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Examining the Short-Run Price Elasticity of Gasoline Demand in the United States

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EXAMINING THE SHORT-RUN PRICE ELASTICITY OF GASOLINE DEMAND IN THE UNITED STATES

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ABSTRACT

Estimating the consumer demand response to changes in the price of gasoline has important implications regarding fuel tax policies and environmental concerns. There are reasons to believe that the short-run price elasticity of gasoline demand fluctuates due to changing structural and behavioral factors. In this paper I estimate the short-run price elasticity of gasoline demand in two time periods, from 2001 to 2006 and from 2007 to 2010. This study utilizes data at both the national and state levels to produce estimates. The short-run price elasticities range from -0.034 to -0.047 during 2001 to 2006, compared to -0.058 to -0.077 in the 2007 to 2010 period. This paper also examines whether there are regional differences in the short-run price elasticity of gasoline demand in the United States. However, there appears to only be modest variation in price elasticity values across regions.

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1. INTRODUCTION

The short-run price elasticity of gasoline demand has been estimated frequently in the literature. It is important to develop an accurate estimate of this measure in order to make effective policy recommendations and better understand a market in which the majority of Americans participate. For instance, the efficacy of gasoline tax policies depends upon accurately forecasting the consumer response to an increase in gasoline prices. There has been a significant push towards reducing gasoline consumption as a nation for a variety of reasons including diminishing potentially harmful greenhouse emissions, decreasing our reliance on Middle-Eastern oil, and lowering congestion on our highways. In 1975 the U.S. government issued the Corporate Average Fuel Economy (CAFE) regulations, which impose financial penalties on automobile manufacturers who fail to meet fuel economy standards. In 2007 President Bush signed the Energy Independence and Security Act, which set a goal for the national fuel economy standard to be 35 miles per gallon by 2020. In 2009 President Obama proposed an even more ambitious national fuel economy program that set a target of an average fuel economy of 35.5 miles per gallon by 2016. This target is nearly forty percent higher than the current average of 25 miles per gallon and would reduce fuel consumption by a sizeable magnitude.

In addition to these factors, alternative fuels are being introduced into the automobile market. Consumers can even find fairly simple instructions on the Internet demonstrating how to convert diesel automobile engines to run on vegetable oil. All in all, consumers have significantly more options than what has existed in the past. On the other hand, automobile ownership is increasing in general and there is evidence consumers are becoming more dependent on driving as opposed to using public transit. Also, the expansion of sprawling suburbs around metro areas increases the commute time for households, as well as the driving distance to other non-discretionary locations. All of these factors likely impact the short-run price elasticity of gasoline demand.

Because of these ever changing variables, it is possible that the short-run price elasticity of gasoline demand changes over time. The purpose of this paper is to obtain an accurate and recent measure of this elasticity and examine if there has been any change in the periods 2001-2006 to 2007-2010. These two time periods are chosen for several reasons. The first is that 2001-2006 provides a fairly recent benchmark to compare against, as studies in the literature have examined this time period. This period also experienced relatively stable economic conditions. 2007-2010 is chosen because it represents the most recent period for which complete data is available. The turbulent economic conditions may have also precipitated a shift in the short-run price elasticity of gasoline demand.

In addition to changes over time, it is likely that the price elasticity of gasoline demand varies between geographical regions in the United States due to differences in industry, culture, and population distribution. Therefore, this paper will also investigate if different regions within the United States have different price elasticity of gasoline demand values.

Figure 1 displays the average relationship between gasoline price and per capita consumption of gasoline in the United States for the years 1976-2011. The noisy monthly fluctuations have been removed in order to allow a clearer picture. As economic intuition would suggest, there appears to be an inverse relationship between the two variables. When prices are trending upwards, consumption is typically falling and vice a versa. The purpose of this paper is to attempt to identify an exact measure of the short-term relationship between these two variables.

In this paper I estimate the short-run price elasticity of gasoline demand in two time periods, from 2001 to 2006 and from 2007 to 2010. The paper proceeds as follows: In section 2, I review some of the pertinent literature related to the price elasticity of gasoline demand. Section 3 presents a model using national level data. In section 4, I use state level data to take advantage of state-by-state variations that may provide a more accurate estimate. Section 5 examines regional differences in price elasticities and section 6 discusses some potential problems that can arise when investigating this issue. Section 7 concludes and discusses the implications of the results. Elasticity estimates will vary according to the type of data used and specification of the model (Espey, 1998). Therefore, the results from the different data sets and models may not be directly comparable, but the main point is to examine if there has been a shift in elasticity from the first period to the second and to examine state level or regional differences. Several econometric models similar to those used previously in the literature are implemented in order to formulate elasticity estimates. In the period from 2001-2006, the short-run price elasticity of gasoline demand estimates range from -0.034 to -0.047. During the years 2007 to 2010, the price elasticity estimates range between -0.058 and -0.077.

2. LITERATURE REVIEW

There have been numerous studies examining issues related to the price elasticity of gasoline demand. Elasticity estimates vary considerably between time periods and regions. Other common areas of research include the effect of taxes on gasoline consumption and the effect of gas price changes on vehicle miles traveled and fuel efficiency. Brons, Nijkamp, Pels, and Rietveld (2007) formulate a meta-estimate of the short-run price elasticity of gasoline demand in their paper "A Meta-Analysis of the price elasticity of gasoline demand. A SUR Approach." Using a Seemingly Unrelated Regression model they combine estimates consisting of 158 elasticity observations from 43 studies in the literature. The primary studies used are from the years 1974-1998 and range across several different counties. Their meta-analysis finds the mean price elasticity of gasoline demand to be -0.36 in the short-run and -0.81 in the long run. However, the individual elasticity estimates in the literature vary drastically with regard to geographic location and time period.

Espey (1998) also performed a meta-analysis of elasticity estimates of gasoline demand. Espey finds a median short-run price elasticity of -0.23 and a median short-run income elasticity of 0.39. A key finding is that vehicle ownership is an important explanatory variable and models that exclude this variable likely have biased results. Typically, there were not significant differences between results derived from linear, log-linear, or log-log functional forms. Also, there tended to be no significant differences between studies that used state data compared to those using national data.

A concern with these meta-analyses is that they focus on research primarily from the 1970s to the 1990s. Hughes, Knittel, and Sperling (2008) found indication of a shift in the short-run price elasticity of gasoline. They hypothesized that there are a number of reasons to believe that modern elasticities differ from previous periods, as transportation analysts have suggested that behavioral and structural factors over the past several decades have changed the responsiveness of U.S. consumers to changes in gasoline prices. Examining two time periods, 1975-1980 and 2001-2006, they find that both periods have similarities in the gasoline market.

The authors estimate several different models and develop elasticity estimates in the range of -0.21 to -0.34 in the 1975-1980 period and in the range of -0.034 to -0.077 in the 2001-2006 period. In all models, the null hypothesis that price elasticities are the same in both periods is rejected. Hughes et al. (2008) conclude that the short-run price elasticity of gasoline demand is significantly more inelastic today than in previous decades. These results support the existence of a structural change in the demand for gasoline. Some of the possible explanations include better gas mileage for automobiles, higher dependence on automobiles for daily transportation, and that as real incomes have increased the budget share represented by gasoline consumption has decreased making consumers less sensitive to price increases.

These findings display the importance of consistently updating the estimate of short-run price elasticity of gasoline demand as it can change for a number of reasons. There have been other recent estimates that differ from the range of -0.034 to -0.077 found by Hughes, et al. (2008). Levin, Lewis, and Wolak (2012) found much larger estimates in their research "High Frequency Evidence on the Demand for Gasoline." Using several different econometric model specifications they arrive at price elasticity estimates that are in the range of -0.29 to -0.61 for the period February 1, 2006 to December 31, 2009. These results are nearly a magnitude larger than the results obtained by Hughes, et al. (2008). There are several reasons these results may differ by such a large magnitude. The methodology incorporated by Levin et al. (2012) uses data at the individual consumer level. They measure daily gasoline price and expenditure data for 243 metropolitan areas throughout the United States. However their data set is unique; the expenditure data is obtained from Visa and shows both individual customer gasoline purchases, and total daily purchases made at gas stations in a given city.

Levin et al. (2012) note that the reason their estimates have such a large discrepancy is because of this unique daily individual level data. As a trial they aggregated their data and estimated demand models similar to those used in previous studies, which led to considerably more inelastic results. They find substantial evidence that there is a temporary response in the probability of an individual purchasing gasoline in the days after a price change. It is significant that they are estimating a daily elasticity. This measure may not be especially relevant with regard to policy because it does not especially matter if a consumer fills up on a Friday as opposed to a Monday after a price increase. Another factor that could affect their results is the access to public transportation in cities. Because their analysis focuses solely on metropolitan areas, they are studying a demographic with many more alternatives to driving than a rural consumer. One would expect the elasticity for urban individuals to be of greater magnitude.

Parry and Small (2005) examine whether gas taxes are at the optimal level in the United States and the United Kingdom. They estimate that the gas tax should be more than double the current rate in the United States and almost half the current rate in the United Kingdom. They believe that the most detrimental externality of gasoline consumption is traffic congestion, but the fuel tax is a poor means of addressing externalities related to congestion because these types of taxes tend to cause greater shifts in fuel economy of vehicles as opposed to amount of travel. They suggest instead of an indirect fuel tax, a direct tax on vehicle miles traveled would generate more beneficial results. Li, Haefen and Timmins (2008) and Klier and Linn (2010) both find that high gasoline prices substantially increase the demand for newer more fuel-efficient vehicles. However, Klier and Linn (2010) believe that a gasoline tax increase would only have a small effect on average fuel efficiency.

3. NATIONAL LEVEL ANALYSIS

31. Empirical Model

This study begins with an estimate of the price elasticity of gasoline demand at the national level. This is similar to the basic model proposed by Hughes, et al.

(2008) and many other previous studies of gasoline demand. The model is as follows:

$$lnC_{it} = \beta_0 + \beta_1 \, lnP_{it} + \beta_2 \, lnY_{it} + \varepsilon_i + e_{it}$$

where C_{it} is per capita gasoline consumption in gallons in month *i* and year *t*. The per capita measure is used in order to control for the effect of population change on gasoline demand. P_{it} is the real retail price of gasoline in month *i* and year *t*. Y_{it} is the measure of real per capita disposable income in month *i* and year *t*. ε_i represents monthly fixed effects and e_{it} is a mean zero error term. The gasoline price and disposable income variables have been adjusted to 2005 dollars. The fixed month effects are included because there is substantial evidence that gasoline consumption varies between seasons. Figure 2 displays average monthly gasoline consumption in the years 2000-2011. The averages range from a low of 34.7 gallons/month in February to a high of 40.7 gallons/month in August. The double-log functional form is employed, as it seems to provide the best fit of the standard functional forms. Furthermore, since many other papers in the literature use this functional form (Li, Linn and Muehlegger 2012 & Hughes et al. 2008), it will allow for comparison of results. The double-log functional form assumes that elasticity is constant over each time period. However, results from semi-log and linear functional forms will be displayed in the appendix and discussed in brief.

3.2 National Level Data

The first model uses U.S. aggregate monthly data as reported by several U.S. government agencies from the period 1976 to 2011. Gasoline consumption is estimated as monthly product supplied reported by the U.S. Energy Information Administration. This is a measure of how many monthly-thousand barrels of finished motor gasoline are supplied each month, calculated as domestic production plus imports, minus exports and changes to stocks. This measure is used because it is the same consumption measure used by Hughes et al. (2008) and will allow comparison to their results. Although this data is a measure of gasoline product supplied, it appears to adequately match the same values and trends in per capita gallons per month as gasoline consumption data from the Federal Highway Administration used later in this study. Real gasoline prices are U.S. city average prices for unleaded regular fuel from the U.S. Bureau of Labor Statistics, CPI-Average Price Data. The disposable income is from the Federal Reserve Bank of St. Louis Real Monthly Disposable Income Measure. Gas price and income are converted to 2005 dollars using the GDP implicit price deflator from the Bureau of Economic Analysis. The gasoline consumption data is turned into a per capita measure by converting thousand barrels to gallons and dividing by yearly U.S. population obtained from the Bureau of Economic Analysis.[1] Summary statistics for the data of interest in the 2001-2006 and 2007-2010 periods are located in Table 1 and Table 2 respectively.

A problem that arises when comparing the time periods of 2001-2006 to 2007-2010 is the difference in economic climate between the two periods. While there was a small recession after the dot com bubble burst, the early time period experienced mostly healthy economic conditions. On the other hand, the later

[1] (Monthly Thousand Barrels × 1000 × 42 gallons/barrel) ÷ Population = Per Capita Consumption

period includes the recent recession. While the disposable income variable should capture some of the changes in economic climate, it is likely that there are many unobserved factors affecting consumer gasoline purchases in this time period, such as changes in unemployment, interest rates, and other macroeconomic variables. Figure 3 displays the monthly trend in gas prices for the time period 2000-2010. It is apparent that gas prices in the years 2007-2010 are significantly more volatile than in the prior period. Due to increased worldwide demand, among other factors, the prices in the 2007-2010 period are considerably higher as well. These issues could affect the comparison of elasticity measures.

