The Effects of Exogenous Tax Shocks on Economic Growth

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1 Abstract

We examine the effects of tax shocks on various economic indicators. Restricting our analysis to those tax changes which are exogenous to the economy, we find that an increase in tax rates corresponds to a significant decline in economic health over the next two years, followed by a slight bounceback to return partway to pre-tax levels. By examining the political party affiliations of the president in power at the time of the tax change and in future periods, we show that this bounceback is not caused by a new administration reversing previous policies, but instead exists across all political climates.

2 Introduction

Our paper is focused on investigating the relationship between tax policy and economic growth in the United States. There is much debate about the effect of tax changes on overall output, especially in the political arena. There are those who claim that lowering taxes will spur increased economic activity, and may even result in increased government revenue. Others disagree, arguing that raising taxes, especially among high earners, helps pay for government programs that subsidize lower income individuals, therefore encouraging them to be more productive. While we are not aiming to find conclusive evidence on these topics of interest specifically, we are interested in the question on a broader level.

Many recent papers involve regressing GDP growth directly on tax levels or tax changes, but the problem of endogeneity could persist in these models. More specifically, does the change in tax correlate with the error term in those models? Potential endogeneity of explanatory variables could cause estimators to be biased and inconsistent. Therefore, we are interested in focusing solely on those tax shocks which are exogenous to current economic conditions, and examining their effects on various measures of productivity and output.

In our paper, we drew inspiration from Romer and Romer's 2010 paper "The Macroeconomics of Tax Changes: Estimates Based on a New Measure of Fiscal Shocks." To write their paper, the authors went through the historical

record of tax changes and categorized them as either endogeneous or exogenous to the current state of the economy. They then regressed GDP growth on the last three years of tax changes, and found that an exogenous tax increase indeed caused a substantial decline in GDP (a one percent of GDP tax increase caused a maximum three percent drop in GDP growth 10 quarters later, before rebounding slightly and stabilizing around two percent).

Our paper delves deeper into the mechanism of this impact by measuring the effect of tax changes on future changes in other important economic indicators, such as industrial production and unemployment. In addition, after a suggestion from Professor Gay, in each given period we separated past exogenous tax changes by the party affiliation of the president who had passed them, to see if the slight bounceback to the mean could at all be explained by incumbent politicians reversing the tax policy of their oppositely-aligned predecessors. This analysis in particular seems important because as the incumbent party changes as well as its agenda, the tax changes from the previous administration could be reveresed, thereby diminishing their effects. Controlling for the effect of party change interacting with the lagged effect of tax change can be an important factor to the analysis of macroeconomic effect of exogenous tax change.

3 Methodology

3.1 Simple Model with Lagged Effects

We use Romer and Romer's categorization of exogenous tax shocks to examine the relation between the economic activity and fiscal policy. We took two approaches to analyze the effect of tax rate change on the interested macroeconomic dependent variables. First, we ran a simple regression of chosen variables on a constant and the contemporaneous value and lags of exogenous changes in the tax rates. Having quarterly data, we included 12 lagged quarterly terms of exogenous tax rate change to capture the long term effect of tax policy shifts on economic activity. Since tax policies usually phase in slowly to economy, people have time to adjust their economic behavior and the model needs to account for the effect of tax policies from the past. We estimated

$$\Delta Y_t = a + \sum_{i=0}^{12} \beta_i \Delta T_{t-i} + e_t$$

where ΔY_t is the percentage change of the output in period t, and ΔT_{t-i} is the exogenous change of tax rates i periods prior to time t (as a percent of GDP in period $t-i$). Since businesses and individuals need time to adjust their labor, investment and consumption decisions, we expect the effects of tax rate changes to fully play out many quarters after they are passed.

3.2 Model with Lagged Party Affiliations

Our second approach added control variables to take into account of presidential party affiliation. The rational for including this data has been mentioned in Section 4.3. Here we introduced dummy variables that compare presidential party affiliation between current quarter and each lagged quarter up to three years back. We estimated

$$\Delta Y_t = a. + \sum_{i=0}^{12} \beta_{\text{same},i} \Delta T_{\text{same},t-i} + e_t$$

Where the vector of $\Delta T_{\text{same},i}$ is the product of taxrate change variable ΔT_i and the vector of dummy variables *same*. An entry in this vector, $same, i$ equals to 1 if the presidential party affiliation of current quarter is the same as the presidential party affiliation i quarters ago, and 0 otherwise. Notice that $\Delta T_{\text{same},i}$ is the interaction term that accounts for the tax change of the same party affiliation, and ignores the effect of the different party's tax effects.

We do not account for cyclical effects in the economy, as Romer and Romer found in their paper that dealing with them has virtually no effect on the regression coefficients. We thus expect in both cases that the residuals will have significant autocorrelation, but will nonetheless not affect our results.

4 Data

Romer and Romer regressed change in GDP on lagged changes in exogenous tax rates. While GDP growth is a standard measure of economic activity and growth, it encompasses many different workings of the overall economy. Therefore, we are interested in trying to understand the effect of exogenous tax changes on more specific economic data. We have compiled the following four variables of interest to regress on exogenous changes in the tax rate: unemployment rate, workforce participation rate, real gross private domestic investment, and Industrial Production Index. We are interested in these variables because we set out to understand the overall macroeconomic effect of exogenous tax rate changes, and the listed variables are significant measures of macroeconomy.

4.1 Data Description and Rationale

The unemployment rate is defined as the number of people unemployed over the total number of people in the labor force. If more people are employed, we expect output to be higher as there are more people providing goods and services. Therefore, unemployment and GDP are assumed to be negatively correlated. Therefore, we are interested if there is a perceivable relationship between changes in tax rates and unemployment, the idea being if taxes are higher, then people will be spending less, which therefore lowers the demand for goods and services. This would therefore lower the demand for labor, causing an increase in the unemployment rate.

The workforce participation rate is calculated as the number of employed and unemployed people looking for a job as a percentage of the total number of people sixteen years of age or older. While this statistic is similar to the unemployment rate, it captures a different picture about the labor force. Even in recent years, as unemployment has fallen steadily to around five percent (as of the writing of this paper), critics of current policy argue that the labor force participation rate is relatively low, therefore implying that the economy is not as healthy as some claim. While there will always be a significant portion of the population over sixteen that will not work, i.e. those who are retired, it has been interpreted by some as a measure of confidence in the economy on the part of workers. If the labor force participation rate is high, then there is a relatively large number of people who are employed or seeking employment, therefore giving us some insight about the expectation that people have on the ability to find work. Conversely, if the labor force participation rate is relatively low, then this could be an indication that potential workers do not think that they will be able to acquire jobs. Therefore, we are interested in a possible relationship between a change in tax rates and labor force participation. Such a relationship could happen if, for example, raising taxes causes people to be unemployed for longer, therefore making potential workers have a negative outlook on the economy that might cause them to eventually stop looking for employment.

