The Great, Greater, and Greatest Recessions of US States

Howard Wall
Lindenwood University

Received: 06/16/2022
Accepted: 01/09/2023

Abstract

This paper examines state-level differences in the timing, depth, and total employment effects of the Great Recession. It finds that several states were in recession prior to the official start of the recession, while more than a dozen states didn't enter recession until six months or more after it. States' exits from recession were similarly staggered. As a result, 11 states' recessions were one year long or shorter, while the recessions for five states were at least 24 months long. Further, there were geographic patterns to the spread of the recession across states. I use these state-level estimates to introduce a new approach for calculating the total effects of recessions on state employment, one that accounts for lost employment growth as well the decrease in employment. States formed distinct geographic groupings according to these total effects, with states in the West and Southeast tending to have seen the greatest harm. Finally, many of the state-level differences in the effects of the Great Recession were related to differences in industry mix and the prevalence of sub-prime mortgages. The states with the longest and deepest recessions also tended to have been those with the highest shares of subprime mortgages.

1 Introduction

This paper examines the differences in the effects of the Great Recession on aggregate employment across US states. Specifically, I apply the methodology of Owyang et al. (2005, 2013), hereafter OPW, to obtain state-specific peaks, troughs, and depths for payroll employment during and surrounding the Great Recession of 2008-2009. This approach to the business cycle is based on Burns and Mitchell (1946), in which the business cycle is a series of distinct expansion and recession phases, as with the official recession dates from the NBER Business Cycle Dating Committee. OPW looked at states and metro areas to demonstrate and examine how the US business cycle has a spatial dimension in addition to its time dimension.

As shown by OPW, the business cycle for US states and metro areas can differ significantly from the national business cycle. In particular, during periods of national recession: (1) some states and metro areas will not experience a recession at all, (2) state and metro recessions follow a geographic pattern, and (3) state and local recessions are deeper in manufacturing-heavy areas. In other applications: Owyang et al. (2008) found that states experienced the Great Moderation of the 1980s sometimes several years apart, Hamilton and Owyang (2012) found that states tend to experience the business cycle in clusters, Wall (2013) found that the cycle can differ between neighboring cities as the result of intra-metro specialization in function and human capital, and Owyang et al. (2015) showed that knowledge of early state-level recessions can improve forecasts of national recessions.[1]

When I apply the OPW approach to the period of the Great Recession, I find that all states experienced the recession, although at different times and to vastly different degrees. Further, differences in sectoral diversity and the prevalence of subprime lending were significant drivers of differences in both the timing and the depths of state recessions. These state-level effects of the Great Recession are of interest on their own, but they also are useful for understanding the national business cycle. Although it is only recently

[1]Most applications have been to the US, but it has also been applied to New Zealand (Hall and McDermott, 2007), Japan (Wall, 2006), Spain (Gadea et al., 2012), China (Gatfaoui and Girardin, 2015), the United Kingdom (Martin et al., 2016), Canada (Lange, 2017), Europe Gómez-Loscos et al. (2020), and Mexico (Kondo, 2022).

gaining traction among macroeconomists, there is a long-standing literature in urban/regional economics mixing macroeconomic concepts and models to spatially disaggregated data. Pioneers include Carlino and DeFina (1998), which uses VARs to estimate differences in the impacts of monetary policy on states and regions. Also, Carlino and Sill (2001), Carlino and DeFina (2004), Partridge and Rickman (2005) estimate and examine the co-movement of state and regional employment over the business cycle. Examples of the use of spatially disaggregated data in the macroeconomics literature include Fogli et al. (2013), Mian and Sufi (2014) Beraja et al. (2019) and Guren et al. (2021).

The Great Recession has received a great deal of attention as an aggregate, national event. Much less attention has been paid to its effects across spatial units, however, and even fewer have addressed the timing of the recession. Cainelli et al. (2021) calculate the business cycle similarity between pairs of US states during the period 2002-11. They use a band-pass filter to determine whether states are in an upswing or a downswing, and devise a measure of state-pair synchronicity which is comparable to the business cycle concordance measures of Owyang et al. (2013) for metro areas. They find a general synchronization between states that increases during recession and is related to spatial effects and regional economic structure.

In a pair of papers, Gjerde et al. (2019) and Prescott and Gjerde (2022) examine the role of state-level fiscal policies in starting and ending state recessions. They use the Philadelphia Fed's coincident index and apply the arbitrary rule of thumb that a recession begins (ends) at the start of a cumulative decline (increase) of 0.5 percent that lasts for at least three months. Their results are not directly comparable to mine primarily because of the rule of thumb that determines the endpoints of their recession.[2] Nevertheless, they find that state fiscal policy decisions were not related to lengths of states' recessions, but that they were related to the overall percent decrease in the state indices.

Other papers of note examining the Great Recession include Rickman and Guettabi (2015) who look at the economic performance of non-metro areas, Beyers (2013) who constructs clusters of states according to their industry unemployment trends, and Deller and Watson (2016) who look at economic diversity and county employment stability. Walden (2014) looks at the determinants of the speed at which state GSP and employment grew from their recessionary low points. Han and Goetz (2015) look at the resilience of county employment, which they measure using the drop in employment relative to the velocity of its recovery. Connaughton and Swartz (2017) measure the severity of the Great Recession in term of state GSP relative to its potential. Stumpner (2019) finds evidence that intra-state trade contributed to the geographic spread of the Great Recession.

The remainder of the paper proceeds as follows. Section 2 describes the Markov-switching model and applies it to US payroll employment to obtain the peak and trough of the national employment cycle. The model is applied to states in Section 3, which describes the results and their geographic patterns. Possible explanations for the differences in state recession characteristics are examined in Section 4, while Section 5 calculates and examines two measures of the overall employment effects of state recessions. Section 6 concludes.

2 Recession Dating

As with OPW, I use the Hamilton (1989) version of the Markov-switching model to determine the state-level recession and expansion phases. The absence of useful, high-frequency state-level data for GDP means that we are limited to discussing state employment cycles rather than the general business cycle for states. As such, I use payroll employment growth to measure the condition of state economies. Finally, I restrict my sample to 2005-2019 to avoid having to assume that the Great Recession was structurally the same as the 2001 and 2020 recessions.

In the Hamilton model, there are two distinct phases to the business cycle: recession and expansion. Over time, shocks make an economy switch between the two phases, each of which has its own growth rate. Formally, let μ_0 be the growth rate of employment during expansion, and let μ_1, which is normalized to be negative, be the difference between the recession and expansion growth rates (the recession gap). The

[2]For example, the recessions that result from applying my empirical model to the Philadelphia Fed's indices are much more similar in length to the recessions I obtain in this paper using payroll employment than they are to those in Prescott and Gjerde (2022).

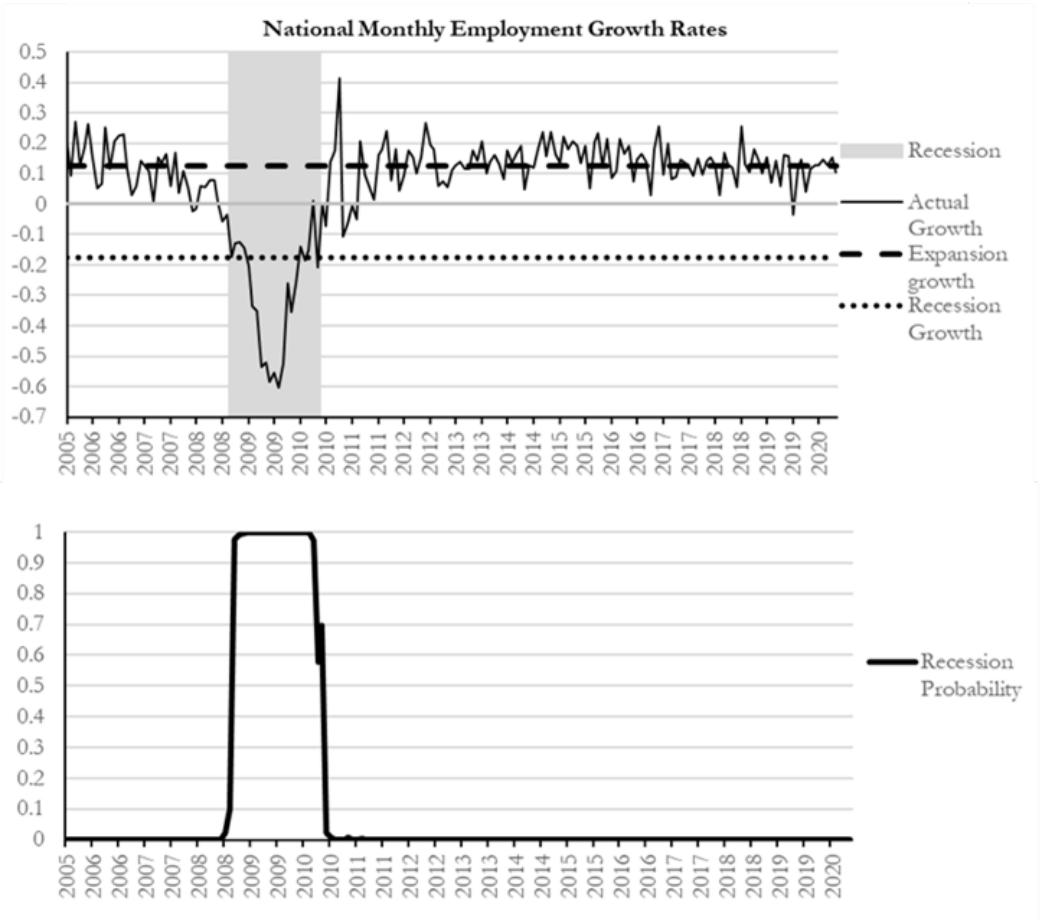
switching between recession and expansion is governed by a state variable, $S_t = \{0, 1\}$, and deviations from the phase growth rates are a stochastic disturbance, $\varepsilon_t \sim N(0, \alpha_\varepsilon^2)$. When S_t switches from 0 to 1 (from expansion to recession), the growth rate switches from μ_0 to $\mu_0 + \mu_1$, and vice versa. In general, therefore, the growth rate of employment, y_t, is

$$y_t = \mu_0 + \mu_1 S_t + \varepsilon_t \tag{1}$$

Note that the value of S_t summarizes any persistence from the previous period in that, because the process for S_t is a first-order two-state Markov chain, the probability process driving S_5 is captured by the transition probabilities. I apply the model to each state's monthly employment growth and estimate it using the multi-move Gibbs-sampling procedure for Bayesian estimation of Markov-switching models of Kim et al. (1999).[3]

Figure 1, which uses national payroll employment, is useful for illustrating how the model determines the national employment cycle. Recall that the model assumes that this series has two average growth rates that the economy switches between. In the figure, these growth rates are the two dotted lines: expansion growth is positive ($\mu_0 = 0.125$ percent) while recession growth is negative ($\mu_0 + \mu_1 =$ -0.177 percent). The recession gap ($\mu_1 =$ -0.302 percent) represents the monthly growth loss during recession. The model also assigns each observation a probability that it is in the recession phase. If the phases are distinct enough, the probability of recession (the bottom panel of Figure 1) will periodically switch from being 0 (or very close to it) to 1 (or very close to it), and vice versa.

Figure 1. Markov-Switching and National Employment Recession



[3]See Chauvet and Piger (2013) for a full description of the estimation procedure.

