RGNP. Okun first found $\widehat{\alpha} = 0.3$ and $\widehat{\beta} = -0.3$. The interpretation for $\widehat{\beta}$ is a one-percent decrease in the RGNP growth rate will cause unemployment to increase by 0.3 percent, or a three-to-one relationship between changes in output to unemployment. Over time the relationship has slowly shifted into the two-to-one relationship that is commonly reported in textbooks.Throughout this paper we will refer to equation 1 as the difference specification (denoted by $_d$ in equation 1).

Okun also estimated a level specification:

$$u_t = u_t^* + \beta_l (y_t - y_t^*) + e_t \tag{2}$$

where the constant term, u_t^*, measures the natural rate of unemployment and $(y_t - y_t^*)$ is the output gap. Okun assumes potential output, y_t^*, follows a 3.5 percent trend line. Later studies have relied on time-series filtering measures to decompose output into trend and cyclical components. Okun finds $u_t^* = 3.72$ and $\beta_l = -0.36$. These results are consistent with a three-to-one relationship estimated in equation 1 and a natural rate of 3.72%. For our purpose, equation 2 will be denoted as the level specification denoted by $_l$ in equation 2.

Recently, Ball, Leigh, and Loungani (2013) analyzes Okun's Law in twenty advanced economies since 1980. They find the relationship varies substantial across countries but does not find evidence of a "jobless recovery". Further they find considerable differences across the countries which they contribute to idiosyncratic features of national labor markets, but not differences in employment protection legislation. In relationship to the United States, Knotek II (2007) analyzes changes in Okun's coefficient in conjunction with changes in the business cycle. He finds the output-unemployment relationship to be less sensitive during expansions but significantly more sensitive during recessions. He also finds evidence that the contemporaneous correlation has decreased over time, but correlation between unemployment and lagged growth rates has increased.

There have been a number of studies that have analyzed Okun's Law across regions. Maza and Villaverde (2007) and Villaverde and Maza (2009) analyze Okun's Law across

Spanish regions. The authors find the inverse relationship between unemployment and output remains but the coefficients range from -0.80 to -0.95 which are three times lower than Okun's original estimates. This suggests a more sensitive relationship between output and unemployment. Marieestelle and Facchini (2013) finds Okun's Law holds for fourteen French regions but breakdowns for eight regions and identifies regional factors to explain the disparities. Huang and Yeh (2013) use a pooled mean group estimator that allows the authors to estimate the short- and long-run relationship across countries and states. The authors find unemployment and output are cointegrated and the unemployment-output linkages are negative and significant across both dimensions.

In addition to papers focusing directly on cross regional differences, a number of researchers have explored Okun's Law across larger regional blocks. Fouquau (2008) uses a non-dynamic panel threshold model to test the relationship among 20 OECD countries. The authors find evidence supporting a nonlinear relationship with four specific regimes tied to varying levels of cyclical unemployment where the coefficient displays the most sensitivity at the lowest and highest levels of cyclical unemployment. Harris and Silverstone (2001) estimates Okun's Law across seven OECD countries testing for asymmetry in the relationship. The authors find failing to correct the asymmetries across the business cycle will result in a rejection of Okun's Law.

3 Empirical Models and Data

In our analysis we estimate equations 1 and 2 for the United States, individually for each state, and in pooled regressions using quarterly data from 1990 through 2012. Starting in 1990 allow us to capture the dynamics over two complete business cycles plus the recovery from the Great Recession. After estimating Okun's Law we use industry employment levels to explain state differences in Okun's coefficient. The biggest challenge using state-level data is finding an appropriate measure of real GDP and potential output. At the state level, real gross domestic product is produced on an annual frequency. Total personal income is the only variable captured on a quarterly frequency. The challenge in using total personal income occurs when converting the variable to real income. The Bureau of Labor Statistics does not produce inflation measures by state but by large metropolitan statistical areas and geographical regions. Instead of attempting to find an appropriate conversion of total personal income we use the economic coincident index produced by the Federal Reserve Bank of Philadelphia, created by Stock and Watson (1989), and applied to states by Crone and Clayton-Matthews (2005). The economic coincident index is produced on a monthly frequency and is constructed to follow the trend for each states real gross product. The long-term growth rate of the coincident index will match the long-term growth of real gross state product. Using the state index allows us to capture the cyclical variation at a higher frequency but maintains the same long-term growth for each state.