3.3 National Level Results

Ordinary Least Squares is employed to estimate the model described in the prior section. The regressions are performed with Newey-West standard errors to control for autocorrelation and heteroskedasticity.[2] Table 3 displays the regression results for the years 2001-2006 and Table 4 displays the regression results for the years 2007-2010. The model has a satisfactory fit in both periods with R-squared values of 0.958 for the earlier and 0.749 for the later.[3] The early period price elasticity estimate is -0.037 and is significant. This fits within the range, albeit on the low end, estimated by Hughes et al. (2008). The income elasticity of gasoline demand estimate in the early period is 0.45, which is similar to results found in the literature. The monthly dummy variables provide comparison to December and are

[2] Newey-West standard errors utilizing a 12-month lag order.
[3] R-squared values not reported in Newey-West regression and are computed manually.

mostly significant, with the exception of June and October. These fixed effects accurately demonstrate the differing seasonal demand for gasoline (typically higher in the summer and lower in the winter). The semi-log and linear model results for 2001-2006 are presented in Tables 14 and 15 in the appendix. These functional forms produce point elasticity estimates of -0.037 and -0.038.

The results for the later period are not as convincing. The price elasticity of gasoline demand is -0.009 and is extremely insignificant. The income elasticity of gasoline demand is 0.66, which once again seems plausible, but due to the insignificance of other variables may not mean much. The monthly fixed effects are not as thoroughly significant in this time period either. Tables 16 and 17 in the appendix display the regression results for the semi-log and linear functional forms. The price elasticity estimates using these models are -0.023 and -.022 and are a little more precise, but not enough to warrant a significant result. This could be due to the recession influencing factors that are unobserved in these models or the increased volatility of prices during this period. Another issue is that because this data is monthly national there are only 48 observations, which could lead to a less precise measure. A more robust model must be introduced in order to estimate more meaningful results.

4. STATE LEVEL ANALYSIS

4.1 Empirical Model

A weakness with examining this problem at the national level is that there may be considerable state-by-state variations that affect the price elasticity of gasoline demand. A more accurate measure may be estimated if these variations are taken into account. Figure 4 displays average monthly state per capita gasoline consumption against the average retail price for the years 2000-2010. There is considerable state-by-state variation in consumption levels ranging from 25.0 to 57.1 gallons per month with a standard deviation of 5.45 gallons per month. There is also notable price variation between states ranging from $2.08 to $2.67 with a standard deviation of $0.11. The trend line displays a clear negative correlation between retail price and gas consumption. Taking these state level variations in consumption and price into consideration may allow for more accurate results. To account for state level differences the following model is estimated:

$$lnC_{sit} = \beta_0 + \beta_1 \, lnP_{sit} + \beta_2 \, lnY_{sit} + \beta_3 \, U_{st} + \beta_4 V_{st} + \varepsilon_i + \phi_s + e_{sit}$$

where C_{sit} is per capita gasoline consumption reported by state *s* in month *i* and year *t*. Once again the per capita measure is used in order to control for population change. P_{sit} is the real retail price of regular gasoline in state *s* for month *i* and year *t*. Y_{sit} is the measure of real per capita personal income in state s for month *i* and year *t*. U_{st} is the percent of a state's population that lives in an urban area in year *t*. This variable is included to account for the greater access to alternative forms of transportation available in urban areas. Figure 5 displays the relationship between average monthly state per capita gasoline consumption and percent of state population living in urban areas for the years 2000-2010. There is a clear negative correlation between these two variables. This may help explain why the price elasticity estimates for gasoline demand obtained by Levin et al. (2012), who restricted their analysis to metropolitan areas, are so much larger than the rest found in the literature. There is also the potential of consumers purchasing gasoline outside of metro areas in which they may live or work to take advantage of the lower prices typically found outside city centers.

V_{st} is state per capita motor vehicle registrations in year t. This variable is highly important in explaining gasoline consumption and omission of this variable may lead to biased results (Espey, 1998). ε_i represents monthly fixed effects, ϕ_s are state fixed effects, and e_{sit} is a mean zero error term. The gasoline price and disposable income measures have been adjusted to 2010 dollars. Once again the double-log functional form is the primary model estimated and results from other functional forms will be displayed in the appendix.

4.2 State Level Data

This model uses state level monthly data reported by various U.S. government agencies from the period 2000-2010. Gasoline consumption is obtained from the Federal Highway Administration's annually published Highway Statistics Series. The measure is monthly thousand gallons of gasoline sold reported by wholesale distributors in each state for taxation reports. Using yearly state population data obtained from the Bureau of Economic Analysis, this is transformed into a per capita measure. The retail price of regular gasoline is obtained from the U.S. Energy Information Administration state price reports. However, this data is the price of gasoline excluding taxes. In order to attain the retail price consumers pay at the pump the state and federal tax rates from each year had to be added to this price. This tax data is also from the Federal Highway Administration's Highway Statistics Series. The personal income variable is from the Bureau of Economic Analysis Regional Economic Accounts. This data is reported quarterly at the state level, however it is used as monthly data in my analysis. January, February and March personal income values are defined as the value for quarter 1, April, May and June personal income values are defined as the value for quarter 2 and so forth. Gas price and personal income are converted to 2010 dollars using the GDP implicit price deflator from the Bureau of Economic Analysis. Percent of state residents living in an urban area is from U.S. Census data. Because this data only exists for the years 2000 and 2010, the values for the years in-between are interpolated as scaled averages of the 2000 and 2010 data. While this forces the assumption that changes to urban population occur at a uniform rate, there does not appear to be a better alternative for constructing this data and the main purpose of this variable is to capture across state variation as opposed to within state variation over time. State motor vehicle registrations data is also from the Federal Highway Administration's Highway Statistics Series. This data is private and commercial automobiles registered per capita, excluding commercial trucks and buses.

Because of data limitations, Washington D.C. is not included in the analysis. Furthermore, more people commute to work in Washington D.C. than actually live there. Crossing borders for gas prices would likely be a common occurrence so this data could be inaccurate in the first place and not be beneficial to this analysis. Summary statistics for the data in each time period are located in Table 5 and Table

6. Correlation coefficients for the data in the two time periods are located in Table 7 and Table 8. Table 9 lists the state names corresponding to the state fixed effects.

4.3 State Level Results

This model is estimated using Ordinary Least Squares and the dependent variable is per capita gasoline consumption. The standard errors are cluster-robust to control for heteroskedasticity and correlation across states.[4] Similar to Li et al. (2012), state population is used to weight the observations, and the coefficients on independent variables are therefore interpreted as population-weighted effects on gasoline consumption. Table 7 displays the regression results for the years 2001-2006. The model provides strong fit with an R-squared value of 0.809. The short-run price elasticity of gasoline demand is estimated to be -0.034, which is on the lower end, but within the range estimated by Hughes et al. (2008). The income elasticity variable is slightly low compared to results found in the literature at 0.169 and is not significant at the 10% level. The urban population percentage variable is significant and in the expected direction. A one percent increase in a state's urban population will result in -0.75 percent drop in gasoline consumption on average. Vehicles per capita is neither significant nor in the expected direction. However, the coefficient is negligibly small. A potential reason for the non-significance of vehicles per capita is questionable data from the Highway Statistics Series. Some states seem to have kept better record of this figure than others, as there are sometimes improbable jumps in per capita motor vehicle registrations between years in certain

[4] Clustered by state.

states. The monthly fixed effects are typically significant with the correct sign, displaying increased summer demand. The state fixed effects are compared to Alabama and vary in degrees of significance. The reason the urban population percentage, vehicles per capita, and state fixed effect variables are not highly significant across the board is because of the correlation that exists between these two explanatory variables and the state fixed effects. When urban percentage and vehicles per capita are excluded from the regression, the state fixed effects are almost all highly significant. However, if these variables are dropped from the regression the fraction of their explanatory power that is not captured by the state fixed effects will fall into the error term, which is not desirable. It is completely reasonable to assume that urban population percentage and vehicles per capita are explanatory factors of gasoline consumption and therefore remain in the model, as well as the state fixed effects which will pick up any other state factors not considered. Furthermore, this study is focused on estimating an accurate measure of the short-run price elasticity of gasoline demand, and dropping urban percentage and vehicles per capita does not change the price coefficient by a significant margin. The semi-log and linear model results for 2001-2006 are presented in Tables 18 and 19 in the appendix. The price elasticity of gasoline demand estimates in these models are slightly more elastic at -0.042 and -0.047 respectively.

Table 8 displays the regression results for the 2007-2010 period. This model also has a satisfactory R-squared value of 0.827. The price elasticity of gasoline demand is found to be -0.058 and is significant. This elasticity estimate is larger in magnitude than the estimate from the previous period and the two elasticity estimates differ at the 10% level using a Student's t-test.[5] The income elasticity is 0.503, which is nearly equal to results found in the literature. The fact that the income elasticity estimate is much larger in this period than in the 2001-2006 period may reflect the impact of the economic recession. Perhaps during the recession purchasing gasoline represents an increased proportion of consumers' budget shares, causing them to be more sensitive to price increases. Also, higher unemployment may result in fewer people making non-discretionary trips to the workplace. The percent urban variable exhibits a higher degree of significance, and once again the coefficient on vehicles per capita is negligibly different from zero. The monthly and state effects follow the same trends as the period from 2001-2006. The results from the semi-log and linear functional forms are presented in Tables 20 and 21 in the appendix. Once again, these models generate slightly more elastic results of -0.077 and -0.072 respectively.

The models using state level data seem to provide more accurate and reasonable estimates than those using national level data. The elasticity in the 2007-2010 period does in fact appear to have risen in magnitude compared to the period of 2001-2006. This could be due to a number of factors. Gas prices are higher in general compared to the previous period so perhaps people are more likely to cut back their gasoline consumption when prices increase even more due to increased total spending. Furthermore, due to the recession people have lower incomes so

[5] Under the assumption that samples from each period are independent.

they may react strongly to increases in gasoline prices. In the recent years there has been a national push to lower gasoline consumption in general due to environmental factors as well.

5. PRICE ELASTICITY REGIONAL COMPARISONS

5.1 Empirical Model

There are reasons to believe that consumers react differently to an increase in gas price in different regions of the country. In the previous section it was clear that different states consume dissimilar amounts of gasoline per capita. However, this fact alone does not describe if there are regional differences in reactions to gasoline price changes. In order to test the possibility of regional variability in the short-run price elasticity of gasoline demand, I estimate two models. The first is as follows:

$$lnC_{sit} = \beta_0 + \beta_1 \, lnP_{sit} + \beta_2 \, lnY_{sit} + \beta_3 \, U_{st} + \beta_4 \, V_{st} + \varepsilon_i + \phi_s + e_{sit}$$

This model is identical to the model estimated in section 4, however it will be regressed separately for each of the four different regions of the United States: the South, Midwest, Northeast, and West.[6] These regional comparison regressions will only be performed for the 2007-2010 period due to that data generating more stable results in the previous section. Also, each regional regression will include only the state fixed effects corresponding to the states in the given region.

[6] Regional divisions used by the United States Census Bureau, except Maryland and Delaware are included in the Northeast instead of South.

This proposed model of examining regional differences in the short-run price elasticity of gasoline demand should generate unbiased estimates for each region. However, another model is implemented that benefits from using the entire data sample for the 2007-2010 period. The model is as follows:

$$lnC_{sit} = \beta_0 + \beta_1 \, lnP_{sit} + \beta_2 \, lnY_{sit} + \beta_3 U_{st} + \beta_4 V_{st} + \beta_5 NE + \beta_6 MW + \beta_7 WEST + \beta_8 P_{sit} * NE + \beta_9 P_{sit} * MW + \beta_{10} P_{sit} * WEST + \varepsilon_i + e_{sit}$$

The gas consumption, gas price, personal income, urban percentage, and vehicles per capita variables are identical to the model in section 4. However, this model includes dummy variables for each region of the United States (*NE, MW,* and *WEST*). The South is the excluded regional variable against which the regional dummies will be compared. The regional dummy variables also interact with the gasoline price variable. These interaction terms will estimate regional variability in consumption response to gasoline price changes not captured in the other explanatory variables. ε_i represents monthly fixed effects; state fixed effects are excluded from this model in favor of the regional dummy variables. The data for both models is the same as the data implemented in the state level model.