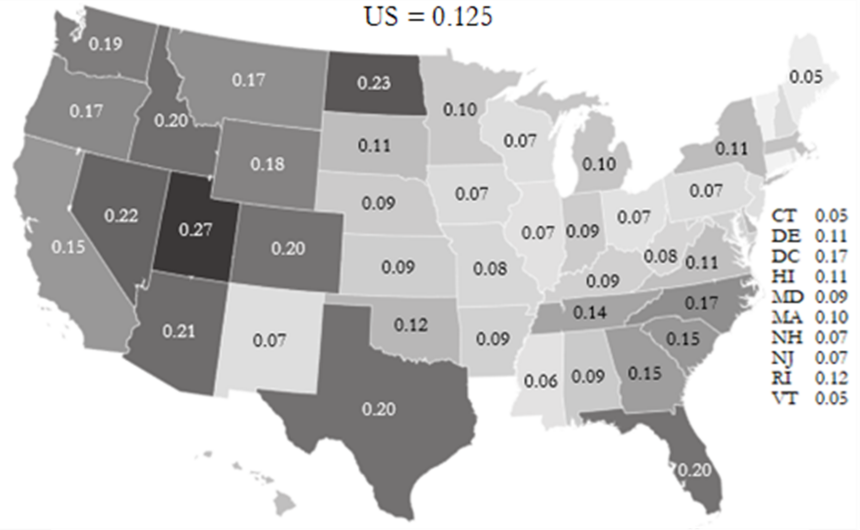
The model works extremely well in separating national employment into its two phases in that almost every month is clearly an expansion or recession month. If the probability of recession is not close to 0 or 1, the convention is to use 0.5 to distinguish between the two phases.[4] The peak and trough of the national employment recession were March 2008 and December 2010, respectively, so the employment recession was 21 months long. Note that the employment recession does not coincide with the official NBER recession, which usually is closely related to GDP growth. According to the NBER, the national business cycle peaked in December 2007 and reached its trough in June 2009. It has become common for the national employment recession to end after the end of the NBER recession (jobless recoveries). For the Great Recession the gap was six months.

3 State-Level Recessions

3.1 Growth Rates and Recession Gaps

I apply the model independently to 48 states and the District of Columbia. Alaska is excluded because its cycle is extremely idiosyncratic relative to the rest of the country, and Louisiana is excluded because the effects of Hurricane Katrina on its economy dwarf even those of the Great Recession.[5] In effect, Louisiana was in permanent recession after August 2005. The estimates of 49 "state" expansion growth rates (μ_0) are provided by Figure 2, which indicates a geographic pattern similar to long-standing trends in growth. States in the West and South tended to grow faster during expansionary periods than did states in the Northeast and Midwest. North Dakota stands out because of its large oil and natural gas sector.

Fig 2. Monthly Expansion Growth Rates



Average growth during a month of expansion (μ_0)

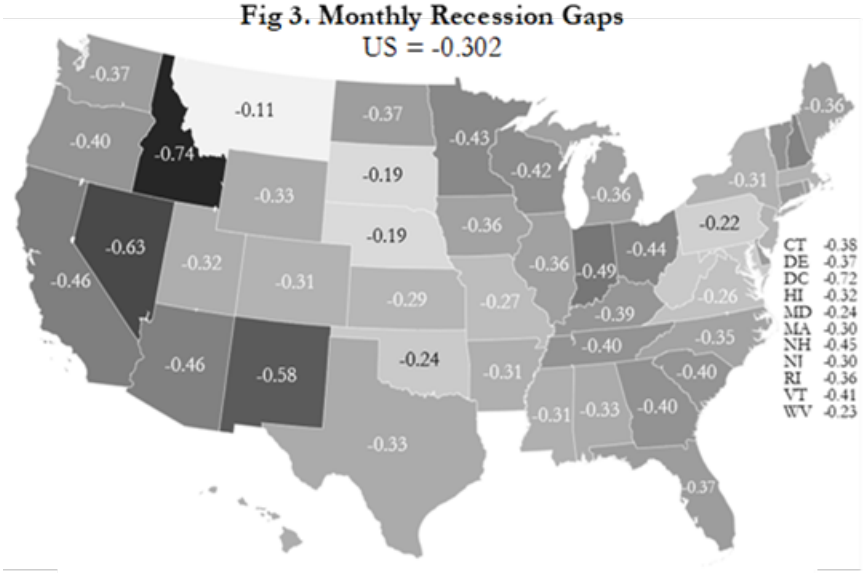
Keep in mind that when determining the effects of a recession on growth, it's not really the job losses during recession that matter, but the lost job growth. That is, the states' recession gaps—the μ_1's —are better measures of the monthly effects of the recession on state employment. If a state's growth even during good times isn't that strong, then a moderate recession growth rate is less severe for that state than it is for a state that grows rapidly during expansion. Figure 3 shows that the absolute recession gaps tended to be larger in the West and Mountain regions, across much of the South, and for Indiana, Ohio, Minnesota, New Hampshire, and Wisconsin. States in the Plains and on the east coast from New York to Virginia

[4]There are only two phases, so each period is assigned to a phase according to which is more likely.

[5]When the model is applied to Alaska, the state's probability of recession during 2008-09 fluctuated between 0.12 and 0.36, with an average of 0.24. Recall from the previous section that US employment was in recession for all but the first two months of the period, and that the probability of recession averaged 0.85.

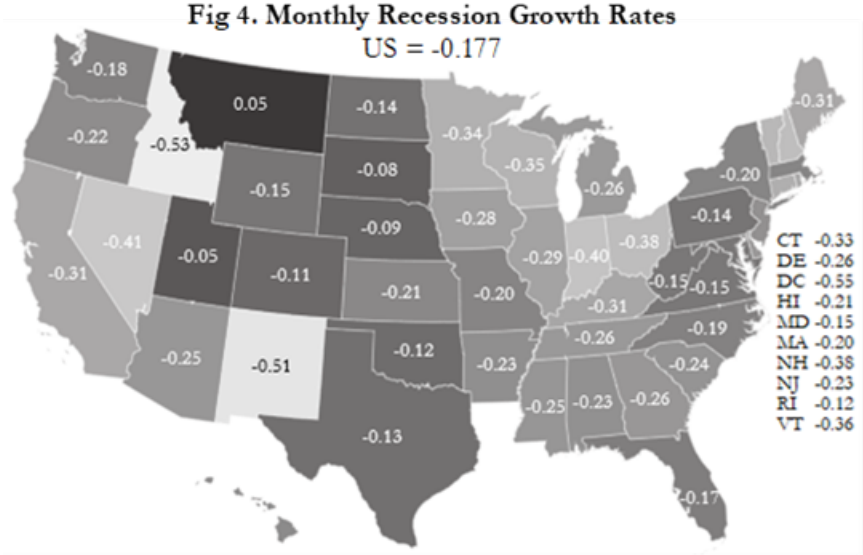
were among those with the smallest absolute recession gaps. Generally speaking, the recession gaps have a more-scattershot geographic pattern than do the expansion growth rates.

Fig 3. Monthly Recession Gaps



Average growth lost during a month of recession (μ_1)

Fig 4. Monthly Recession Growth Rates



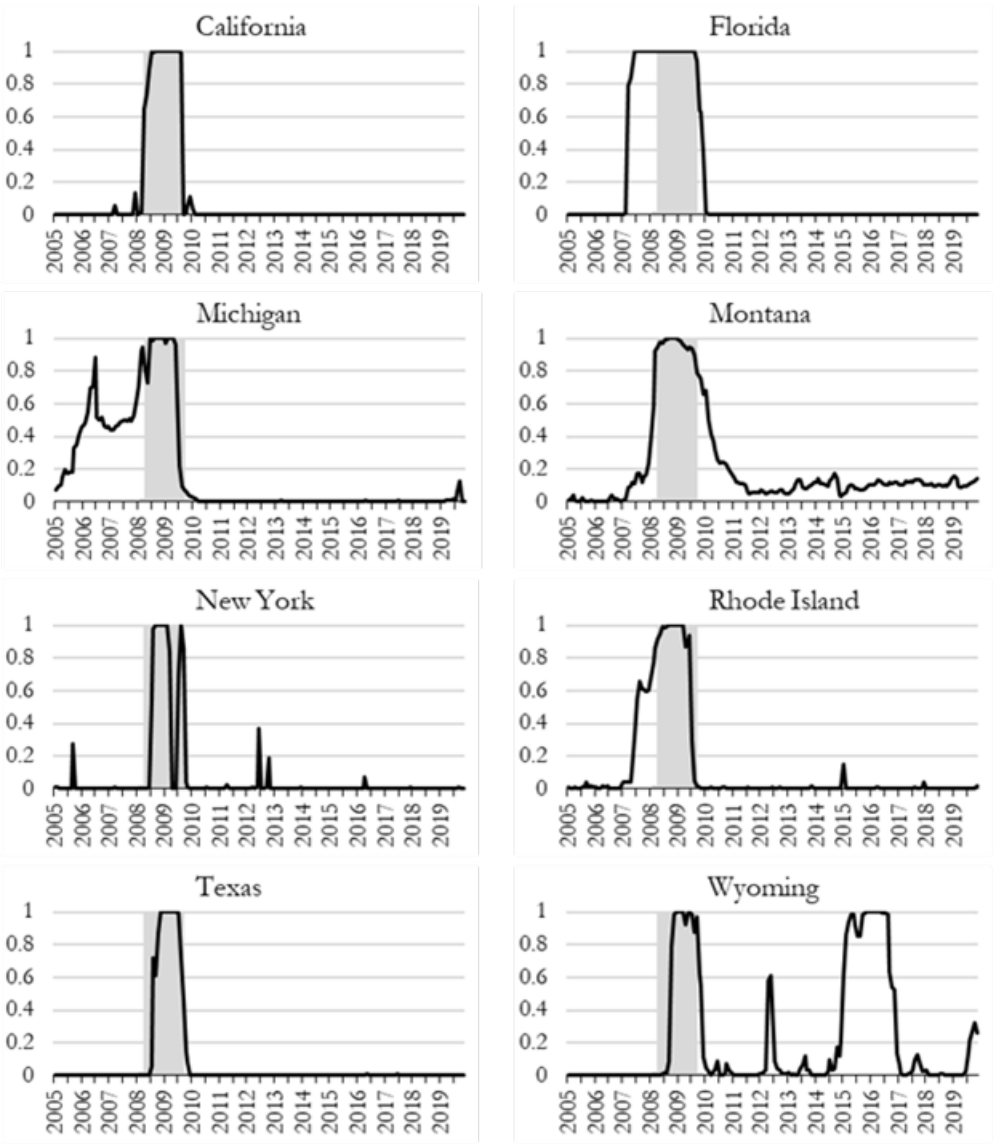
Average growth during a month of recession ($\mu_0 + \mu_1$)

Because the recession gaps were large relative to expansion growth rates, the scattershot geography of the recession gaps largely is also true for states' recession growth rates (Figure 4). States from the West, Northeast, and Great Lakes regions were some of those with the greatest monthly job losses, while the West, the Great Plains, and the Northeast contained some of those with the lowest recession gaps. DC, Idaho, Nevada, Indiana, and New Mexico stand out as states with extremely large monthly employment losses during recession, whereas Montana, Utah, South Dakota, and Nebraska had relatively little monthly job loss during recession. In fact, Montana had a positive recession growth rate.