The next challenge arises while estimating equation 2 and constructing an appropriate measure for potential GDP at the state level. The Congressional Budget Office estimates national potential output but no measure exists at the state level. To estimate potential output we use the HP filter with a smoothing parameter of $\lambda = 1{,}600$ (and 16,000). We elect to use the filter to estimate potential output and not the natural rate of unemployment. Instead, we estimate the natural rate of unemployment in the level specification. This approach follows Owyang and Sekhposyan (2012).

One concern with the HP filter centers around estimating the end of sample trend. The HP filter exaggerates the change in the trend at the end of sample. In fact, under both smoothing parameters we find the average growth rate for potential output following the Great Recession to be less than 1%. To alleviate this concern we extrapolate the estimated trend from 2004 through 2007 forward. Averaged across states this gives us a trend growth rate of approximately 2.5%.

The employment measures are from the Bureau of Labor Statistics. Data for the unemployment rate are obtained from the Labor Force Statistics produced in the Current Population Survey (CPS). The data for employment by sector are from the Current Employment Statistics (CES) database for State and Area Employment, Hours, and Earnings. We include data from 10 unique sectors of interest. These are construction; manufacturing; trade, transportation, and utilities (trade); information services (information); financial activities (financial); professional and business services (services); education and health services (education); leisure and hospitality (leisure); government; and other services.

4 Results

We present the results for equation 1 in table V across four time periods: 1990 to 2012, 1990 to 1999, 2000 to 2007, and 2008 to 2012. The breakpoints are selected to capture one complete business cycle (peak to trough to peak). The first column for each state presents the results for Okun's coefficient estimated from 1990 to 2012. All the estimated coefficients are statistically significant at a one-percent level, with the exception of Iowa which is significant at a five-percent level. We present the results from a pooled panel regression using OLS and fixed effects at the bottom of each table. For the entire sample both regressions show an estimated coefficient of -0.30 which is identical to the original results found by Okun. Across states the weakest effects are -0.112 (North Dakota), -0.147 (Montana), -0.16 (Nebraska), -0.168 (Idaho) and -0.175 (Alaska) compared with the strongest effects of -0.581 (Louisiana), -0.479 (California), -0.45 (New York), -0.435 (Alabama), -0.415 (New Jersey), and -0.407 (Tennessee). The estimates for Louisiana are largely biased from the effects of Hurricane Katrina. The estimates broken down over time show the impact Hurricane Katrina had on the labor market of Louisiana. From 1990 to 1999 Okun's coefficient measured -0.083 but strengthed to -0.746 from 2000 through 2007. States with the weakest relationship tend to be more right leaning and heavily dependent on agriculture and natural resources. We expected to find a stronger effect for Midwest states which have been hard hit by jobs losses in manufacturing sector but find little evidence support our hypothesis.

The estimated coefficients from 1990 to 1999 are weaker for most states. This period will capture the recession at the beginning of the decade but mostly the economic expansion that occurred with the tech bubble. The pooled regressions show a slightly weaker relationship. This is also true for the aggregated measure for the United States (-0.442). Nearly all the coefficients are statistically significant at the one-percent level. The only exceptions are the coefficients for Delaware, Iowa, Montana, and Oklahoma which are statistically significant at the five-percent level. States with the weakest relationship are -0.083 (Louisiana), -0.092 (Iowa), -0.093 (Georgia), -0.095 (Montana), and -0.122 (South Dakota). States with the strongest relationship are -0.488 (Kentucky), -0.435 (Illinois), -0.421 (Indiana), -0.42

(California), and -0.416 (Alabama). Agricultural based states tend to have the weakest relationship whereas Midwest appear to have a stronger response to changes in output. This is not surprising as outsourcing and international trade increased rapidly during this period.

