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One Nation Under the Dollar? The State-Level Impact of Monetary Policy Shocks and Implications for the United States as an Optimal Currency Area

–Abstract

This paper examines the Optimal Currency Area status of the United States using an updated Romer and Romer monetary policy shock series and Coincident Economic Index data to quantify impact of policy shocks on US states. It employs a distributed lag model to produce a cumulative impulse response function for each state. The results of this analysis suggest that different states respond in different ways to monetary policy shocks, bringing the optimal currency area status of the US into question.

–Introduction

When the Euro was created, it was modelled on the United States' use of the dollar, on the assumption that the US constitutes an Optimal Currency Area. An Optimal Currency Area, as defined by Mundell (1961) and McKinnon (1963) is a territory with flexible wages and prices in which capital and labor are free to move to where they are needed, similar business cycles (meaning a recession or boom in part of the territory is indicative of a recession or boom across the entire territory), and a means of spreading risk across the territory by redistributing money to parts negatively affected by the aforementioned flexible wages and prices (typically in the form of taxes and subsidies). Accordingly, a territory with these characteristics would benefit from using a single currency and a single central bank to conduct its monetary policy as opposed to having several such banks to service the needs of smaller regions of the territory. However, there has been some disagreement in the academic literature as to whether or not the US indeed constitutes an OCA. In order to answer this question, this paper employs a more robust metric for identifying and quantifying monetary policy shocks than previous papers on the subject have used. The resulting policy shock metric is used in conjunction with monthly state-level output data to test the US' OCA status. The results of this analysis show that monetary policy shocks had a mostly negative medium-term effect on output, as expected, but that the magnitude of the responses differs across states, contradicting the OCA hypothesis.

–Literature Review

This paper can be split in two parts: 1.) developing a robust series for identifying and quantifying policy shocks, and 2.) the employment of this series to test the US' status as an optimal currency area. For the first part, I rely heavily on Christina and David Romer's method for quantifying monetary policy shocks described in their seminal 2004 paper on the subject. In it, the Romers use Federal Reserve Greenbook data on unemployment and predictions about GDP growth to attempt to strip away the effects produced by the more obvious factors at play in the Federal Reserve's determination of what the Funds Rate should be–namely the level of the Funds Rate at the previous meeting of the FOMC, the projected changes in both GDP and its deflator index, and unemployment. They construct their shock series from the residuals, the factor in their regression equation that represents the otherwise unexplained portion of the outcome and thus genuine shocks to monetary policy.

The second part, testing the OCA status of the US, relies on a broader body of knowledge and scholarly work, starting with that of Mundell (1961) and McKinnon (1963), who collectively pioneered the notion of an Optimal Currency Area in the literature in the 1960's. Mongelli (2002) gave a broader overview of the state of the literature on the subject some years later after it had had time to mature and develop and wrote in the context of the then-recently established European Monetary Union and the implications of OCA theory for its operation.

This was all in service of understanding Beckworth's 2009 paper which in turn served as the inspiration for this one. Drawing on previous papers whose results called the US' OCA status into question, such as the observed variation in business cycles

across the US as noted by Owyang et al. (2005) and Crone (2005, 2006), asymmetric effects of monetary policy shocks across the US as noted by Owyang and Wall (2006), and Kouparitsas' (2001) finding several BEA regions of the US not being in the dollar OCA, Beckworth sought in his paper to test the OCA status of the US by testing the reaction of US states economies to monetary policy shocks, much in the same way this paper does. Beckworth used a strategy of seemingly unrelated regressions to estimate a vector autoregression for each state representing its response to monetary policy shocks. While his analysis is more detailed as he accounts for the effects of spillover between neighboring states, his use of vector autoregressions represents a potential problem as these have been suggested to be of questionable effectiveness in accurately identifying the effects of monetary policy shocks due to well-known problems of fundamentalness. In short, this means VARs have a tendency to misattribute the timing and/or magnitude of shocks on account of economic agents being privy to information, such as forecasts of the future state of the economy, which the econometricians estimating VAR models do not have access to. As such, response functions to monetary policy which are estimated using VARs are prone to bias. The approach taken by the Romers, on the other hand, avoids this pitfall by explicitly accounting for forward-looking anticipatory movements in the funds rate, resulting in a shock series devoid of these issues.

–Methods

However, before we can explore the effect of monetary policy shocks on state economies, we need a means of accurately identifying those shocks. This is one of the primary ways my paper differs from Beckworth's, as he used a vector autoregression to identify the size of policy shocks. While vector autoregressions are generally a valid way of making forecasts, their efficacy with respect to identifying shocks to monetary policy is somewhat questionable. This is due to the well-known issues of fundamentalness VARs have, whereby the econometricians estimating them are not privy to all of the same information possessed by economic agents. Enter the measure of monetary policy shocks developed by Christina and David Romer in their seminal 2004 paper on the subject. The way they measure shocks makes their series comparatively devoid of the aforementioned issues associated with vector autoregressions as well as more general concerns relating to endogeneity and anticipatory movements in response to predictions about the future.

In their paper, they attempt to strip away the effects of the more obvious factors affecting the determination about the level of the federal funds rate by the Federal Reserve's Federal Open Markets Committee (FOMC). The Funds Rate determines how expensive it is for banks, and by extension people and businesses, to borrow money, since one of the key functions of the Federal Reserve is to act as a lender of last resort or a banker's bank. Specifically, the Romers account for 1) the level of the Funds Rate at the previous meeting of the FOMC, 2) forecasted changes in GDP and its deflator index, and 3.) the unemployment rate as of the meeting of the FOMC meeting. Assuming there are no other systematic factors at play in the FOMC's decision to raise or lower the Funds

Rate, only the genuine shock would be left, this genuine shock being what the Romers' paper attempts to measure. To do this, they use data on the change in GDP and its index as well as estimated current unemployment taken from Federal Reserve Greenbooks used during meetings of the Federal Open Markets Committee. They estimate the following regression.

$$\Delta ff_m = \alpha + \beta ffb_m + \sum_{i=-1}^{2} \gamma_i \widetilde{\Delta y}_{mi} + \sum_{i=-1}^{2} \lambda_i \left(\widetilde{\Delta y}_{mi} - \widetilde{\Delta y}_{m-1,i}\right) + \sum_{i=-1}^{2} \varphi_i \tilde{\pi}_{mi}$$

$$+ \sum_{i=-1}^{2} \theta_i \left(\tilde{\pi}_{mi} - \tilde{\pi}_{m-1,i}\right) + \rho \tilde{u}_{m0} + \varepsilon_m$$

β, γ_i, λ_i, φ_i, θ_i, and ρ are all coefficients of the variables (or groups thereof) they are positioned next to. Δff_m is the percentage change in the federal funds rate at meeting *m*, ffb_m is the level of the funds rate before any changes stemming from meeting *m*, $\widetilde{\Delta y}_{mi}$ is the Greenbook forecast of the percentage change in real annualized GDP growth at meeting *m* in quarter *i*, $\tilde{\pi}_{mi}$ is the Greenbook forecast of the percentage change in the GDP deflator at meeting *m* in quarter *i*, $\tilde{u}_{m0}$ is the Greenbook forecast of unemployment for the month in which meeting *m* takes place, and ε_m is a residual term representing the genuine monetary policy shock the Romers were aiming to identify and quantify. Thus, it is this residual term which comprises the series the Romers develop, and they spend the rest of their paper showing how well it makes predictions about a variety of phenomena, including the Funds Rate.

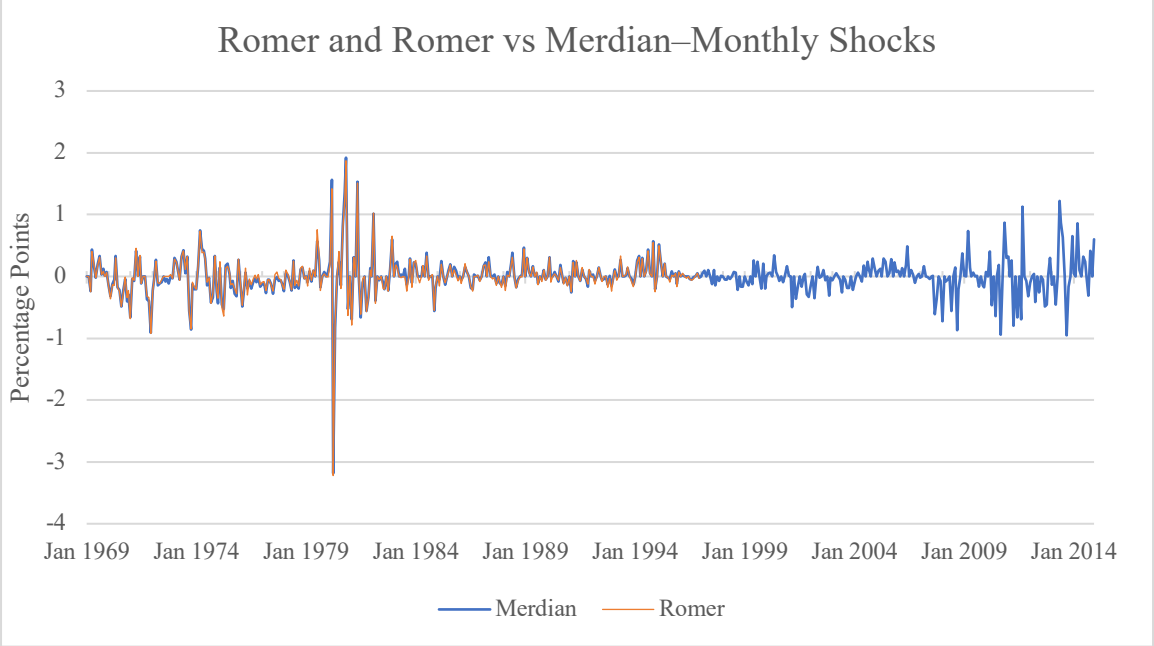
However, the Romer's series has one major flaw: the data it utilizes (specifically the forecasts of the change in GDP, its index, and unemployment) is initially highly confidential upon being produced, only becoming public after a 7-year lag, so the

Romers' original series only runs from 1969 through the end of 1996. However, as previously stated, the data does eventually become public and so a major part of the work involved in writing this paper consisted of replicating and then extending the Romers' monetary policy shock series through the end of 2014 in order to extend the time period over which the effect of shocks could be examined.

This was achieved using publicly available Greenbook projections of growth in both GDP and its price index (plus derivations of these two representing changes in their predicted levels) as well as unemployment to fill in these variables for the period between 1997 and 2014. To extend the variable representing the intended federal funds rate at FOMC meetings, I used the method described by Breitenlechner (2018), professor of economics at the University of Innsbruck, who used the Federal Reserve Bank of St Louis' Federal Reserve Economic Database (FRED) end-of-month federal funds rate data series for the period between January 1997 and November 2008. He used the average of the FOMC's target federal funds rate range for December 2008, and monthly averages of the shadow short rate as described by Wu and Xia (2016) starting January 2009. The reason for using the shadow short rate after the end of 2008, at the onset of the Great Recession, is that the funds rate was already near zero by that point and conventional economic wisdom held that negative interest rates (i.e. depositors effectively paying their banks to hold their money instead of the other way around) were not really possible, or rather would cause severe economic consequences if they were ever tried, so many central banks, including the Federal Reserve, were hesitant to implement them. However, even though the Federal Reserve never actually implemented negative interest rates as such, Wu and Xia's (2016) series suggests that the overall monetary policy stance

(including quantitative easing and forward guidance) was consistent with negative nominal interest rates. The result of all of this work is a series that matches up almost perfectly with the Romers' series over the same period ($r^2 = .9854$). After this, the updated Romer series is converted from a series with a frequency measured in FOMC meetings to one measured in months. Though the FOMC now meets 8 times per year, it usually met 12 or 13 times per year prior to switching to its current schedule in 1981. As such, the FOMC occasionally met more than once in the same month, such as the two meetings which took place in May of 1970. In such cases, the residuals of both meetings were added together to obtain that month's entry in the monthly series.

Figure 1: Original vs Extended Romer Shock Series



Having explained my recreation of the Romers' policy shock series, let us now move on to how this was used to test the optimal currency area status of the US. The measure used to represent the various state economies was the monthly coincident economic index (CEI) produced by the Philadelphia Federal Reserve Bank for the period

of January 1979 through December 2014. Based on the work of Stock and Watson (1989), the CEI is a dynamic single-factor model which uses four state-level variables (nonfarm payroll employment, average hours worked in manufacturing, wage and salary disbursements deflated by the US City Average of the Consumer Price Index, and unemployment) to produce a single statistic meant to summarize real economic conditions. It is useful for our purposes here because it is measured in real rather than nominal terms (and thus does not need to be deflated in order to account for inflation, something which would otherwise be an issue) and is constructed such that all states may be compared to each other and the nation as a whole. Each state's CEI series was regressed against the updated Romer shock series using a Distributed Lag model with 24 lags to produce a cumulative impulse response function to quantify impact, with the US CEI series being used as a control. This resulted in the equation

$$\Delta \ln CEI_s = \alpha + \sum_{i=1}^{24} \beta_{s,i} RR04_{t-i} + \sum_{i=0}^{24} \gamma_i \Delta \ln USCEI_{t-i} + \mu_s$$

where $\Delta \ln CEI_s$ is the first difference in the natural log of the coincident economic index for state *s*, $RR04_{t-i}$ is the Romer shock series at month *t* minus *i*, $\Delta \ln USCEI_{t-i}$ is the first difference in the natural log of the coincident economic index for the US at month *t* minus *i*, and μ_s is the error term for the regression of state *s*. Natural logs and first differences were used for the CEI variables in order to avoid issues of nonstationarity.