3.2 Recession Timing

Select state recession probabilities are provided by Figure 5, which includes eight states to illustrate their variety. Each state's recession probability is shown relative to the national employment recession, which is shaded gray. The complete set of recession probabilities is provided by Appendix A. Note first that all of the state employment growth series tend to split very neatly into the two business cycle phases. This "success" of the model is typical in other studies covering different periods and places but is much easier given that the depth of the Great Recession creates a great deal of separation between the two phases. There are, however, significant differences across states in the movement in and out of employment recession.

Figure 5. Select State Recession Probabilities, 2005-2019
Gray shading indicates national employment recession



Note first that California was largely in sync with the country as a whole, while Florida saw its recession probability shoot up prior to the national recession and shoot down at about the same time as the national recession. The recession probabilities for Rhode Island and Michigan, on the other hand, rose well before the national recession, and fell prior to the end of it. Michigan suffered an idiosyncratic recession in 2006

that it was still recovering from when the Great Recession hit.

At the other end of the range of experiences is Texas, which saw its recession probability rise and fall well within the bounds of the national recession. Montana's recession probability, on the other hand, rose and fell outside of the national recession. New York and Wyoming were idiosyncratic: New York saw a double-dip recession, with both dips occurring within the national recession, and Wyoming was hit by the Great Recession and the collapse of oil prices during the second half 2014, when the price of a barrel of oil fell from about $120 to $40.

The states' employment cycle experiences during the period of the Great Recession are summarized by Figure 6, which translates the state recession probabilities into recession and expansion phases using the rule of thumb that a recession is when the recession probability exceeds 0.5. Note that the national employment recession is shaded light gray and the NBER recession months are indicated by dark gray shading of the dates at the top of the figure. The figure shows the great variety of state-level experience even for a massive downturn like the Great Recession: 11 states' peaks were prior to the national peak, 10 states' troughs were later than the national trough, and 16 states didn't enter recession until September 2008, 5 months after the national employment recession began, and nine months after the start of the official NBER recession. As

Figure 6. Recession Months

Black = State, Light Gray = National, Dark Gray = NBER

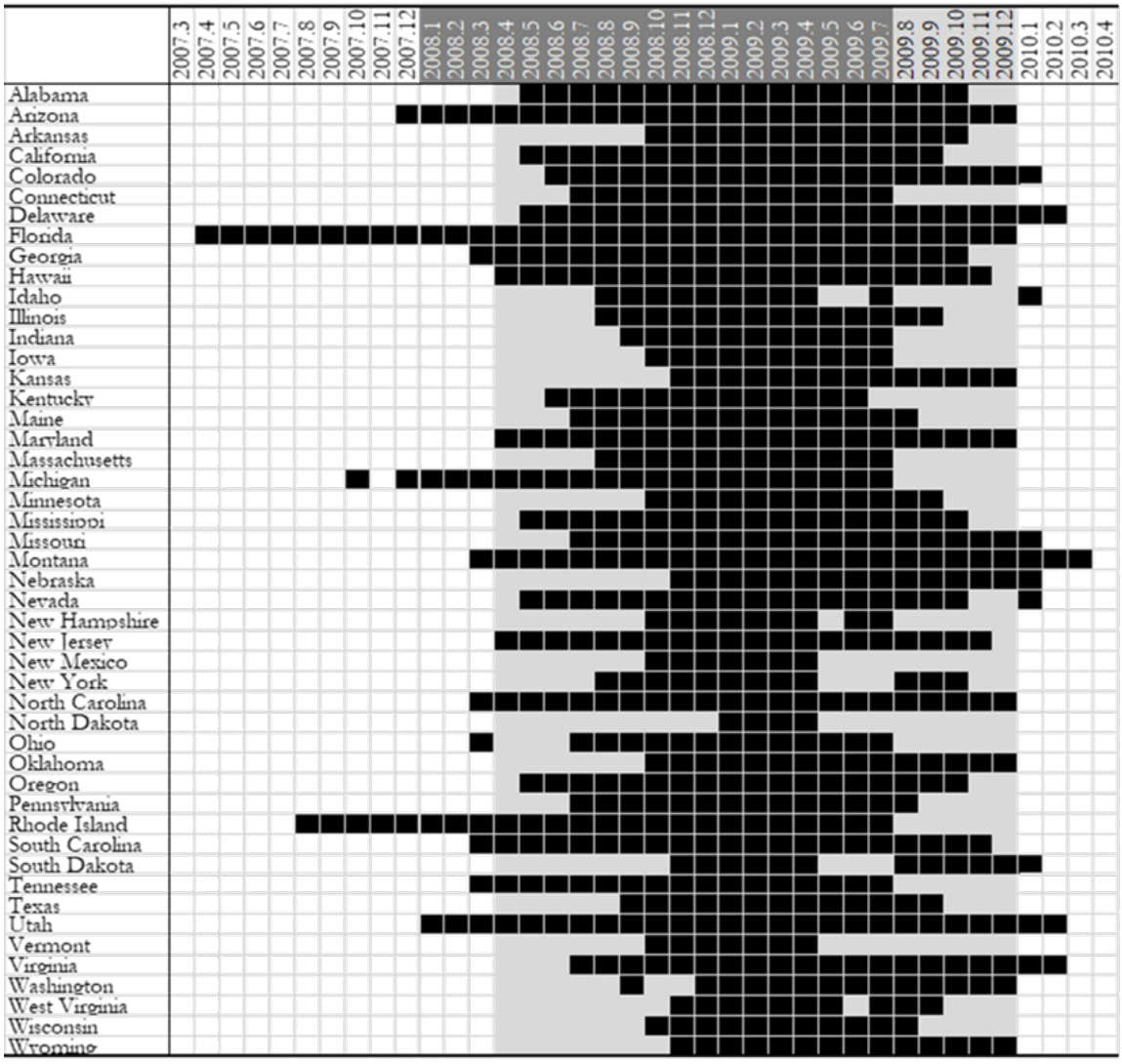
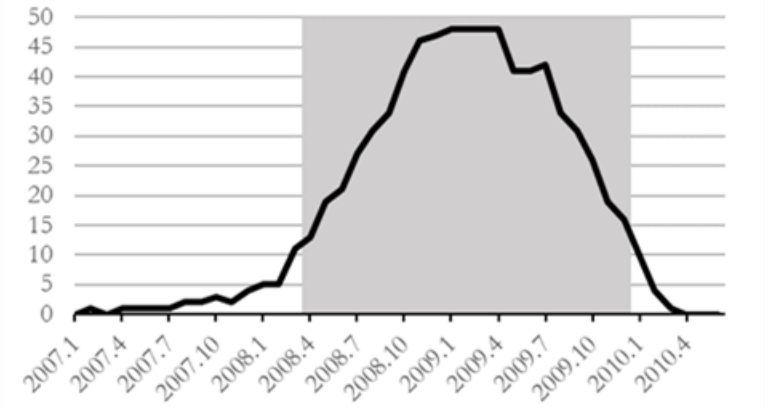


Figure 7 shows, it wasn't until the financial crisis in the fall of 2008 that the great mass of states had switched into recession. And by May 2009, some states began switching into expansion even though the official recession didn't end until July and national employment remained in recession until the end of the year.

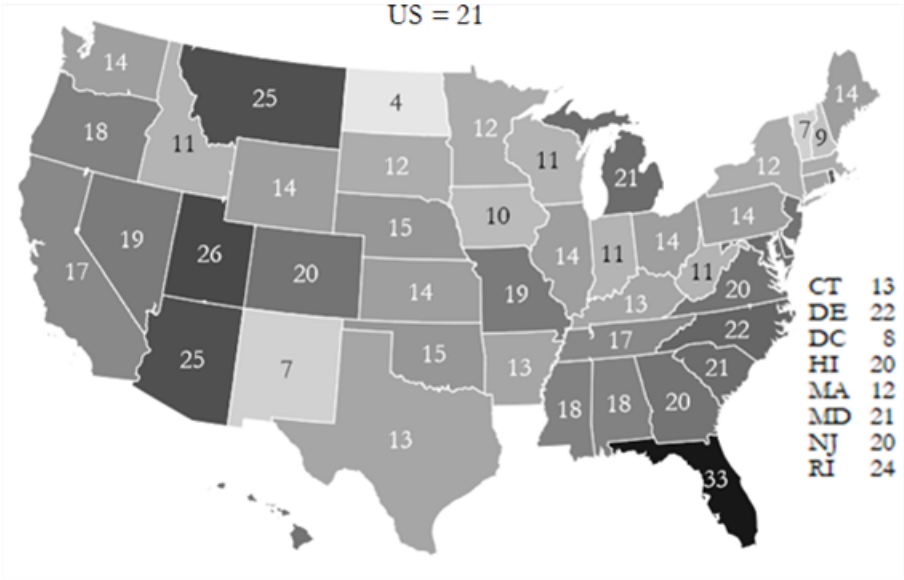
Figure 7. Number of States in Recession, 2007-2010
Gray area = national employment recession



3.3 The Geography of the Great Recession

The search for patterns in the state-level employment recessions begins with Figure 8, which shows the geographic distribution of recession frequency surrounding the Great Recession. Generally speaking, states

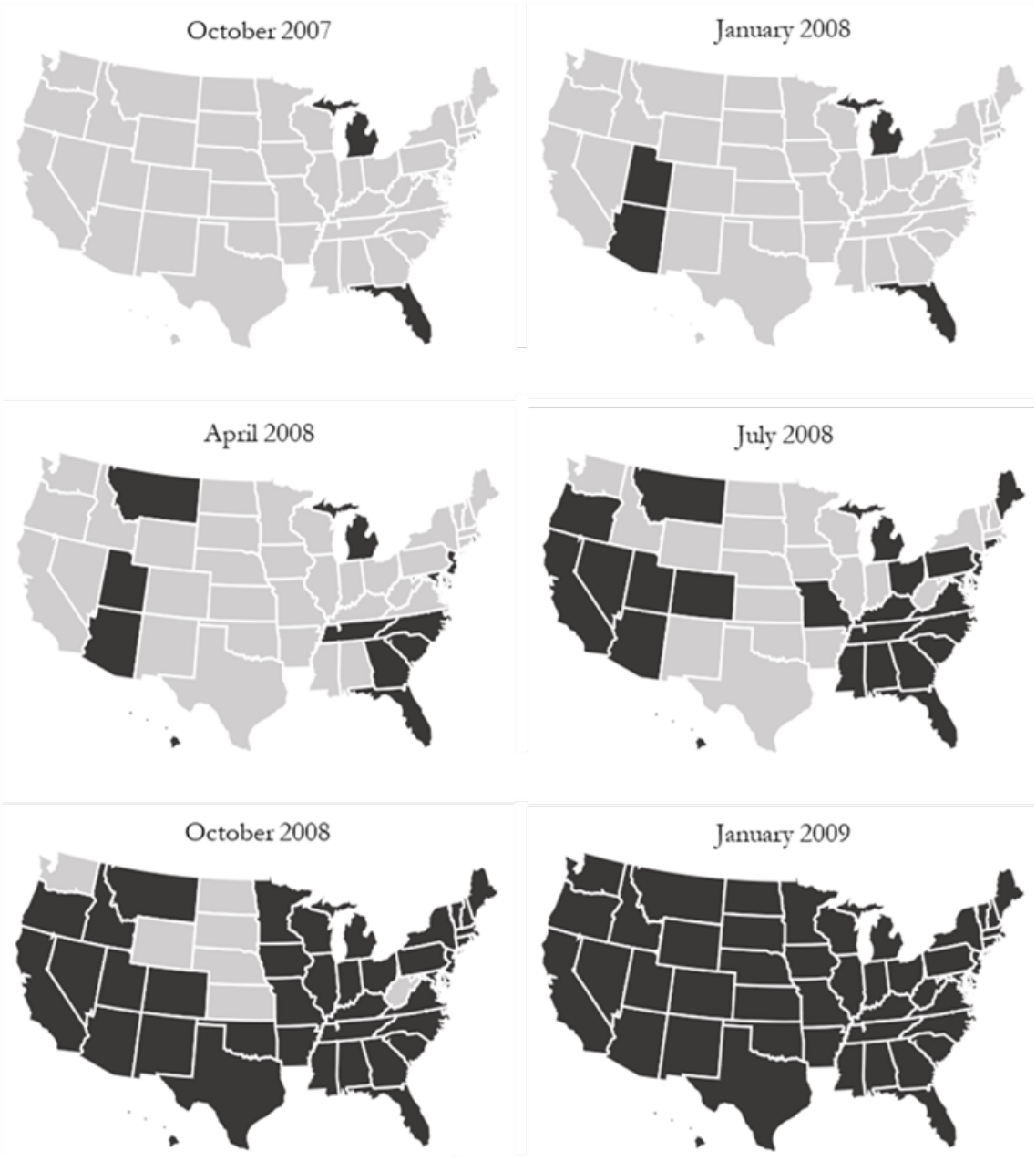
Figure 8. Months of Recession, 2007-2010
US = 21



with the most recession months tended to be in the Mountain and Far West regions, or on the Atlantic coast from New Jersey to Florida. Wide swaths of the middle of the country from New Mexico to Maine, and from Texas to South Dakota had frequencies well below the average.