From 2000 to 2007 pooled regressions show a more sensitive relationship, but still in line with the original estimates of Okun. We also see the estimated coefficient strengthens for the United States to -0.496. Most of the coefficients are significant at the one-percent level. The coefficients for Alaska, Minnesota, and Mississippi are significant at the five-percent level. The coefficient for Montana is not significant. The states with the weakest effects are -0.049 (Montana), -0.112 (Wyoming), -0.144 (Minnesota), -0.152 (Idaho), and -0.178 (Rhode Island). States with the strongest effects are -0.746 (Louisiana), -0.661 (Mississippi), -0.526 (New Jersey), -0.474 (New Mexico), and -0.440 (New York). The estimated coefficients for Mississippi and Louisiana are likely to be biased from the large increase in unemployment that resulted post Hurricane Katrina. Agricultural states generally have a weaker relationship.

The most radical change comes in the 2008 to 2012 period. The coefficients from the pooled regressions and the United States regression become more sensitive, -0.419 and -0.622, respectively. All of the coefficients are statistically significant at a one-percent level with the exceptions of Iowa and Louisiana which are not significant. Aside from Mississippi and Louisiana the only other states to experience a weaker relationship are Connecticut, New Jersey, New Mexico, and North Dakota. North Dakota has benefitted from an oil boom, they have the weakest relationship at -0.114 followed by -0.208 (Louisiana), -0.244 (Montana), -0.278 (Nebraska), and -0.284 (Maine). This period is largely driven by the fall in the housing market, not surprising states that were relatively immune to the housing bubble were also the least sensitive to changes in output. The lowest coefficients during this period are -0.669 (Alabama), -0.621 (Utah), -0.591 (Virginia), -0.582 (Missouri), and -0.581 (California).

Despite the crash in the housing sector, aside from California and parts of Virginia, most states with a relatively stronger effect are not those that were plagued with massive home depreciation. Although on average states that experienced large housing price depreciation also had the relationship strengthen. Arizona, Florida, and California have estimated coefficients that are nearly double the previous period. Okun's coefficient more than doubled for Nevada.

The results for equation 2 are presented in table VI. We present the results only for the case of the HP trend using a smoothing parameter of $\lambda = 1,600$.[4] In addition to reporting Okun's coefficient we report the constant term which can be interpreted as the natural rate of unemployment. The results are dependent on estimating potential output which makes them less reliable when compared to results from the differenced specification.

Using the complete sample the estimated natural rate of unemployment and Okun's coefficients for the United States are 0.057 and -0.66, respectively. The pooled regressions report a natural rate of 0.053 and a coefficient of -0.32. Because we allow the natural rate to vary across periods the results seem to suggest a tradeoff between a higher natural rate of unemployment and a weaker relationship between output and unemployment. For example the pooled regressions report a weaker Okun's coefficient following the Great Recession, but

[4]Results using a smoothing parameter of $\lambda = 16,000$ or additional filter methods (i.e. quadratic filtering and Baxter King filter) are available from the authors upon requests. The results are nearly identical to those presented here.

a relatively large increase in the natural rate of unemployment. Nearly all states show an increase in the natural rate of unemployment during the 2008 to 2012 period. Following the Great Recession there has been a tremendous discussion surrounding changes in the natural rate of unemployment. As economist attempt to answer whether the rise in unemployment is tied to structural or cyclical factors our results suggest a rise in structural unemployment. Our findings of a higher natural rate are also consistent with the Federal Reserves announcement of continued monetary easing until unemployment reaches 6.5%.

The results across states follow fairly closely to those estimated through the difference equation. The coefficients are slightly different but the states with the lowest and highest coefficients remain fairly stable. Looking at column two of table VI states with the weakest relationship are Alaska, Idaho, Montana, North Dakota, New Mexico, and Wyoming. States with the strongest relationship include California, Connecticut, Indiana, Mississippi, New Jersey, New York, and Tennessee.