5.2 Regional Comparison Results

These two models are estimated for only the 2007-2010 period and the dependent variable is per capita gasoline consumption. The models are estimated using Ordinary Least Squares and the standard errors are cluster-robust to control for heteroskedasticity and correlation across states in each region. Observations are weighted by the state or regional population. The separate regression tables for each region are found in Tables 9-12. The short-run price elasticity of gasoline demand is estimated to be -0.059 for the South, -0.055 for the Midwest, -0.065 for the Northeast, and -0.043 for the West. All price elasticity estimates are significant. These results do not indicate that there is extensive variation in the price elasticity of gasoline demand in different regions of the United States. However, the null hypothesis that price elasticity estimates are the same between regions can be rejected when comparing the Northeast to the West.[7] The income elasticity is estimated to be 0.33 for the South, 0.48 for the Midwest, 0.54 for the Northeast, and 0.55 for the West. These income elasticity estimates display a higher degree of variation than the price elasticity estimates. The monthly fixed effects display the expected trend of increased summer demand in all regions.

The regression results for the alternate region-price interaction model are found in Table 13. The exclusion of state fixed effects produces slightly more elastic results in general for the short-run price elasticity of gasoline demand. This is expected because elasticity estimates will vary according to the type of data used and specification of the model (Espey 1998). The price elasticity of gasoline demand is estimated to be -0.068 for the South, -0.064 for the Midwest, -0.071 for the Northeast, and -0.066 for the West. However, the price-region interaction coefficients are all insignificant so there is no real evidence of differing regional price elasticities in this model. There is a significant difference in gasoline

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[7] Student t-test at the 10% level.

consumption for each region, with all other regions consuming at least 12% less gasoline on average than the South.

There is not extraordinarily strong evidence of regional variation in the short-run price elasticity of gasoline demand for the years 2007-2010. However, the results from the separate regional regression model demonstrate regional variations that border on significance. An area for further research would be to reexamine this problem giving more attention to differences in urban and rural price elasticities as opposed to just regional characteristics.

6. OTHER ISSUES

Accurately estimating the short-run price elasticity of gasoline demand is a formidable task. An ideal model must allow for considerable complexities in order to produce an accurate estimate. The preceding sections have demonstrated that the short-run price elasticity of gasoline demand is a measure that changes over time and to a lesser extent between regions. The elasticity of gasoline demand is of particular importance when making decisions regarding appropriate gas taxes. Suitable gasoline taxation policies must be of the correct magnitude and flexible with respect to time and unique conditions in order to achieve optimal results.

Li, et al. (2012) examine the oftentimes-used assumption in policy analysis that consumers react to a gasoline tax similarly to gasoline price changes. “Our understanding of the optimal gasoline tax and the efficacy of existing taxes is largely based on empirical analysis of consumer responses to gasoline price changes” (Li, et al. 2012). They believe there are two reasons that consumers may respond differently to a gas tax than to a change in gas prices. The first is legislation and proposals to change gas taxes are subject to media and public debate, which may raise consumer awareness. Secondly, the durable nature of automobiles suggests that changes in gasoline prices are dependent upon consumer anticipations of future fuel costs. Because taxes are viewed as permanent, a response to an increased gas tax could arise in substitution to cars with better fuel economy. Their findings reveal that consumers change their consumption habits more dramatically with respect to a gasoline tax increase than to an equivalent change in the tax-exclusive gasoline price.

These findings have broad implications. For one, this suggests that gasoline taxes would be more effective than previously thought to combat air pollution and foreign energy dependence. Also, these results affect the literature on the optimal gasoline tax. Most studies estimate the optimal tax level using the short-run price elasticity of gasoline demand assuming that the gasoline tax elasticity and tax-exclusive price elasticity of gasoline demand are the same. The results in my paper are derived from using tax-inclusive gasoline prices to estimate the effect of price change on consumption habits. In order to make the most effective policy recommendations, one would need to consider the tax elasticity and tax-exclusive price elasticity of gasoline demand as separate entities in the analysis. Policy makers should also explore other avenues of taxation, such as taxing vehicle miles travelled as opposed to motor fuel.

Another issue that could affect the results in this paper is simultaneity bias. This is a common issue when estimating demand equations with price and quantity both being determined through shifts in supply and demand (Hughes, et al. 2008). The problem can be even more drastic when comparing elasticity estimates between two time periods. High gasoline price in the years 2001-2006 are mostly a product of increased demand so I would expect the estimates from this period to be less elastic than their true value. However, the high gas prices in 2007-2010 are more difficult to quantify as simply just demand or supply driven. The recession reduced demand for gasoline in affected countries, but developing countries were still demanding more gasoline than ever. Also, the world faces deteriorating oil reserves to meet the challenges of increased demand from developing nations so supply factors are becoming more prevalent in influencing the price of gasoline. Therefore, the direction of the bias in 2007-2010 is difficult to estimate.

An appropriate instrument is one that is correlated with gasoline price, but uncorrelated with quantity demanded. However, such an instrument is difficult to identify. Hughes, et al. (2008) experiment with two types of instrumental variables: crude oil quality and crude oil production disruptions. Crude oil quality relates to its specific gravity and sulfur content. Heavy high sulfur content crude oil will have increased manufacturing costs compared to light sweet crude oil. However, they find this instrument to not produce a significant result. For the second instrument they use crude oil production disruptions for three countries, Hurricane Katrina in the United States (2005), the second Gulf War in Iraq (2003), and a strike by oil workers in Venezuela (2002). Crude oil production disruptions are quantified as the difference between the production forecast and actual production. This set of instrumental variables leads to significant results and generates a short-run price elasticity of gasoline demand estimate of -0.077 for the United States in the time period of 2001-2006. This estimate is more elastic than my state level estimate of -0.034 for this time period and could reveal potential endogeneity bias. A problem with using a similar instrument in my model is that I would need to find U.S. supply shocks for the entire period of 2001-2010 in my analysis. Also, because my data is state level, I would need an instrument that would be correlated with all the state prices over this time, otherwise I would lose the state-by-state variations.

7. Conclusion

This paper attempts to estimate an accurate and recent approximation of the short-run price elasticity of gasoline demand. I investigate whether this elasticity has changed from the period 2001-2006 to 2007-2010 as well as whether different geographical regions of the United States have different elasticities. I find evidence that the short-run price elasticity of gasoline demand is more elastic today than during the years 2001-2006. This observed difference indicates that there have been changes in the market for gasoline in the United States. The recent recession is likely responsible for a wide variety of changes in this market. Also, the public is more conscious about reducing gasoline consumption and automobiles are being built with improved fuel economy. There is marginal evidence that different geographical regions of the United States have different short-run price elasticities of gasoline demand. It appears that the urban population percentage could be a significant attribute with regards to consumer response to an increase in gasoline price. This is likely due to urban consumers having access to alternative forms of transportation as well as more trips being discretionary. Future research may want to focus on properly quantifying these effects. Also, obtaining more accurate state level data for vehicle ownership could enhance future models. Another potential avenue of research is identifying the most appropriate functional form for models attempting to estimate the price elasticity of inelastic goods such as gasoline.