The geographic pattern of states' entry into recession mirrors the frequency pattern, suggesting that it was a state's time of entry into recession, rather than exit from it, that drove whether the state saw a long or short recession. Figure 9 shows this pattern of switching into recession using three-month intervals and

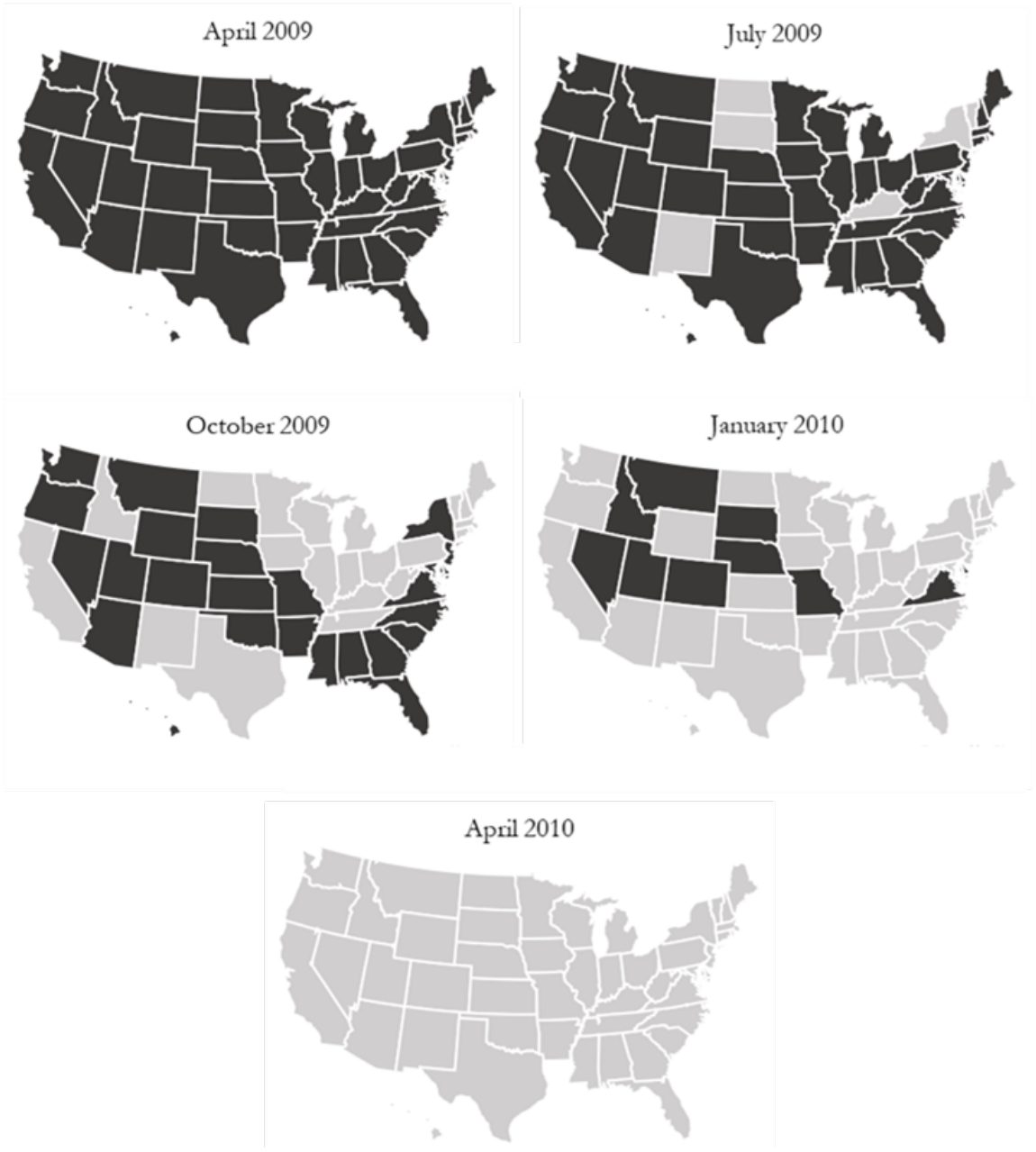
Figure 9. Entering the Great Recession
Gray = Expansion, Black = Recession, AK and LA excluded



shading recessionary states in black. As early as October 2007, states as varied as Michigan, Florida, and Rhode Island were already in recession, and were joined by Utah and New Mexico by January 2008, the first month of the official NBER recession. By April, several states along the Atlantic coast, plus Montana, had entered recession. By July, much of the East and West were in recession, but most of the states in the middle of the country, as well as New York and parts of New England and West were still in expansion. As the financial system spiraled into crisis in September and October, only West Virginia, Washington, and

some states of the Great Plains were still in expansion. By January, the recession was truly national in that it was occurring in every state. It's worth noting that such geographic uniformity is rare. Only briefly in 1982 were there months in the post-war period in which every state was in recession at once (Owyang et al., 2008).

Figure 10. Exiting the Great Recession
Gray = Expansion, Black = Recession, AK and LA excluded



Exit from employment recession was not as drawn out as was entry into it, although it too had a strong geographic component. As Figure 10 shows, all states were in still in recession in April 2009, but several had exited by July of the same year. By October 2009 almost the entire Midwest, all of New England, plus Texas, California, New Mexico, and Idaho were in expansion . By January 2010, the first month of national employment expansion, only 10 states—mostly in the Plains and Mountain regions—were still in recession.

By April, two years after the national employment recession began, all states had switched into expansion.

4 Explaining Recession Characteristics

In the previous section I reported substantial differences across states in the depths and timing of state-level employment recessions associated with the Great Recession. Instead of a single recession to examine, we have 49 of them, so it is possible to see if there are variables that describe the recession characteristics across states. This is not a large number of observations—and they are reduced to 48 by data availability—but they are sufficient for obtaining some simple regression results to suggest the sources of the geographic variations. For parsimony, I selected only those variables that are typical bellwethers of recessions, or which highlight unique aspects of the 2008-09 recession. For example, the Great Recession was unlike other post-war recessions in that it included by a massive financial crisis preceded by a housing bubble and a sharp increase in the issuance of subprime mortgages. Because of this, I include a measure of the importance of subprime mortgages in a state. Specifically, I proxy for the prevalence of subprime mortgages at the start of the recession with "subprime originations as a share of housing units" for 2005 from Mayer and Pence (2008).[6] See Appendix B for the distribution of subprime lending across states.

I include two bellwether sectors—Manufacturing and Mining, logging, and construction—to detect similarities between the Great Recession and typical recessions. Manufacturing, in particular tends to be hit relatively hard by recessions via a decrease in the demand for durables as the economy slows. The two sectors also are usually targeted by monetary policy as a channel for the Fed to boost aggregate demand to end a recession. Manufacturing might be thought of as an innocent bystander during the Great Recession in that it was affected by the general downturn but did not have a role in initiating the downturn. As outlined by Barker (2011), manufacturing employment fell at more than twice the rate of total employment from December 2007 until the end of 2009 and began to rise somewhat earlier than did total employment.

The mining and construction subsectors had experiences that were somewhat idiosyncratic to the Great Recession. First, because housing played a special role in fomenting the recession, employment in construction did not follow its usual pattern. Specifically, national employment in construction declined sharply prior to the start of the general recession and kept declining throughout it (Hadi, 2011). Second, mining employment, which includes oil extraction, had a strong and early rebound in the middle of the national recession as oil prices recovered (Davidson, 2011). This rebound is reflected in the experience of North Dakota and West Virginia, although is less obvious for other energy-producing states where the industry's state-wide impact is smaller. Unfortunately, the conflicting experiences of construction and mining cannot be separated at the state level because disclosure rules prevent the BLS from reporting mining employment for every state.

The third sector that I included is Financial activities, which is usually a source of relative employment stability during recessions. The Great Recession, however, was very different from most recessions (Prassas, 2011): The housing crisis that preceded the recession meant that the sector's employment started falling nationally in 2007. For states with a large Financial activities sector, the recession was likely to have begun earlier than average. Having a large Financial activities sector might have meant a deeper and longer recession because of the financial crisis and the general decline of the sector well into 2010.

In addition to the prevalence of certain sectors, sectoral diversity has been found to be related to economic performance during and after recessions. As mentioned already, Deller and Watson (2016) look at whether economic diversity was related to county-level employment stability during the Great Recession. They define "stability" as the "sensitivity to fluctuations caused by outside factors," which encompasses both the timing and depth of recession. According to their summary of the theoretical literature, industrial diversity is similar to financial portfolio diversity so the effects of external shocks such as a national recession should be tempered. The diversity measure I include in my estimation is simply 1 minus the state-level Herfindahl index of two-digit sectoral employment shares.

Table 1 provides summary statistics for the dependent and independent variables used in the estimation. See Appendix C for an illustration of the differences across states in the prevalence of jobs, measured by the

[6] They use data from First American LoanPerformance on mortgages sold in subprime pools. These mortgages are usually subprime because of the low credit scores of the borrowers and high loan-to-value ratio. Mayer and Pence don't include Hawaii, however, so my dataset is reduced to 48 observations.