–Results

The results of this regression show that most states (42 out of 50) would have a cumulatively negative response to an increase in the Fed Funds Rate at any time horizon within 24 months of the shock. By comparison, only 28 states ever had cumulatively positive responses at any time horizon within 24 months of the shock. Out of the 1200 responses, 824 were negative compared to only 376 positive responses. In general, more states responded in a cumulatively negative fashion as the number of months since the shock went up. However, most of the responses in either direction fail to achieve any level of statistical significance; only 36 states have any statistically significant responses at or above the 90% level, 28 at or above the 95% level, and 18 at or above the 99% level. Out of 1200 responses, only 471 were significant at or above the 90% level, 391 at or above the 95% level and 298 at or above the 99% level.

In the context of the literature, the responses being mostly negative in response to raising the funds rate is not especially surprising or interesting (both Beckworth and the Romers found similar results), and this lines up with classical economic theories; raising the Funds rate would make it more expensive for banks, and by extension people and businesses, to borrow money, a state of affairs which would inevitably have a negative effect on the economy as a whole. However, the fact that the responses were mostly, rather than universally, negative is of some interest, as is the fact that the magnitude of the responses differed considerably between states (see Figure 2 for an abridged visual summary of the results).

This suggests different states respond to policy shocks in different ways, and thus by extension that the US does not represent an optimal currency area. If these or similar

results do indeed continue to be the case in future studies of this topic, it would provide evidence against the US being an optimal currency area. As it stands, it would appear that some areas of the country, all else equal, might benefit from having greater control of their own monetary policy, particularly states in the rust belt such as Michigan and West Virginia (which respond negatively to increases in the Funds Rate), as well as Texas and Georgia (which respond positively to them).

Speaking of the rust belt states (Pennsylvania, West Virginia, Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota), most of them respond negatively to increases in the funds rate as mentioned previously. This may be because increases in the cost of borrowing money are especially detrimental to the industries which have historically driven the economies of these states, all of which are known for having large manufacturing and resource extraction sectors, and particularly for the products and resources they made and extracted being less competitive on the global market over the last 40 or so years. At the very least it would not surprise me if the decline of the coal and auto industries in this region was fueled in some part by the funds rate hikes and stagflation in the 1970's and 1980's. Indiana, on the other hand, seems uniquely immune from the effects of these shocks one way or the other. While it does not appear to benefit significantly from funds rate hikes either, its neutrality is nonetheless interesting.

Indiana isn't alone in scarcely being affected by rate hikes; Idaho, Nebraska, Kansas, Missouri, Arkansas, Louisiana, Connecticut, Maine and New Jersey seem to be similarly unaffected by them. For some, this could be because their economies have transitioned away from industrial manufacturing, notably New Jersey. I suspect this sector left the state as it became more of a suburb of both New York and Philadelphia,

which would have driven up the price of real estate. Idaho, Nebraska, and Kansas, all known for their large agricultural sectors, may be apparently unaffected because the CEI does not look at farm payroll employment as one of its factors. If commercial fishing counts under farm payroll employment, Maine might be similarly affected.

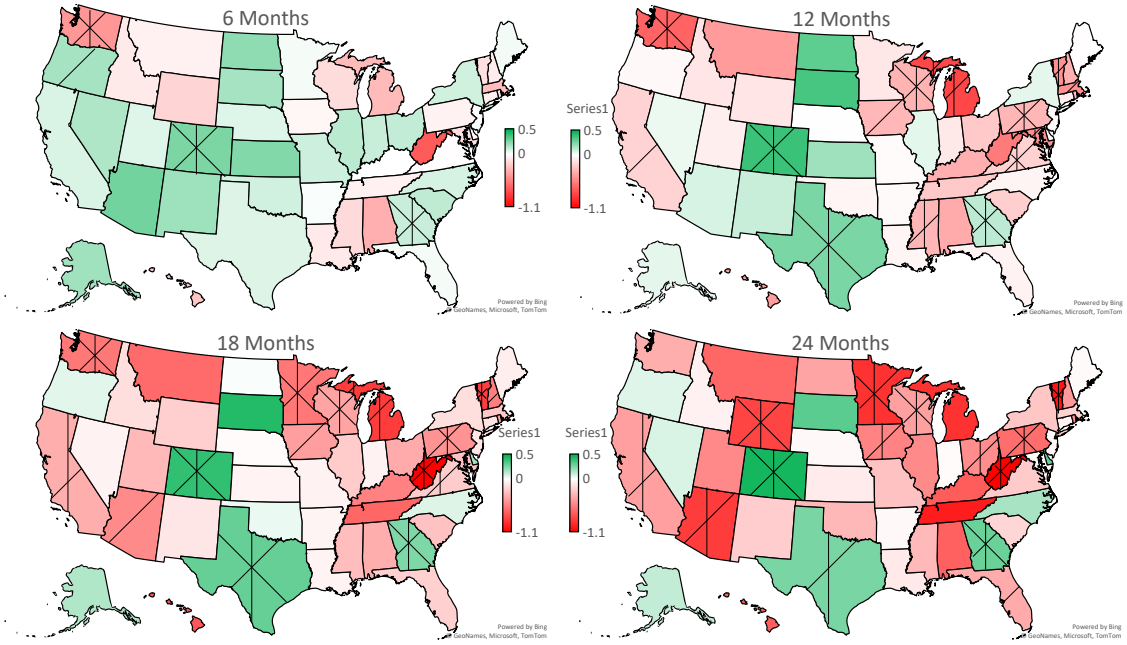
Some states seem to be not only more resilient to policy shocks but actually seem to benefit from them, notably Texas, Colorado, and Georgia, and to a lesser extent South Dakota, North Carolina, and Delaware. Texas seems interesting since it is also famous for its petrochemical industry, though it also has a strong technology and agriculture sectors.

North and South Dakota are a case of two houses which start out alike in dignity but do not end as such. Both see positive effects from funds rate hikes after 6 and 12 months, but after 18 months, North Dakota is borderline, becoming negative after 24 months, while South Dakota retains positive effects from the shock throughout. It is unclear what might be behind this divergence, but this is certainly fertile ground for future research.

All of this points to a myriad of fascinating explanations for why this has been the case, such as how diversification of a state's economy affects its response to policy shocks. It could also be the case that the risk sharing mechanisms in place to mitigate the effects of regional downturns are not working as well as they need to in order to maintain the US' OCA status. Alternatively, it may have something to do with the inability of people in certain parts of the country to move to where their labor is needed, for reasons as varied as a lack of public transit to lack of affordable housing (public or otherwise) to a simple skills mismatch, as some workers have skills which translate to different jobs

more easily than others, which will make it easier for them to find and get new jobs in the event they find themselves laid off than those whose skills do not transfer as well.

Figure 2: Map of IRF Results at 6, 12, 18, and 24 months



–Conclusion

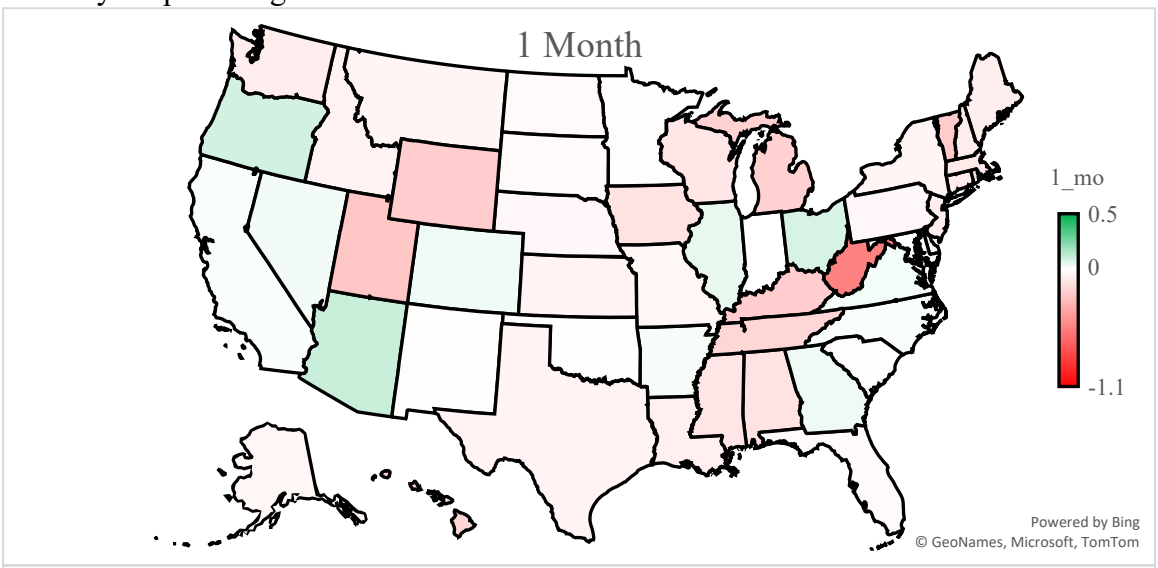
This paper used a measure of monetary policy shocks relatively immune from problems of endogeneity and anticipatory movements to measure the effect of those shocks on US state economies. The results of this analysis show that the directionality of the response to these shocks was not universal, and nor was the magnitude of said responses. Such an observation is contrary to the criteria needed to form an optimal currency area. While, in the context of the literature, it is not surprising that the responses to raising the funds rate would be mostly negative, it *is* notable that that they are only mostly, rather than near-enough universally, negative. Also of note is the considerable range in the magnitude of the responses in question. Taken together, these results give credence to the notion of the US not being an optimal currency area. The reasons for this are varied and likely interconnected.

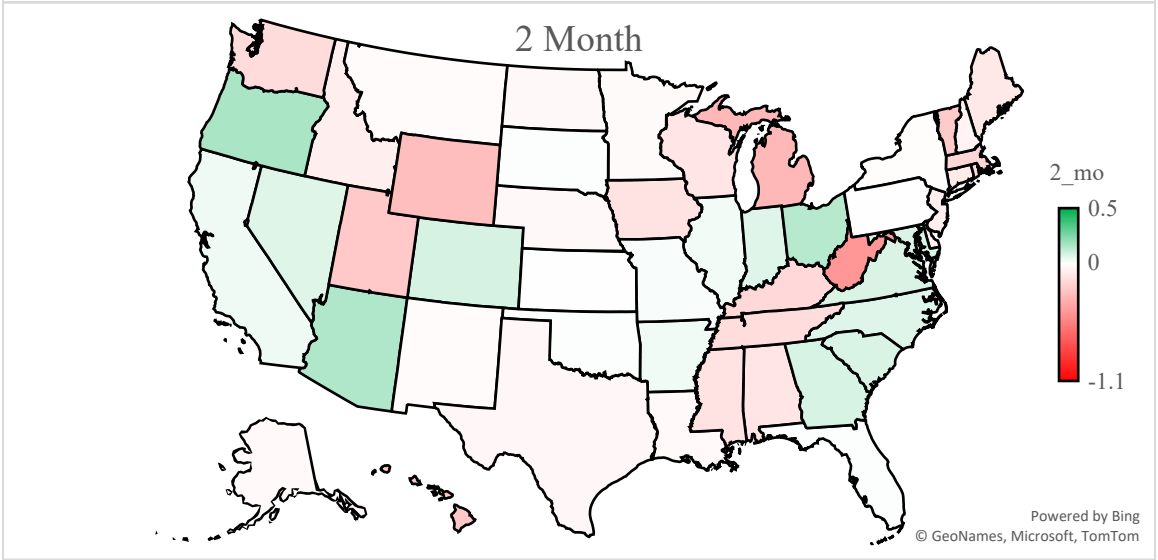
So where do we go from here? What could I have done differently? Well, for a start, it would have been nice to be able examine a time period longer than 36 years, either from before 1979 or after 2014, though I doubt this will be possible except with the passage of time. The Romers' shock series starts a whole decade before the CEI series does, though I imagine 1979 was chosen as the starting year for the CEI data since that was the most recent year the requisite data was available for all 50 states at the time the series was first produced, so this is unlikely to happen, at least in my eyes. I am similarly pessimistic about a reduction in lag associated with the Romers' series owing to the extant security concerns that already surround it. That said, it will be interesting to re-run this experiment in a few years once the data used in the Romers' series finally reflects the US economy's exit from the period of the Shadow Short Rate's use in late 2015 as well

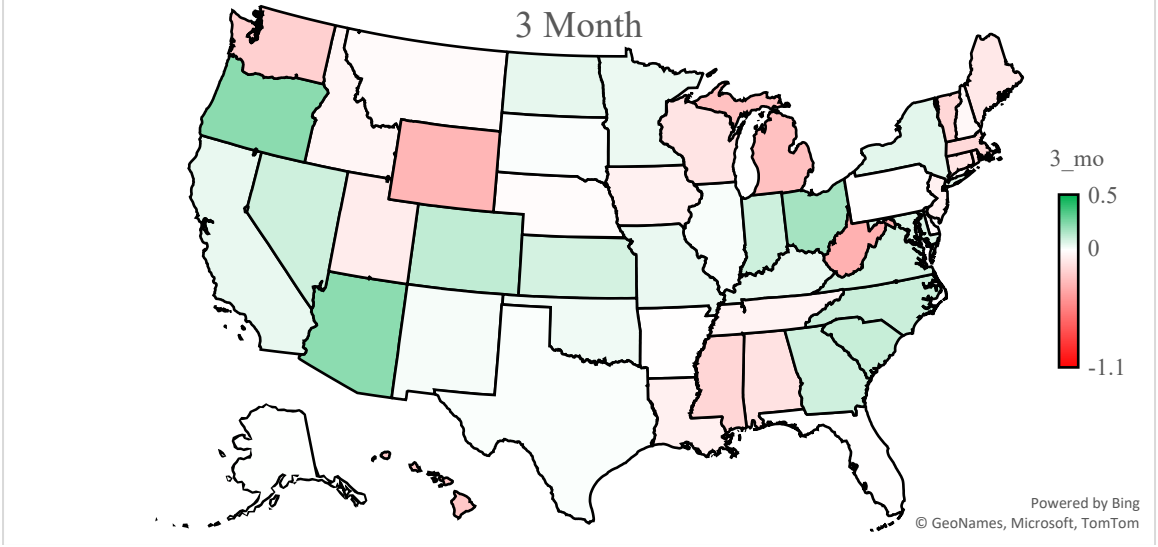
as the state of the economy during the COVID pandemic. Additionally, my paper does not employ the more sophisticated method Beckworth used in his paper that enabled him to account for the effect of spillover between neighboring states as well as more regional trends which might have affected a few geographically close states rather than the country as a whole.