FIGURES

Figure 1

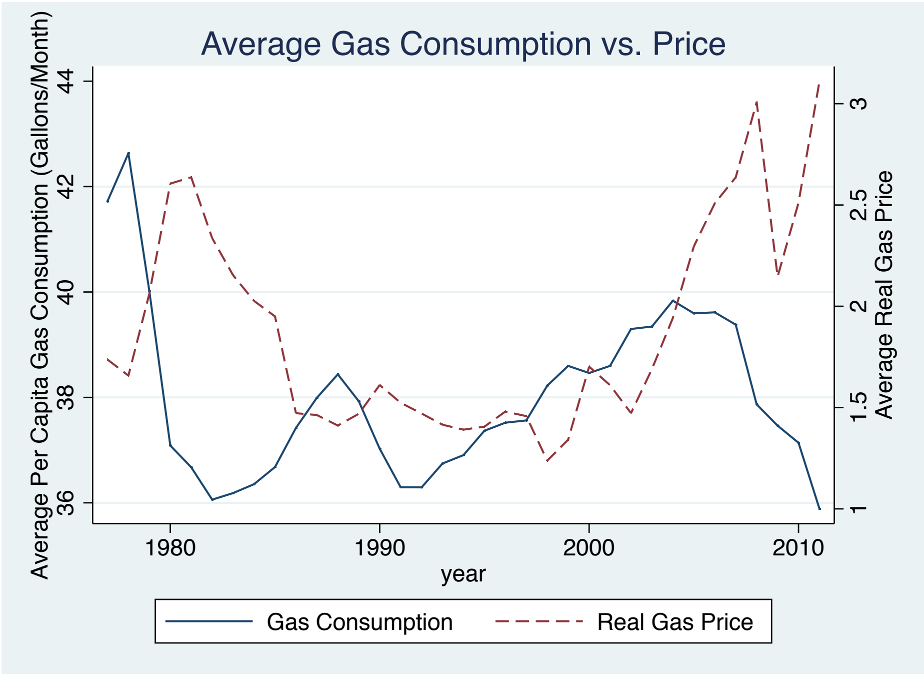


Figure 2

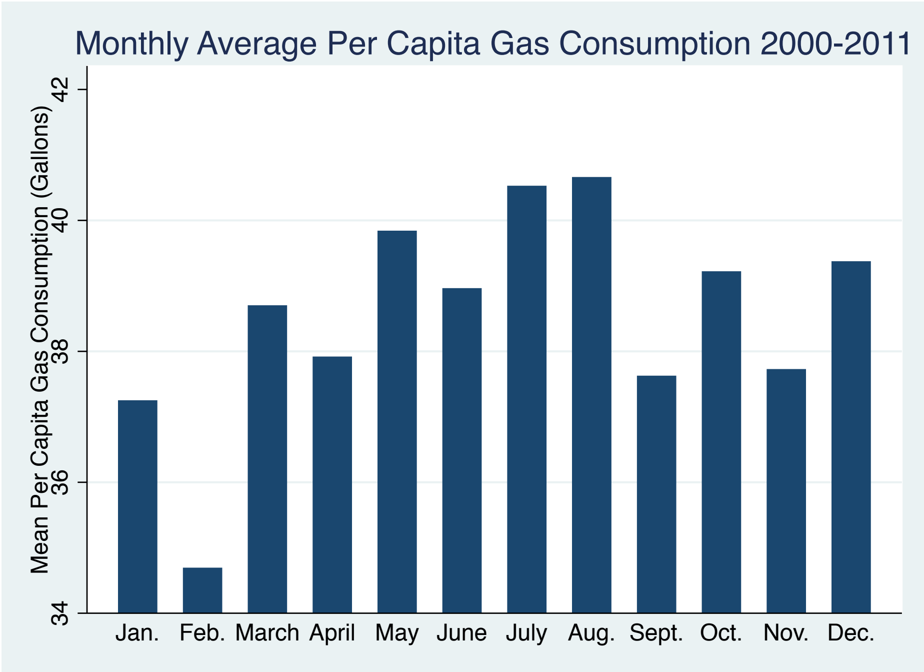


Figure 3

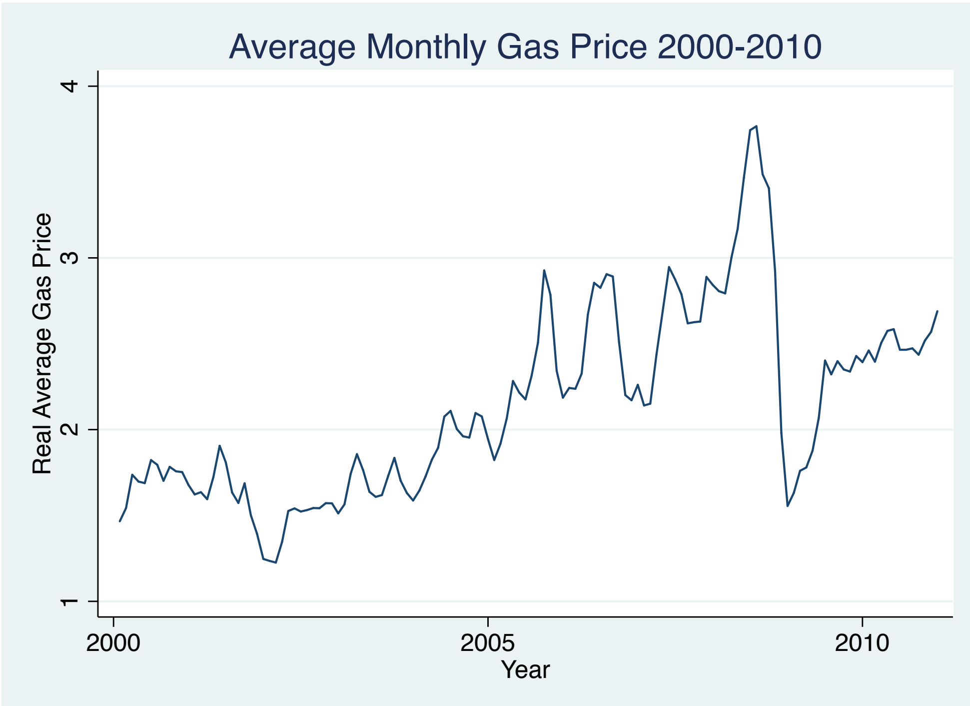


Figure 4

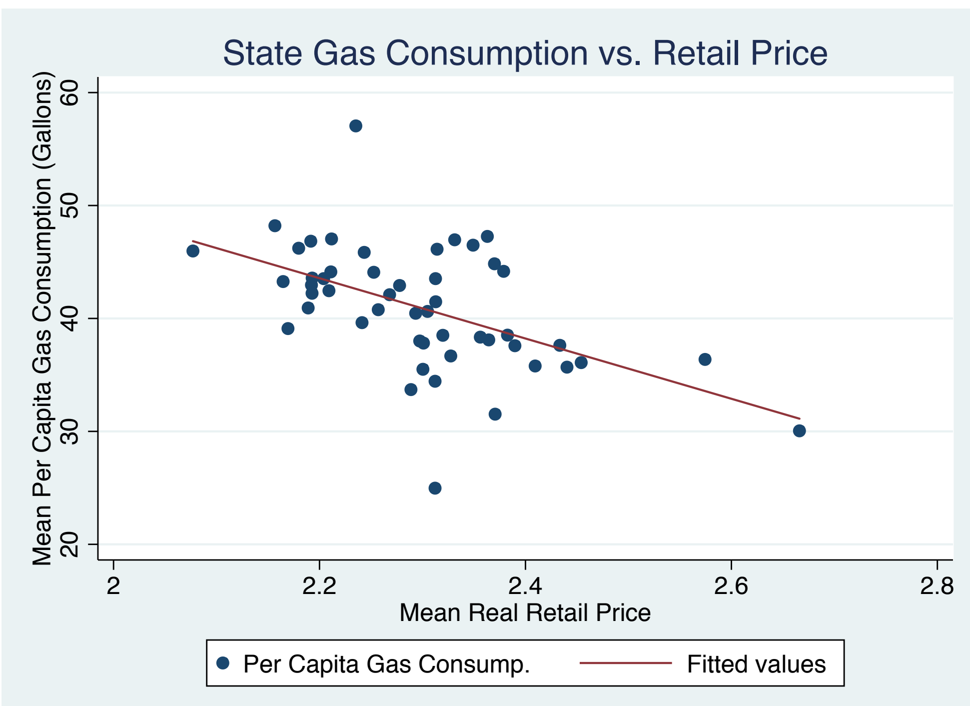
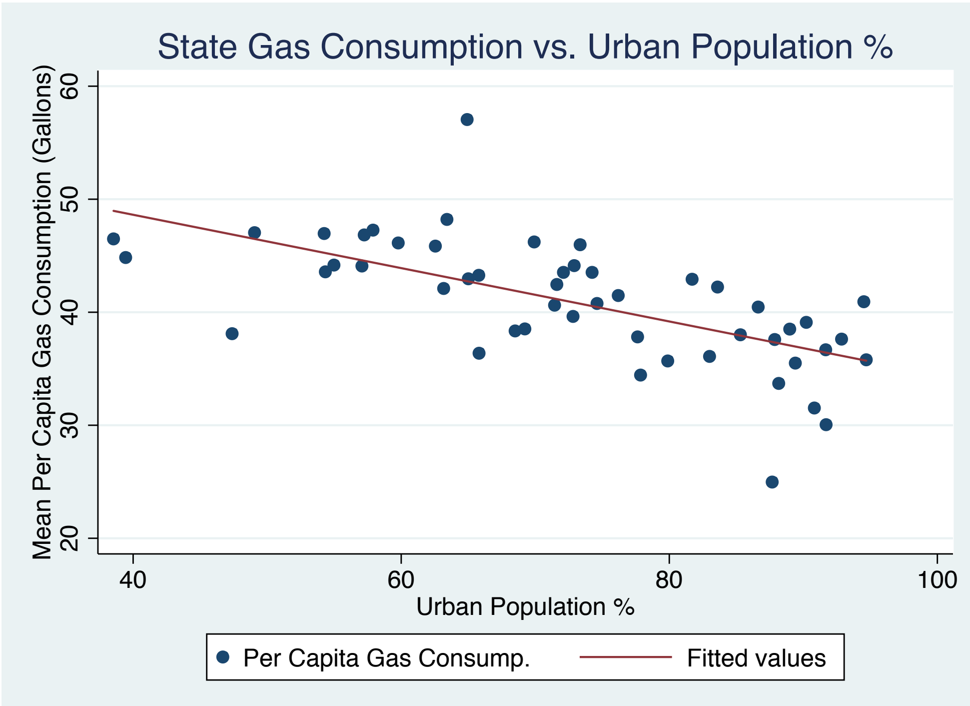


Figure 5


State Gas Consumption vs. Urban Population %
Mean Per Capita Gas Consumption (Gallons)
20
30
40
50
60
40
60
80
100
Urban Population %
Per Capita Gas Consump.
Fitted values

TABLES

Table 1: Summary Statistics for National Level Data 2001-2006

Variable	Obs	Mean	Std. Dev.	Min	Max
year	72	2003.5	1.71981	2001	2006
C	72	39.38102	1.81113	33.97772	42.23845
P	72	1.919736	.4284356	1.22565	2.927
Y	72	30808.41	1046.855	28992.98	32925.81

Table 2: Summary Statistics for National Level Data 2007-2010

Variable	Obs	Mean	Std. Dev.	Min	Max
year	48	2008.5	1.129865	2007	2010
C	48	37.96258	1.777904	32.61668	41.66479
P	48	2.575408	.4933223	1.555506	3.766739
Y	48	32631.49	564.6702	31644.4	34648.17

Table 3: National Level Analysis Results 2001-2006

Regression with Newey-West standard errors — Number of obs = 72
maximum lag: 12 — F(13, 58) = 255.52
Prob > F = 0.0000

ln_C	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_P	-.0366452	.0097632	-3.75	0.000	-.0561884	-.017102
ln_Y	.4527825	.0775864	5.84	0.000	.2974763	.6080886
January	-.0500979	.0057057	-8.78	0.000	-.0615192	-.0386766
February	-.1281631	.0105924	-12.10	0.000	-.149366	-.1069601
March	-.0143843	.00746	-1.93	0.059	-.0293172	.0005485
April	-.032089	.0063353	-5.07	0.000	-.0447705	-.0194075
May	.0189604	.0062052	3.06	0.003	.0065394	.0313815
June	-.0050445	.0048431	-1.04	0.302	-.014739	.00465
July	.0380424	.0050811	7.49	0.000	.0278714	.0482133
August	.0408885	.0049316	8.29	0.000	.0310168	.0507601
September	-.0403423	.0049803	-8.10	0.000	-.0503115	-.0303732
October	.0025493	.0063119	0.40	0.688	-.0100854	.015184
November	-.0355403	.0049435	-7.19	0.000	-.0454358	-.0256448
_cons	-.9671385	.7992742	-1.21	0.231	-2.56706	.6327827

Table 4: National Level Analysis Results 2007-2010

Regression with Newey-West standard errors — maximum lag: **12**

Number of obs = **48**
F(13, 34) = **55.72**
Prob > F = **0.0000**

ln_C	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_P	-.009405	.0228096	-0.41	0.683	-.0557598	.0369498
ln_Y	.6629692	.3576244	1.85	0.072	-.0638111	1.38975
January	-.0311389	.0147877	-2.11	0.043	-.0611911	-.0010866
February	-.1101842	.0140841	-7.82	0.000	-.1388066	-.0815618
March	.0010476	.0139911	0.07	0.941	-.0273857	.0294808
April	-.0174834	.0124393	-1.41	0.169	-.0427632	.0077964
May	.0177454	.0159636	1.11	0.274	-.0146965	.0501872
June	-.003062	.0159595	-0.19	0.849	-.0354955	.0293715
July	.0396274	.0144874	2.74	0.010	.0101855	.0690692
August	.0384272	.012341	3.11	0.004	.0133472	.0635071
September	-.035635	.0201401	-1.77	0.086	-.0765645	.0052945
October	.0109435	.00753	1.45	0.155	-.0043594	.0262464
November	-.0353027	.0059712	-5.91	0.000	-.0474377	-.0231676
_cons	-3.235518	3.705376	-0.87	0.389	-10.76575	4.294712

Table 5: Summary Statistics for State Level Data 2001-2006

Variable	Obs	Mean	Std. Dev.	Min	Max
year	3595	2003.502	1.708333	2001	2006
population	3595	5825753	6387825	494657	3.60e+07
C	3595	41.7235	7.466942	12.23383	96.28608
P	3595	2.052257	.4708182	1.064335	3.49867
Y	3595	37416.43	5339.932	27515.05	57627.2
Urban_Perc	3595	72.3788	14.62148	38.25168	94.74751
VPC	3595	45.26184	7.613254	17.8512	64

Table 6: Summary Statistics for State Level Data 2007-2010

Variable	Obs	Mean	Std. Dev.	Min	Max
year	2391	2008.497	1.118826	2007	2010
population	2391	6108210	6702711	534876	3.73e+07
C	2391	39.62799	6.971056	14.4144	82.97983
P	2391	2.785451	.5515904	1.434927	4.549831
Y	2391	39416.79	5757.15	29973.87	59151.73
Urban_Perc	2391	73.34322	14.44508	38.66	94.95
VPC	2391	42.68747	7.521339	12.54192	59.46759

Table 7: Correlation Coefficients for State Level Data 2001-2006

	C	P	Y	Urban_~c	VPC
C	1.0000				
P	-0.0535	1.0000			
Y	-0.2172	0.2066	1.0000		
Urban_Perc	-0.4594	0.0643	0.5631	1.0000	
VPC	0.0677	-0.1430	0.2498	-0.0185	1.0000

Table 8: Correlation Coefficients for State Level Data 2007-2010

	C	P	Y	Urban_~c	VPC
C	1.0000				
P	-0.0119	1.0000			
Y	-0.1607	0.1540	1.0000		
Urban_Perc	-0.4973	0.0063	0.4707	1.0000	
VPC	0.1359	0.0179	0.2747	-0.0438	1.0000

Table 9: State Names

State	Number	State	Number
Alabama	1	Montana	27
Alaska	2	Nebraska	28
Arizona	3	Nevada	29
Arkansas	4	New Hampshire	30
California	5	New Jersey	31
Colorado	6	New Mexico	32
Connecticut	7	New York	33
Delaware	8	North Carolina	34
Florida	10	North Dakota	35
Georgia	11	Ohio	36
Hawaii	12	Oklahoma	37
Idaho	13	Oregon	38
Illinois	14	Pennsylvania	39
Indiana	15	Rhode Island	40
Iowa	16	South Carolina	41
Kansas	17	South Dakota	42
Kentucky	18	Tennessee	43
Louisiana	19	Texas	44
Maine	20	Utah	45
Maryland	21	Vermont	46
Massachusetts	22	Virginia	47
Michigan	23	Washington	48
Minnesota	24	West Virginia	49
Mississippi	25	Wisconsin	50
Missouri	26	Wyoming	51