Table 1. Summary Statistics of State Characteristics

	Mean	Std. Dev
Recession gap	0.367	0.121
Recession frequency	15.90	5.73
Peak month	15.56	4.19
Trough month	29.69	2.96
Subprime as % of housing	0.033	0.018
Mining, logging, and construction share	6.40	2.57
Manufacturing share	10.13	3.85
Financial activities share	5.81	1.28
Sectoral diversity	0.866	0.011

share of total state employment in 2007, in the three industries and in sectoral diversity. As already noted, both the entry and exit of states into recession had strong geographic patterns and, to a lesser extent, so did the recession gaps and the recession frequency. I also include dummy variable for the eight Bureau of Economic Analysis regions.[7]

Table 2 presents the Ordinary Least Squares results using the recession gap, recession frequency, first peak month, and final trough month, respectively, as dependent variables.[8] Given that regions can contain as few as five states, their estimated effects are suppressed in the table. To test the joint statistical significance of the region effects, Table 2 includes versions of the model that assume that regional effects do not matter. In short, the results indicate that state recession gaps were larger (i.e., the recessions were deeper per month) the more prevalent subprime mortgages were and the more sectoral diversity there was. They were not, however, related to the shares of the three included industries, nor to a state's region. To put the importance of subprime mortgages into perspective, consider Arizona, which had one of the highest rates of subprime mortgages, and the seventh largest recession gap in absolute terms. If its share of subprime mortgages had been the average across states, it would have lost only about 1/4 of the employment per month that it did, and have had the 26^{th} largest absolute gap, just above that of Texas. The result for sectoral diversity is what might be expected from the theory: Diverse states tended to have had shallower recessions per month and, for some states, a lack of diversity accounted for a large part of their recession gap. For example, if DC and Nevada—states with the second and third largest recession gaps—had had the average level of sectoral diversity, their recession gaps would have been three-fifths and one-fifth smaller, respectively.

As with the recession gap, recession frequency was related to sectoral diversity and the prevalence of subprime mortgages: States saw longer recessions if they had lots of subprime mortgages and if their economy was diverse. The first of these effects should not be surprising and, combined with the effect on the recession gap, mean that the prevalence of subprime mortgages meant a longer and deeper recession. The second effect is, perhaps, surprising because diversity is thought to be beneficial in dampening the harm from recession. As described in the next section, the positive link between diversity and recession frequency negated the link between diversity and the recession gap to the extent that diversity was not related to the overall effects of the recession on state employment. The final two sets of result indicate that subprime mortgages and sectoral diversity tended to mean earlier business cycle peaks but were not related to business cycle troughs. That is, they meant longer recessions because they tended make state recessions begin earlier.

In contrast with previous literature, states' industry mixes were not related to their recession characteristics during the Great Recession. The exception is that Financial activities shares were related to their recession troughs: The larger a state's financial sector, the longer it took for the recession to end. Finally, regional effects were related to the frequency and length of state recessions, but not to their monthly depth. States tended to switch between recession phases around the same times as their neighbors, but the growth

[7] New England, Mideast, Southeast, Southwest, Great Lakes, Plains, Rocky Mountain, and Far West.
[8] Months are numbered 1 through 179, starting with February 2005.

Table 2. State Recession Characteristics and the Influence of Subprime Loans, Industry Shares, and Regional Effects

Dependent variable	Recession Gap		Recession Frequency		Peak Month		Trough Month	
Model	Unre-stricted	Regional effects = 0	Unre-stricted	Regional effects = 0	Unre-stricted	Regional effects = 0	Unre-stricted	Regional effects = 0
Constant	-0.738*	-0.534*	36.204*	45.634*	3.147*	-3.884	19.669*	24.642*
	(0.396)	(0.428)	(14.173)	(18.340)	(11.702)	(12.572)	(10.762)	(12.268)
Subprime as % of housing	2.810*	3.420*	174.350*	133.730*	-152.144*	-121.970*	10.038	-1.617
	(1.260)	(0.764)	(50.289)	(49.789)	(36.296)	(38.168)	(30.590)	(24.878)
Mining, logging, and construction share	-0.007	0.001	−0.09968	0.201	0.341	0.201	−0.05054	0.183
	(0.009)	(0.006)	(0.337)	(0.240)	(0.215)	(0.167)	(0.190)	(0.154)
Manufacturing share	0.012	0.011	−0.19485	-0.231	0.100	0.129	−0.14837	-0.183
	(0.009)	(0.007)	(0.353)	(0.335)	(0.279)	(0.208)	(0.238)	(0.200)
Financial activities share	0.006	-0.007	0.315	-0.230	-0.046	0.433	0.747†	0.577
	(0.021)	(0.020)	(0.643)	(0.748)	(0.453)	(0.443)	(0.430)	(0.493)
Sectoral diversity	-6.682*	-5.292*	213.271*	236.389*	-112.417*	-136.651*	-27.757	-18.019
	(1.461)	(1.727)	(55.348)	(80.365)	(50.370)	(58.659)	(47.314)	(56.913)
Region dummies	Yes	No	Yes	No	Yes	No	Yes	No
R^2	0.479	0.391	0.616	0.371	0.613	0.334	0.391	0.168
Adjusted R^2	0.300	0.182	0.484	0.296	0.481	0.255	0.182	0.069
p-value for restrict'n		0.401		0.004*		0.000*		0.001*

Robust standard errors are in parentheses. Statistical significance at the 5 percent and 10 percent levels are indicated by "*" and "†", respectively.

losses during the recessions were state-specific. One might think of the business cycle moving across space as well as over time, but that the experiences within each phase of the cycle are determined by mostly local factors. This result is reminiscent of the state-level business cycle synchronization described by Cainelli et al. (2021).

5 The Great, Greater, and Greatest State Recessions

Having found the characteristics of state-level recessions, it is now possible to calculate state-specific effects of the economic shock of the Great Recession. Traditionally, one would look at the percentage changes in employment between the peak and trough of the NBER recession. National recession dates can be quite misleading at the state level, however, because state recessions were often very different from them. To show the importance of the distinction, Table 3 provides the percentage changes in states' employment between the NBER peak and trough, as well as between states' own peaks and troughs from Figure 6. For the most part, states with large job losses during the NBER recession tended to see large job losses during their own employment recessions. There were, nevertheless, some anomalies—DC and North Dakota had positive job growth between the NBER peak and trough.

Looking at the second of these two measures of the effect of recession, the average state saw employment changes of −5.2 percent, but three states—North Dakota, DC, and Vermont—saw changes below −2 percent, while three states—Nevada, Florida, and Arizona—saw employment changes of −10.9 percent or worse. As illustrated by Figure 11, except for Michigan, the states with the largest decreases in employment were in either the West or the Southeast. The Upper Midwest had a concentration of states with small employment decreases, with other of these states scattered from New Mexico to New England. The Northeast and states between Texas and North Dakota in the middle of the country tended to have seen relatively small decreases in employment.

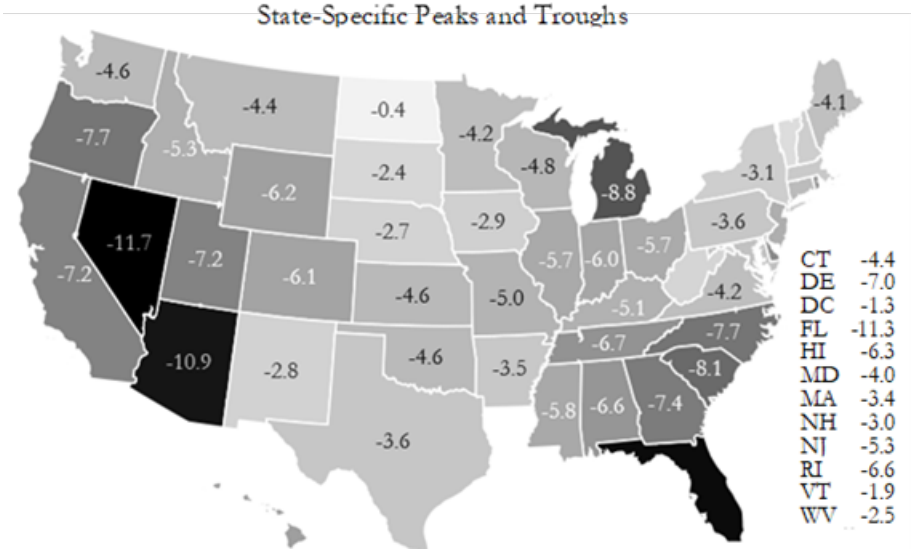
The calculations in the first column are not that interesting except in how those in the second column

Table 3. State Employment Effects of the Great Recession

Type of effect	% Change	% Change	Forgone	Type of effect	% Change	% Change	Forgone
Peaks and troughs	NBER	State-specific	State-specific	Peaks and troughs	NBER	State-specific	State-specific
United States	*−5.6*	*−6.1*	*−8.5*	Montana	−4.2	−4.4	−8.0
Alabama	−6.6	−6.6	−8.0	Nebraska	−1.9	−2.7	−3.8
Arizona	−9.7	−10.9	−15.1	Nevada	−12.0	−11.7	−14.7
Arkansas	−3.8	−3.5	−4.5	New Hamp	−4.1	−3.0	−3.6
California	−7.5	−7.2	−9.3	New Jersey	−5.0	−5.3	−6.5
Colorado	−5.1	−6.1	−9.4	New Mexico	−4.7	−2.8	−3.1
Connecticut	−5.2	−4.4	−4.9	New York	−2.4	−3.1	−4.5
Delaware	−6.1	−7.0	−9.1	North	−6.8	−7.7	−10.7
DC	0.8	−1.3	−4.0	North Dakota	1.2	−0.4	−0.9
Florida	−9.2	−11.3	−16.6	Ohio	−7.3	−5.7	−6.3
Georgia	−7.0	−7.4	−9.9	Oklahoma	−2.7	−4.6	−6.0
Hawaii	−6.0	−6.3	−8.9	Oregon	−7.5	−7.7	−10.2
Idaho	−7.8	−5.3	−6.6	Pennsylvania	−3.8	−3.6	−4.4
Illinois	−6.0	−5.7	−6.5	Rhode Island	−6.5	−6.6	−7.9
Indiana	−7.6	−6.0	−6.8	South	−7.4	−8.1	−10.7
Iowa	−3.6	−2.9	−3.5	South Dakota	−1.1	−2.4	−3.8
Kansas	−3.5	−4.6	−5.6	Tennessee	−7.3	−6.7	−8.6
Kentucky	−5.7	−5.1	−6.0	Texas	−2.6	−3.6	−5.8
Maine	−4.4	−4.1	−4.7	Utah	−6.8	−7.2	−13.1
Maryland	−3.7	−4.0	−5.5	Vermont	−4.3	−1.9	−2.2
Massachusetts	−3.8	−3.4	−4.4	Virginia	−3.7	−4.2	−6.0
Michigan	−9.9	−8.8	−10.4	Washington	−5.1	−4.6	−6.5
Minnesota	−4.6	−4.2	−5.1	West Virginia	−2.3	−2.5	−3.2
Mississippi	−5.6	−5.8	−6.8	Wisconsin	−5.4	−4.8	−5.4
Missouri	−4.4	−5.0	−6.2	Wyoming	−3.4	−6.2	−8.2

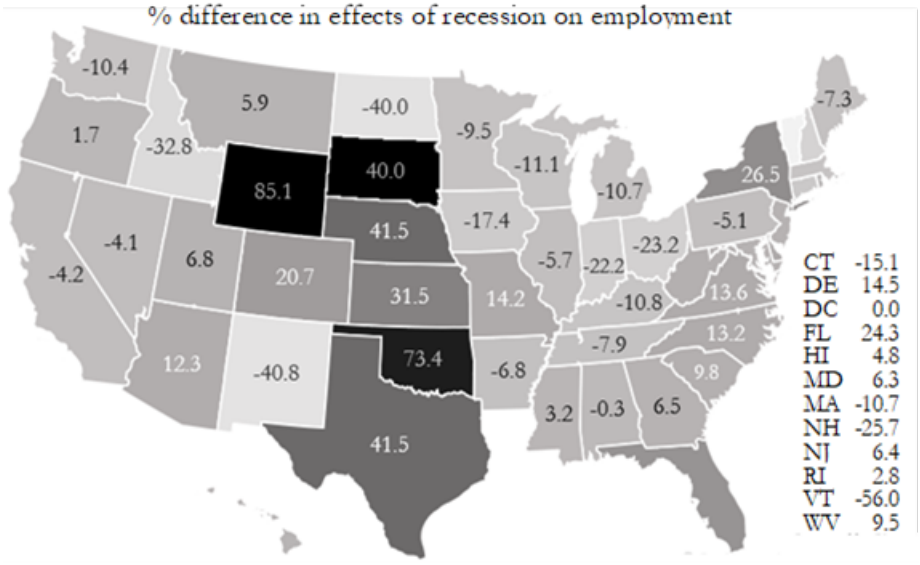
The percent change in employment is calculated either between the NBER peak and trough or the states' first peak and final trough in Figure 6. Forgone employment is the percent difference between potential and actual employment at the state's final trough.