But this does not tell the whole story about labor decisions. From microeconomic theory, there are two effects at play when taxes are increased, the income effect and the substitution effect. As an increase in taxes increases the price of consumption, we would need to see individuals working more to achieve the same level of consumption as before. But there is also the countering substitution effect; when taxes increase, we may see individuals working less due to increasing marginal disutility of labor as individuals work more. Therefore, without a model of the individual, we cannot be certain how individuals change their labor supply decisions.

We looked at the effect of tax rates on real gross private domestic investment, which includes the change in private inventories and nonresidential and residential fixed investment. It is taken that the amount of investment is positively correlated with GDP, as investment lets businesses buy more physical capital, hire more employees, and so on. It is often claimed that those with higher incomes are the ones doing most of the investment. Therefore, because we expect individuals who have higher incomes to be most affected by tax changes, we expect investment to be negatively correlated with tax changes in earlier periods.

The Industrial Production Index is a measure of real output from various industries. We expect industrial production to be positively correlated with GDP, therefore we are interested in a possible negative relationship between a change in tax rates and industrial production. An increase in taxes may have a two fold effect on industrial production. First, as taxes increase, we may see people consuming more leisure, therefore causing people to work less on average, which would then affect total output. Second, an increase in taxes may cause consumers to spend less, therefore causing industrial production to decrease.

4.2 Data Specification

The data on exogenous tax changes from Romer and Romer are specified for each quarter from 1945 to 2007. We therefore match our data to their specifications whenever possible. For some of our dependent variables (such as the workforce participation rate), data was only available back until 1967. We obtained all of our data from the Federal Reserve Bank of St. Louis research website (FRED).

4.3 Political Party Data

Tax policy differs significantly between the Republican and Democratic parties, therefore, while Romer and Romer took into account various political and historical moments in their exogenous tax rate data, we want to control for the possibility of tax rate changes based on presidential party affiliation. Data on change in president are readily available.

4.4 Exogenous Tax Changes

The distinction between endogenous and exogenous tax change is important because it helps us isolate the pure effect tax policy has on macroeconomic variables. Government changes its tax rate based on three motivations: 1) it becomes concerned about the ongoing or expected abnormal economic condition and wants to offset it by increasing or decreasing its spending, which requires changing its taxes 2) the government has a large deficit in budget, and wants to pay its debts by increasing tax and collecting more revenues 3) driven by economic belief or philosophy, it believes that the tax reduction will result in long term economic growth. These three motivations can hint at the distinction in taxes that are endogenous or exogenous to macroeconomic conditions of the time.

The first tax policy is countercyclical to the ongoing economic force, because the government responds to the force by the changing fiscal policy. In this case, the ongoing economic condition affects both the fiscal policy and the macroeconomic variables at the same time, thereby creating the endogeneity problem in our model. As such, we exclude the countercyclical tax policies from our regressor data. An example of this would be 1975 tax changes to combat recessiona at the time. Both the Ford Administration and Congress wanted to pursue anti-recession policy, and stimulate the economy by reducing the tax. The plan involved some tax cuts for households and businesses vided a 10 percent rebate on 1974 tax liability (200 dollars cap) and created a temporary 30 dollars general tax credit for each taxpayer and dependent. The investment tax credit was temporarily increased to 10 percent through 1976. This type of tax would be classified as the endogenous tax policy.

On the other hand, the tax policy designed to balance budget is to decrease the deficit from the past, which does not affect the ongoing macroeconomic variables. The Clinton tax increase in 1993, the Omnibus Budget Reconciliation

Act, otherwise known as Budget Deficit Reduction Act for the reduction of budget deficit, was such a case. In particular, it created new tax brackets of marginal income tax for top income earners as well as corporate incomes. This law was passed in the backdrop of high budget deficit inherited from the prior Republican administrations. During Reagan administration, the budget deficit accrued hundreds of billion of dollars each year. These two taxes and other budget deficit reduction taxes would be classified as exogenous tax policies.

Furthermore, the tax change based on the economic belief or philosophy that lowering taxes would result in long-term economic growth. Again, such economic policies would be enacted exogenous to the current economic conditions. The specific examples of such tax policies would be the Kennedy 1964 tax change or Reagan's 1982 tax would be classified as such taxes. The Kennedy-Johnson Act in 1964's stated goal was to cut taxes to raise personal incomes, increase consumption, and increase capital investments. Reagan and his supporters believed that decreases in taxes, especially for corporations, is the best way to stimulate economic growth: the idea is that if the expenses of corporations are reduced, the savings will "trickle down" to the rest of the economy, spurring growth. This policy change would not be motivated by the contemporary economic conditions, but by the vision for future economy, and as such would be classified as exogenous tax changes and be the second basis for our predictor data.

5 Results and Interpretation

We first want to begin the analysis of our results with the effect of exogenous tax changes on GDP so as to compare them to Romer and Romer's results. We will then continue our analysis by looking at the results of exogenous tax changes on investment, workforce participation, industrial production, and unemployment. In our results below, we report the coefficients that are significant at the 10% significance level.

5.1 GDP

The graphs presented (Figures 1 and 2) plot how current GDP is affected by exogenous tax changes from the current and the previous twelve quarters. We display the partial sums of the coefficients to understand the individual effect of a change in taxes in a specific quarter, and the overall effect of tax changes from the current and previous twelve quarters.

In the regression controlling for a change in political party of the president, we find significant coefficients for constant and the seventh and eleventh lagged terms: the coefficient of the constant is .738 with a standard error of .069; the coefficient of the seventh lagged term is -.491 with a standard error of .292; the coefficient of the eleventh lagged term is .514 with a standard error of .302. In the regression that did not control for a party change of the president, we get significant coefficients in for the constant and the seventh, eleventh, and twelfth

lagged terms: the coefficient of the constant is .744 with a standard error of .067; the coefficient of the seventh lagged term is -.584 with a standard error of .284; the coefficient of the eleventh lagged term is .617 with a standard error of .284; the coefficient of the twelfth lagged term term is .488 with a standard error of .291. Data for these regressions are presented in Tables 1 and 6.

In both regressions, we find a similar pattern, where the current, first, and second quarters back have little impact on output, while from about the third quarter to the seventh quarter back we find a large negative impact of a tax increase on GDP. After about the eighth previous quarter and further back, we see a positive correlation between a tax increase and output.