In general the coefficients are weakest during the 1990-1999 period and strongest in the 2000 to 2007 period. The natural rate of unemployment is highest for the 2008 to 2012 period. In the latest period states with the highest measures of the natural rate of unemployment are Michigan (0.104), California (0.078), Mississippi (0.075), Ohio (0.074), and South Carolina (0.073). Many of these states have employment based in manufacturing or experienced large adverse shocks tied to the housing bubble. States with the lowest measures of the natural rate are Nebraska (0.036), South Dakota (0.037), and North Dakota (0.037) which are predominately agricultural states.

4.1 Okun's Law and Employment Types

In order to better understand Okun's Law across states we run simple regressions with average levels of employment across industries on the estimated coefficients from the equations 1 and 2. The estimated Okun coefficients are the dependent variables. Average employment ratios are calculated for each state as the average number of employees in each industry relative to total state employment. The averages are calculated for each time period. Table I presents the results for simple regressions where employment levels are regressed on Okun's coefficients from equation 1. The first column presents the results for the entire sample. We are interested in seeing if the types of jobs determine the relationship between changes in output and unemployment. The coefficients on average employment in services and manufacturing are negative and statistically significant at the 5% level. This suggest states with a greater proportion of employment within these sectors are more likely to observe greater changes in unemployment following changes in output, a stronger Okun effect. During the 1990 through 1999 period states with increased employment in construction, manufacturing, and other services are more likely to experience greater shifts in unemployment. From 2000 through 2007 only an increase in services corresponds with a more sensitive relationship. Finally, following the financial crisis increased employment in government, services, construction, manufacturing, and leisure leads to a strong effect.

Table II presents the results for the regressions with average employment and Okun's coefficients from equation 2. The results are similar to the difference specification with a few exceptions. Increased employment in information services results in a stronger effect over the entire sample but particularly during the 2000 through 2007 period. Added government

Table I: The Relationship Between β_d and Industry Employment (Equation 1)

	β_{all}	β_{90-99}	β_{00-07}	β_{08-12}
Government	0.224 (0.362)	0.687 (1.2)	-1.474 (-1.585)	-1.124 (-1.843)
Financial	0.032 (0.026)	-1.329 (-1.035)	0.627 (0.424)	-0.144 (-0.139)
Services	-1.373 (-2.366)	-0.047 (-0.055)	-1.757 (-2.382)	-1.564 (-2.408)
Construction	-1.505 (-1.238)	-2.017 (-1.896)	1.407 (1.005)	1.013 (0.922)
Manufacturing	-0.999 (-2.558)	-1.126 (-3.489)	-0.667 (-0.965)	-1.339 (-2.124)
Education	-0.257 (-0.394)	0.586 (0.808)	-0.414 (-0.517)	0.471 (0.921)
Leisure	0.073 (0.143)	-0.002 (-0.005)	-0.46 (-0.711)	-0.922 (-2.434)
Information	-0.837 (-0.258)	-3.926 (-1.215)	2.074 (0.549)	-4.637 (-1.636)
Other Services	-1.589 (-0.858)	-5.882 (-2.779)	2.016 (0.89)	-1.625 (-1.048)
Trade	0.546 (0.516)	0.987 (0.943)	0.321 (0.231)	1.05 (0.988)

t statistics in parentheses, calculated using White corrected standard errors.

employment results in a weaker relationship during the 1990 through 1999 period and a positive but statistically insignificant relationship following the Great Recession.

Table II: The Relationship Between β_l and Industry Employment (Equation 2)