Table 10: State Level Analysis Results 2001-2006

```
Linear regression                               Number of obs =      3595
                                                F( 14,     49) =         .
                                                Prob > F      =         .
                                                R-squared     =    0.8087
                                                Root MSE      =    .07706

                           (Std. Err. adjusted for 50 clusters in statenum)
```

ln_C	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_P	-.0336972	.012572	-2.68	0.010	-.0589617	-.0084327
ln_Y	.1690203	.1153901	1.46	0.149	-.0628647	.4009053
Urban_Perc	-.0074777	.0041457	-1.80	0.077	-.0158088	.0008534
VPC	-.0007242	.0004708	-1.54	0.130	-.0016703	.0002218
January	-.074202	.009591	-7.74	0.000	-.0934757	-.0549282
February	-.1094937	.011682	-9.37	0.000	-.1329696	-.0860179
March	-.0226037	.0089053	-2.54	0.014	-.0404996	-.0047078
April	-.0171064	.0100509	-1.70	0.095	-.0373044	.0030916
May	.0282003	.0071636	3.94	0.000	.0138044	.0425961
June	.0123186	.0080954	1.52	0.135	-.0039498	.028587
July	.0338824	.007778	4.36	0.000	.018252	.0495128
August	.0428719	.0085273	5.03	0.000	.0257357	.0600082
September	-.0173921	.0080329	-2.17	0.035	-.0335347	-.0012495
October	-.0052095	.0072068	-0.72	0.473	-.0196921	.0092731
November	-.0352677	.0090955	-3.88	0.000	-.0535458	-.0169896
state_2	-.2298416	.0402628	-5.71	0.000	-.3107527	-.1489305
state_3	.0609515	.1309908	0.47	0.644	-.2022844	.3241874
state_4	-.0625089	.013462	-4.64	0.000	-.0895618	-.035456
state_5	-.0028883	.1561571	-0.02	0.985	-.3166977	.3109211
state_6	-.0443488	.1136479	-0.39	0.698	-.2727328	.1840351
state_7	-.0314832	.1341594	-0.23	0.815	-.3010867	.2381203
state_8	.0542922	.1019017	0.53	0.597	-.1504869	.2590713
state_10	.0590676	.1370532	0.43	0.668	-.2163512	.3344864
state_11	.1140581	.0675603	1.69	0.098	-.0217094	.2498256
state_12	-.1831142	.1418731	-1.29	0.203	-.4682188	.1019905
state_13	-.1173248	.0462547	-2.54	0.014	-.210277	-.0243725
state_14	-.1191679	.1288016	-0.93	0.359	-.3780045	.1396686
state_15	.0172372	.0612771	0.28	0.780	-.1059037	.1403781
state_16	.0128481	.028798	0.45	0.657	-.0450236	.0707199
state_17	-.0865273	.0627811	-1.38	0.174	-.2126907	.039636

state_18	-.0405617	.0043308	-9.37	0.000	-.0492649	-.0318586
state_19	.0684278	.0673191	1.02	0.314	-.0668551	.2037106
state_20	-.2034477	.0729363	-2.79	0.008	-.3500186	-.0568767
state_21	.0012946	.1235781	0.01	0.992	-.247045	.2496342
state_22	-.0450771	.1458857	-0.31	0.759	-.3382455	.2480913
state_23	-.0059935	.0741724	-0.08	0.936	-.1550485	.1430615
state_24	.0194271	.0656896	0.30	0.769	-.112581	.1514352
state_25	-.038811	.0322762	-1.20	0.235	-.1036725	.0260504
state_26	.0693465	.0543172	1.28	0.208	-.039808	.1785009
state_27	-.0614347	.0087164	-7.05	0.000	-.0789509	-.0439185
state_28	-.0473917	.0595728	-0.80	0.430	-.1671077	.0723243
state_29	.0314347	.1435497	0.22	0.828	-.2570392	.3199086
state_30	-.0390923	.0349132	-1.12	0.268	-.1092531	.0310685
state_31	.0758675	.1566043	0.48	0.630	-.2388407	.3905757
state_32	.0029953	.0794986	0.04	0.970	-.1567632	.1627538
state_33	-.4517137	.1270451	-3.56	0.001	-.7070204	-.196407
state_34	-.0688757	.0240246	-2.87	0.006	-.1171549	-.0205965
state_35	.0056198	.0107839	0.52	0.605	-.0160514	.0272909
state_36	-.0602191	.0876645	-0.69	0.495	-.2363874	.1159492
state_37	-.0214617	.0382328	-0.56	0.577	-.0982933	.0553699
state_38	-.1072652	.0928932	-1.15	0.254	-.2939411	.0794106
state_39	-.1695478	.086633	-1.96	0.056	-.3436432	.0045477
state_40	-.1814863	.1402511	-1.29	0.202	-.4633315	.100359
state_41	.0564273	.0255561	2.21	0.032	.0050704	.1077841
state_42	-.0319118	.0197905	-1.61	0.113	-.0716823	.0078587
state_43	-.0322405	.0340551	-0.95	0.348	-.1006768	.0361958
state_44	.0811793	.1081802	0.75	0.457	-.1362169	.2985755
state_45	-.0152765	.1346312	-0.11	0.910	-.2858281	.2552751
state_46	-.1594151	.0798334	-2.00	0.051	-.3198465	.0010162
state_47	.0255212	.0751296	0.34	0.736	-.1254574	.1764999
state_48	-.0833151	.1071174	-0.78	0.440	-.2985755	.1319453
state_49	-.2990408	.0398159	-7.51	0.000	-.3790537	-.2190278
state_50	-.1209062	.0513698	-2.35	0.023	-.2241376	-.0176748
state_51	.2083152	.04121	5.05	0.000	.1255007	.2911297
_cons	2.591672	1.17601	2.20	0.032	.2283907	4.954954

Table 11: State Level Analysis Results 2007-2010

Linear regression

Number of obs =	2391
F(14, 49) =	.
Prob > F =	.
R-squared =	0.8275
Root MSE =	.07075

(Std. Err. adjusted for 50 clusters in statenum)

ln_C	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_P	-.0581127	.008014	-7.25	0.000	-.0742175	-.042008
ln_Y	.5033628	.0862772	5.83	0.000	.3299822	.6767433
Urban_Perc	-.0265914	.0092878	-2.86	0.006	-.0452559	-.0079268
VPC	.0000416	.0006082	0.07	0.946	-.0011806	.0012637
January	-.0395139	.0087551	-4.51	0.000	-.057108	-.0219198
February	-.0832601	.0120195	-6.93	0.000	-.1074142	-.059106
March	.0022723	.0092132	0.25	0.806	-.0162422	.0207868
April	-.0007242	.0115533	-0.06	0.950	-.0239415	.0224931
May	.0438874	.0059491	7.38	0.000	.0319322	.0558427
June	.0333666	.0088003	3.79	0.000	.0156817	.0510516
July	.0569784	.0066372	8.58	0.000	.0436405	.0703162
August	.048987	.0061099	8.02	0.000	.0367087	.0612653
September	-.0046429	.0063115	-0.74	0.465	-.0173264	.0080406
October	.0172173	.0059718	2.88	0.006	.0052164	.0292181
November	-.0202635	.0079657	-2.54	0.014	-.0362713	-.0042558
state_2	-.1938057	.0807509	-2.40	0.020	-.3560808	-.0315306
state_3	.5559433	.2874855	1.93	0.059	-.0217803	1.133667
state_4	-.1540567	.033068	-4.66	0.000	-.2205093	-.0876041
state_5	.5467379	.3526178	1.55	0.127	-.161874	1.25535
state_6	.3555744	.2605181	1.36	0.179	-.1679564	.8791052
state_7	.271002	.3046248	0.89	0.378	-.3411643	.8831684
state_8	.4746023	.2369139	2.00	0.051	-.001494	.9506986
state_10	.5752276	.3071201	1.87	0.067	-.0419533	1.192408
state_11	.3180236	.1507264	2.11	0.040	.0151277	.6209196
state_12	.29638	.3174448	0.93	0.355	-.3415492	.9343092
state_13	.0832498	.1017547	0.82	0.417	-.121234	.2877336
state_14	.3192051	.2897384	1.10	0.276	-.2630461	.9014562
state_15	.2194874	.1285563	1.71	0.094	-.0388562	.477831
state_16	.0666725	.0575699	1.16	0.252	-.0490186	.1823636
state_17	.1462474	.1460557	1.00	0.322	-.1472625	.4397573

state_18	-.0737376	.0074467	-9.90	0.000	-.0887024	-.0587729
state_19	.258338	.1400527	1.84	0.071	-.0231084	.5397845
state_20	-.6221043	.1795057	-3.47	0.001	-.9828346	-.261374
state_21	.4661872	.2848571	1.64	0.108	-.1062545	1.038629
state_22	.4317239	.3335881	1.29	0.202	-.2386464	1.102094
state_23	.2357278	.1513896	1.56	0.126	-.068501	.5399565
state_24	.1541512	.1475805	1.04	0.301	-.1424229	.4507253
state_25	-.2002282	.0925956	-2.16	0.035	-.386306	-.0141503
state_26	.2414835	.113832	2.12	0.039	.0127294	.4702375
state_27	-.1861273	.0279154	-6.67	0.000	-.2422254	-.1300292
state_28	.1214805	.139279	0.87	0.387	-.1584111	.4013722
state_29	.6075414	.3290413	1.85	0.071	-.0536919	1.268775
state_30	-.1008676	.0350757	-2.88	0.006	-.1713549	-.0303804
state_31	.6181439	.3574957	1.73	0.090	-.1002706	1.336558
state_32	.3294432	.1682936	1.96	0.056	-.0087556	.6676419
state_33	-.0359235	.2916573	-0.12	0.902	-.6220307	.5501837
state_34	.0218842	.0625626	0.35	0.728	-.1038401	.1476085
state_35	-.0565217	.0230501	-2.45	0.018	-.1028427	-.0102007
state_36	.2519448	.1853982	1.36	0.180	-.1206269	.6245165
state_37	.0655019	.0736527	0.89	0.378	-.0825086	.2135125
state_38	.2361628	.2080261	1.14	0.262	-.1818812	.6542068
state_39	.1223046	.1947737	0.63	0.533	-.2691078	.5137169
state_40	.3667245	.3107744	1.18	0.244	-.2578001	.9912492
state_41	.2259651	.0627089	3.60	0.001	.0999468	.3519833
state_42	-.215474	.0191736	-11.24	0.000	-.2540047	-.1769433
state_43	.0786624	.0715465	1.10	0.277	-.0651156	.2224405
state_44	.5010422	.2442282	2.05	0.046	.0102474	.9918371
state_45	.5174978	.2934307	1.76	0.084	-.0721732	1.107169
state_46	-.6330028	.1750072	-3.62	0.001	-.9846931	-.2813126
state_47	.2084936	.1698948	1.23	0.226	-.1329228	.5499101
state_48	.249453	.2473437	1.01	0.318	-.2476029	.7465088
state_49	-.4911096	.1009342	-4.87	0.000	-.6939444	-.2882748
state_50	.036577	.1119231	0.33	0.745	-.1883409	.2614949
state_51	.150526	.0764497	1.97	0.055	-.0031055	.3041574
_cons	.1882052	1.305006	0.14	0.886	-2.434302	2.810712

Table 12: Regional Comparison Analysis Results – South Region

```
Linear regression                               Number of obs =        666
                                                F( 12,     13) =          .
                                                Prob > F       =          .
                                                R-squared      =     0.3986
                                                Root MSE       =     .09073

                                  (Std. Err. adjusted for 14 clusters in statenum)
```

ln_C	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_P	-.0585531	.0174832	-3.35	0.005	-.0963233	-.0207829
ln_Y	.3308325	.1007739	3.28	0.006	.1131236	.5485413
Urban_Perc	-.0262596	.0147951	-1.77	0.099	-.0582224	.0057032
VPC	-.0007342	.0026323	-0.28	0.785	-.006421	.0049526
January	-.0277853	.0183823	-1.51	0.155	-.0674979	.0119273
February	-.0566139	.0227565	-2.49	0.027	-.1057762	-.0074515
March	.0207375	.0070384	2.95	0.011	.0055319	.0359431
April	.0201697	.0228972	0.88	0.394	-.0292967	.0696361
May	.050326	.0135226	3.72	0.003	.0211122	.0795398
June	.0563986	.019398	2.91	0.012	.0144917	.0983055
July	.0496437	.0132182	3.76	0.002	.0210875	.0781998
August	.0499946	.0082471	6.06	0.000	.0321778	.0678115
September	-.0087691	.0144721	-0.61	0.555	-.0400341	.0224959
October	.0098749	.0124049	0.80	0.440	-.0169242	.036674
November	-.0006204	.0165278	-0.04	0.971	-.0363264	.0350857
state_4	-.1697029	.0710506	-2.39	0.033	-.3231984	-.0162074
state_10	.5867877	.4748254	1.24	0.238	-.4390101	1.612586
state_11	.3185	.2322663	1.37	0.193	-.1832808	.8202808
state_18	-.0803688	.0109045	-7.37	0.000	-.1039265	-.0568111
state_19	.268748	.2140216	1.26	0.231	-.1936175	.7311134
state_25	-.2177467	.1525638	-1.43	0.177	-.5473407	.1118474
state_34	.0214548	.0872226	0.25	0.810	-.1669781	.2098877
state_37	.073155	.112271	0.65	0.526	-.1693917	.3157016
state_41	.2170642	.0990287	2.19	0.047	.0031256	.4310027
state_43	.0832336	.1118685	0.74	0.470	-.1584437	.3249109
state_44	.5072974	.3686321	1.38	0.192	-.2890839	1.303679
state_47	.2527026	.2594598	0.97	0.348	-.3078262	.8132314
state_49	-.5057995	.1680961	-3.01	0.010	-.8689492	-.1426499
_cons	1.994602	1.575903	1.27	0.228	-1.409928	5.399132