Note that the shape of both graphs is quite similar to that obtained by Romer and Romer, when performing the party-independent regression on a different set of years. This shows that our and their results are robust to slightly different data specifications. This shape suggests a pattern of reversion towards previous GDP levels. Therefore, an increase in taxes from the previous seven to twelve quarters stop having a negative impact on output. This is definitely an interesting finding, especially because we find a significant positive coefficient for the eleventh and twelfth lagged term. We cannot make any claims as to why a positive effect persists for quarters further back, but we can speculate some reasons.

One reason could be that tax increases far back enough allow the government to expand certain programs that, in the end, increase output. Another possible reason could be that once an exogenous tax increase happens, individuals and corporations adjust by cutting back spending and investment, but this cut back, especially by corporations, may be an overreaction therefore resulting in increased investment in the future by the same companies or allowing others to come in the market and fill some void. These are speculations with no backing in our current data, therefore, while there may be a general consensus that tax increases lowers the incentives of individuals and firms to invest, therefore driving output down in the near term, we cannot accurately understand why tax increases further back are positively correlated with GDP.

An explanation we can plausibly rule out, however, is that an eventual change in the political affiliation of the administration causes policies to be passed to roll back the previous party's tax changes. As our pair of graphs look nearly the same (a similarity that notably persists for every other dependent variable we test), it seems that the effects of a tax change on the future economy are independent of the party identification of the president at the time.

5.1.1 Robustness Result

The regression model for difference in GDP passes the tests for most of the Gauss-Markov Assumptions. By visually inspecting the standardized residuals vs fitted values graph, and conducting the White (p-value for Chi-squared = 0.1367 - independent; 0.5627- party-affiliated) and Breusch-Pagan test (p-value for F-test = 0.9993 - independent; 0.9977 for party-affiliated), we do not reject the null hypothesis that there is no heteroscedasticity. Thus, we have that the

residuals have mostly constant variance given the data. Next, visually inspecting the normality plot we do not detect any significant deviation from standard normal plot. However, we tested for autocorrelation, and Durbin-Watson test p-value was 0 for both party-affiliated and independent reressions, suggesting that we do reject the null hypothesis that there is no autocorrelation. We addressed this issue by transforming the model with Cochrane-Orcutt estimation, and obtained new estimates. The estimates were very similar to the pre-transformed model, so we it did not alter our conclusions. Finally, testing for collinearity, we see that the variance inflation factor (VIF) values are very low (the mean value 1.02 for both the regression independent of party and interacting with party), removing any concern for multicollinearity in the dependent variables. The collinearity relation between covariates is the same for all the other regressions, since we retain the same covariates, so this result will not be mentioned for other regressions.

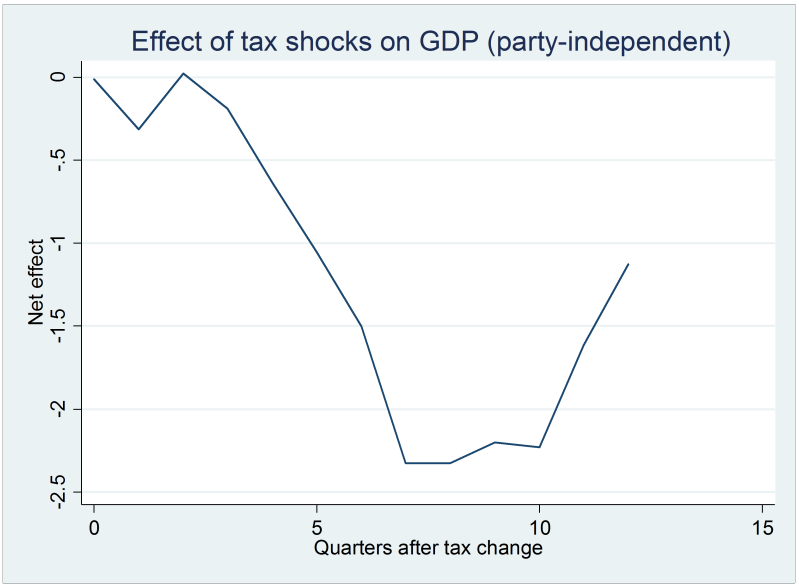

Figure 1: Tax Shocks on GDP (Party-Independent)

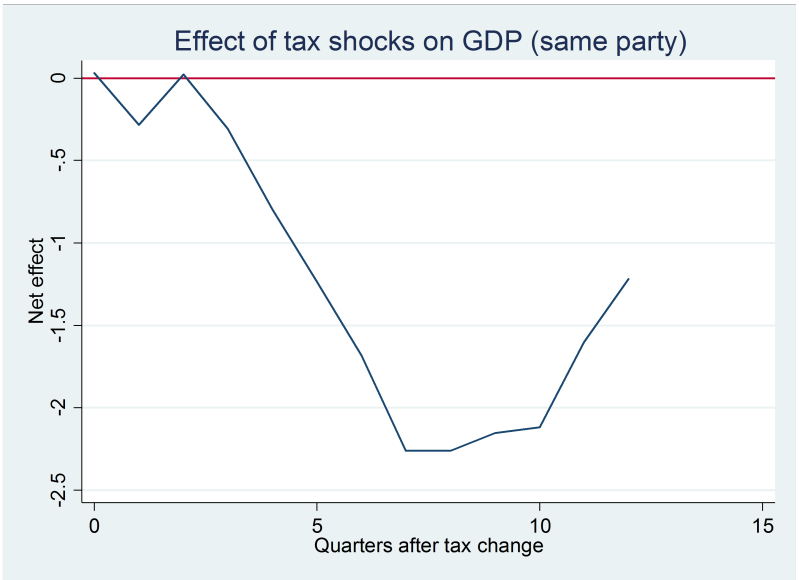

Figure 2: Tax Shocks on GDP (Same Party)

5.2 Workforce Participation

The graphs below (Figures 3 and 4) plot the partial sums of the regression coefficients from the present quarter to twelve quarters back. We can interpret the coefficients of the regression as describing how a one percent change in exogenous tax changes the workforce participation rate in the current quarter. Therefore, the graph depicts how a one percent change in each previous quarter would affect the change in the workforce participation rate in the current quarter.

In the regression controlling for a change in the party of the president, we only get significant coefficients for the constant and the current quarter: the coefficient of the constant term is .035 with a standard error of .014; the coefficient of the current quarter is .134 with a standard error of .059. In the regression that did not control of a change in the party of the president, we also get significant coefficients for the constant and the current quarter: the coefficient of the constant term is .036 with a standard error of .014; the coefficient of the current quarter is .129 with a standard error of .059. Data for these regressions are presented in Tables 2 and 7.