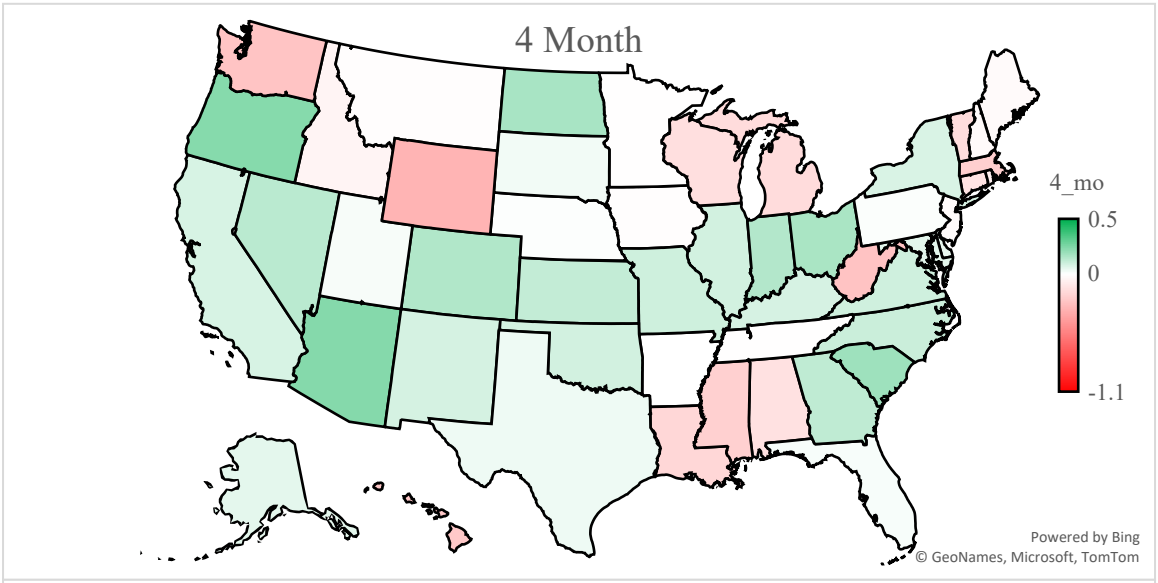
Beyond this, it would be fascinating to examine other micro- and macro-economic explanations of the observed results, such as how diversification of a state's economy affects its response to policy shocks. It could also be the case that the risk sharing mechanisms in place to mitigate the effects of regional downturns are not working as well as they need to in order to maintain the US' OCA status. Alternatively, it may have something to do with the inability of people in certain parts of the country to move to where their labor is needed, for reasons as varied as a lack of public transit to lack of affordable housing (public or otherwise) to a simple skills mismatch, as some workers have skills which translate to different jobs more easily than others, which will make it easier for them to find and get new jobs in the event they find themselves laid off than those whose skills do not transfer as well. Finally, it could be due to increased risk aversion brought about by America attaining its place in the global middle class, something which might have made most of her population afraid to lose what they had toiled so long to attain, so why take the risk of making things better when what you have is already quite comfortable? All of these however are purely speculative as explanations for the observed divergent effects of monetary policy shocks across states.