Table 13: Regional Comparison Analysis Results – Midwest Region

```
Linear regression                               Number of obs =        575
                                                F( 10,     11) =          .
                                                Prob > F      =          .
                                                R-squared     =     0.8422
                                                Root MSE      =     .05107

                          (Std. Err. adjusted for 12 clusters in statenum)
```

ln_C	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_P	-.05486	.0145269	-3.78	0.003	-.0868334	-.0228865
ln_Y	.484401	.0734863	6.59	0.000	.3226587	.6461433
Urban_Perc	-.0456463	.0155174	-2.94	0.013	-.0798	-.0114927
VPC	-.0006956	.0011683	-0.60	0.564	-.0032669	.0018757
January	-.072794	.0126634	-5.75	0.000	-.1006659	-.0449221
February	-.1040345	.0151532	-6.87	0.000	-.1373864	-.0706826
March	-.0325041	.0120755	-2.69	0.021	-.0590821	-.0059261
April	-.0072584	.0118268	-0.61	0.552	-.0332889	.0187722
May	.0362107	.0105596	3.43	0.006	.0129692	.0594522
June	.0374089	.0049527	7.55	0.000	.0265081	.0483096
July	.0643437	.0035937	17.90	0.000	.0564341	.0722533
August	.0522022	.0129617	4.03	0.002	.0236737	.0807306
September	-.0075157	.0156161	-0.48	0.640	-.0418865	.026855
October	.0191445	.0097927	1.95	0.076	-.0024092	.0406981
November	-.0339331	.0055199	-6.15	0.000	-.0460823	-.0217839
state_15	-.410967	.2536751	-1.62	0.134	-.9693022	.1473682
state_16	-.7179138	.3848839	-1.87	0.089	-1.565038	.1292099
state_17	-.4625929	.2297707	-2.01	0.069	-.9683147	.043129
state_23	-.3488008	.216434	-1.61	0.135	-.8251687	.1275671
state_24	-.4573513	.2396147	-1.91	0.083	-.9847396	.070037
state_26	-.4258183	.282762	-1.51	0.160	-1.048173	.1965368
state_28	-.5000736	.2454183	-2.04	0.066	-1.040236	.0400885
state_35	-.9249739	.450818	-2.05	0.065	-1.917218	.0672699
state_36	-.265227	.1649231	-1.61	0.136	-.6282204	.0977663
state_42	-1.152804	.5041525	-2.29	0.043	-2.262436	-.0431716
state_50	-.6370979	.2882967	-2.21	0.049	-1.271635	-.0025611
_cons	2.432065	1.667577	1.46	0.173	-1.238247	6.102376

Table 14: Regional Comparison Analysis Results – Northeast Region

Linear regression

Number of obs =	528
F(9, 10) =	.
Prob > F =	.
R-squared =	0.9596
Root MSE =	.04568

(Std. Err. adjusted for **11** clusters in statenum)

ln_C	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_P	-.0652992	.0150406	-4.34	0.001	-.0988117	-.0317867
ln_Y	.5413557	.0951956	5.69	0.000	.3292467	.7534646
Urban_Perc	-.0533442	.0212771	-2.51	0.031	-.1007526	-.0059358
VPC	-.0019624	.002031	-0.97	0.357	-.0064877	.0025629
January	-.0353156	.0114207	-3.09	0.011	-.0607624	-.0098687
February	-.1433414	.0112121	-12.78	0.000	-.1683235	-.1183593
March	-.0308031	.0137268	-2.24	0.049	-.0613884	-.0002179
April	-.0407723	.026051	-1.57	0.149	-.0988175	.017273
May	.0371526	.0122156	3.04	0.012	.0099345	.0643706
June	.0017801	.0114226	0.16	0.879	-.023671	.0272313
July	.0562763	.0098614	5.71	0.000	.0343037	.0782489
August	.0322513	.0123765	2.61	0.026	.0046748	.0598278
September	-.0121992	.0073927	-1.65	0.130	-.0286711	.0042727
October	.0149302	.0155113	0.96	0.358	-.0196311	.0494915
November	-.0233728	.0127128	-1.84	0.096	-.0516987	.0049532
state_8	.0686028	.119546	0.57	0.579	-.1977624	.334968
state_20	-2.219997	1.055971	-2.10	0.062	-4.572847	.1328534
state_21	.154867	.0379371	4.08	0.002	.0703378	.2393962
state_22	.2531942	.0810841	3.12	0.011	.0725275	.4338608
state_30	-1.123799	.5986759	-1.88	0.090	-2.457732	.2101338
state_31	.5028487	.1371441	3.67	0.004	.1972727	.8084247
state_33	-.3318238	.0335044	-9.90	0.000	-.4064762	-.2571713
state_39	-.4116126	.2142625	-1.92	0.084	-.8890193	.065794
state_40	.160198	.0654619	2.45	0.034	.0143399	.3060561
state_46	-2.224101	1.053776	-2.11	0.061	-4.572061	.1238594
_cons	2.533598	2.241637	1.13	0.285	-2.461082	7.528277

Table 15: Regional Comparison Analysis Results – West Region

```
Linear regression                               Number of obs =        622
                                                F( 11,     12) =          .
                                                Prob > F      =          .
                                                R-squared     =     0.5705
                                                Root MSE      =     .06559

                          (Std. Err. adjusted for 13 clusters in statenum)
```

ln_C	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_P	-.0429833	.0080033	-5.37	0.000	-.060421	-.0255456
ln_Y	.5460227	.0852523	6.40	0.000	.3602739	.7317715
Urban_Perc	-.0582172	.0234372	-2.48	0.029	-.1092826	-.0071519
VPC	.0007932	.0006326	1.25	0.234	-.0005852	.0021716
January	-.0327267	.0154062	-2.12	0.055	-.0662939	.0008405
February	-.0548585	.0129952	-4.22	0.001	-.0831725	-.0265444
March	.031636	.0090994	3.48	0.005	.0118102	.0514618
April	.0062509	.0082112	0.76	0.461	-.0116398	.0241415
May	.0439272	.0084471	5.20	0.000	.0255225	.0623318
June	.0188342	.0142499	1.32	0.211	-.0122138	.0498821
July	.0581245	.0218705	2.66	0.021	.0104728	.1057763
August	.0556955	.0181946	3.06	0.010	.0160528	.0953381
September	.0072503	.015268	0.47	0.643	-.0260159	.0405165
October	.0263968	.0136332	1.94	0.077	-.0033075	.0561011
November	-.0347864	.013449	-2.59	0.024	-.0640893	-.0054835
state_3	1.508117	.546833	2.76	0.017	.3166705	2.699564
state_5	1.643424	.6739092	2.44	0.031	.1751023	3.111746
state_6	1.193542	.469177	2.54	0.026	.1712928	2.21579
state_12	1.309928	.6048988	2.17	0.051	-.0080331	2.62789
state_13	.4177603	.0877248	4.76	0.000	.2266243	.6088962
state_27	-.3102095	.2506741	-1.24	0.240	-.8563814	.2359624
state_29	1.695048	.6499051	2.61	0.023	.279026	3.111069
state_32	.888308	.2526046	3.52	0.004	.3379299	1.438686
state_38	.9019522	.3394297	2.66	0.021	.1623984	1.641506
state_45	1.485738	.5590215	2.66	0.021	.2677346	2.703741
state_48	.9986062	.4139364	2.41	0.033	.0967163	1.900496
state_51	.3032787	.0281051	10.79	0.000	.242043	.3645143
_cons	1.575405	2.043162	0.77	0.456	-2.876263	6.027073

Table 16: Regional Price Interaction Model Results

Linear regression

Number of obs =	**2391**
F(21, 49) =	**50.21**
Prob > F =	**0.0000**
R-squared =	**0.4233**
Root MSE =	**.12821**

(Std. Err. adjusted for **50** clusters in statenum)

ln_C	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_P	**-.0682012**	**.0242467**	**-2.81**	**0.007**	**-.1169267**	**-.0194757**
ln_Y	**.1270999**	**.128912**	**0.99**	**0.329**	**-.1319585**	**.3861582**
Urban_Perc	**-.0055554**	**.0010822**	**-5.13**	**0.000**	**-.0077302**	**-.0033806**
VPC	**.0016585**	**.0016904**	**0.98**	**0.331**	**-.0017384**	**.0050554**
ne	**-.1764248**	**.0969559**	**-1.82**	**0.075**	**-.371265**	**.0184154**
mw	**-.1235271**	**.0397079**	**-3.11**	**0.003**	**-.203323**	**-.0437312**
west	**-.1217437**	**.0372228**	**-3.27**	**0.002**	**-.1965458**	**-.0469417**
p_ne	**-.0314259**	**.0426137**	**-0.74**	**0.464**	**-.1170614**	**.0542096**
p_mw	**.0401871**	**.0250823**	**1.60**	**0.116**	**-.0102178**	**.0905919**
p_w	**.0175043**	**.0276555**	**0.63**	**0.530**	**-.0380716**	**.0730802**
January	**-.0451819**	**.0090007**	**-5.02**	**0.000**	**-.0632695**	**-.0270942**
February	**-.0885688**	**.012721**	**-6.96**	**0.000**	**-.1141325**	**-.0630051**
March	**-.0032229**	**.0094958**	**-0.34**	**0.736**	**-.0223055**	**.0158596**
April	**-.0027418**	**.011944**	**-0.23**	**0.819**	**-.0267441**	**.0212604**
May	**.0420504**	**.007487**	**5.62**	**0.000**	**.0270047**	**.0570961**
June	**.0321314**	**.011086**	**2.90**	**0.006**	**.0098532**	**.0544097**
July	**.0558175**	**.0087307**	**6.39**	**0.000**	**.0382726**	**.0733625**
August	**.0480965**	**.0080231**	**5.99**	**0.000**	**.0319735**	**.0642195**
September	**-.0054268**	**.0075309**	**-0.72**	**0.475**	**-.0205607**	**.0097071**
October	**.0175325**	**.0063862**	**2.75**	**0.008**	**.004699**	**.030366**
November	**-.020074**	**.0081064**	**-2.48**	**0.017**	**-.0363643**	**-.0037836**
_cons	**2.793354**	**1.304993**	**2.14**	**0.037**	**.1708721**	**5.415836**

APPENDIX

Table 17: National Level Analysis Results 2001-2006 (Semi-log)

```
Regression with Newey-West standard errors          Number of obs  =        72
maximum lag: 12                                     F( 13,    58)  =    257.65
                                                    Prob > F       =    0.0000
```

ln_C	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
P	-.0199109	.0045201	-4.40	0.000	-.0289589	-.0108629
Y	.000015	2.73e-06	5.51	0.000	9.57e-06	.0000205
January	-.0497295	.0056296	-8.83	0.000	-.0609984	-.0384606
February	-.1278958	.0107234	-11.93	0.000	-.149361	-.1064307
March	-.0142107	.0076438	-1.86	0.068	-.0295114	.0010901
April	-.0317507	.0064084	-4.95	0.000	-.0445784	-.0189229
May	.0194823	.0063861	3.05	0.003	.0066992	.0322655
June	-.0045821	.0050062	-0.92	0.364	-.014603	.0054389
July	.038689	.0052863	7.32	0.000	.0281072	.0492708
August	.0416265	.0048598	8.57	0.000	.0318986	.0513545
September	-.0396193	.004832	-8.20	0.000	-.0492916	-.029947
October	.0029361	.0063674	0.46	0.646	-.0098096	.0156817
November	-.0355036	.0051238	-6.93	0.000	-.04576	-.0252472
_cons	3.263913	.0794274	41.09	0.000	3.104921	3.422904

Table 18: National Level Analysis Results 2001-2006 (Linear)

Regression with Newey-West standard errors	Number of obs	=	**72**
maximum lag: **12**	F(13, 58)	=	**279.71**
	Prob > F	=	**0.0000**

C	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
P	**-.7573714**	**.16858**	**-4.49**	**0.000**	**-1.094821**	**-.419922**
Y	**.0005784**	**.0001035**	**5.59**	**0.000**	**.0003713**	**.0007855**
January	**-1.954914**	**.2119675**	**-9.22**	**0.000**	**-2.379213**	**-1.530615**
February	**-4.808509**	**.3957463**	**-12.15**	**0.000**	**-5.600681**	**-4.016337**
March	**-.5868085**	**.2994749**	**-1.96**	**0.055**	**-1.186273**	**.0126557**
April	**-1.272805**	**.2510009**	**-5.07**	**0.000**	**-1.775238**	**-.7703725**
May	**.7553692**	**.2534829**	**2.98**	**0.004**	**.247968**	**1.26277**
June	**-.2058732**	**.1990543**	**-1.03**	**0.305**	**-.6043237**	**.1925773**
July	**1.553618**	**.2066768**	**7.52**	**0.000**	**1.13991**	**1.967327**
August	**1.681955**	**.2015481**	**8.35**	**0.000**	**1.278513**	**2.085397**
September	**-1.576198**	**.1899939**	**-8.30**	**0.000**	**-1.956512**	**-1.195884**
October	**.0979263**	**.2532863**	**0.39**	**0.700**	**-.4090813**	**.604934**
November	**-1.416799**	**.2050685**	**-6.91**	**0.000**	**-1.827288**	**-1.00631**
_cons	**23.65913**	**3.029021**	**7.81**	**0.000**	**17.59589**	**29.72238**