	β_{all}	β_{90-99}	β_{00-07}	β_{08-12}
Government	0.943 (1.191)	2.809 (2.356)	-0.774 (-1.028)	0.702 (0.699)
Financial	-1.785 (-0.985)	0.399 (0.157)	0.785 (0.542)	0.489 (0.388)
Services	-1.029 (-1.299)	-1.45 (-1.054)	-1.193 (-1.775)	-1.641 (-1.876)
Construction	-0.876 (-0.763)	-3.849 (-1.8)	0.104 (0.176)	-1.057 (-0.649)
Manufacturing	-2.39 (-4.839)	-0.808 (-1.053)	-0.028 (-0.065)	-1.469 (-2.177)
Education	-0.168 (-0.306)	-0.294 (-0.216)	-0.726 (-0.862)	-1.028 (-1.795)
Leisure	-0.535 (-1.098)	1.013 (1.44)	0.416 (1.145)	-0.134 (-0.233)
Information	-9.491 (-2.327)	-7.788 (-0.928)	-5.908 (-2.437)	-4.261 (-0.995)
Other Services	-1.347 (-0.771)	-6.067 (-1.686)	2.192 (1.129)	-1.394 (-0.638)
Trade	1.614 (1.225)	-0.672 (-0.32)	0.186 (0.142)	0.983 (0.749)

t statistics in parentheses, calculated using White corrected standard errors.

Finally, we use the average employment measures to explain differences in the natural rate of unemployment. Table III presents the results for regressions with the estimated natural rate of unemployment by state from equation 2 with average employment ratios. Positive coefficients suggest states with a higher proportion of employment in that industry will have a higher natural rate of unemployment. For example, column one presents the results for the entire sample. States with relatively large employment shares in services (0.22), construction (0.159), manufacturing (0.112), and education (0.13) are more likely to have a higher natural rate of unemployment. Meanwhile states with a higher employment share within financial (-0.222), leisure (0.055), information (-0.003), and trade (-0.09) have lower natural rates of unemployment.

There is some variability across the three time periods. From 1990 through 1999 a relatively large share of employment in leisure resulted in a lower natural rate (0.009). After the Great Recession the coefficient increased significantly (0.161) and is statistically significant at the one-percent level. Whereas, the effects of an increase in employment in the government sector on the natural rate decreased following the Great Recession.

4.2 Voting Preferences

In the last section we explore the relationship between the strength of Okun's Law and voting preferences across states. Many states with a relatively strong Okun effect are more left

Table III: The Relationship Between the U^* and Industry Employment (Equation 2)

	U^*_{all}	U^*_{90-99}	U^*_{00-07}	U^*_{08-12}
Government	0.072 (0.96)	0.046 (0.508)	0.104 (1.714)	0.002 (0.023)
Financial	-0.222 (-1.619)	-0.212 (-1.215)	-0.121 (-1.106)	-0.171 (-1.19)
Services	0.22 (2.451)	0.22 (2.055)	0.155 (2.253)	0.261 (2.268)
Construction	0.159 (1.484)	0.341 (2.14)	0.065 (0.683)	0.098 (0.939)
Manufacturing	0.112 (2.976)	0.063 (1.514)	0.141 (3.754)	0.247 (3.643)
Education	0.13 (2.639)	0.218 (3.711)	0.041 (0.86)	0.086 (1.421)
Leisure	0.055 (1.427)	0.009 (0.196)	0.063 (1.648)	0.161 (3.653)
Information	-0.003 (-0.013)	0 (-0.001)	0.119 (0.65)	0.108 (0.351)
Other Services	0.073 (0.245)	0.059 (0.149)	-0.014 (-0.075)	-0.097 (-0.411)
Trade	-0.09 (-1.034)	-0.094 (-0.821)	-0.069 (-1.025)	-0.092 (-0.876)

t statistics in parentheses, calculated using White corrected standard errors.

leaning (California, Massachusetts, New Jersey, New York, and Rhode Island) and states with a weaker effect appear right leaning (North Dakota, Idaho, Nebraska, and Wyoming). Using the Cook Partisan Voting Index (henceforth PVI) we calculate Spearman's rank correlation where we rank states in order of the magnitude of their Okun coefficient (with 1 being the most sensitive) and political leanings (with 1 being the highest percentage voting Democrat relative to the national average). We focus specifically on the coefficients from the 2008 through 2012 period. The PVI is calculated from the 2008 and 2012 elections as a weighted average of the percent within each state that voted Democrat relative to the national average. The results are presented in table IV.