Monthly Maps of Regression Results





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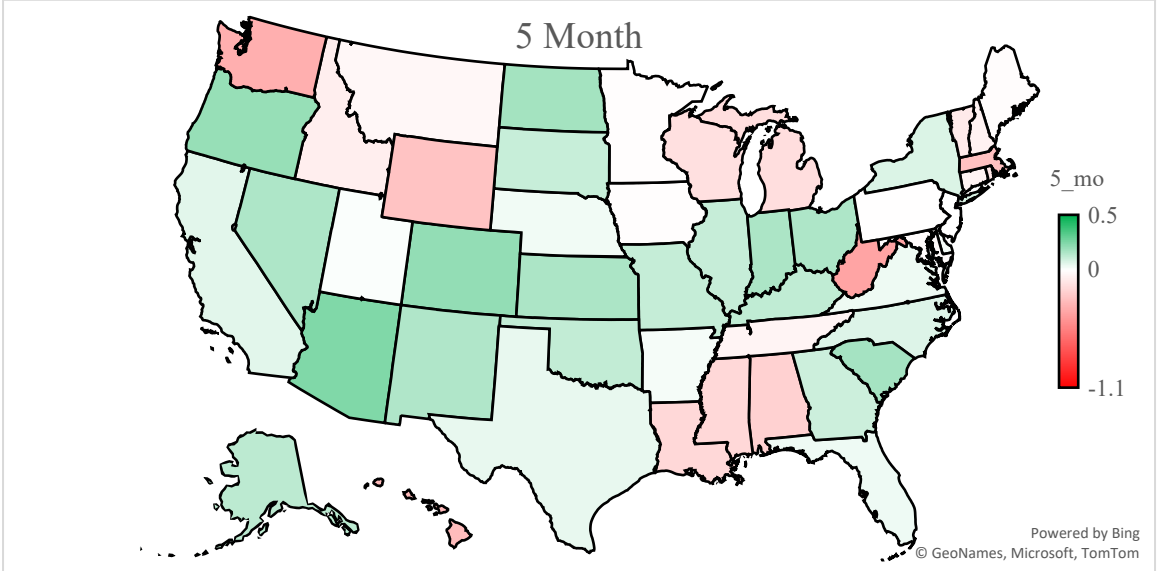
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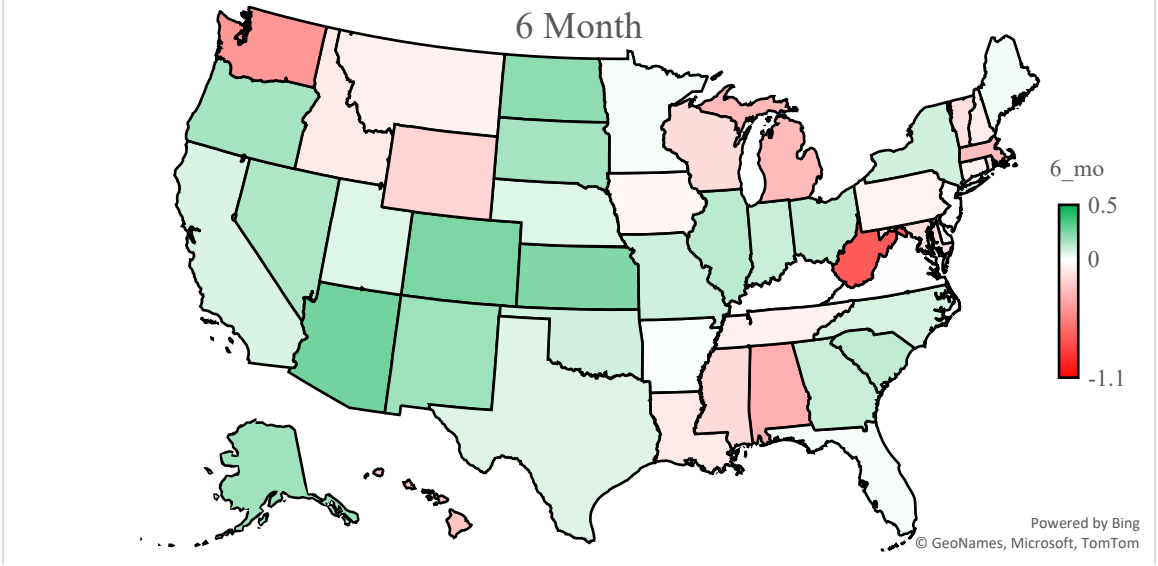
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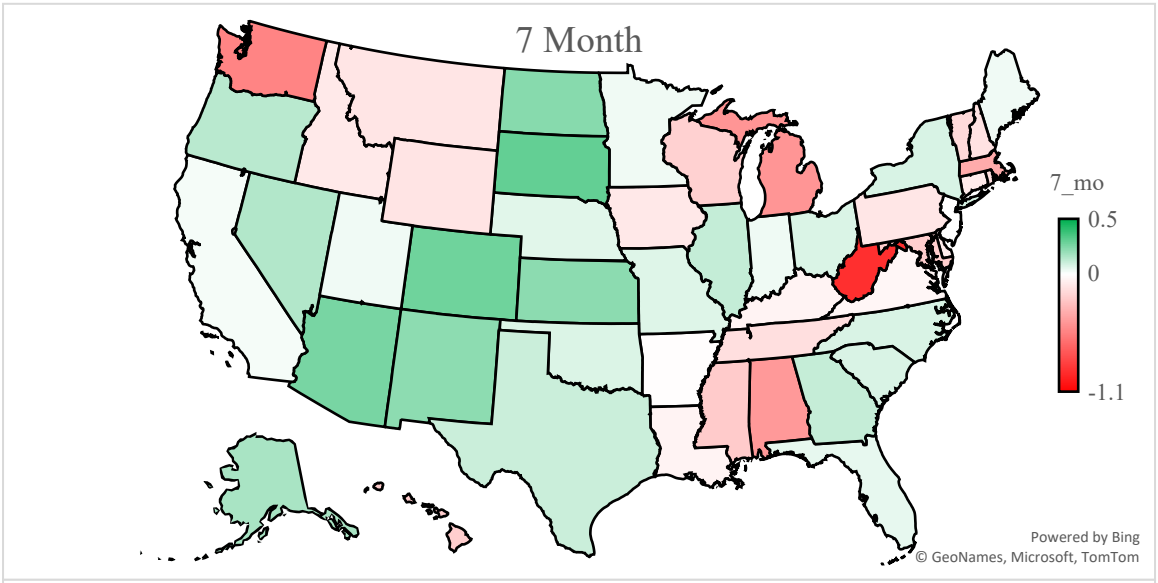
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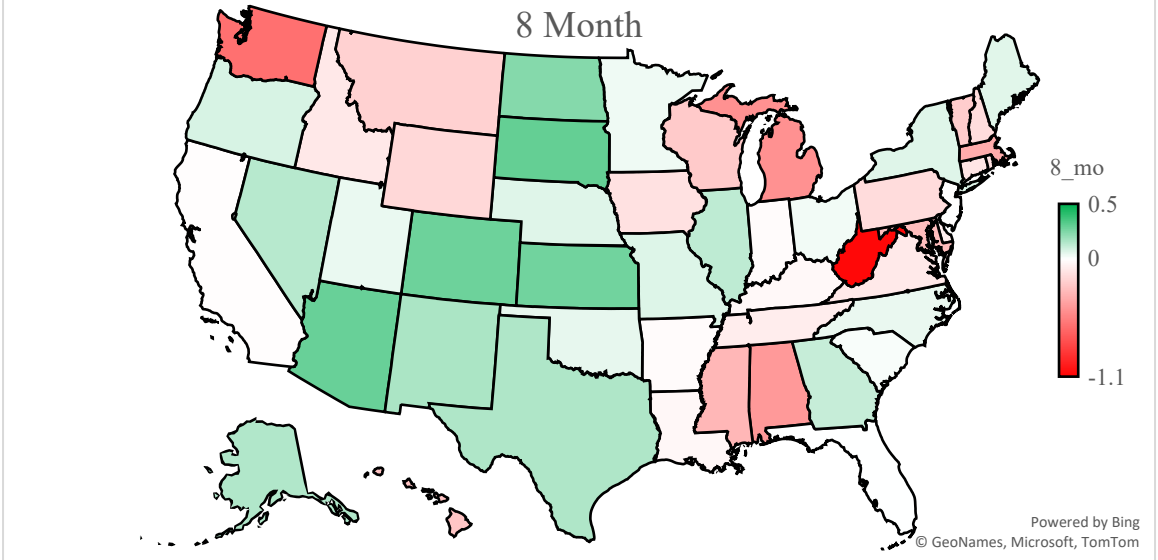
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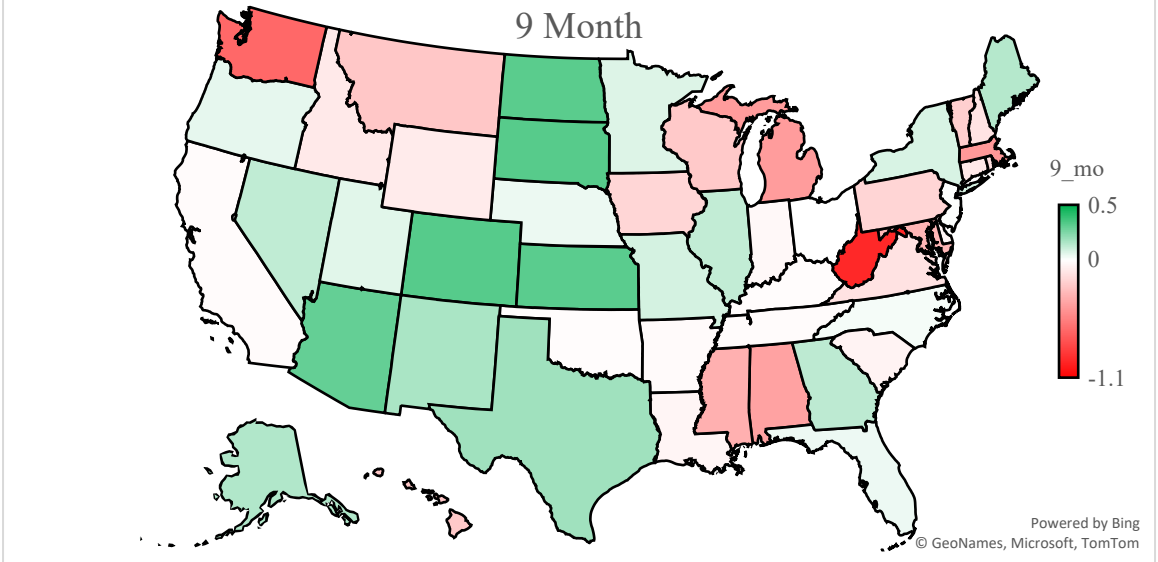
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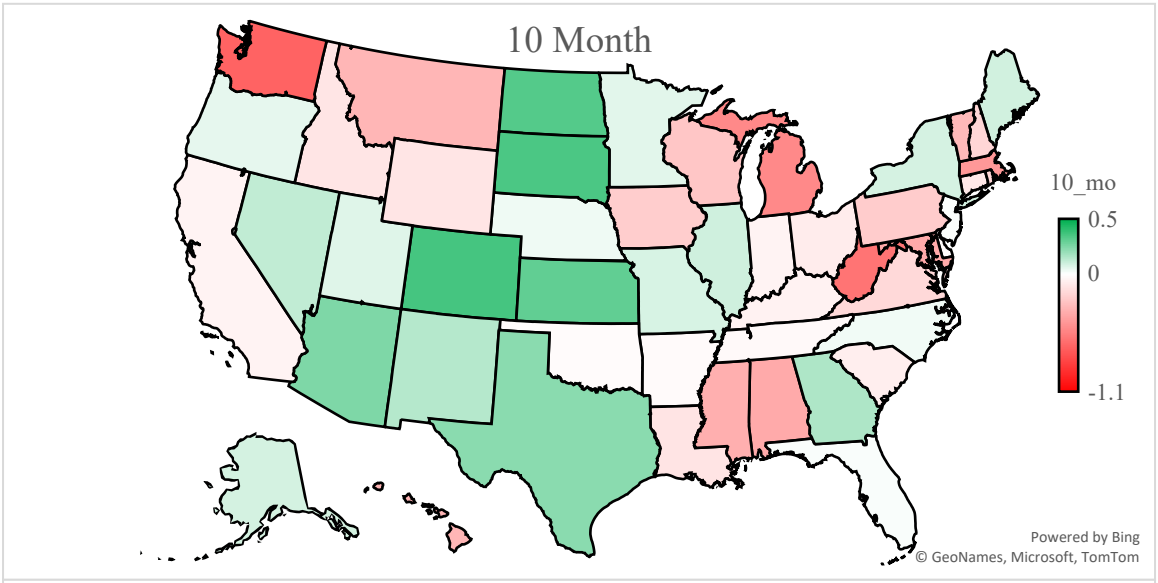