Due to the lack of significance in the regression coefficients besides the current quarter and constant, and the complete lack of significance in their partial sums – which are themselves of lesser magnitude than the standard error of even one of their terms – we cannot come to any conclusions about how exogenous tax changes affect the workforce participation rate. This may be due to the competing income and substitution effects, but this analysis is beyond the

scope of this paper. For example, within families where some individuals are not participants in the labor force, when taxes increase, these individuals may become participants to offset a decrease in income by the breadwinner, but over time, these individuals who did not work before eventually leave the labor force due to a preference of leisure over consumption. But this is just one possible scenario as to why we do not find any significant trends between exogenous tax changes and workforce participation.

Again, we did not find any significant difference between the regression controlling for a change in the party of the president and the regression disregarding this extra information. As stated earlier in the analysis of the the effect of tax changes on investment, this may be due to the difficulties of the legislative process, therefore preventing significant changes in tax policy. Therefore, we have no conclusive evidence that a change in political party of the president has a significant impact on our regression results.

5.2.1 Robustness Result

The regression model for difference in labor force participation passes the tests for Gauss-Markov Assumptions. By visually inspecting the standardized residuals vs fitted values graph, and conducting the White (p-value for Chi-squared = 0.97 for party-affiliated; 0.7265 for independent) and Breusch-Pagan test (p-value for F-test = 0.9280 - party-affiliated; 0.9423 for independent), we do not reject the null hypothesis that there is no heteroscedasticity. Next, visually inspecting the normality plot we do not detect any significant deviation from standard normal plot. In addition, we tested for autocorrelation, and runs test p-value was 0.57 for both party-affiliated and independent regressions, and the corresponding Durbin-Watson test statistic was above the table value, suggesting that we do not reject the null hypothesis that there is no autocorrelation.

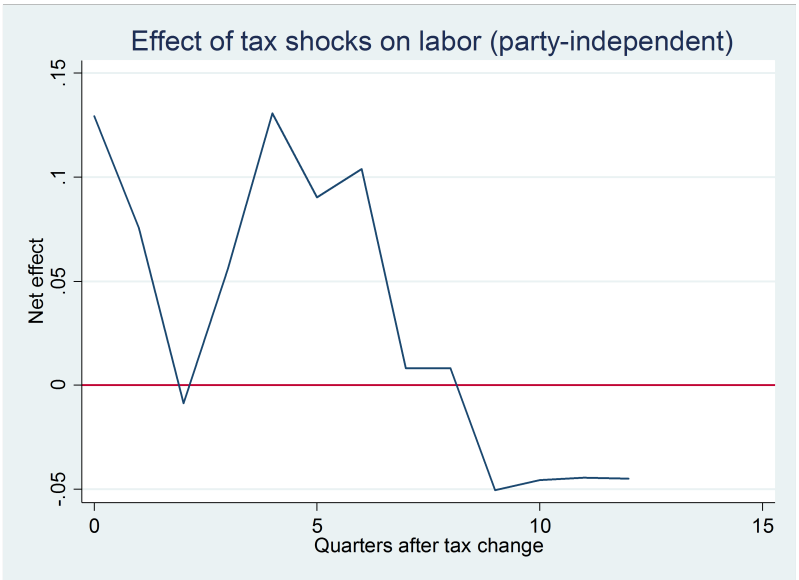

Figure 3: Tax Shocks on Labor (Party-Independent)

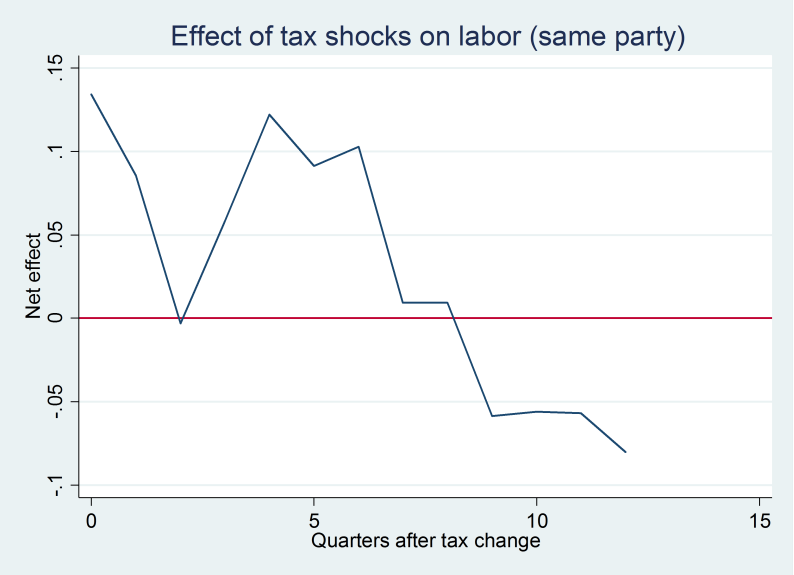

Figure 4: Tax Shocks on Labor (Same Party)

5.3 Investments

The graphs provided (Figures 5 and 6) plot the partial sums of the regression coefficients from the present quarter to the twelve quarters back. We can interpret each coefficient as describing how a one percent increase in exogenous tax in a previous quarter changes current investment. Therefore, we can interpret the partial sums as the net effect that tax increases from the current and previous twelve quarters have on output.

In the regression controlling for a party change of president, we get significant coefficients for the constant and fourth, seventh, and twelfth lagged terms: the coefficient of the constant term is .990 with a standard error of .327; the coefficient on the fourth lagged term is -2.541 with a standard error of 1.378; the coefficient of the seventh lagged term is -3.524 with a standard error of 1.378; the coefficient for the twelfth lagged term is 3.991 with a standard error of 1.485. In the regression that did not control for a party change of the president, we again get significant coefficients for the constant and seventh and twelfth lagged terms: the coefficient of the constant term is 1.000 with a standard error of .315; the coefficient of the seventh lagged term is -3.869 with a standard error of 1.338; the coefficient for the twelfth lagged term is 4.477 with a standard error of 1.367. Data for these regressions are presented in Tables 3 and 8.

In both regressions, we find a similar change in investment pattern when exogenous tax changes are made. As one may expect, there is very little change in investment from a tax change in the current and very recent quarters. This is to be expected; decisions about investment, especially by corporations, are made and set over longer terms, therefore decisions are more forward looking. From four to about eight quarters back, we see that taxes have a significant impact on investment. Again, because investment decision are made on a longer time frame, companies take into account the current expectations about the future and plan for them. Therefore, if a tax increase is announced currently, a company may be more likely to start cutting output a year from now, as it may be difficult to change output in the current quarter.