Table IV: Spearman's Correlation Matrix Between Okun's Law and Cook Partisan Voting Index

	β_{08-12}	U^*_{08-12}	β^d_{08-12}
PVI	0.3036**	0.1807	0.1744

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The rank correlation between PVI and Okun's coefficient from the level specification is positive and significant at a five percent level. This suggests a positive correlation between the strength of Okun's Law and states leaning Democrat. It is important to note that we are not implying causation. There are a number of variables that could be driving this result include religious preferences, unionization rates, and industry structure. Further we do not distinguish between the direction of causation. States with more cyclical unemployment might be more likely to vote Democrat or states that vote Democrat could have more cyclical unemployment.

The positive correlation appears to be only a short-run effect. We do not find a significant relationship between the natural rate and voting preference. The natural rate will capture long-run trends whereas Okun's coefficient emphasizes short-run fluctuations.

5 Conclusion

Our objective was to estimate Okun's Law across the fifty states to better understand how Okun's Law has changed over time. Further we are able to explain the movements in Okun's Law through the employment makeup of each state. We find that Okun's coefficient is lowest for the 1990 through 1999 period and highest for the period immediately following the Great Recession. In terms of explaining the heterogeneity across states we find increased employment within manufacturing and professional services are primarily responsible for the more sensitive relationship. This is especially true following the Great Recession. There is no evidence to suggestion added (or decreased) employment in government sectors causes unemployment to be more sensitive to changes in output.

When we estimate Okun's Law through the output gap specification we find evidence that a tradeoff exists between a higher natural rate and a less sensitive output to unemployment relationship. For the 2008 through 2012 we do not find evidence that Okun's Law has statistically changed but there is overwhelming evidence supporting an increase in the natural rate of unemployment. We do find states that strongly lean Democrat also have a stronger Okun effect. This could potential explain why left leaning states are more supportive of fiscal policies relative to right leaning states.

In addition to employment levels there are a number of other factors that are likely to explain the differences in Okun's Law across states. A larger project would consist of estimating Okun's Law controlling for changes in employment by industry, productivity measures by industry, unemployment compensation programs, and key macroeconomic variables (foreign trade measures). It is also worth while to explore the panel nature of the data through dynamic panel techniques.

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Table V: Okun's Law: $\Delta U_t = \alpha + \beta \Delta Y_t + e_t$

	β_{all}	β_{90-99}	β_{00-07}	β_{08-12}
United States	-0.503	-0.442	-0.496	-0.622
Alaska	-0.175	-0.154	-0.198[a]	-0.419
Alabama	-0.435	-0.416	-0.325	-0.669
Arkansas	-0.248	-0.315	-0.289	-0.402
Arizona	-0.249	-0.217	-0.249	-0.453
California	-0.479	-0.42	-0.392	-0.581
Colorado	-0.279	-0.288	-0.335	-0.4
Connecticut	-0.342	-0.289	-0.43	-0.366
Delaware	-0.284	-0.346[a]	-0.187	-0.375
Florida	-0.388	-0.371	-0.37	-0.564
Georgia	-0.24	-0.093	-0.205	-0.456
Hawaii	-0.294	-0.182	-0.375	-0.384
Iowa	-0.242[a]	-0.092[a]	-0.207	-0.38[b]
Idaho	-0.168	-0.181	-0.152	-0.3
Illinois	-0.375	-0.435	-0.293	-0.478
Indiana	-0.373	-0.421	-0.334	-0.415
Kansas	-0.223	-0.183	-0.198	-0.371
Kentucky	-0.378	-0.488	-0.388	-0.496
Louisiana	-0.581	-0.083	-0.746	-0.208[b]
Massachusetts	-0.331	-0.294	-0.298	-0.489
Maryland	-0.297	-0.23	-0.274	-0.443
Maine	-0.208	-0.19	-0.247	-0.284
Michigan	-0.291	-0.314	-0.273	-0.349
Minnesota	-0.286	-0.233	-0.144[a]	-0.475
Missouri	-0.352	-0.287	-0.419	-0.582
Mississippi	-0.385	-0.34	-0.661[a]	-0.518
Montana	-0.147	-0.095[a]	-0.049[b]	-0.244
North Carolina	-0.339	-0.365	-0.263	-0.449
North Dakota	-0.112	-0.292	-0.22	-0.114
Nebraska	-0.16	-0.174	-0.275	-0.278
New Hampshire	-0.231	-0.201	-0.243	-0.423
New Jersey	-0.415	-0.34	-0.526	-0.512
New Mexico	-0.221	-0.158	-0.474	-0.42
Nevada	-0.216	-0.222	-0.207	-0.424
New York	-0.45	-0.389	-0.44	-0.565
Ohio	-0.29	-0.246	-0.315	-0.354
Oklahoma	-0.277	-0.2[a]	-0.232	-0.38
Oregon	-0.306	-0.291	-0.344	-0.426
Pennsylvania	-0.32	-0.306	-0.296	-0.343
Rhode Island	-0.26	-0.199	-0.178	-0.451
South Carolina	-0.37	-0.317	-0.376	-0.511
South Dakota	-0.252	-0.122	-0.267	-0.43
Tennessee	-0.407	-0.329	-0.38	-0.552
Texas	-0.307	-0.292	-0.285	-0.379
Utah	-0.352	-0.19	-0.327	-0.621
Virginia	-0.366	-0.307	-0.334	-0.591
Vermont	-0.347	-0.327	-0.351	-0.493
Washington	-0.34	-0.415	-0.33	-0.477
Wisconsin	-0.384	-0.393	-0.365	-0.541
West Virginia	-0.332	-0.354	-0.255	-0.361
Wyoming	-0.264	-0.308	-0.112	-0.355
Pooled (OLS)	-0.291	-0.225	-0.309	-0.389
Pooled (FE)	-0.302	-0.269	-0.342	-0.419