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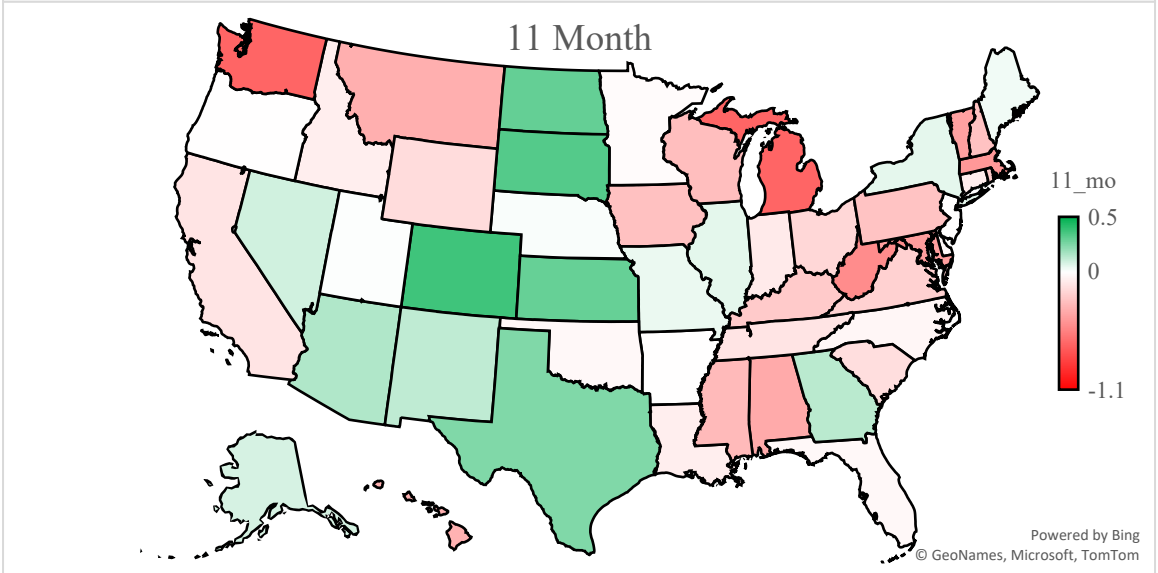
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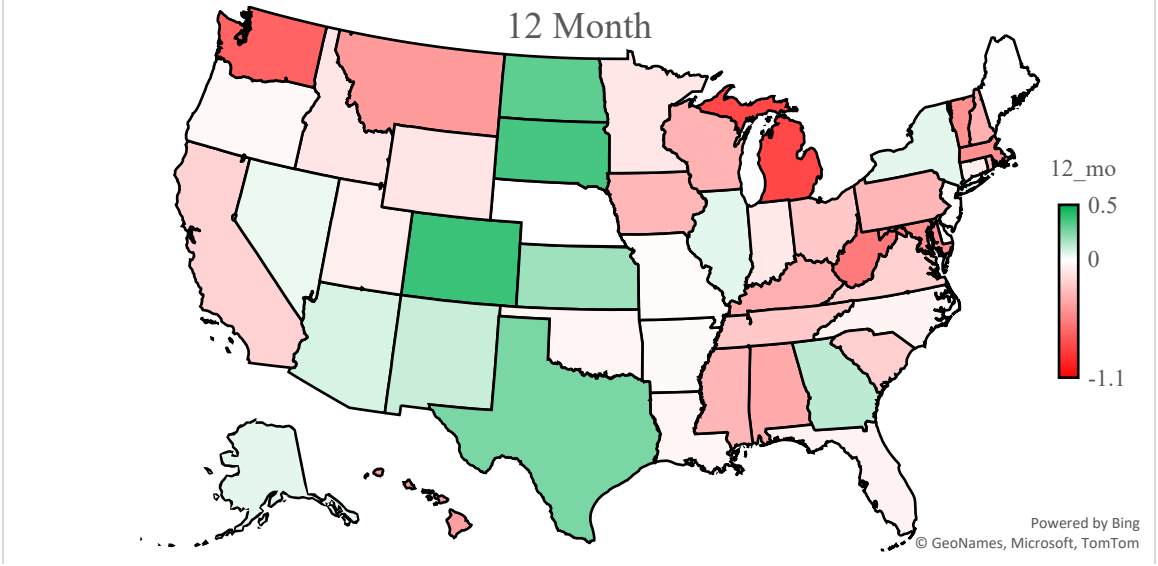
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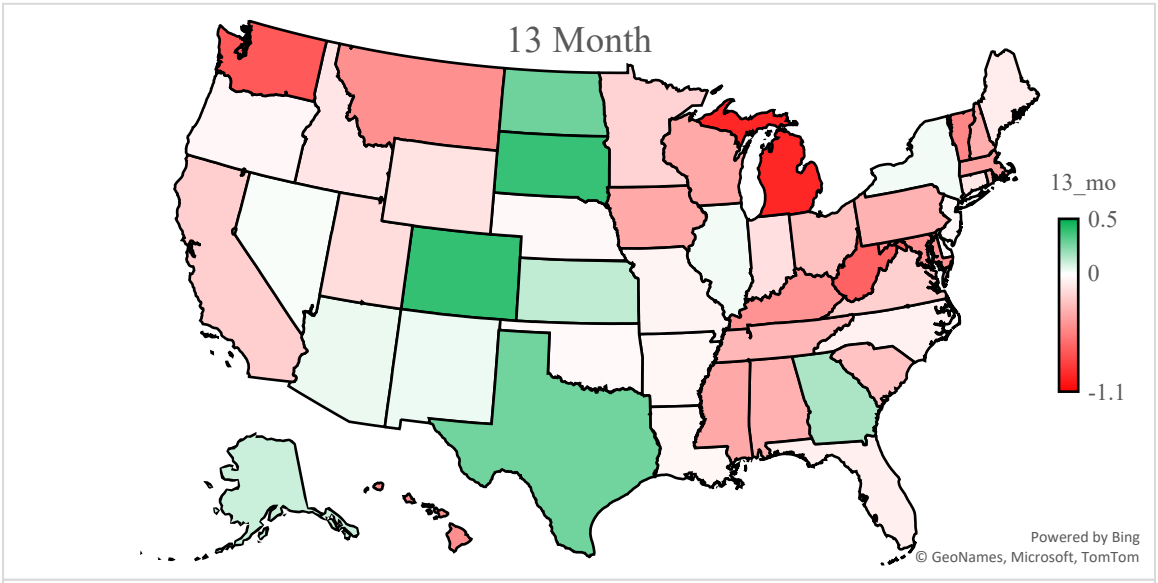
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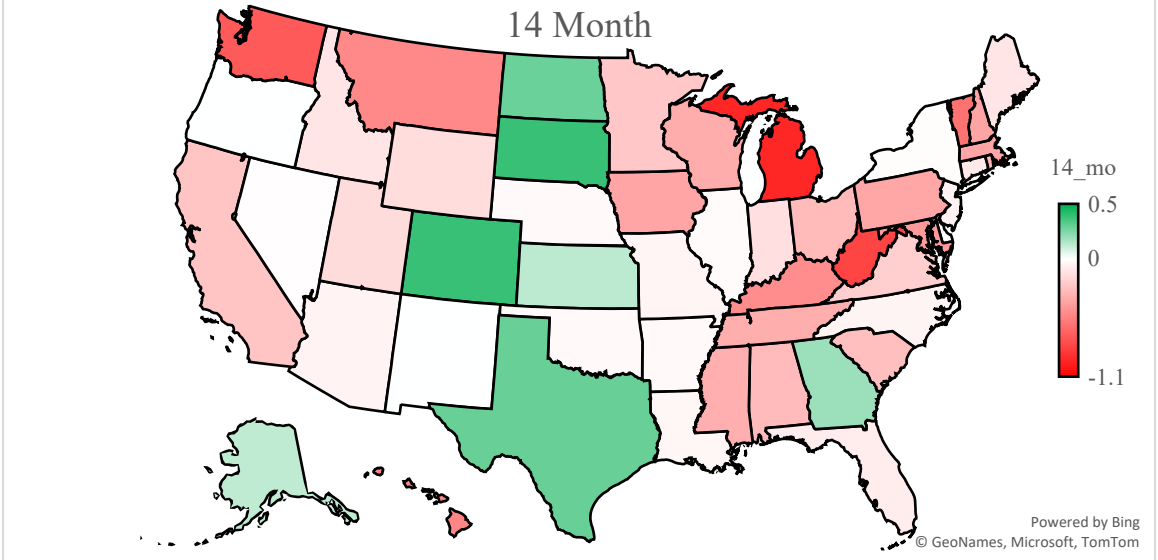
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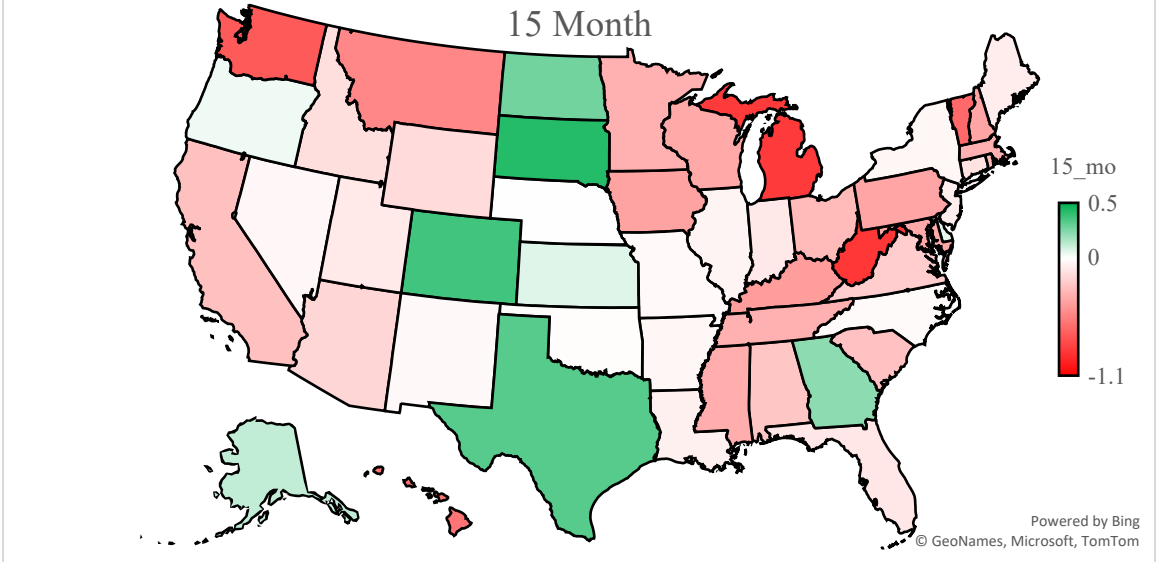
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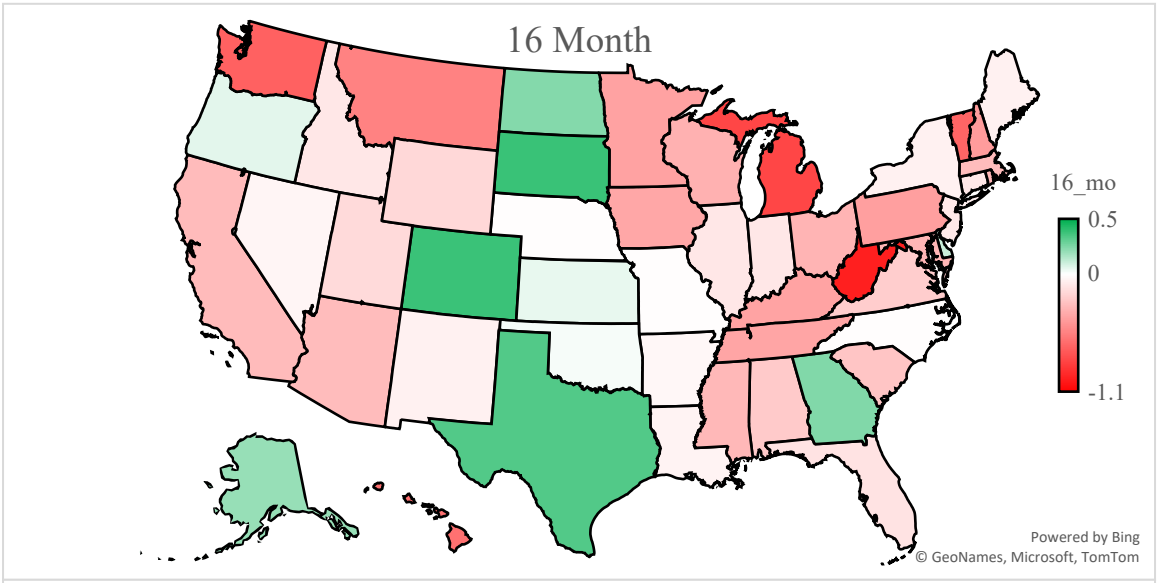