Table 19: National Level Analysis Results 2007-2010 (Semi-log)

```
Regression with Newey-West standard errors          Number of obs  =        48
maximum lag: 12                                     F( 13,    34)  =     53.91
                                                    Prob > F       =    0.0000
```

ln_C	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
P	-.0091161	.0098623	-0.92	0.362	-.0291588	.0109265
Y	.0000229	.0000108	2.12	0.041	9.47e-07	.0000449
January	-.0314143	.0143453	-2.19	0.035	-.0605673	-.0022612
February	-.1103187	.0141249	-7.81	0.000	-.1390239	-.0816134
March	.0016557	.0139728	0.12	0.906	-.0267404	.0300518
April	-.0161575	.0121248	-1.33	0.192	-.0407981	.0084831
May	.0184278	.0167493	1.10	0.279	-.0156108	.0524664
June	-.0006495	.0149904	-0.04	0.966	-.0311137	.0298147
July	.0423142	.0135018	3.13	0.004	.0148753	.0697532
August	.0406988	.0113914	3.57	0.001	.0175486	.063849
September	-.0335938	.0179672	-1.87	0.070	-.0701075	.0029199
October	.0123295	.0071657	1.72	0.094	-.002233	.026892
November	-.0347799	.0062392	-5.57	0.000	-.0474595	-.0221003
_cons	2.92036	.3356134	8.70	0.000	2.238311	3.602408

Table 20: National Level Analysis Results 2007-2010 (Linear)

```
Regression with Newey-West standard errors          Number of obs  =        48
maximum lag: 12                                     F( 13,    34)  =     55.42
                                                    Prob > F       =    0.0000
```

C	Coef.	Newey-West Std. Err.	t	P>|t|	[95% Conf.	Interval]
P	-.3247857	.3703252	-0.88	0.387	-1.077377	.4278056
Y	.0008481	.0004018	2.11	0.042	.0000315	.0016647
January	-1.184768	.5455809	-2.17	0.037	-2.293522	-.0760145
February	-3.992664	.489241	-8.16	0.000	-4.986921	-2.998406
March	.0592124	.538558	0.11	0.913	-1.035269	1.153694
April	-.6277044	.4658407	-1.35	0.187	-1.574407	.3189978
May	.7228895	.6452552	1.12	0.270	-.5884269	2.034206
June	-.0375343	.575221	-0.07	0.948	-1.206524	1.131455
July	1.638182	.5383494	3.04	0.004	.5441248	2.73224
August	1.571526	.4526398	3.47	0.001	.6516515	2.491401
September	-1.262866	.6680373	-1.89	0.067	-2.620481	.0947493
October	.4596698	.2760295	1.67	0.105	-.1012896	1.020629
November	-1.31198	.2318949	-5.66	0.000	-1.783247	-.8407131
_cons	11.45622	12.50091	0.92	0.366	-13.94868	36.86112

Table 21: State Level Analysis Results 2001-2006 (Semi-log)

Linear regression			
	Number of obs	=	3595
	F(14, 49)	=	.
	Prob > F	=	.
	R-squared	=	0.8090
	Root MSE	=	.07699

(Std. Err. adjusted for **50** clusters in statenum)

ln_C	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
P	-.0205673	.00543	-3.79	0.000	-.0314794	-.0096553
Y	4.72e-06	2.49e-06	1.90	0.064	-2.79e-07	9.71e-06
Urban_Perc	-.0044272	.0039718	-1.11	0.270	-.0124088	.0035544
VPC	-.0007426	.0004838	-1.53	0.131	-.0017149	.0002297
January	-.0741413	.0095825	-7.74	0.000	-.093398	-.0548846
February	-.1093544	.0115673	-9.45	0.000	-.1325998	-.0861089
March	-.0221451	.0087153	-2.54	0.014	-.0396592	-.0046311
April	-.0160858	.0100387	-1.60	0.115	-.0362592	.0040876
May	.0295318	.0068963	4.28	0.000	.0156731	.0433906
June	.0135325	.0077639	1.74	0.088	-.0020697	.0291346
July	.0351507	.0076107	4.62	0.000	.0198563	.050445
August	.044408	.0083068	5.35	0.000	.0277148	.0611011
September	-.0158776	.0078334	-2.03	0.048	-.0316195	-.0001357
October	-.0045168	.0071566	-0.63	0.531	-.0188985	.0098649
November	-.0352118	.0090929	-3.87	0.000	-.0534847	-.0169388
state_2	-.2565967	.0384464	-6.67	0.000	-.3338576	-.1793359
state_3	-.0352833	.1262796	-0.28	0.781	-.2890516	.2184851
state_4	-.0549334	.0127822	-4.30	0.000	-.0806203	-.0292465
state_5	-.1187975	.1519721	-0.78	0.438	-.4241968	.1866019
state_6	-.1324561	.1108893	-1.19	0.238	-.3552964	.0903842
state_7	-.13952	.1324547	-1.05	0.297	-.4056977	.1266576
state_8	-.0201738	.0993124	-0.20	0.840	-.2197494	.1794019
state_10	-.0415082	.132933	-0.31	0.756	-.308647	.2256307
state_11	.0660075	.0656052	1.01	0.319	-.0658311	.1978461
state_12	-.2867494	.1374111	-2.09	0.042	-.5628873	-.0106115
state_13	-.1507856	.0443755	-3.40	0.001	-.2399615	-.0616098
state_14	-.2152298	.1254471	-1.72	0.093	-.4673252	.0368657
state_15	-.0262685	.0594799	-0.44	0.661	-.1457978	.0932608
state_16	-.0021376	.0280535	-0.08	0.940	-.0585133	.0542381
state_17	-.1334255	.0611117	-2.18	0.034	-.2562341	-.010617

state_18	-.04047	.0042185	-9.59	0.000	-.0489475	-.0319926
state_19	.0193653	.0645777	0.30	0.766	-.1104084	.149139
state_20	-.1497819	.0683736	-2.19	0.033	-.2871837	-.01238
state_21	-.0936215	.1208643	-0.77	0.442	-.3365073	.1492643
state_22	-.1585206	.1429458	-1.11	0.273	-.4457811	.1287398
state_23	-.0592488	.0721308	-0.82	0.415	-.2042012	.0857035
state_24	-.0270649	.0638795	-0.42	0.674	-.1554356	.1013057
state_25	-.017931	.031096	-0.58	0.567	-.0804207	.0445587
state_26	.0306771	.052841	0.58	0.564	-.075511	.1368651
state_27	-.0546317	.0083592	-6.54	0.000	-.0714301	-.0378333
state_28	-.0894587	.0580328	-1.54	0.130	-.2060799	.0271625
state_29	-.0767703	.1393854	-0.55	0.584	-.3568758	.2033352
state_30	-.0492351	.0300445	-1.64	0.108	-.1096117	.0111415
state_31	-.0468609	.1532584	-0.31	0.761	-.3548451	.2611234
state_32	-.0556061	.0756537	-0.74	0.466	-.207638	.0964257
state_33	-.5488851	.1240678	-4.42	0.000	-.7982087	-.2995615
state_34	-.0845815	.0232452	-3.64	0.001	-.1312944	-.0378686
state_35	.0053488	.0099509	0.54	0.593	-.0146483	.0253459
state_36	-.1220974	.0851669	-1.43	0.158	-.2932466	.0490518
state_37	-.0483002	.0369788	-1.31	0.198	-.1226119	.0260114
state_38	-.1749723	.0901275	-1.94	0.058	-.3560902	.0061456
state_39	-.2321359	.0843537	-2.75	0.008	-.401651	-.0626209
state_40	-.2846751	.13627	-2.09	0.042	-.5585199	-.0108304
state_41	.0387153	.0245244	1.58	0.121	-.0105682	.0879989
state_42	-.0206815	.0165158	-1.25	0.216	-.0538713	.0125083
state_43	-.0551165	.0331417	-1.66	0.103	-.1217173	.0114843
state_44	.0011887	.1047679	0.01	0.991	-.2093504	.2117278
state_45	-.1137922	.1288474	-0.88	0.381	-.3727207	.1451363
state_46	-.1021104	.0741695	-1.38	0.175	-.2511596	.0469388
state_47	-.0278015	.0731634	-0.38	0.706	-.1748288	.1192257
state_48	-.1619119	.1043977	-1.55	0.127	-.371707	.0478832
state_49	-.270903	.0386259	-7.01	0.000	-.3485246	-.1932813
state_50	-.1565035	.0500322	-3.13	0.003	-.257047	-.05596
state_51	.1821798	.0389467	4.68	0.000	.1039136	.260446
_cons	4.039461	.2331801	17.32	0.000	3.570868	4.508054

Table 22: State Level Analysis Results 2001-2006 (Linear)

Linear regression

Number of obs	=	3595
F(14, 49)	=	.
Prob > F	=	.
R-squared	=	0.7734
Root MSE	=	3.1342

(Std. Err. adjusted for **50** clusters in statenum)

C	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
P	-.9633101	.237452	-4.06	0.000	-1.440488	-.4861323
Y	.0002005	.0001074	1.87	0.068	-.0000152	.0004163
Urban_Perc	.0365643	.2497598	0.15	0.884	-.4653467	.5384754
VPC	-.0091058	.0251775	-0.36	0.719	-.059702	.0414903
January	-2.839882	.3693144	-7.69	0.000	-3.582047	-2.097717
February	-4.128441	.4710642	-8.76	0.000	-5.07508	-3.181802
March	-.833548	.3194831	-2.61	0.012	-1.475573	-.1915226
April	-.5573639	.3956784	-1.41	0.165	-1.35251	.2377817
May	1.17748	.2888929	4.08	0.000	.5969282	1.758032
June	.5858112	.317261	1.85	0.071	-.0517486	1.223371
July	1.451875	.3161583	4.59	0.000	.8165315	2.087219
August	1.870537	.3482164	5.37	0.000	1.17077	2.570304
September	-.5279709	.320672	-1.65	0.106	-1.172385	.1164437
October	-.0975663	.2868878	-0.34	0.735	-.674089	.4789563
November	-1.33019	.3574523	-3.72	0.001	-2.048517	-.6118625
state_2	-12.29272	2.334764	-5.27	0.000	-16.9846	-7.600834
state_3	-8.904353	7.966878	-1.12	0.269	-24.91439	7.105688
state_4	-1.506633	.7826279	-1.93	0.060	-3.079382	.0661171
state_5	-13.76137	9.567272	-1.44	0.157	-32.98752	5.464787
state_6	-11.59098	7.001536	-1.66	0.104	-25.66109	2.479137
state_7	-13.4107	8.1398	-1.65	0.106	-29.76824	2.946844
state_8	-6.358298	6.233984	-1.02	0.313	-18.88596	6.169362
state_10	-9.718659	8.37274	-1.16	0.251	-26.54431	7.106992
state_11	-1.049625	4.117694	-0.25	0.800	-9.324441	7.22519
state_12	-17.95564	8.683346	-2.07	0.044	-35.40548	-.5058022
state_13	-8.842434	2.792644	-3.17	0.003	-14.45446	-3.230406
state_14	-15.81774	7.897849	-2.00	0.051	-31.68906	.0535844
state_15	-4.829005	3.735379	-1.29	0.202	-12.33553	2.67752
state_16	-1.946584	1.664632	-1.17	0.248	-5.291788	1.39862
state_17	-9.125799	3.86694	-2.36	0.022	-16.89671	-1.354892

state_18	-1.996948	.2148512	-9.29	0.000	-2.428707	-1.565188
state_19	-2.976078	4.055919	-0.73	0.467	-11.12675	5.174596
state_20	-1.708923	4.257247	-0.40	0.690	-10.26418	6.846334
state_21	-11.07025	7.559536	-1.46	0.149	-26.26171	4.121205
state_22	-14.82831	8.921733	-1.66	0.103	-32.7572	3.100583
state_23	-6.997138	4.537203	-1.54	0.129	-16.11499	2.120713
state_24	-4.979702	3.934559	-1.27	0.212	-12.88649	2.927091
state_25	1.02284	1.950522	0.52	0.602	-2.896882	4.942561
state_26	-1.869229	3.319254	-0.56	0.576	-8.53952	4.801063
state_27	-1.933963	.5044784	-3.83	0.000	-2.94775	-.9201758
state_28	-7.415287	3.635617	-2.04	0.047	-14.72133	-.1092399
state_29	-11.19414	8.824447	-1.27	0.211	-28.92753	6.539252
state_30	-3.109739	1.45251	-2.14	0.037	-6.028668	-.1908108
state_31	-10.80823	9.591553	-1.13	0.265	-30.08318	8.466715
state_32	-5.441777	4.751346	-1.15	0.258	-14.98996	4.10641
state_33	-25.74375	7.792022	-3.30	0.002	-41.40241	-10.0851
state_34	-5.226585	1.446827	-3.61	0.001	-8.134092	-2.319078
state_35	-.0738726	.5115548	-0.14	0.886	-1.10188	.9541352
state_36	-10.37389	5.341423	-1.94	0.058	-21.10788	.360104
state_37	-4.097496	2.312137	-1.77	0.083	-8.74391	.5489184
state_38	-12.30171	5.692729	-2.16	0.036	-23.74167	-.8617416
state_39	-14.32888	5.301868	-2.70	0.009	-24.98338	-3.674377
state_40	-18.5141	8.587764	-2.16	0.036	-35.77186	-1.25634
state_41	1.001471	1.52623	0.66	0.515	-2.065603	4.068546
state_42	-.172195	.9061742	-0.19	0.850	-1.99322	1.64883
state_43	-4.559692	2.065283	-2.21	0.032	-8.710034	-.4093504
state_44	-6.219853	6.615298	-0.94	0.352	-19.51379	7.074087
state_45	-11.97546	8.096245	-1.48	0.146	-28.24547	4.294556
state_46	-.3943491	4.588789	-0.09	0.932	-9.615867	8.827169
state_47	-5.558617	4.513392	-1.23	0.224	-14.62862	3.511384
state_48	-12.80642	6.565608	-1.95	0.057	-26.00051	.3876619
state_49	-7.798118	2.433473	-3.20	0.002	-12.68836	-2.907871
state_50	-9.651151	3.130309	-3.08	0.003	-15.94174	-3.36056
state_51	8.872854	2.285097	3.88	0.000	4.28078	13.46493
_cons	41.65109	14.4853	2.88	0.006	12.5418	70.76038