A somewhat peculiar finding is how tax changes from the previous nine through twelve quarters show a mean reversion effect, yet not fully achieving the previous high. One might expect current investment to be more negatively affected by tax increases from about two to three years prior. The reason for this could be that individuals and companies "overreact" in the near term, only to reinvest or allow other competitors to enter the market, therefore bringing the total impact of a tax change on investment almost back up to the previous investment level.

While we ran the both of the regressions, one accounting for change in party of the president and one that disregards it, given that the standard error in both regressions are relatively high, we can see that there is no significant difference in coefficients of the two models. It may be the case that, even though successive presidents may have significantly different outlooks on future policy, the ability to implement policy is difficult. If a president wants to raise or lower taxes, they then face congress, which could reject any such bills, and even if the president

gets some form of their desired legislation through, the end product could be a significantly watered down version of the original proposal (think of the Affordable Care Act, and how the original idea to have a single-payer system was scrapped). Regardless of the mechanism, we have no conclusive evidence that a change in the party of the president has a significant impact on investment.

5.3.1 Robustness Result

The regression model for difference in investment passes the tests for Gauss-Markov Assumptions. By visually inspecting the standardized residuals vs fitted values graph, and conducting the White (p-value for Chi-squared = 0.2524 - party-affiliated; 0.3962 - independent) and Breusch-Pagan test (p-value for F-test = 0.8017 - party-affiliated; 0.7182 - independent), we do not reject the null hypothesis that there is no heteroscedasticity. Next, visually inspecting the normality plot we do not detect any significant deviation from standard normal plot. In addition, we tested for autocorrelation, and Durbin-Watson test p-value was 0.09 (for party-affiliated; 0.17 for independent), suggesting that we do not reject the null hypothesis that there is no autocorrelation, given the significance level 0.05.

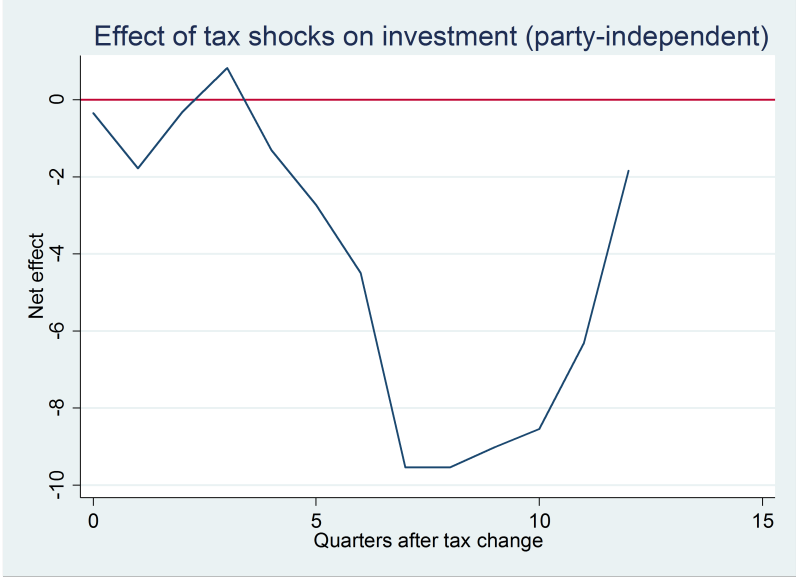

Figure 5: Tax Shocks on Investment (Party-Independent)

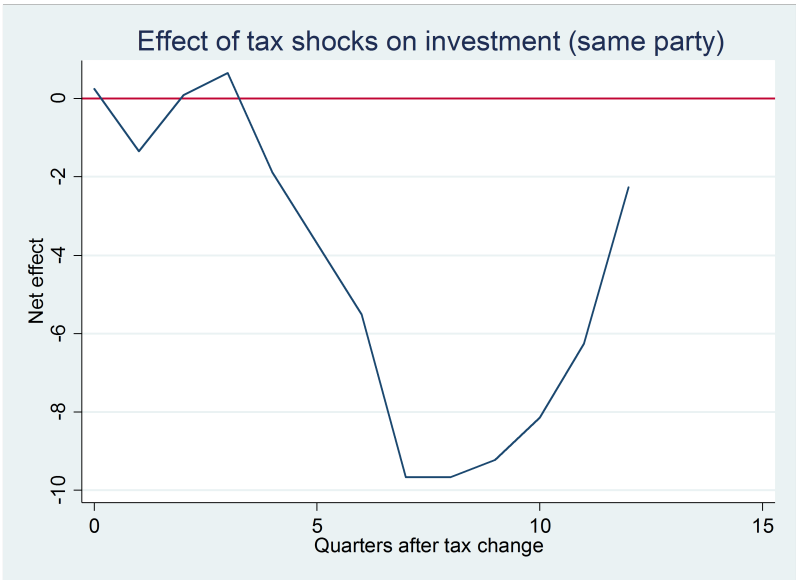

Figure 6: Tax Shocks on Investment (Same Party)

5.4 Industrial Production

The graphs below (Figures 7 and 8) plot the relationship between the twelve quarters and their net effect on industry production, with and without control for party change in the presidential administration.

When controlling for the party change of the presidency, the regression results show significance in the sixth, tenth, and eleventh quarters prior. The sixth quarter has a coefficient of -0.919 with a standard error of 0.526. The tenth quarter has a coefficient of 0.993 with a standard error of 0.544. The eleventh quarter has a coefficient of 1.045 with a standard error of 0.545. In the regression without control for presidential party change, we found significance in the sixth, tenth, eleventh, and twelfth lagged quarter. The sixth quarter has a coefficient of -1.022 and a standard error of 0.514. The tenth quarter has a coefficient of 1.078 and a standard error of 0.511. The eleventh quarter has a coefficient of 1.138 and a standard error of 0.513. The twelfth quarter has a coefficient of 1.050 and a standard error of 0.524. Data for these regressions are presented in Tables 4 and 9.

We found similar patterns in both regressions. For quarters close to the present, the effects are small and insignificant. Then starting from the sixth quarter, the tax rates have negative impact on the industrial output. A possible explanation for such negative impact is that the tax increase discourages companies to expand production. With higher taxes, companies face higher costs of operation and therefore reduce total production. Such negative impacts on the output typically need some time to take effects. Therefore, we see significant

negative correlation starting from the sixth quarter.