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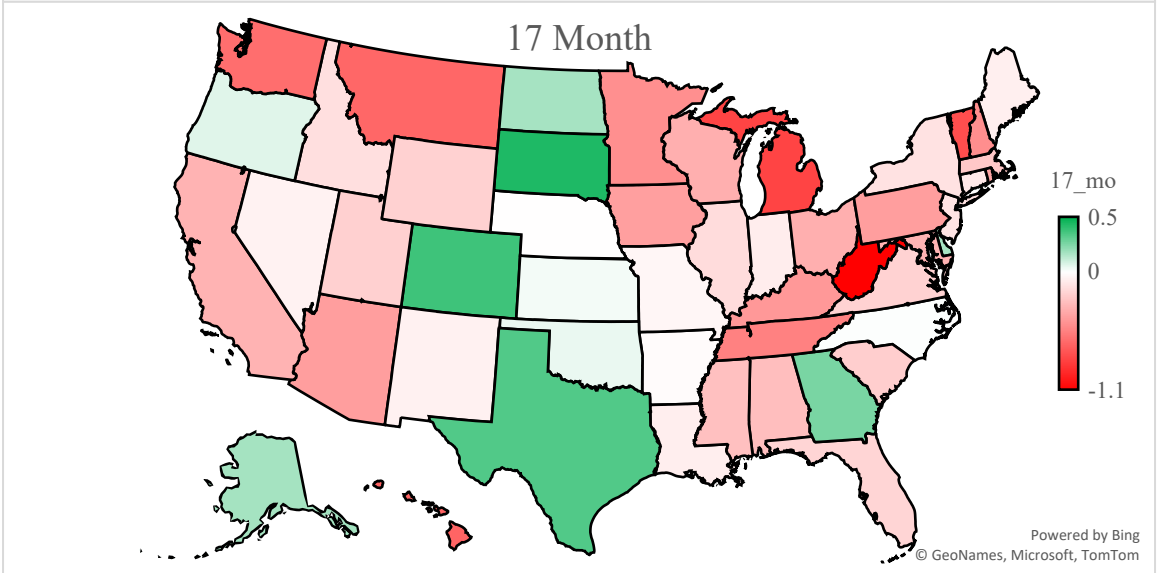
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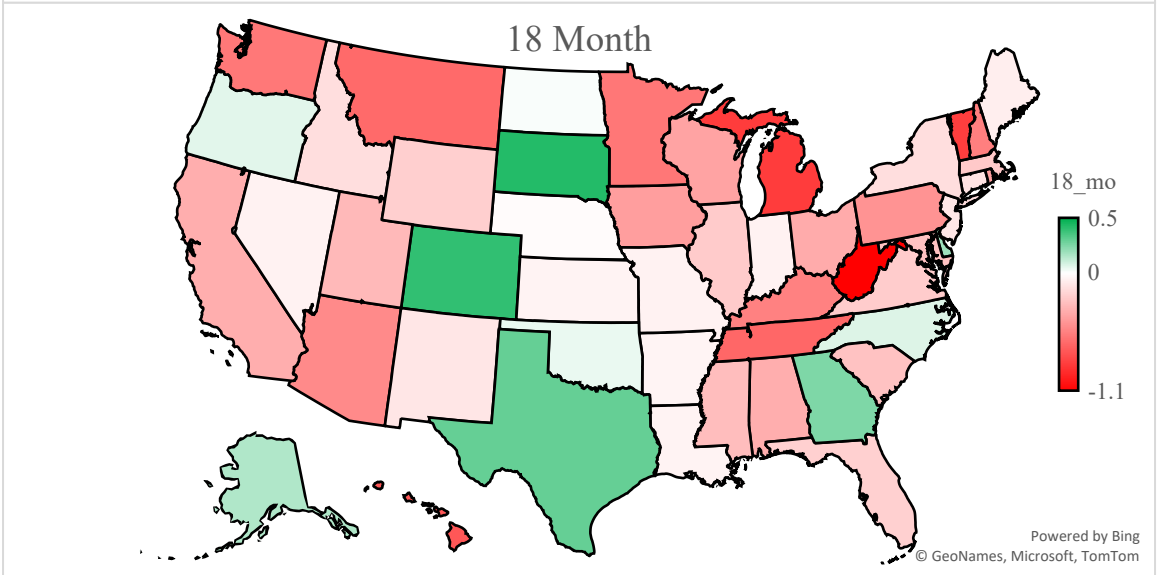
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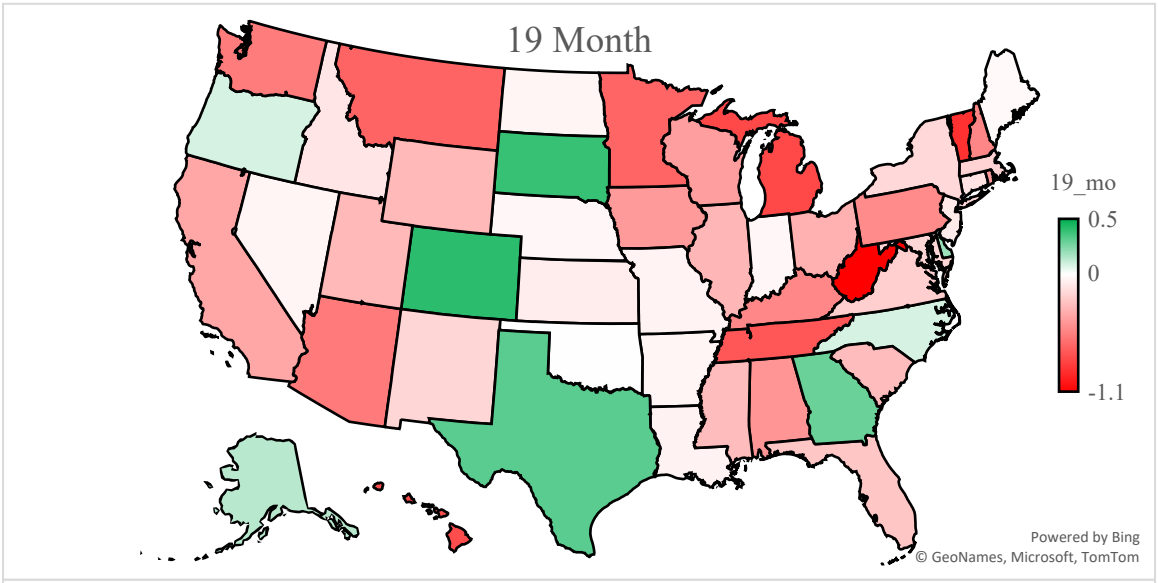
19 Month
19_mo
0.5
0
-1.1
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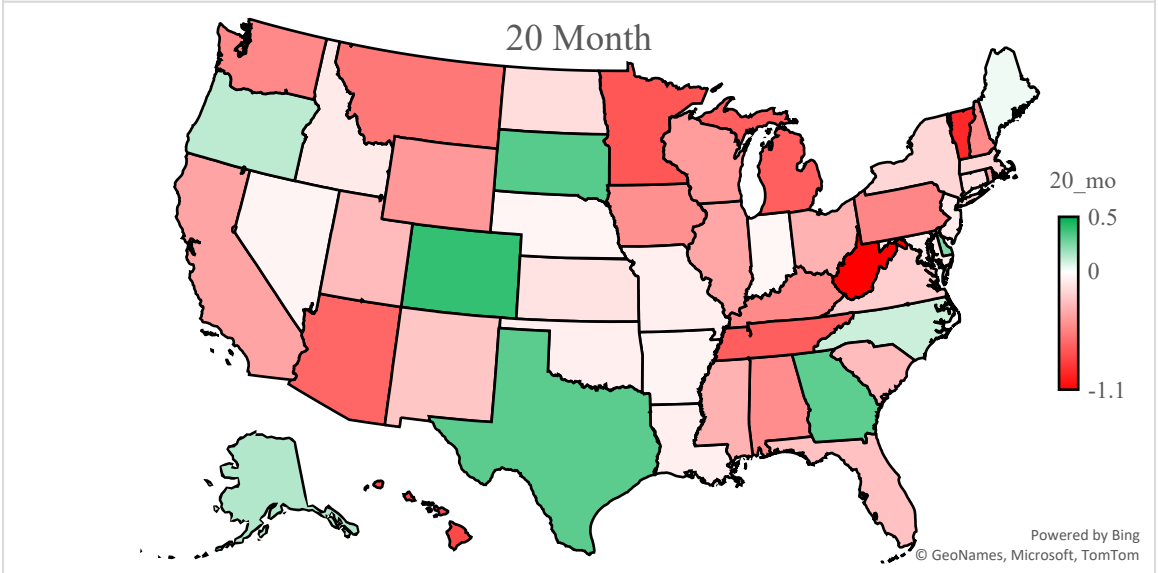
20 Month
20_mo
0.5
0
-1.1
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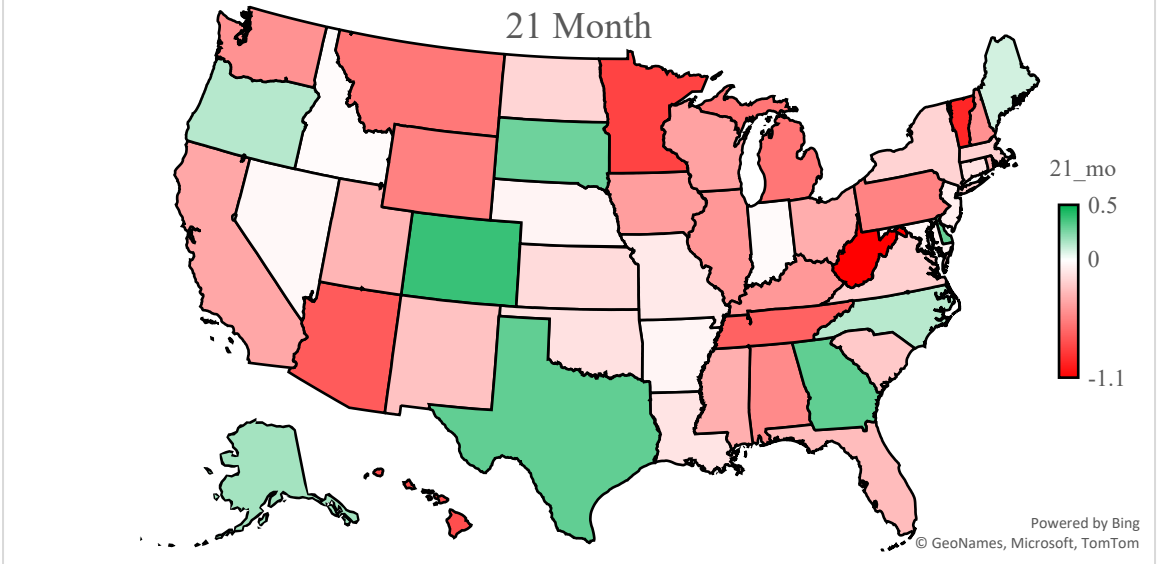
21 Month
21_mo
0.5
0
-1.1
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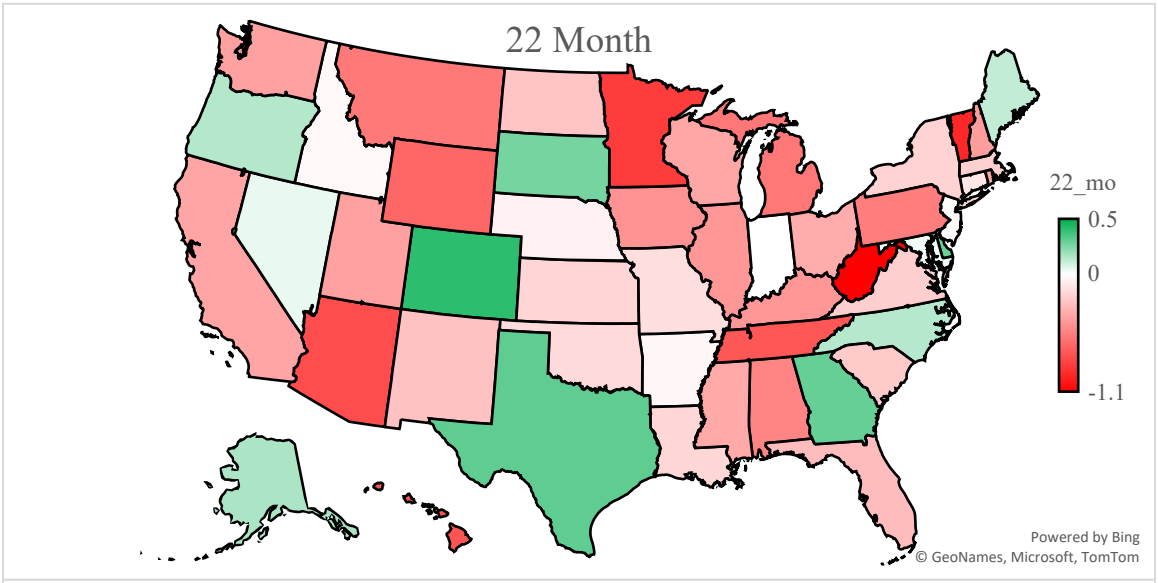