Table 23: State Level Analysis Results 2007-2010 (Semi-log)

```
Linear regression                               Number of obs =     2391
                                                F( 14,     49) =        .
                                                Prob > F      =        .
                                                R-squared     =   0.8292
                                                Root MSE      =   .07041

                             (Std. Err. adjusted for 50 clusters in statenum)
```

ln_C	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
P	-.0278228	.0035583	-7.82	0.000	-.0349734	-.0206722
Y	.0000142	1.89e-06	7.53	0.000	.0000104	.000018
Urban_Perc	-.028086	.0086599	-3.24	0.002	-.0454888	-.0106833
VPC	1.73e-06	.0005376	0.00	0.997	-.0010787	.0010821
January	-.0395653	.0086932	-4.55	0.000	-.057035	-.0220956
February	-.0835274	.0119559	-6.99	0.000	-.1075537	-.0595012
March	.003006	.0092076	0.33	0.745	-.0154975	.0215094
April	.0004882	.0114751	0.04	0.966	-.0225717	.0235482
May	.0466822	.0058913	7.92	0.000	.0348432	.0585211
June	.0369465	.0085346	4.33	0.000	.0197955	.0540975
July	.0600866	.0064129	9.37	0.000	.0471994	.0729739
August	.050924	.0060489	8.42	0.000	.0387684	.0630797
September	-.0030224	.0062874	-0.48	0.633	-.0156574	.0096126
October	.0170656	.0059912	2.85	0.006	.0050259	.0291053
November	-.0207048	.0079372	-2.61	0.012	-.0366551	-.0047544
state_2	-.1916351	.0732815	-2.62	0.012	-.3388998	-.0443704
state_3	.602354	.2678472	2.25	0.029	.0640948	1.140613
state_4	-.1598087	.029954	-5.34	0.000	-.2200036	-.0996138
state_5	.5918522	.326437	1.81	0.076	-.0641475	1.247852
state_6	.3851094	.2414628	1.59	0.117	-.1001283	.870347
state_7	.2527765	.2826433	0.89	0.376	-.3152164	.8207694
state_8	.5072925	.2189099	2.32	0.025	.0673766	.9472084
state_10	.6205984	.2849106	2.18	0.034	.0480491	1.193148
state_11	.3418102	.1400084	2.44	0.018	.0604529	.6231676
state_12	.3437513	.2942704	1.17	0.248	-.2476073	.9351098
state_13	.0996076	.0956557	1.04	0.303	-.0926197	.2918349
state_14	.3547693	.2680534	1.32	0.192	-.1839042	.8934429
state_15	.2404312	.1195443	2.01	0.050	.0001979	.4806646
state_16	.0743107	.0518745	1.43	0.158	-.029935	.1785564
state_17	.1661293	.1349448	1.23	0.224	-.1050525	.4373111

state_18	-.0750024	.0063326	-11.84	0.000	-.0877283	-.0622766
state_19	.2798738	.1294839	2.16	0.036	.0196661	.5400814
state_20	-.6499827	.1681785	-3.86	0.000	-.98795	-.3120154
state_21	.4806134	.2633589	1.82	0.074	-.048626	1.009853
state_22	.4418068	.3089942	1.43	0.159	-.1791402	1.062754
state_23	.2604939	.1406933	1.85	0.070	-.0222398	.5432277
state_24	.1666807	.1353486	1.23	0.224	-.1053126	.4386739
state_25	-.2181641	.0847601	-2.57	0.013	-.3884959	-.0478324
state_26	.2587576	.1050769	2.46	0.017	.0475977	.4699174
state_27	-.1891695	.0261617	-7.23	0.000	-.2417434	-.1365955
state_28	.1400966	.1281741	1.09	0.280	-.117479	.3976722
state_29	.6579576	.3059987	2.15	0.037	.0430302	1.272885
state_30	-.1107045	.0302751	-3.66	0.001	-.1715446	-.0498645
state_31	.6320708	.3314059	1.91	0.062	-.0339144	1.298056
state_32	.3569757	.1574689	2.27	0.028	.0405302	.6734212
state_33	-.0217168	.2698158	-0.08	0.936	-.5639319	.5204983
state_34	.0326413	.0579734	0.56	0.576	-.0838606	.1491431
state_35	-.0586583	.0191857	-3.06	0.004	-.0972134	-.0201032
state_36	.2821741	.1717707	1.64	0.107	-.0630121	.6273602
state_37	.0767767	.0679236	1.13	0.264	-.0597208	.2132743
state_38	.2706603	.1931963	1.40	0.168	-.1175821	.6589028
state_39	.1485061	.1797168	0.83	0.413	-.2126484	.5096606
state_40	.4086778	.2877249	1.42	0.162	-.1695271	.9868827
state_41	.235133	.0589203	3.99	0.000	.1167283	.3535378
state_42	-.2212876	.0186611	-11.86	0.000	-.2587884	-.1837868
state_43	.0903404	.0661845	1.36	0.178	-.0426624	.2233432
state_44	.537653	.2265634	2.37	0.022	.0823567	.9929492
state_45	.5650874	.2738551	2.06	0.044	.0147551	1.11542
state_46	-.6640533	.1647874	-4.03	0.000	-.995206	-.3329005
state_47	.2193813	.1560422	1.41	0.166	-.0941973	.53296
state_48	.2786836	.2284414	1.22	0.228	-.1803866	.7377538
state_49	-.5079193	.0928227	-5.47	0.000	-.6944536	-.3213851
state_50	.053702	.1029511	0.52	0.604	-.1531859	.2605899
state_51	.1392562	.0691874	2.01	0.050	.0002189	.2782934
_cons	5.063341	.5519226	9.17	0.000	3.954211	6.172471

Table 24: State Level Analysis Results 2007-2010 (Linear)

```
Linear regression                               Number of obs =      2391
                                                F( 14,     49) =         .
                                                Prob > F      =         .
                                                R-squared     =    0.7969
                                                Root MSE      =    2.7711

                          (Std. Err. adjusted for 50 clusters in statenum)
```

C	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
P	-1.029003	.1556798	-6.61	0.000	-1.341853	-.716153
Y	.0005107	.0000634	8.06	0.000	.0003834	.0006381
Urban_Perc	-1.142784	.3066546	-3.73	0.001	-1.759029	-.5265385
VPC	-.003679	.0196091	-0.19	0.852	-.0430849	.035727
January	-1.464439	.3148754	-4.65	0.000	-2.097205	-.8316736
February	-2.96749	.4102115	-7.23	0.000	-3.79184	-2.143139
March	.1703147	.3157443	0.54	0.592	-.4641973	.8048267
April	.1243925	.3852566	0.32	0.748	-.6498096	.8985946
May	1.815414	.2419866	7.50	0.000	1.329124	2.301705
June	1.533451	.3801846	4.03	0.000	.769442	2.297461
July	2.329064	.263942	8.82	0.000	1.798653	2.859476
August	2.042962	.2502368	8.16	0.000	1.540093	2.545832
September	-.0833447	.2403033	-0.35	0.730	-.5662522	.3995628
October	.7226669	.2347585	3.08	0.003	.2509021	1.194432
November	-.6649569	.3234093	-2.06	0.045	-1.314872	-.0150416
state_2	-6.842224	2.582766	-2.65	0.011	-12.03249	-1.651963
state_3	24.55592	9.480234	2.59	0.013	5.504673	43.60716
state_4	-6.929555	1.065342	-6.50	0.000	-9.070441	-4.78867
state_5	24.96643	11.5568	2.16	0.036	1.742166	48.19069
state_6	16.20167	8.54161	1.90	0.064	-.9633436	33.36667
state_7	11.83037	9.994785	1.18	0.242	-8.254906	31.91564
state_8	20.92007	7.75091	2.70	0.010	5.34403	36.4961
state_10	25.39946	10.08623	2.52	0.015	5.130429	45.6685
state_11	13.72901	4.956963	2.77	0.008	3.767625	23.6904
state_12	17.12976	10.41199	1.65	0.106	-3.793911	38.05344
state_13	3.994977	3.382358	1.18	0.243	-2.802127	10.79208
state_14	15.7496	9.488163	1.66	0.103	-3.317579	34.81678
state_15	9.512517	4.233173	2.25	0.029	1.005638	18.0194
state_16	3.337265	1.835624	1.82	0.075	-.3515593	7.02609
state_17	6.852949	4.773393	1.44	0.157	-2.739543	16.44544

state_18	-3.415784	.2233884	-15.29	0.000	-3.8647	-2.966868
state_19	11.40251	4.58309	2.49	0.016	2.192449	20.61258
state_20	-26.32551	5.958775	-4.42	0.000	-38.30012	-14.3509
state_21	20.33022	9.318234	2.18	0.034	1.60453	39.05592
state_22	19.12981	10.93296	1.75	0.086	-2.840801	41.10041
state_23	10.41137	4.981842	2.09	0.042	.3999809	20.42275
state_24	7.095665	4.787462	1.48	0.145	-2.5251	16.71643
state_25	-8.973294	3.002295	-2.99	0.004	-15.00663	-2.939956
state_26	10.67619	3.719689	2.87	0.006	3.201193	18.15118
state_27	-7.713981	.9314473	-8.28	0.000	-9.585795	-5.842168
state_28	5.851566	4.535114	1.29	0.203	-3.262086	14.96522
state_29	27.09944	10.82789	2.50	0.016	5.339976	48.85891
state_30	-3.835185	1.045674	-3.67	0.001	-5.936545	-1.733825
state_31	26.62919	11.72741	2.27	0.028	3.062084	50.1963
state_32	14.23158	5.571327	2.55	0.014	3.035581	25.42758
state_33	4.189325	9.545957	0.44	0.663	-14.99399	23.37264
state_34	1.219997	2.049737	0.60	0.554	-2.899103	5.339097
state_35	-1.714268	.6575999	-2.61	0.012	-3.035764	-.3927715
state_36	11.53825	6.083594	1.90	0.064	-.6871898	23.76369
state_37	3.638639	2.404293	1.51	0.137	-1.192969	8.470246
state_38	11.739	6.83644	1.72	0.092	-1.999344	25.47734
state_39	6.86681	6.360707	1.08	0.286	-5.915509	19.64913
state_40	18.09926	10.18512	1.78	0.082	-2.368506	38.56702
state_41	10.1952	2.086045	4.89	0.000	6.00313	14.38726
state_42	-7.845257	.6492854	-12.08	0.000	-9.150045	-6.54047
state_43	3.533125	2.343305	1.51	0.138	-1.175922	8.242172
state_44	21.81265	8.018826	2.72	0.009	5.698214	37.92708
state_45	23.62655	9.696235	2.44	0.019	4.141236	43.11186
state_46	-26.72281	5.835087	-4.58	0.000	-38.44885	-14.99676
state_47	9.608141	5.519993	1.74	0.088	-1.484701	20.70098
state_48	12.22059	8.084026	1.51	0.137	-4.024872	28.46604
state_49	-17.95662	3.290428	-5.46	0.000	-24.56899	-11.34426
state_50	2.330851	3.642627	0.64	0.525	-4.989282	9.650983
state_51	9.193874	2.435301	3.78	0.000	4.299953	14.08779
_cons	98.42072	19.51565	5.04	0.000	59.20257	137.6389

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