Figure 11. Percentage Change in Employment from the Great Recession



differ from them. These differences are illustrated by Figure 12, which shows for each state the percentage change in calculated job losses between the two methods. For the eight states shaded black, state-specific peaks and troughs indicated 20 percent more jobs lost during recession when state peaks and troughs are used. South Dakota and DC are also shaded black because they went from gaining to losing jobs when their own peaks and troughs were used. At the other end are eight states for which the move to state peaks and troughs means lower calculated job losses. In all, there were 22 states for which the adjustment meant fewer calculated jobs lost, and 26 for which it meant more calculated jobs lost.

Figure 12. State-Specific Recessions Versus the NBER



These percentage change calculations are an important twist on the usual calculations in that they use state-specific peaks and troughs rather than applying a national peak and trough to all states. They still, however, overlook how the same percentage decrease in employment can mean different things for different states. A state experiences not only the decrease from its initial employment level, but also the employment growth that would have happened if the recession had not occurred. To account for this, my second set of calculations—forgone employment—is the percentage difference at the trough between actual employment and employment that would have occurred if employment had continued growing at its expansion rate.

Looking at the calculations of forgone employment, there are four categories of recession among the states during the period of the Great Recession (Figure 13). There were the 30 states that experienced great recession during which forgone employment was between 2.2 percent and 6.8 percent, 14 states that experienced a greater recession with forgone employment between 7.9 percent and 10.7 percent, and four states that experienced the greatest recessions with forgone employment between 13.1 percent and 16.6 percent. North Dakota stood alone in experiencing a weak recession with forgone employment of just 0.9 percent. Even though forgone employment combines the several different facets of recessions, each with their own geographic pattern, forgone employment has a fairly distinct geographic pattern. States of the Far West and Mountain regions tended to have lost the most from the recession, along Michigan and states of the South East. The great swath of states from New Mexico to Maine and from Texas to Minnesota saw significant effects themselves, but the distribution of forgone employment was skewed toward other groups of states.

Note that using forgone employment rather than the percentage change in employment will necessarily increase the calculated job losses from the recession, and the adjustment differs a great deal across states. As shown by Figure 14, a total of 26 states saw greater than 30 percent increases in calculated job losses when lost job growth is considered. The largest percentage increases occurred for the Dakotas and Montana (although from small bases) and for Texas, Utah, Colorado, Florida. The smallest increases occurred for most of the Great Lakes states and New England.

Figure 13. Great, Greater, and Greatest Recession by Forgone Employment

% Difference between potential and actual employment at the state trough

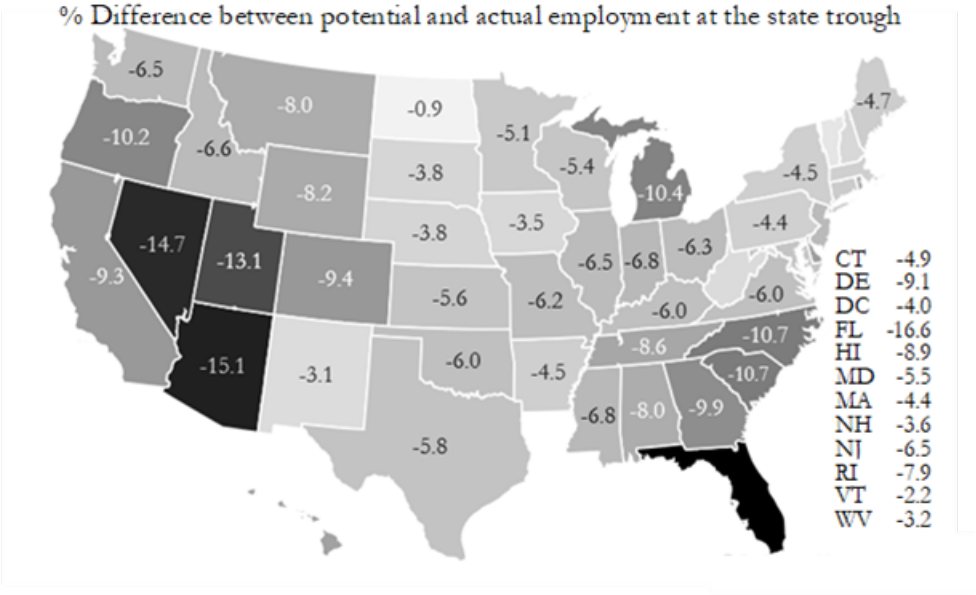


Figure 14. Forgone Employment vs. % Change in Employment

% Difference using forgone employment instead of percent change in employment

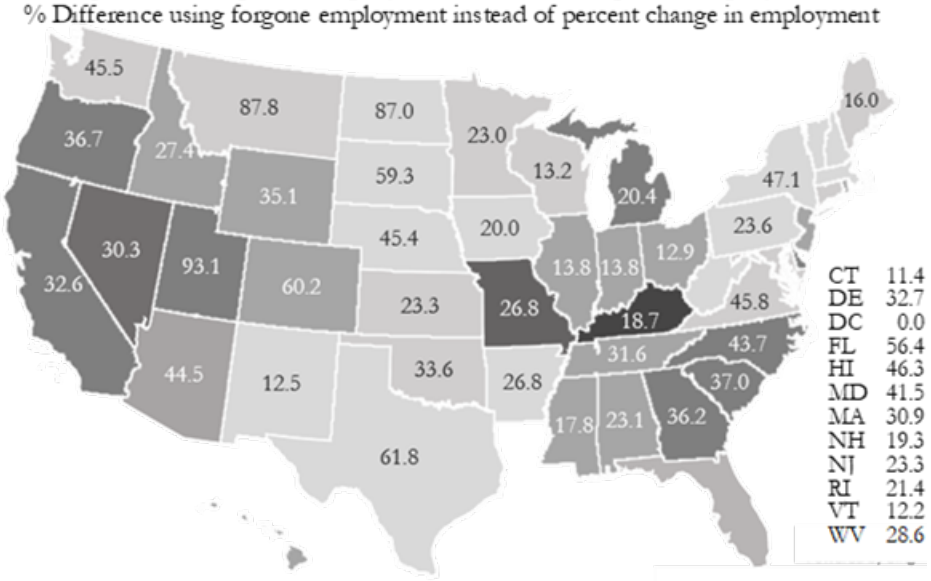


Table 4. Determinants of the Employment Effects of State Recessions

Effect	% Change in Employment		Forgone Employment	
Model	Unrestricted	Regional effects = 0	Unrestricted	Regional effects = 0
Constant	4.950 (6.583)	-0.474 (6.003)	6.532* (6.462)	-0.009 (6.560)
Subprime as % of housing	-93.769* (15.541)	-101.075* (13.274)	-114.122* (14.435)	-111.938* (13.290)
Mining, logging, and construction share	-0.287* (0.091)	-0.393* (0.085)	-0.054 (0.105)	-0.200† (0.113)
Manufacturing share	-0.230* (0.116)	-0.282* (0.091)	-0.195* (0.105)	-0.182* (0.084)
Financial activities share	-0.447 (0.306)	-0.022 (0.290)	-0.426 (0.366)	-0.021 (0.341)
Sectoral diversity	-7.459 (30.208)	-30.282 (26.820)	18.558 (29.006)	-9.706 (30.922)
Region dummies	Yes	No	Yes	No
R^2	0.751	0.615	0.761	0.616
Adjusted R^2	0.666	0.569	0.680	0.570
p-value for restriction		0.007*		0.004*

Robust standard errors are in parentheses. Statistical significance at the 5 percent and 10 percent levels are indicated by "*" and "†", respectively.

Table 4 summarizes the OLS estimates of the links between the latter two employment effect calculations and the subprime, industry, and regional variables from the previous section. The percentage change in employment is related to all three industry shares: A state tended to see a larger decrease in employment from peak to trough the more subprime mortgages it had, and the larger its shares of Mining, logging, and construction and Manufacturing. These links are consistent with the performance of those industries through the period. Regional effects were also statistically significant. The results for forgone employment differ somewhat because, all else equal, forgone employment is higher for states that normally grow relatively fast. Because faster-growing states tended to make greater use of subprime mortgages, the mortgage channel tended to be more important for forgone employment than for the percentage change in employment. Specifically, the coefficient for subprime housing is larger, and the effects for Mining, logging, and construction and Manufacturing are smaller. Note that neither measure of the total effects of the recession were related to sectoral diversity. As shown in the previous section, more sectoral diversity tended to mean a smaller recession gap but a longer recession, so the opposing effects end up cancelling each other out.

Table 5. Partial R^2s

Variable(s)	% Change in Employment	Forgone Employment
Subprime as % of housing	0.508	0.612
Industry shares	0.178	0.126
Sectoral diversity	0.002	0.011
Regional dummies	0.355	0.379

As is typical with recessions, industry composition and regional effects were related to the overall effects of the Great Recession on states. They were, however, dwarfed by the effects of subprime mortgages, as indicated by the partial R^2s provided in Table 5. States with higher shares of subprime mortgages saw larger losses from each month of recession along with earlier and, therefore, longer recessions.

6 Summary and Conclusions

This paper found state-specific recessions for the period of the Great Recession and found that, despite the severity and universality of the recession, there were substantial differences across states:

- States in the west and southeast tended to have had larger absolute recession gaps, meaning that their monthly employment losses during the recession tended to be larger than those in the midwest and northeast. Absolute recession gaps were positively related to the prevalence of subprime mortgages, and negatively related to sectoral diversity.
- Eleven states experienced their peaks prior to the national peak of March 2008, and 16 states did not experience their peaks until September 2008, when the financial crisis began to spiral. Early peaks tended to have occurred in the west and along the southern Atlantic coast. A high share of subprime mortgages tended to mean an earlier start to a state's recession, as did a more-diverse economy.
- Differences in the overall lengths of state recessions were driven by differences in how early they entered recession. As such, states in the west and southeast of the country tended to have had the longest recessions. Sectoral diversity and high shares of subprime mortgages were associated with longer recessions.
- Overall employment losses during state recessions ranged from the double-digit losses of Nevada, Florida, and Arizona to the sub-2 percent losses of North Dakota, Vermont, and the District of Columbia. Foregone losses, which account for lost growth, were often substantially larger than overall employment losses.
- For both measures of employment losses, losses from the Great Recession were positively related to subprime mortgages and the employment shares of Manufacturing and Mining, logging, and construction, but not to sectoral diversity. Regional effects independent of these variables were also associated with state-specific effects of the recession.