22 Month
22_mo
0.5
0
-1.1
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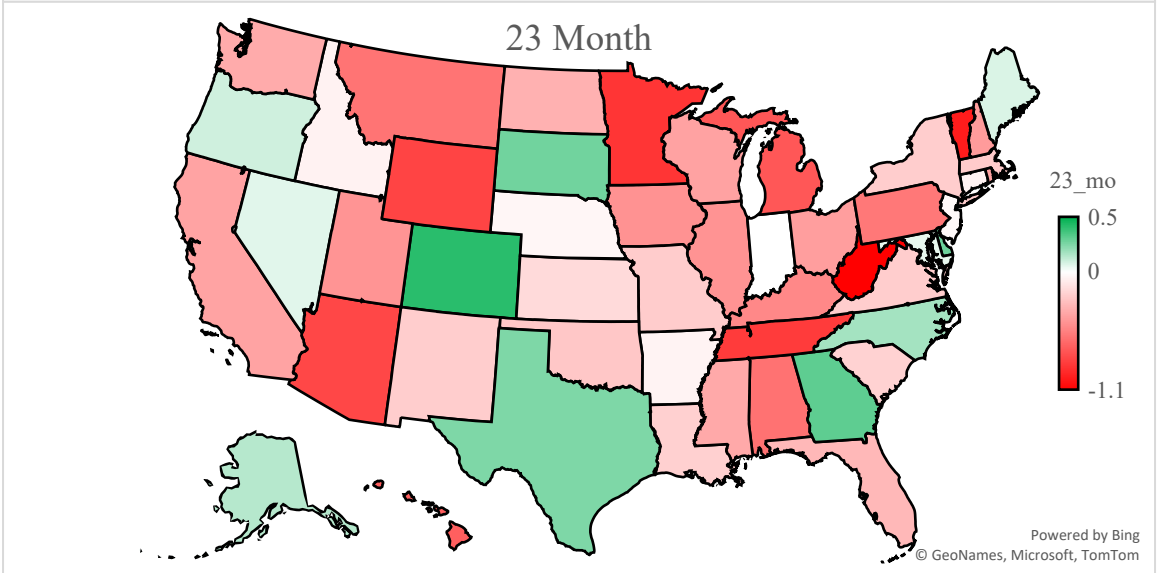
23 Month
23_mo
0.5
0
-1.1
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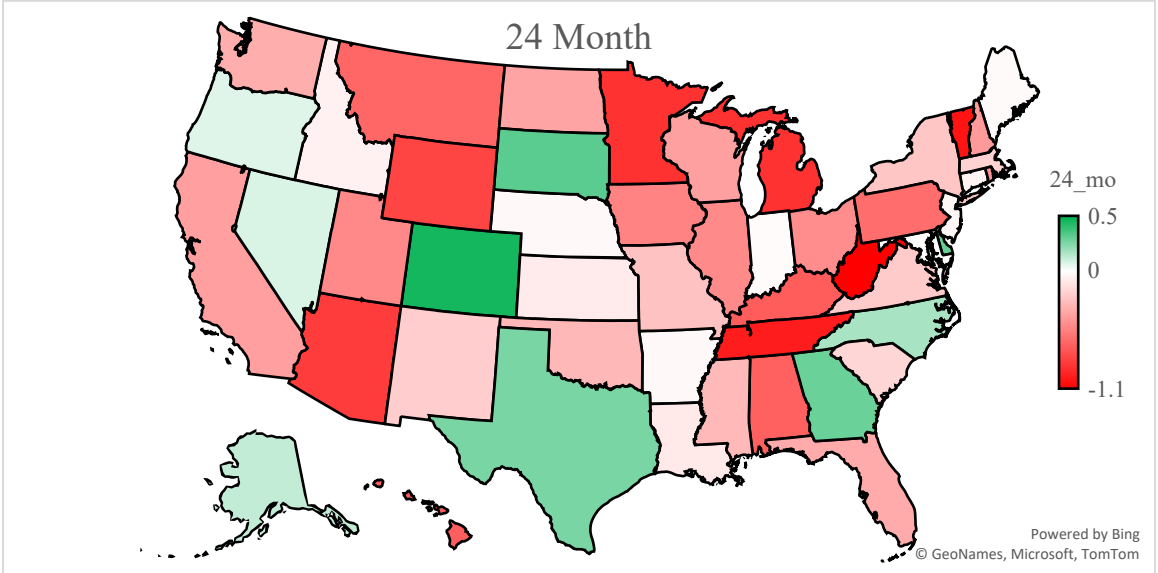
24 Month
24_mo
0.5
0
-1.1
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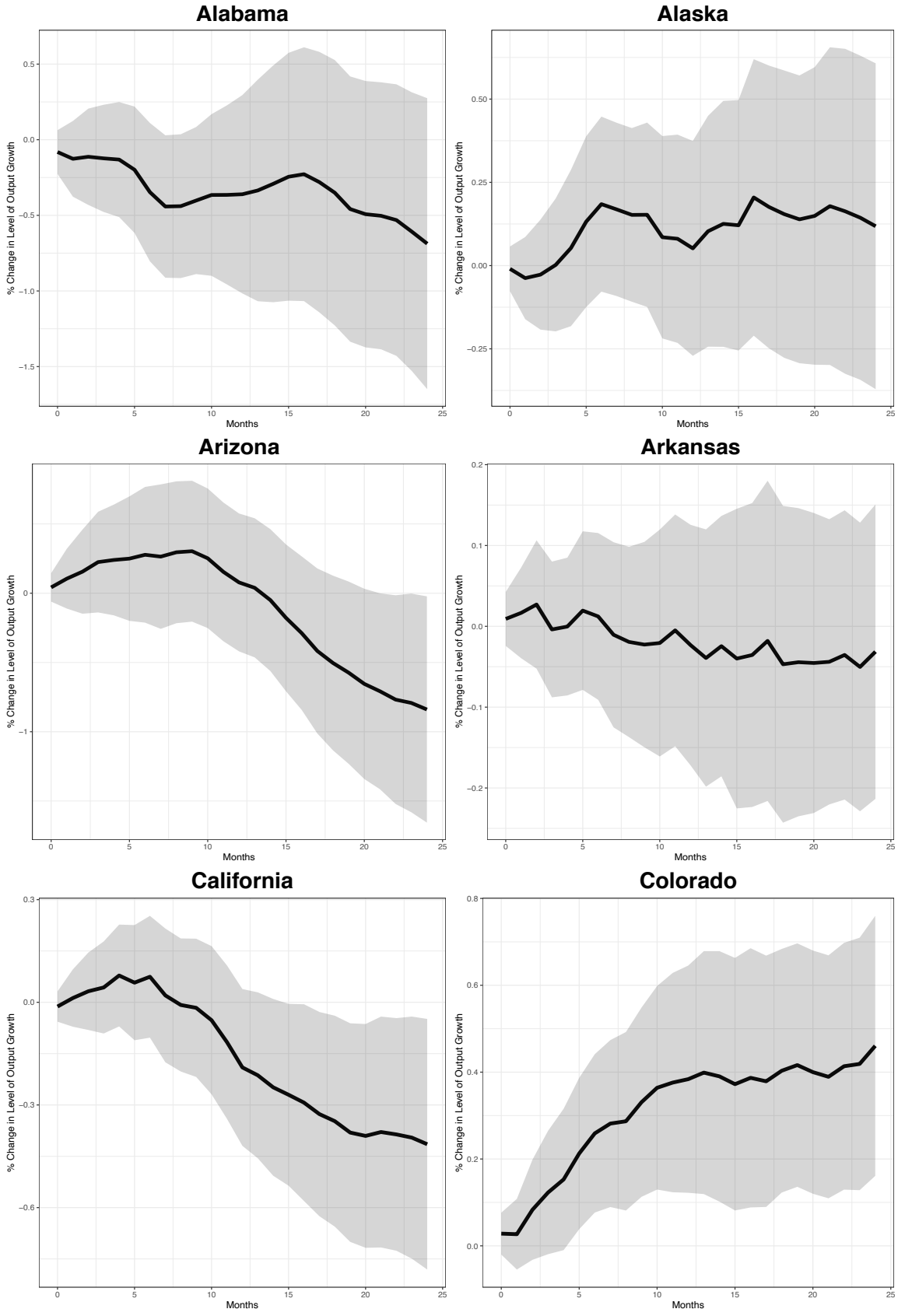
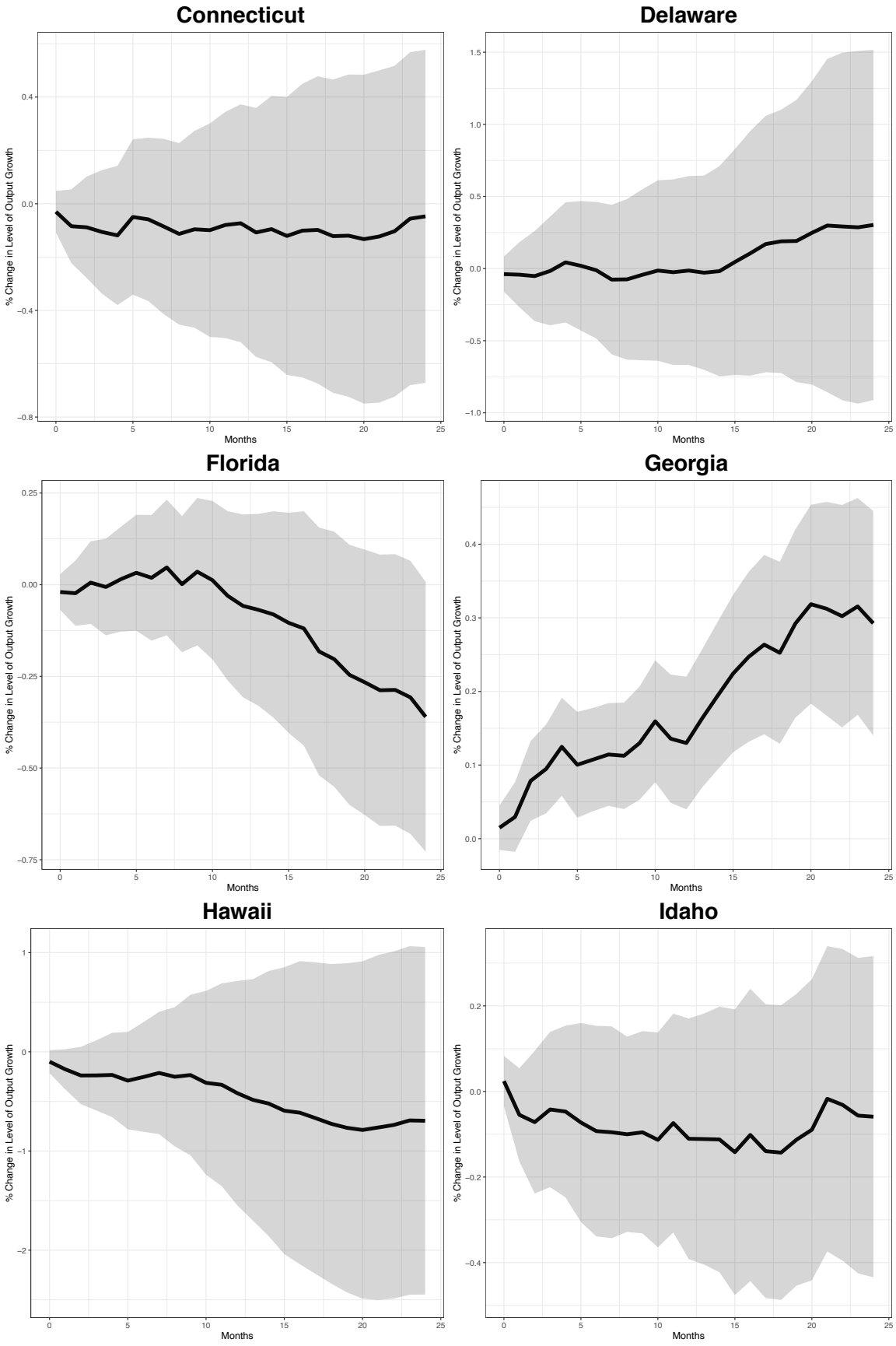
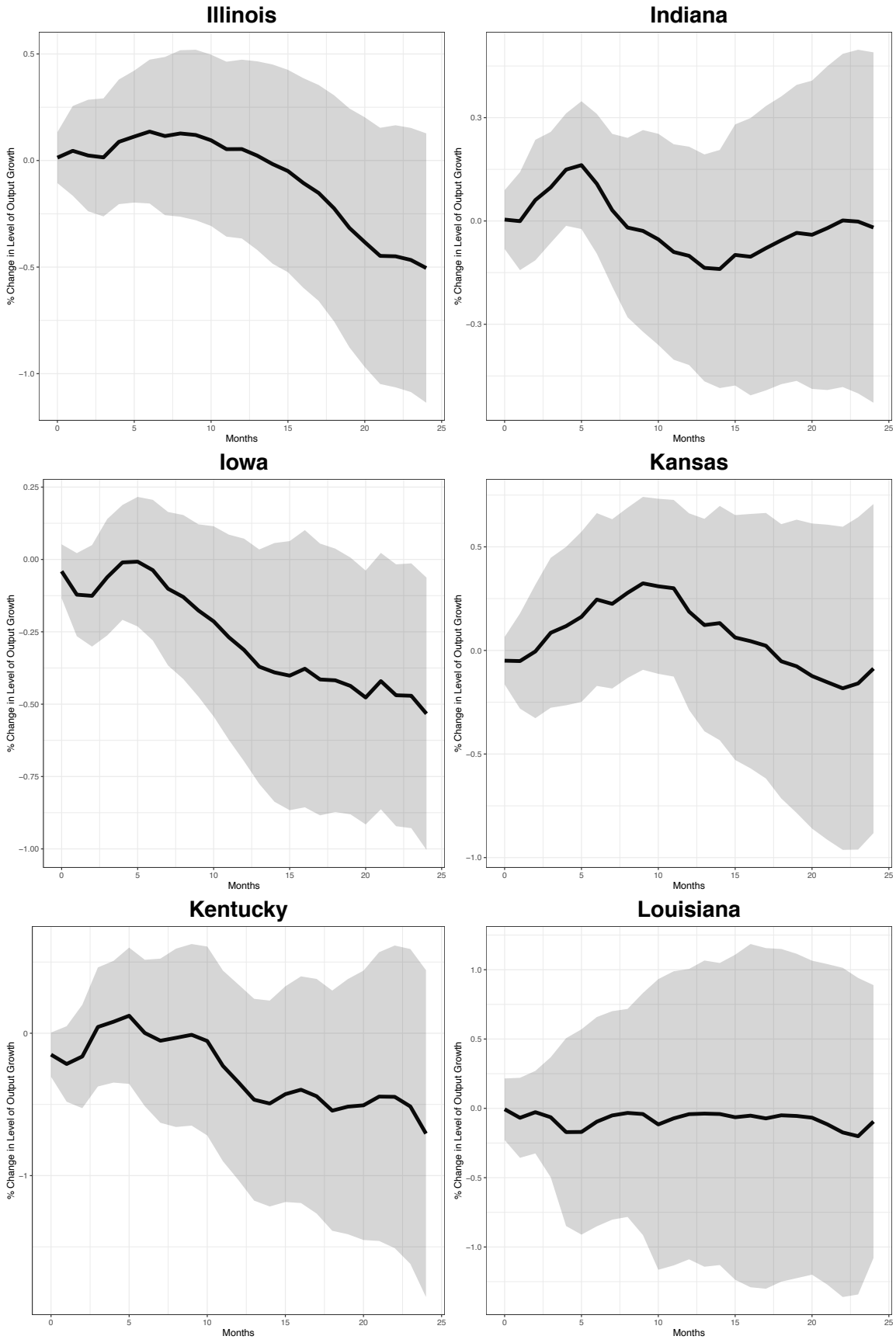
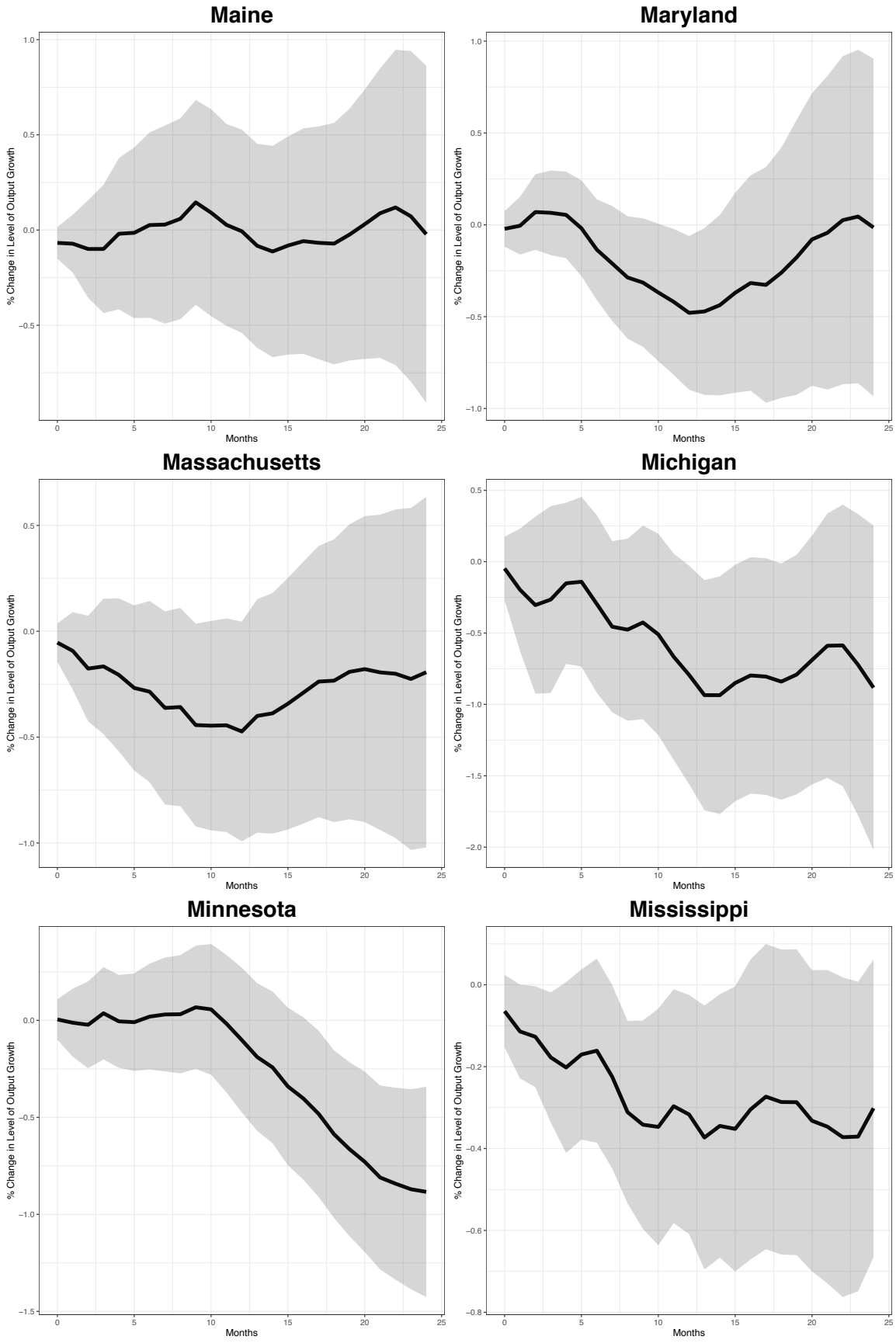
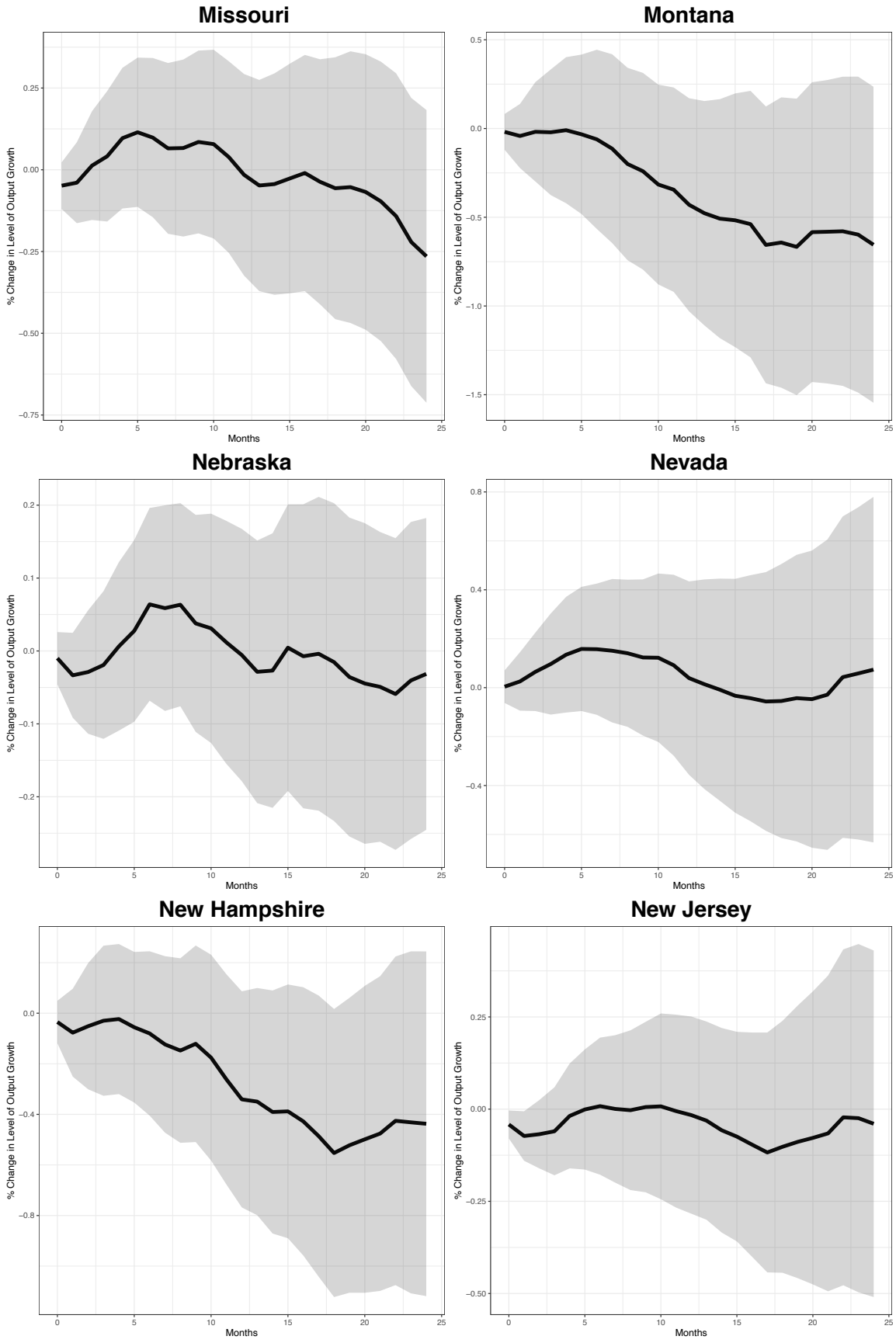
State Impulse Response Functions