After the initial reduction in production, we see positive coefficients of the tax rates starting from the tenth lagged quarter and prior. This means that tax rates in the tenth quarter and prior have positive correlation with the current industrial output. One possibility is that, over a relatively longer time span, the effects of tax rates are offset by the economic growth. The positive correlation may be due to some other factors during this time period that are not observed in our model.

Considering the control for presidential change in the two regressions, we have found that the pattern remains similar regardless of the party changes in the presidency. This could potentially be explained by the hypothesis that though the two parties have different tax policies, their implementation of the tax policies were not fundamental enough to alter the basic structure of economic growth. Therefore, the change in industrial production was not particularly due to the presidential party changes.

5.4.1 Robustness Result

The regression model for difference in industrial production passes the tests for most of the Gauss-Markov Assumptions. By visually inspecting the standardized residuals vs fitted values graph, and conducting the White (p-value for Chi-squared = 0.7908 - independent;) and Breusch-Pagan test (p-value for F-test = 0.8029 - independent), we do not reject the null hypothesis that there is no heteroscedasticity. Thus, we have that the residuals have mostly constant variance given the data. Next, visually inspecting the normality plot we do not detect any significant deviation from standard normal plot. However, we tested for autocorrelation, and Durbin-Watson test p-value was 0, suggesting that we do reject the null hypothesis that there is no autocorrelation. We addressed this issue by transforming the model with Cochrane-Orcutt estimation, and obtained new estimates. The estimates were very similar to the pre-transformed model, so it did not alter our conclusions.

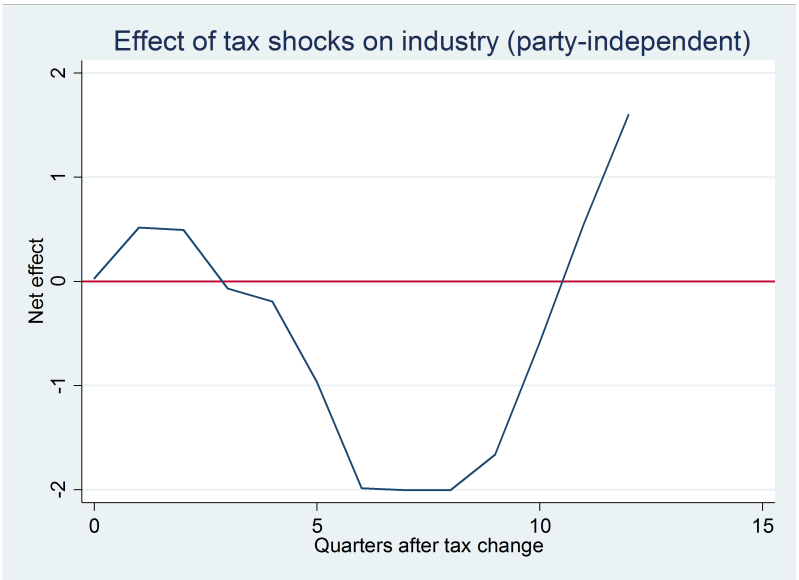

Figure 7: Tax Shocks on Indutrial Production (Party-Independent)

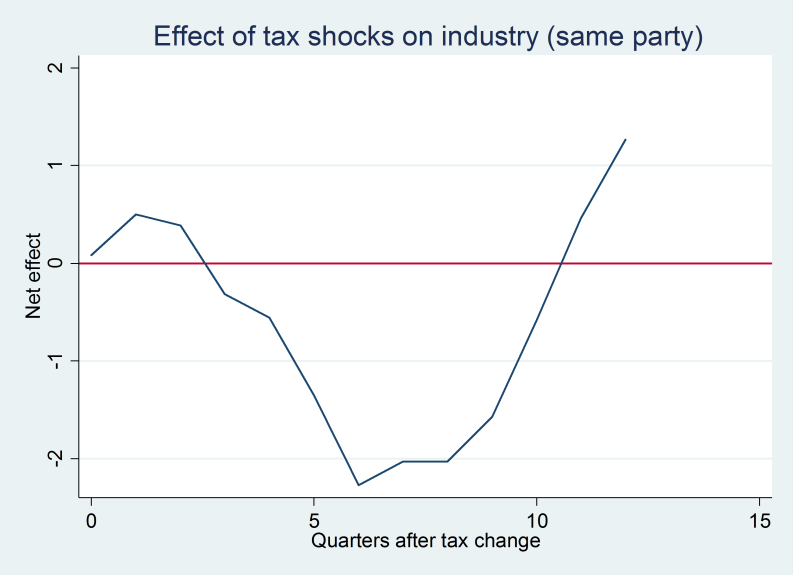

Figure 8: Tax Shocks on Industrial Production (Same Party)

5.5 Unemployment

The graphs below (Figures 9 and 10) plot the relationship between the previous twelve quarters and their net effect on unemployment, with and without control for party change in the presidential administration.

While controlling the tax rate changes under the same presidency, the regression results show significance in the fourth, sixth, seventh, eleventh, and twelfth quarters prior. The fourth quarter has a coefficient of 0.212 with a standard error of 0.110. The sixth quarter has a coefficient of 0.204 with a standard error of 0.110. The seventh quarter has a coefficient of 0.376 with a standard error of 0.110. The eleventh quarter has a coefficient of -.189 with a standard error of .114. The twelfth quarter has a coefficient of -0.257 with a standard error of 0.118. In the regression without control for the presidential party change, the sixth, seventh, eleventh, and twelfth lagged quarters are significant. The sixth quarter has a coefficient of 0.218 with the standard error of 0.107. The seventh quarter has a coefficient of 0.393 with the standard error of 0.107.The eleventh quarter has a coefficient of -0.232 with a standard error of 0.107. The twelfth quarter has a coefficient of -0.270 with the standard error of 0.110. Data for these regressions are presented in Tables 5 and 10.

The effects of tax shocks on unemployment follow similar patterns in both regressions. For recent quarters, the effects are insignificant and small. Starting from the fourth quarter, the tax rates have positive correlation with unemployment. Such impacts become more significant in the sixth and seventh quarter. The p value for the seventh quarter is 0.001 in both regressions. Such positive impact on unemployment is potentially due to the prospect that a tax increase discourages companies from hiring. With higher taxes, companies tend reduce total employment, facing higher costs of operation. The substantial impact on unemployment typically takes some time to take effect. Hence, the significant positive correlation starts from the sixth quarter.