The most significant limit to the analysis was the relatively low number of geographic units and, consequently, relative shortage of observations for estimating the importance of various factors. As such, it should be fruitful for future research to disaggregate the Great Recession further, probably to the level of metro areas. Note, however, that this would require creating a suitable metro-level measure of subprime mortgages. Nevertheless, an expanded data set would allow for the consideration of more-detailed industry variables as well as state and local policies.

References

Barker, M. M. (2011). Manufacturing employment hard hit during the 2007-09 recession. *Monthly Lab. Rev.*, 134:28.

Beraja, M., Fuster, A., Hurst, E., and Vavra, J. (2019). Regional heterogeneity and the refinancing channel of monetary policy. *The Quarterly Journal of Economics*, 134(1):109–183.

Beyers, W. B. (2013). The great recession and state unemployment trends. *Economic Development Quarterly*, 27(2):114–123.

Burns, A. F. and Mitchell, W. C. (1946). *Measuring business cycles*. Number burn46-1. National bureau of economic research.

Cainelli, G., Lupi, C., and Tabasso, M. (2021). Business cycle synchronization among the us states: spatial effects and regional determinants. *Spatial Economic Analysis*, 16(3):397–415.

Carlino, G. and DeFina, R. (1998). The differential regional effects of monetary policy. *Review of economics and statistics*, 80(4):572–587.

Carlino, G. and Sill, K. (2001). Regional income fluctuations: Common trends and common cycles. *Review of Economics and Statistics*, 83(3):446–456.

Carlino, G. A. and DeFina, R. H. (2004). How strong is co-movement in employment over the business cycle? evidence from state/sector data. *Journal of Urban Economics*, 55(2):298–315.

Chauvet, M. and Piger, J. (2013). Employment and the business cycle. *The Manchester School*, 81:16–42.

Connaughton, J. E. and Swartz, C. (2017). Regional implications of the great recession. *Journal of Regional Analysis & Policy*, 47(1):29–43.

Davidson, B. (2011). Mining employment trends of 2007-09: A question of prices. *Monthly Lab. Rev.*, 134:19.

Deller, S. and Watson, P. (2016). Did regional economic diversity influence the effects of the great recession? *Economic Inquiry*, 54(4):1824–1838.

Fogli, A., Hill, E., and Perri, F. (2013). The geography of the great recession. In *NBER International Seminar on Macroeconomics*, volume 9, pages 305–331. University of Chicago Press Chicago, IL.

Gadea, M. D., Gómez-Loscos, A., and Montañés, A. (2012). Cycles inside cycles: Spanish regional aggregation. *SERIEs*, 3:423–456.

Gatfaoui, J. and Girardin, E. (2015). Comovement of chinese provincial business cycles. *Economic Modelling*, 44:294–306.

Gjerde, K. P., Prescott, P., and Rice, J. (2019). The impact of state fiscal policy on states' resilience entering the great recession. *Journal of Regional Analysis & Policy*, 49(1):13–30.

Gómez-Loscos, A., Gadea, M. D., and Bandres, E. (2020). Business cycle patterns in european regions. *Empirical Economics*, 59:2639–2661.

Guren, A., McKay, A., Nakamura, E., and Steinsson, J. (2021). What do we learn from cross-regional empirical estimates in macroeconomics? *NBER Macroeconomics Annual*, 35(1):175–223.

Hadi, A. (2011). Construction employment peaks before the recession and falls sharply throughout it. *Monthly Lab. Rev.*, 134:24.

Hall, V. B. and McDermott, C. J. (2007). Regional business cycles in new zealand: Do they exist? what might drive them? *Papers in Regional Science*, 86(2):167–191.

Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time series and the business cycle. *Econometrica: Journal of the econometric society*, pages 357–384.

Hamilton, J. D. and Owyang, M. T. (2012). The propagation of regional recessions. *Review of Economics and Statistics*, 94(4):935–947.

Han, Y. and Goetz, S. J. (2015). The economic resilience of us counties during the great recession. *Review of Regional Studies*, 45(2):131–149.

Kim, C.-J., Nelson, C. R., et al. (1999). State-space models with regime switching: classical and gibbs-sampling approaches with applications. *MIT Press Books*, 1.

Kondo, K. (2022). Spatial dependence in regional business cycles: Evidence from mexican states. *Journal of Spatial Econometrics*, 3(1):1.

Lange, R. H. (2017). Regional business cycles in canada: A regime-switching var approach. *Journal of Regional Analysis and Policy*, 47(1100-2019-3672):57–74.

Martin, R., Sunley, P., Gardiner, B., and Tyler, P. (2016). How regions react to recessions: Resilience and the role of economic structure. *Regional Studies*, 50(4):561–585.

Mayer, C. J. and Pence, K. (2008). Subprime mortgages: what, where, and to whom? Technical report, National Bureau of Economic Research.

Mian, A. and Sufi, A. (2014). What explains the 2007–2009 drop in employment? *Econometrica*, 82(6):2197–2223.

Owyang, M. T., Piger, J., and Wall, H. J. (2005). Business cycle phases in us states. *Review of Economics and Statistics*, 87(4):604–616.

Owyang, M. T., Piger, J., and Wall, H. J. (2008). A state-level analysis of the great moderation. *Regional Science and Urban Economics*, 38(6):578–589.

Owyang, M. T., Piger, J., and Wall, H. J. (2013). Discordant city employment cycles. *Regional Science and Urban Economics*, 43(2):367–384.

Owyang, M. T., Piger, J., and Wall, H. J. (2015). Forecasting national recessions using state-level data. *Journal of Money, Credit and Banking*, 47(5):847–866.

Partridge, M. D. and Rickman, D. S. (2005). Regional cyclical asymmetries in an optimal currency area: an analysis using us state data. *Oxford Economic Papers*, 57(3):373–397.

Prassas, G. (2011). Employment in financial activities: double billed by housing and financial crises. *Monthly Lab. Rev.*, 134:40.

Prescott, P. and Gjerde, K. P. (2022). The impact of state fiscal policy on states' resilience during the great recession. *Journal of Regional Analysis & Policy*, 52(1):1–18.

Rickman, D. S. and Guettabi, M. (2015). The great recession and nonmetropolitan america. *Journal of Regional science*, 55(1):93–112.

Stumpner, S. (2019). Trade and the geographic spread of the great recession. *Journal of International Economics*, 119:169–180.

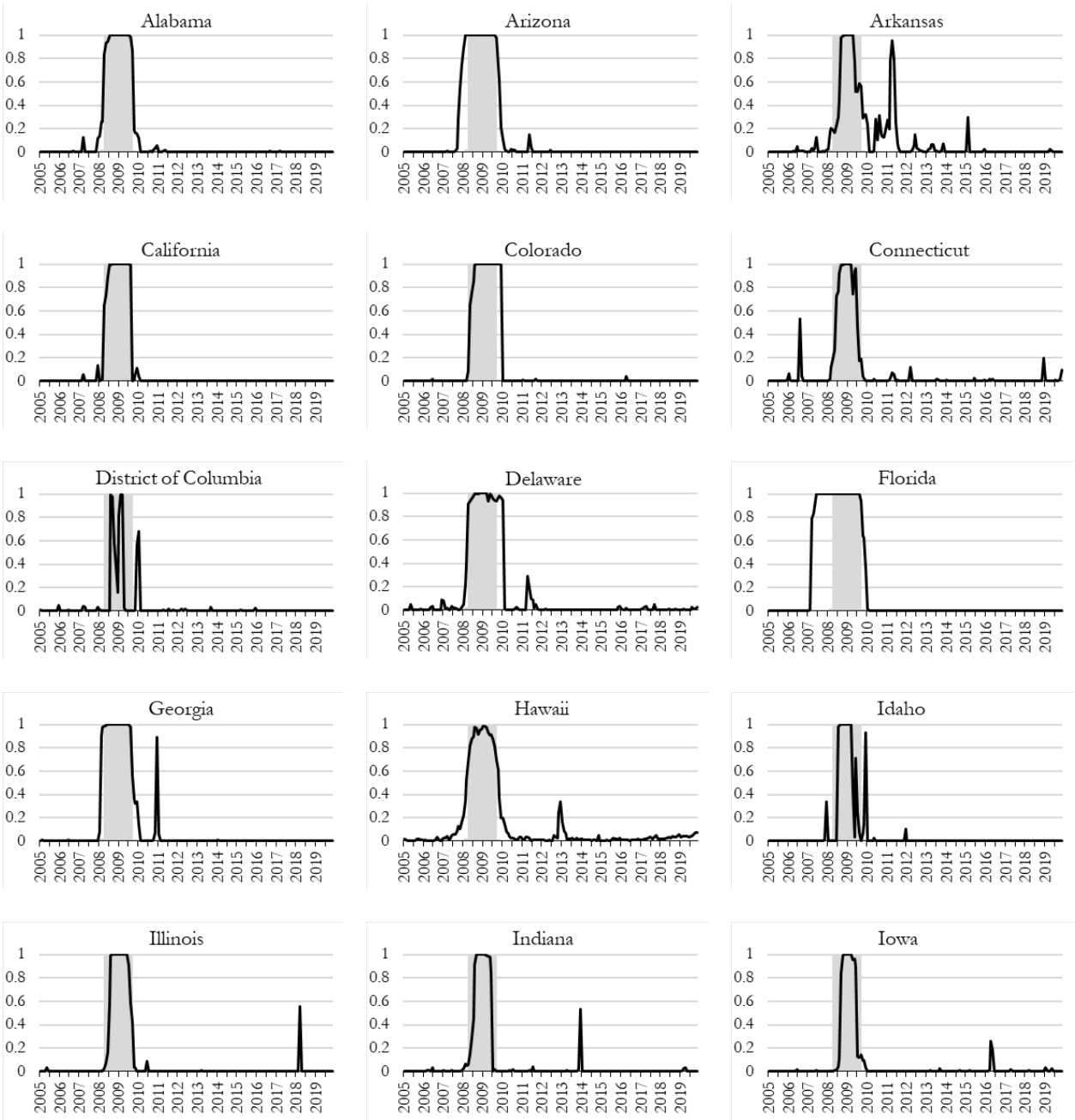
Walden, M. L. (2014). Recovery from the great recession: Explaining differences among the states. *Journal of Regional Analysis and Policy*, 44(1100-2016-90122):166–174.

Wall, H. J. (2006). Regional business cycle phases in japan. *FRB of St. Louis Working Paper No.*

Wall, H. J. (2013). The employment cycles of neighboring cities. *Regional Science and Urban Economics*, 43(1):177–185.