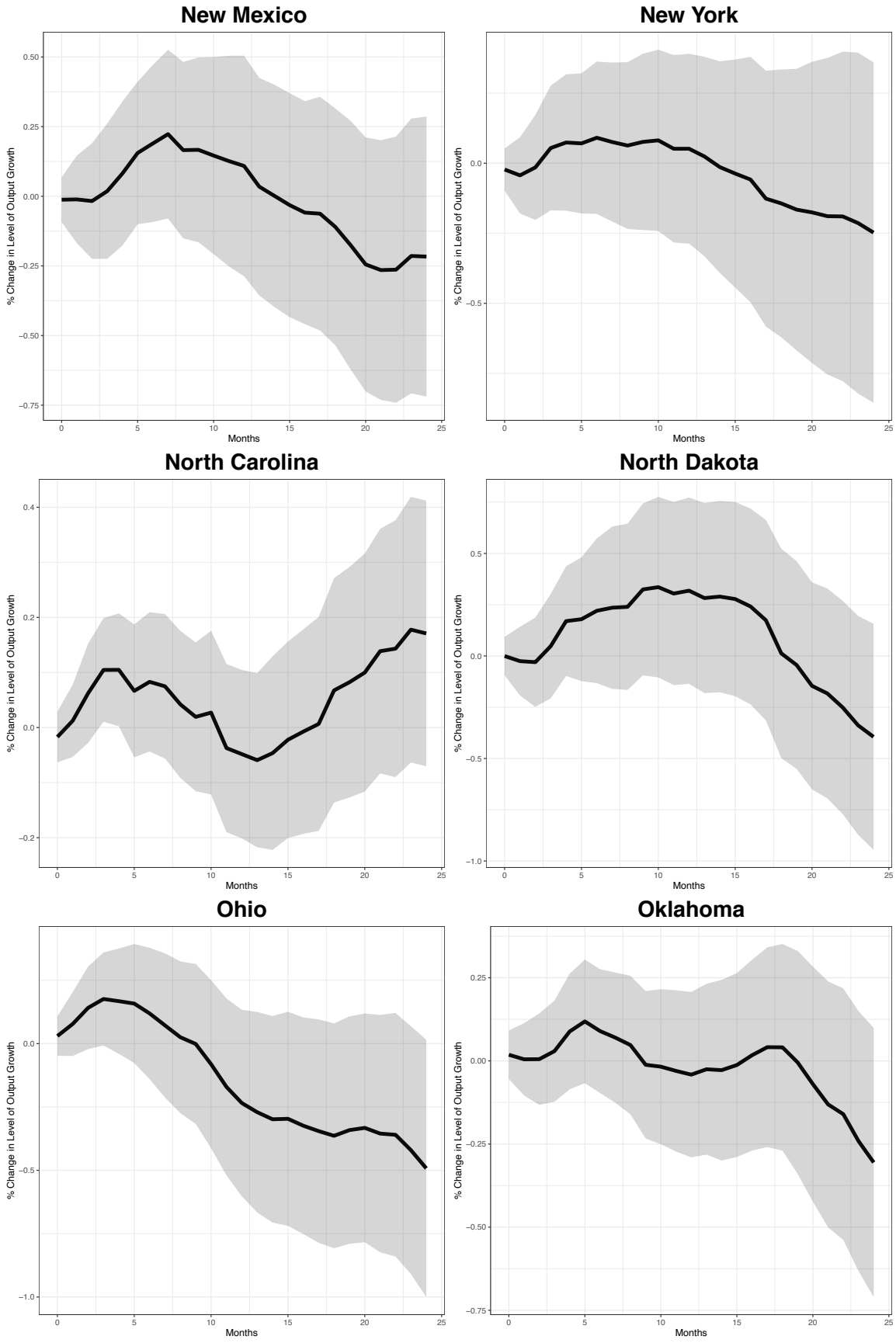


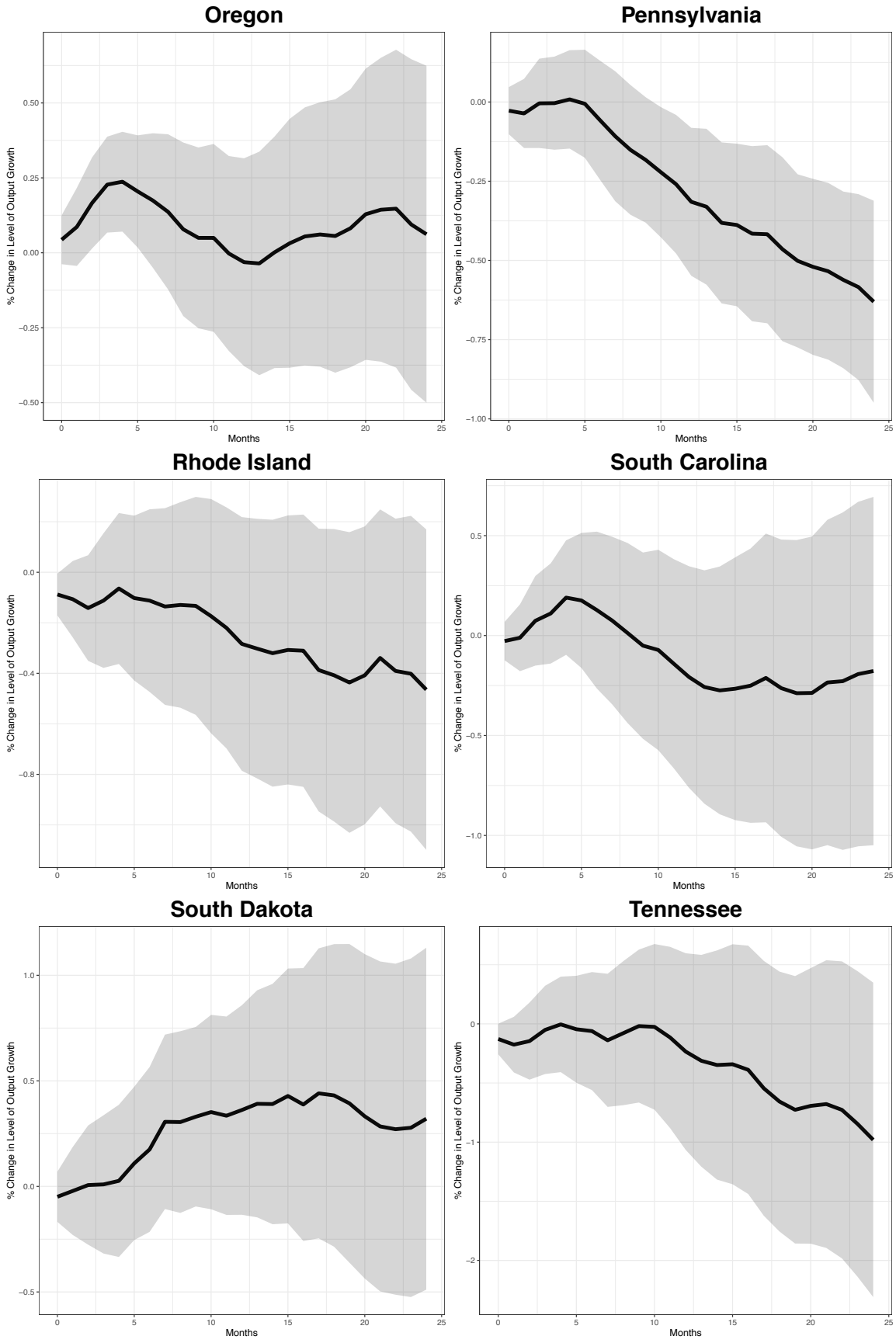

Connecticut
Delaware
Florida
Georgia
Hawaii
Idaho
% Change in Level of Output Growth
Months

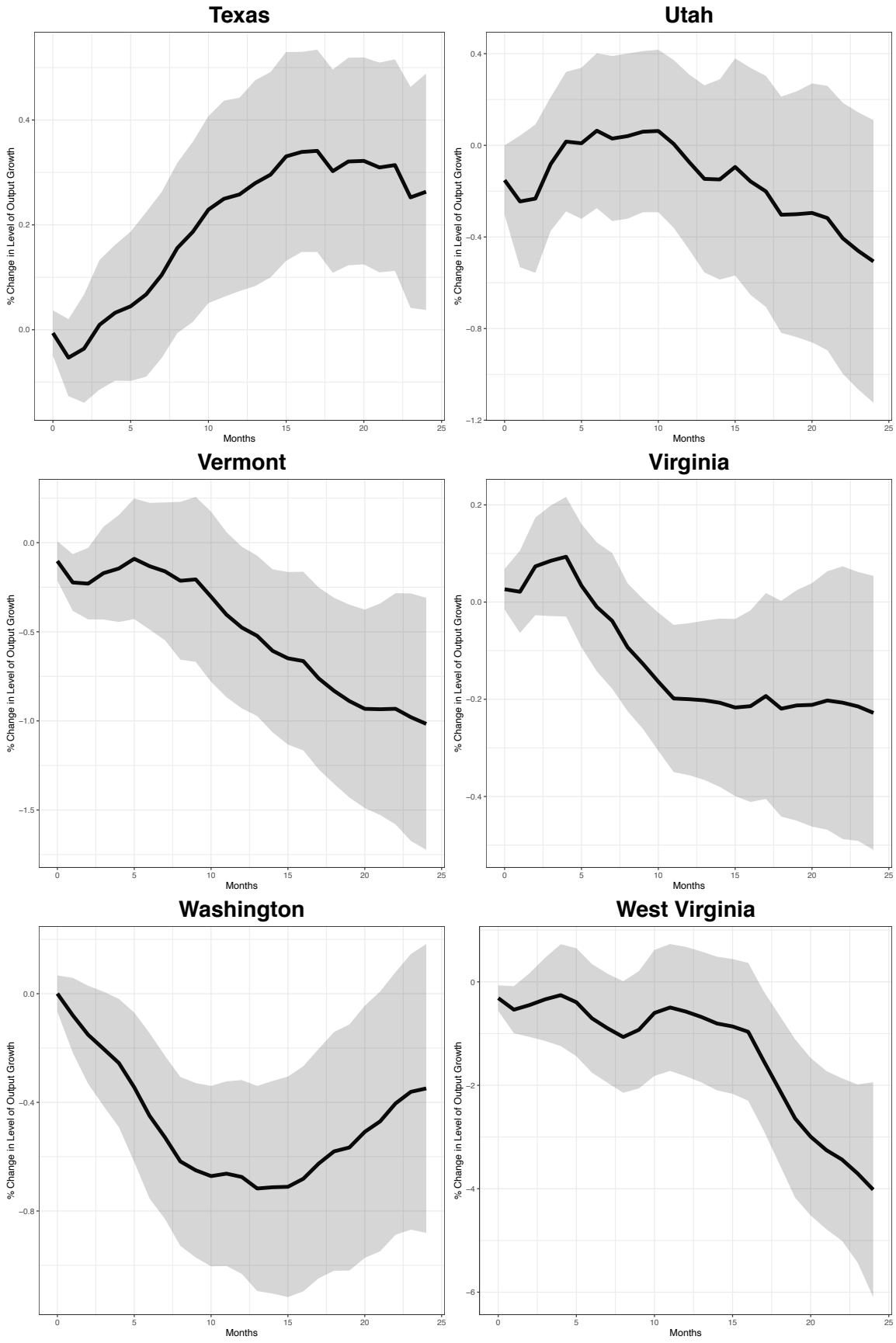

Illinois
Indiana
Iowa
Kansas
Kentucky
Louisiana
% Change in Level of Output Growth
Months

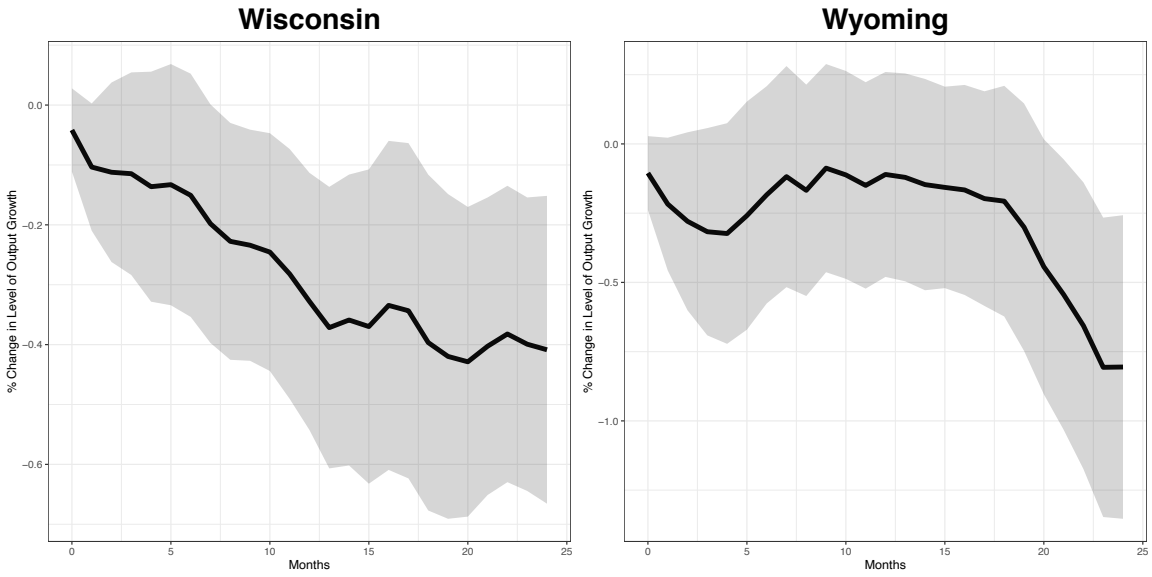

Maine
Maryland
Massachusetts
Michigan
Minnesota
Mississippi
% Change in Level of Output Growth
Months


Missouri
Montana
Nebraska
Nevada
New Hampshire
New Jersey
% Change in Level of Output Growth
Months


New Mexico
New York
North Carolina
North Dakota
Ohio
Oklahoma
% Change in Level of Output Growth
Months


Oregon
Pennsylvania
Rhode Island
South Carolina
South Dakota
Tennessee
% Change in Level of Output Growth
Months


Texas
Utah
Vermont
Virginia
Washington
West Virginia
% Change in Level of Output Growth
Months


Wisconsin
Wyoming
% Change in Level of Output Growth
Months
0.0
−0.2
−0.4
−0.6
−0.5
−1.0
0
5
10
15
20
25

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