After the rise in unemployment starting from the sixth quarter, we see negative coefficients of the tax rates tracing back to the eleventh lagged quarter and prior. The tax rates in the eleventh quarter and prior have negative correlation with unemployment. This is contrary to the initial effects of tax rates, which drove up unemployment. One explanation of such a reverse effect is that in a longer time span, the effects of tax rates are no longer reflected in the long run unemployment. Moreover, the negative correlation may come from some other external factors of the economy that decreased unemployment. Such factors are correlated with the early tax changes but are not captured in our model.

If we consider the control for the presidential change in the two regressions, we have found that the unemployment follows a similar pattern regardless of presidential party changes. Though two parties may have different tax policies, the impact of such tax policies by the partisan differences is the same to unemployment. Unemployment is affected in the same way regardless of whether the tax change comes from a Republican or Democratic government. One explanation is that despite the party differences in the tax policies, the actual impact of the policies on unemployment is independent of the governmental principles.

As long as there are taxes, unemployment reacts the same way regardless of a Republican or Democratic president.

5.5.1 Robustness Result

The regression model for difference in unemployment passes the tests for most of the Gauss-Markov Assumptions. By visually inspecting the standardized residuals vs fitted values graph, and conducting the White test (p-value for Chi-squared test - 0.0157 for party-affiliated; 0.0242 - independent) and Breusch-Pagan test (p-value for F-test = 0.3238 - independent; 0.5074 for party-affiliated), we have an interesting case here that there is no linear heteroscedasticity, but there is a possible quadratic heteroscedasticity. So we ran an FGLS, and the results were not much different but with smaller standard errors for each estimator, as expected. Next, visually inspecting the normality plot we do not detect any significant deviation from standard normal plot. However, we tested for autocorrelation, and Durbin-Watson test p-value was 0, suggesting that we do reject the null hypothesis that there is no autocorrelation. We addressed this issue by transforming the model with Cochrane-Orcutt estimation, and obtained new estimates. The estimates were very similar to the pre-transformed model, so it did not alter our conclusions.

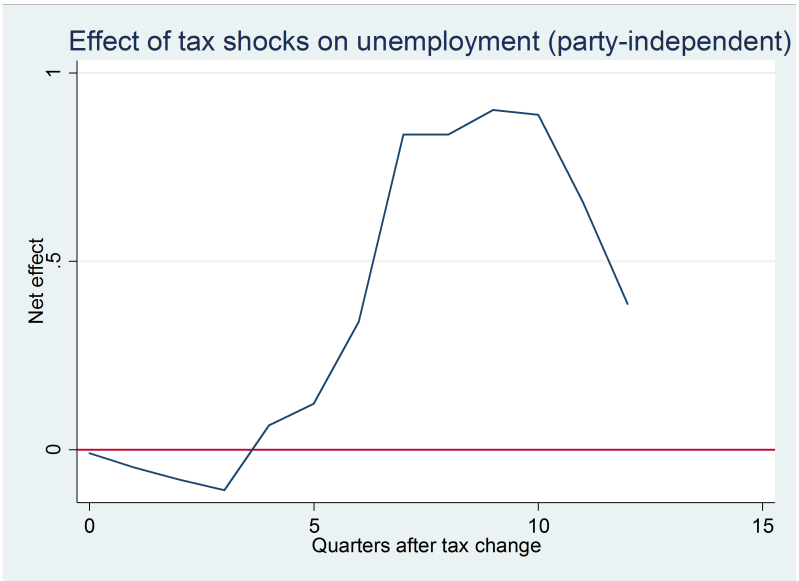

Figure 9: Tax Shocks on Unemployment rate (Party-Independent)

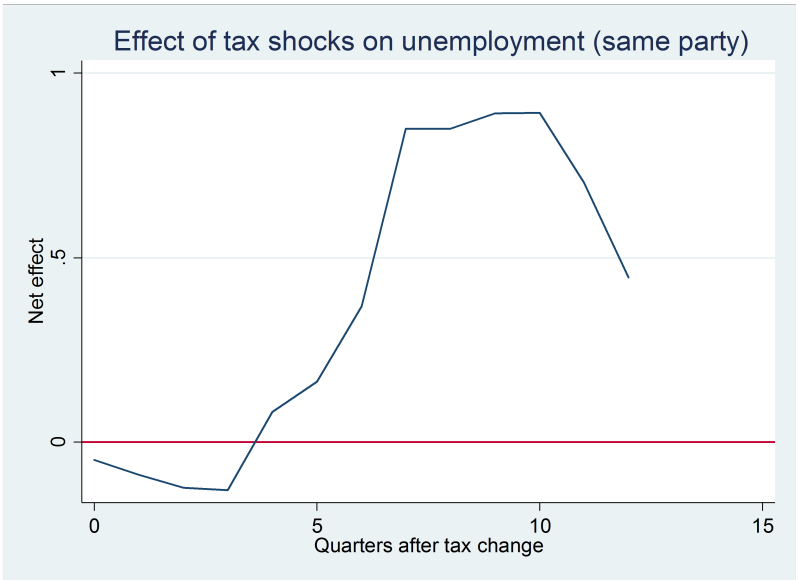

Figure 10: Tax Shocks on Unemployment Rate (Same Party)

6 Extension

After controlling for administration changes, we have recognized the short term and long term economic impacts of tax shocks. For the most part, tax increases cause negative short-term effects on economic indicators such as investment, industry product, or unemployment. In the longer run, however, the tax-induced change in these indicators tend to return most of the way to their pre-tax levels.

One interesting question concerns universality of such a pattern. Do tax rates follow a similar pattern for all components of the economy in addition to the ones we have investigated? Was it pure chance that labor force participation was the only one of the indicators which didn't change significantly after a tax shock? It would be of interest for future research to study the relationship between exogenous tax rates and other elements of the economy, such as inflation, interest rate, etc. Moreover, is this pattern particular to the economic conditions only in the United States? We could also study whether such relationship exists in other economies as well.

Furthermore, more research needs to be done to investigate the underlying causes of our findings. Specifically, what direct effects do these exogenous taxes have on the economic entities? How do such effects in turn lead to changes in the other economic components? Are there interactive effects between the economic elements that comprise general economy? By investigating the immediate causal relationships between exogenous tax rates and the economic elements, we will

have a better understanding of why the aggregate effects of the exogenous taxes follow such a pattern found in our study.

7 Conclusion

Our results are highly suggestive of exogenous tax changes having significant effects on economic growth, across multiple possible macroeconomic indicators. These effects are cumulative, adding up across the years following the tax shock, and hitting their maximum around nine quarters later, before the change rates of these indicators move back (but fail to reach) their pre-tax levels. The near-universality of this phenomenon, combined with its continued presence when we restrict the dataset to years where the same party that passed the tax remains in control, indicates that it is a meaningful pattern which bears further investigation.