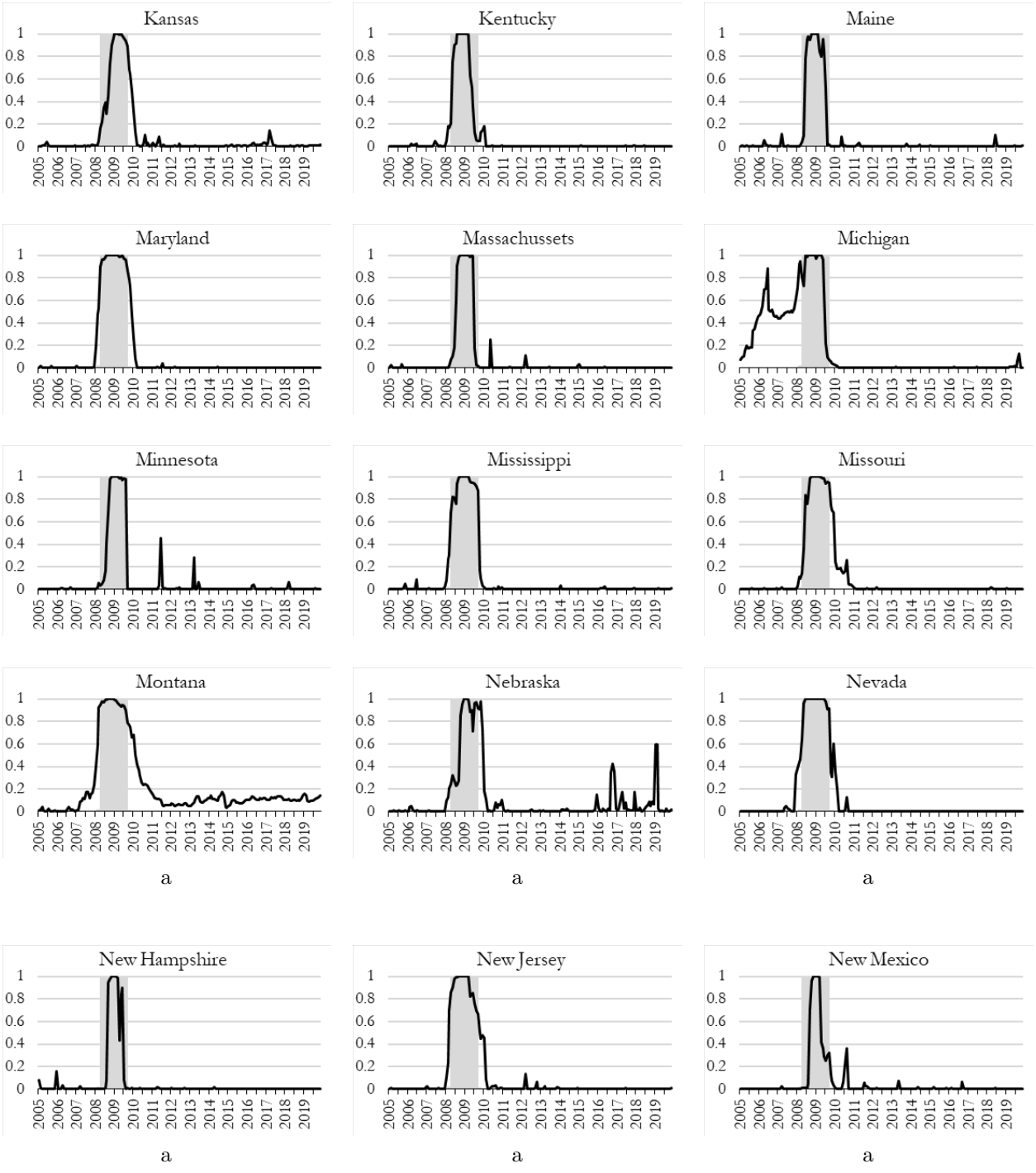
Appendix A: State Recession Probabilities, 2005-2009

Gray shading indicated national employment recession



Appendix A: State Recession Probabilities, 2005-2009

Gray shading indicated national employment recession

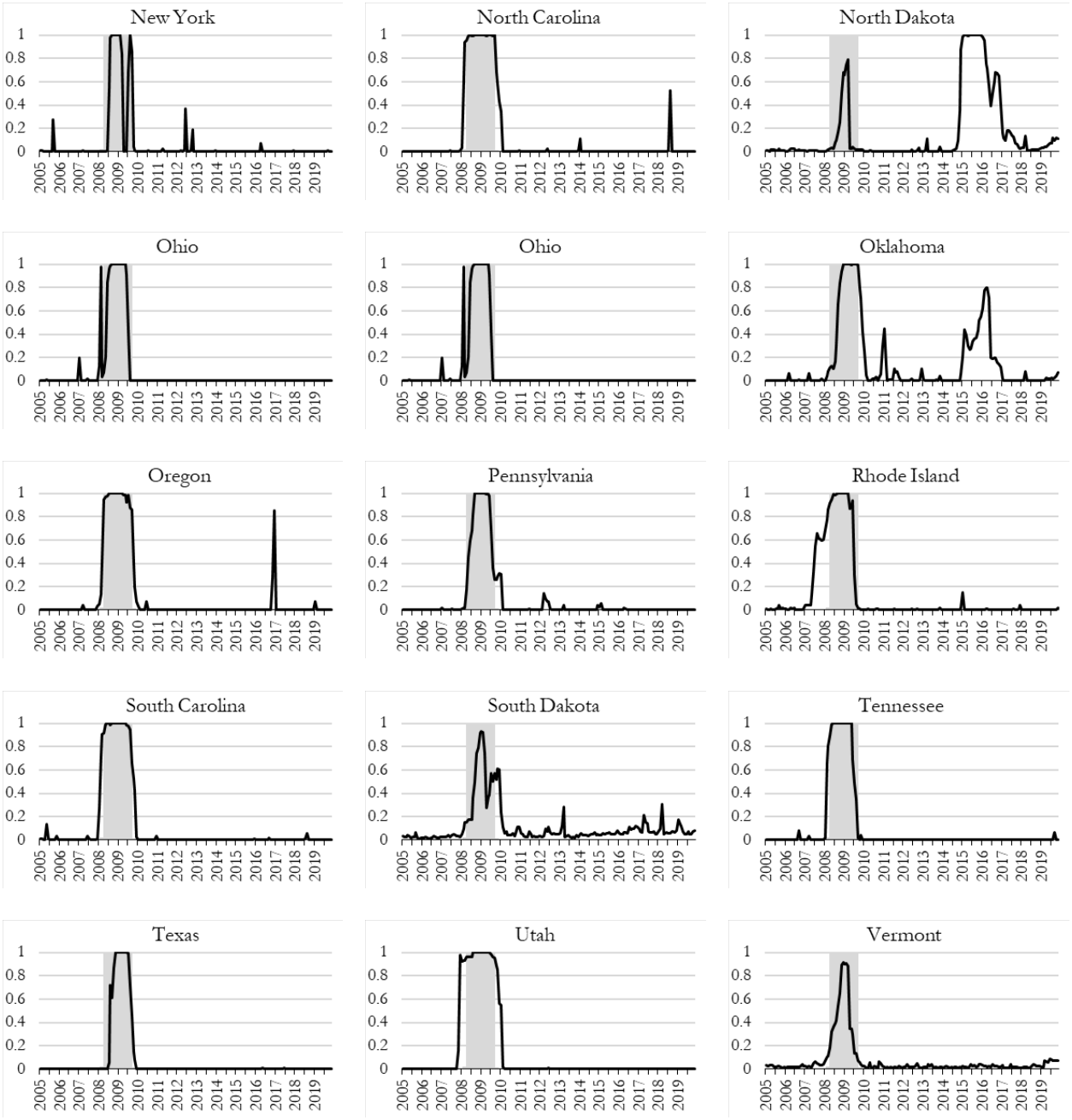


a a a

a a a

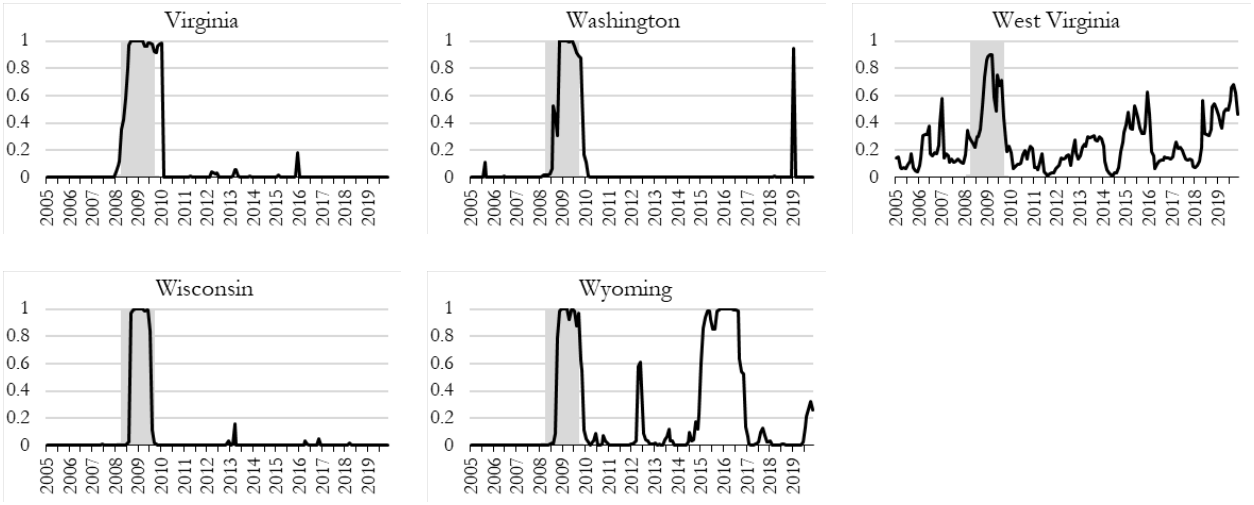
Appendix A: State Recession Probabilities, 2005-2009

Gray shading indicated national employment recession



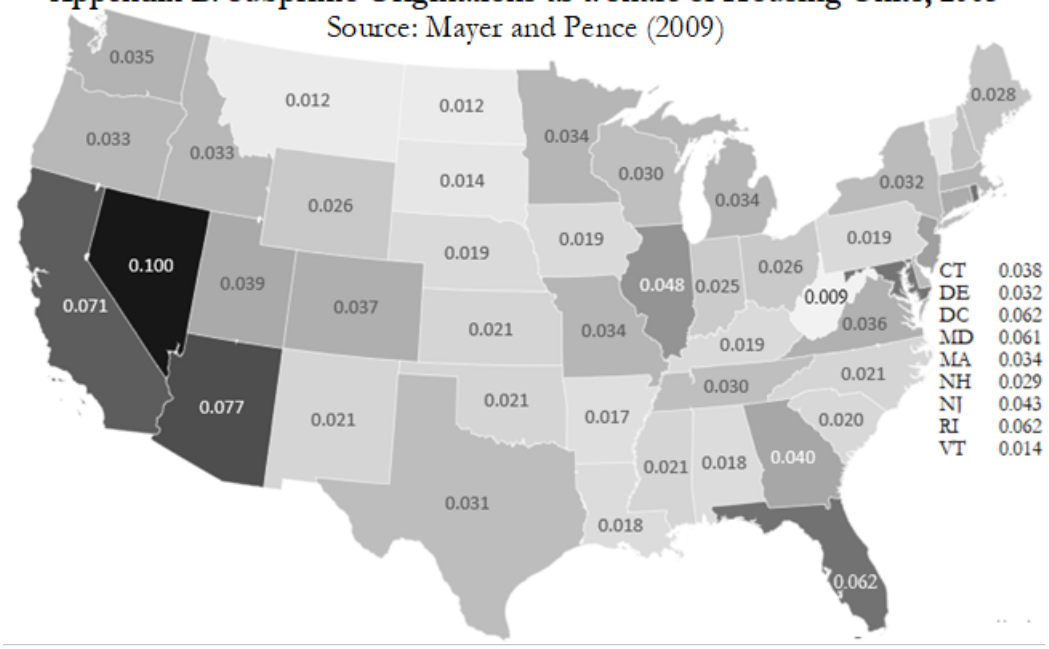
Appendix A: State Recession Probabilities, 2005-2009

Gray shading indicated national employment recession



Appendix B. Subprime Originations as a Share of Housing Units, 2005

Source: Mayer and Pence (2009)



Appendix C. Industry Shares and Sectoral Diversity, 2007