t statistics in parentheses, calculated using White standard errors.
All coefficients significant at a 1% level unless otherwise notes
[a] significant at a 5% level
[b] not significant at a minimum 10% level

Table VI: Okun's Law: $U_t = U_t^* + \beta(Y_t - Y_t^*) + e_t$ (HP-Filter, $\lambda = 1600$)

	U^*_{all}	β_{all}	U^*_{90-99}	β_{90-99}	U^*_{00-07}	β_{00-07}	U^*_{08-12}	β_{08-12}
United States	0.057	-0.66	0.058	-0.791	0.051	-0.439	0.067	-0.487
Alaska	0.071	-0.113	0.073	0.044^b	0.068	-0.26^b	0.068	-0.213^a
Alabama	0.05	-0.367	0.055	-0.759	0.044	-0.332	0.056	-0.308
Arkansas	0.055	-0.339	0.057	-0.553	0.052	-0.207	0.057	-0.318
Arizona	0.053	-0.255	0.055	-0.432	0.048	-0.232	0.061	-0.2
California	0.068	-0.738	0.072	-1.153	0.059	-0.387	0.078	-0.611
Colorado	0.048	-0.494	0.044	-0.362^a	0.047	-0.394	0.06	-0.388
Connecticut	0.05	-0.591	0.052	-0.61	0.043	-0.391	0.064	-0.415
Delaware	0.043	-0.348	0.045	-0.438	0.037	-0.108	0.049	-0.296
Florida	0.054	-0.415	0.06	-0.606	0.046	-0.311	0.056	-0.393
Georgia	0.051	-0.479	0.05	-0.256	0.045	-0.115	0.067	-0.382
Hawaii	0.041	-0.2	0.046	-0.172^b	0.036	-0.26	0.041	-0.191
Iowa	0.039	-0.387	0.038	-0.339	0.038	-0.25	0.046	-0.298
Idaho	0.05	-0.167	0.055	-0.202	0.044	-0.189	0.049	-0.166
Illinois	0.06	-0.539	0.059	-0.551	0.057	-0.333	0.072	-0.428
Indiana	0.05	-0.573	0.044	-0.416	0.048	-0.216	0.072	-0.407
Kansas	0.046	-0.314	0.044	-0.299	0.047	-0.28	0.052	-0.243
Kentucky	0.06	-0.56	0.058	-0.521	0.056	-0.198	0.072	-0.468
Louisiana	0.06	-0.402	0.065	-0.716	0.052	-0.28^b	0.066	-0.716
Massachusetts	0.056	-0.511	0.058	-0.468	0.047	-0.408	0.068	-0.515
Maryland	0.047	-0.36	0.051	-0.379	0.041	-0.237	0.046	-0.369
Maine	0.053	-0.288	0.057	-0.238	0.045	-0.173	0.058	-0.249
Michigan	0.072	-0.338	0.062	-0.393^a	0.064	-0.188^a	0.104	-0.268
Minnesota	0.044	-0.562	0.04	-0.464^a	0.043	-0.301	0.056	-0.376
Missouri	0.052	-0.455	0.05	-0.407	0.049	-0.307	0.066	-0.288