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8 Appendix: Tables and Figures

Table 1: GDP (Same Party)

Variable	**Coefficient**	**(Std. Err.)**
exo	0.032	(0.293)
exo1_same	-0.316	(0.290)
exo2_same	0.308	(0.289)
exo3_same	-0.329	(0.291)
exo4_same	-0.490†	(0.292)
exo5_same	-0.440	(0.292)
exo6_same	-0.449	(0.293)
exo7_same	-0.491†	(0.292)
exo8_same	-0.086	(0.303)
exo9_same	0.108	(0.301)
exo10_same	0.036	(0.302)
exo11_same	0.514†	(0.303)
exo12_same	0.385	(0.315)
Intercept	0.738**	(0.069)

Table 2: Workforce Participation (Same Party)

Variable	**Coefficient**	**(Std. Err.)**
exo	0.134*	(0.059)
exo1_same	-0.048	(0.059)
exo2_same	-0.089	(0.059)
exo3_same	0.061	(0.059)
exo4_same	0.064	(0.059)
exo5_same	-0.031	(0.059)
exo6_same	0.011	(0.059)
exo7_same	-0.034	(0.059)
exo8_same	-0.059	(0.061)
exo9_same	-0.068	(0.061)
exo10_same	0.003	(0.061)
exo11_same	-0.001	(0.061)
exo12_same	-0.023	(0.064)
Intercept	0.035*	(0.014)

Table 3: Investment (Same Party)

Variable	**Coefficient**	**(Std. Err.)**
exo	0.247	(1.382)
exo1_same	-1.586	(1.368)
exo2_same	1.426	(1.365)
exo3_same	0.567	(1.372)
exo4_same	-2.541†	(1.378)
exo5_same	-1.812	(1.378)
exo6_same	-1.810	(1.381)
exo7_same	-3.524*	(1.378)
exo8_same	-0.639	(1.428)
exo9_same	0.444	(1.422)
exo10_same	1.074	(1.424)
exo11_same	1.898	(1.427)
exo12_same	3.991**	(1.485)
Intercept	0.990**	(0.327)

Table 4: Industrial Production (Same Party)

Variable	**Coefficient**	**(Std. Err.)**
exo	0.082	(0.528)
exo1_same	0.420	(0.522)
exo2_same	-0.113	(0.521)
exo3_same	-0.702	(0.524)
exo4_same	-0.241	(0.526)
exo5_same	-0.798	(0.526)
exo6_same	-0.919†	(0.527)
exo7_same	0.029	(0.526)
exo8_same	0.213	(0.545)
exo9_same	0.454	(0.543)
exo10_same	0.993†	(0.544)
exo11_same	1.045†	(0.545)
exo12_same	0.805	(0.567)
Intercept	0.672**	(0.125)

Table 5: Unemployment (Same Party)

Variable	**Coefficient**	**(Std. Err.)**
exo	-0.048	(0.110)
exo1_same	-0.039	(0.109)
exo2_same	-0.036	(0.109)
exo3_same	-0.007	(0.109)
exo4_same	0.212†	(0.110)
exo5_same	0.082	(0.110)
exo6_same	0.204†	(0.110)
exo7_same	0.376**	(0.110)
exo8_same	0.106	(0.114)
exo9_same	0.041	(0.113)
exo10_same	0.002	(0.114)
exo11_same	-0.189†	(0.114)
exo12_same	-0.257*	(0.118)
Intercept	0.015	(0.026)

Table 6: GDP (Party Independent)

Variable	**Coefficient**	**(Std. Err.)**
exo	-0.013	(0.285)
exo1	-0.301	(0.285)
exo2	0.336	(0.284)
exo3	-0.212	(0.284)
exo4	-0.444	(0.285)
exo5	-0.420	(0.285)
exo6	-0.447	(0.285)
exo7	-0.584*	(0.285)
exo8	-0.242	(0.285)
exo9	0.125	(0.284)
exo10	-0.028	(0.284)
exo11	0.617*	(0.284)
exo12	0.488†	(0.291)
Intercept	0.744**	(0.067)

Table 7: Workforce Participation (Party Independent)

Variable	**Coefficient**	**(Std. Err.)**
exo	0.129*	(0.059)
exo1	-0.054	(0.059)
exo2	-0.084	(0.058)
exo3	0.064	(0.058)
exo4	0.075	(0.059)
exo5	-0.040	(0.059)
exo6	0.014	(0.059)
exo7	-0.030	(0.059)
exo8	-0.065	(0.059)
exo9	-0.059	(0.058)
exo10	0.005	(0.058)
exo11	0.001	(0.058)
exo12	0.000	(0.060)
Intercept	0.036**	(0.014)

Table 8: Investment (Party Independent)

Variable	**Coefficient**	**(Std. Err.)**
exo	-0.341	(1.340)
exo1	-1.441	(1.339)
exo2	1.470	(1.334)
exo3	1.138	(1.334)
exo4	-2.124	(1.340)
exo5	-1.431	(1.338)
exo6	-1.758	(1.339)
exo7	-3.869**	(1.338)
exo8	-1.183	(1.340)
exo9	0.525	(1.332)
exo10	0.468	(1.332)
exo11	2.231†	(1.336)
exo12	4.477**	(1.367)
Intercept	1.000**	(0.315)

Table 9: Industrial Production (Party Independent)

Variable	**Coefficient**	**(Std. Err.)**
exo	0.027	(0.514)
exo1	0.489	(0.514)
exo2	-0.021	(0.512)
exo3	-0.563	(0.512)
exo4	-0.126	(0.514)
exo5	-0.773	(0.513)
exo6	-1.022*	(0.514)
exo7	-0.062	(0.513)
exo8	0.045	(0.514)
exo9	0.340	(0.511)
exo10	1.078*	(0.511)
exo11	1.138*	(0.513)
exo12	1.050*	(0.524)
Intercept	0.673**	(0.121)

Table 10: Unemployment (Party Independent)

Variable	**Coefficient**	**(Std. Err.)**
exo	-0.008	(0.107)
exo1	-0.038	(0.107)
exo2	-0.032	(0.107)
exo3	-0.028	(0.107)
exo4	0.172	(0.107)
exo5	0.057	(0.107)
exo6	0.218*	(0.107)
exo7	0.393**	(0.107)
exo8	0.104	(0.107)
exo9	0.064	(0.107)
exo10	-0.012	(0.107)
exo11	-0.232*	(0.107)
exo12	-0.270*	(0.110)
Intercept	0.013	(0.025)