Mississippi	0.068	-0.551	0.069	-0.416	0.064	-0.151^a	0.075	-0.525
Montana	0.05	-0.113	0.057	-0.251	0.041	-0.134	0.047	-0.132
North Carolina	0.052	-0.508	0.046	-0.5	0.054	-0.263	0.072	-0.358
North Dakota	0.036	-0.032	0.037	-0.645	0.033	-0.264	0.038	-0.037
Nebraska	0.031	-0.235	0.026	-0.123	0.034	-0.291	0.036	-0.151
New Hampshire	0.043	-0.288	0.048	-0.336	0.038	-0.286	0.042	-0.275
New Jersey	0.056	-0.593	0.061	-0.635	0.049	-0.457	0.06	-0.534
New Mexico	0.059	-0.123	0.068	-0.125	0.05	-0.568	0.05	-0.178
Nevada	0.055	-0.278	0.056	-0.374	0.049	-0.125	0.072	-0.212
New York	0.062	-0.685	0.065	-0.678	0.053	-0.422	0.069	-0.652
Ohio	0.059	-0.457	0.055	-0.385	0.055	-0.194	0.074	-0.354
Oklahoma	0.047	-0.239	0.051	-0.267^a	0.044	-0.258	0.046	-0.242
Oregon	0.062	-0.322	0.059	-0.365	0.065	-0.326	0.069	-0.27
Pennsylvania	0.055	-0.442	0.059	-0.575	0.05	-0.311	0.059	-0.385
Rhode Island	0.06	-0.552	0.063	-0.329	0.05	-0.067	0.069	-0.501
South Carolina	0.058	-0.461	0.054	-0.484	0.059	-0.246	0.073	-0.357
South Dakota	0.034	-0.32	0.033	-0.083^b	0.033	-0.255	0.037	-0.29
Tennessee	0.056	-0.61	0.055	-0.474	0.051	-0.235	0.07	-0.461
Texas	0.059	-0.41	0.062	-0.587	0.054	-0.359	0.061	-0.382
Utah	0.041	-0.337	0.04	-0.338	0.043	-0.423	0.042	-0.312
Virginia	0.04	-0.391	0.044	-0.486	0.035	-0.308	0.042	-0.36
Vermont	0.043	-0.38	0.046	-0.318	0.038	-0.303	0.045	-0.353
Washington	0.059	-0.345	0.059	-0.448	0.059	-0.348	0.062	-0.313
Wisconsin	0.046	-0.574	0.041	-0.441	0.048	-0.337	0.056	-0.474
West Virginia	0.067	-0.248	0.085	-0.56	0.052	-0.233	0.052	-0.365
Wyoming	0.045	-0.156	0.051	-0.183^a	0.038	-0.171	0.043	-0.17
Pooled (OLS)	0.052	-0.321	0.053	-0.411	0.047	-0.265	0.063	-0.227
Pooled (FE)	0.053	-0.326	0.054	-0.408	0.048	-0.267	0.061	-0.276

t statistics in parentheses, calculated White corrected standard errors.

All coefficients significant at a 1% level unless otherwise notes

[a] significant at a 5% level

[b] not significant at a minimum 10% level