The Composition of Industry and the Duration of State Recessions

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Abstract

In this paper, we investigate the determinants of state level recessions in the United States that occurred over the period 1979 to 1997. Contrary to much of the existing related literature, we find that a significant factor which influences the duration of state recessions is whether or not a state's degree of industrial diversity is increasing or decreasing. Specifically, we find that states that are becoming more diverse have recessions of shorter duration. In states where diversity is decreasing, recessions are longer in duration. This finding we believe is a hopeful message for states that are relatively more concentrated since it seems to indicate that their initial level of diversity is not as important as their change in diversity. Therefore, this could mean that as long as a state can accelerate its industrial diversification, they may be able to reduce the duration of their recessions.

1. Introduction

In recent years, many states have been dealing with budget dilemmas, and cuts at the national level have further worsened their financial situation. This has raised many questions and increased the focus on economic performance at the sub-national level. Why are some states better able to recover from downturns in economic activity while other states find it difficult? While there are many factors that contribute to answering this question, this study finds that it is not just, as some studies imply, the diversity of the industry mix within a state that matters, but rather the changing composition of that mix that plays a dominant and statistically significant role in determining whether a state recovers quickly from a downturn in economic activity or languishes for long periods of time.

More specifically, the objectives of this paper are i) to test whether state-level recessions are more likely or less likely to persist as they increase in duration, and ii) to investigate what factors and characteristics of state economies influence the duration of recessions, with special attention given to the influence of industry diversity (a factor which has not been showcased in earlier work). With respect to the first point, by employing a duration modeling framework and controlling for various factors, we find that most recessions are more likely to end as their duration increases given that they have not ended already. With respect to the second objective, we find that a number of factors are significantly related to longer recessions. The factors associated with longer recessions include decreases in industrial diversity, high unemployment, decreases in real income per capita, high proportions of non-white workers, small total populations, and increases in population growth.

The most interesting and noteworthy finding of this study is that the initial level of industrial diversity in a state is not what significantly influences recession duration, but rather

whether or not industrial diversity is increasing. We find that in states where diversity is increasing, recessions are shorter in duration. In states where diversity is decreasing, recessions are longer in duration. This finding is a hopeful message for states that are relatively more concentrated since it seems to indicate that their initial level of diversity is not as important as their change in diversity. Therefore, this could mean that as long as a state can accelerate its industrial diversification, they may be able to reduce the duration of their recessions.

The economic performance of a state can be evaluated in various ways using a wide range of macroeconomic measures. Some of the most common measures of performance include unemployment, per capita income growth, labor productivity growth, and job creation. This paper extends earlier work in this area by focusing on a less commonly used, and possibly more revealing, measure of economic performance. The measure of economic performance we focus on is a coincident index of state business cycles. This index utilizes consistent economic measures across all 50 states and it is available at a quarterly frequency, whereas alternative measures such as gross state product are only available on an annual basis.

There are several reasons for examining the duration of recessions as opposed to studying their depth where measures of per-capita income growth or employment growth would be more applicable as yardsticks. States are increasingly relying on their "rainy day funds" to meet budget shortfalls in the short run to avoid raising taxes and/or cutting expenditures (Wagner and Elder 2004). The longer the duration of a recession, the more likely it is that a state's rainy day funds will dry up. Moreover, the longer a recession continues, the longer it will be before a state has extra revenue to begin replenishing their rainy day funds. If revenue fails to rebound quickly enough, spending cuts and/or tax increases may have to be larger than previously necessary in order to replenish these emergency funds. Furthermore, people have increased anxiety during

state economic downturns which can lead to increased public pressure on policymakers to stimulate employment and income growth. In short, economic conditions are in general of greater concern when such conditions are poor.

From a labor perspective, longer recessions lead to longer durations of unemployment. More workers become discouraged and drop out of the labor force, leading to corresponding declines in consumption that further exacerbate the impacts of a recession. Furthermore, the longer a state recession persists, the more likely it is that workers will begin to migrate to more prosperous states. Research has shown that gross migration flows tend to fall during national recessions due to factors such as increased difficulties finding a new job or lower earnings in previously attractive destinations (Armstrong and Taylor 2000, p. 158). However, net migration flows among regions are more complex. Cebula (2005) finds that both per capita income and expected per capita income have statistically significant positive impacts on interstate migration flows. If a recession is very short, it is unlikely that the expected earnings differential would outweigh the immediate costs of migrating. On the other hand, if relatively large disparities between states persist, then a longer recession will eventually induce workers to migrate as the gap between job opportunities and earnings increases between their home state and a more prosperous destination state.[1]

In terms of the effect of industrial diversity on the duration of a contraction, it is hypothesized that more industrially diverse states experience shorter recessions as the greater number of industries are able to absorb cyclical unemployment, again acting like a shock absorber, cushioning the state from a downturn in economic activity. Regions experience

[1] Along similar lines, if a state recession persists, new small firms will be less likely to locate in that state where the business climate appears to be depressed. While this has not been researched to our knowledge, it is a possibility. Firms may recognize that certain states recover from economic downturns more quickly and this could affect their location decisions. This is an area of future research which we are currently exploring.

different shocks to output depending on their industry mix because economic shocks tend to affect certain industries more deeply.

2. Determinants of State Economic Activity

Nearly all studies examining regional variations in economic performance find industrial diversity to have a statistically significant effect on economic performance. The difference lies in how they measure industrial diversity. Many studies use industry proportions to indicate the predominance of certain industries.

For example, Garcia-Mila and McGuire (1993) use the shares of employment in certain industries, like farming and non-durable manufacturing, as determinants in explaining employment growth rates and variability at the state level. After controlling for variation in industry growth at the national level and for the composition of fast and slow growth industries at the state level, they find that industrial mix still has a significant effect on state growth rates over the period 1969-1985.

Owyang et al. (2004) also use employment shares of certain industries as explanatory variables in their analysis of growth rates. They examine growth rates within recessions and expansions separately using monthly state coincident data from Crone (2002). The general conclusion from Owyang et al. (2004) is that industrial mix affects growth rates during recessions but not during expansions. Their results indicate that differences in recession growth rates are predominately influenced by industrial mix, while expansion growth rates are related to differences in demographics and not to industrial composition.

Rather than employment shares, Carlino and Sill (2001) use the share of total output accounted for by certain industries as an independent variable in their regressions. They analyze cycle and trend growth rates separately, and they find that industry mix has a differential effect

on real income growth. However, the implications of their study are not clear because the effect of industry mix is sometimes positive and sometimes negative, depending on which region and which growth rate (cycle or trend) they examine.

There are many alternatives to using industry shares to measure diversity, as outlined in Wundt (1992). For example, a "percent durables index" is often used to reflect the fact that durable goods have a higher income-demand elasticity and therefore can predict cyclical instability. The national average index is sometimes used to capture the deviations in state industry shares from the national shares. The entropy index is a very common measure of industrial diversity that equals 0 if a state has perfect concentration or equals 1 if a state has perfect diversity. Wundt (1992) also discusses portfolio variance as a newer tool to measure industrial diversity that is based on detrended industry employment shares as well as interindustry employment variances. Wundt (1992) compares the explanatory power of all of these various measures in predicting regional cyclical employment behavior. He finds most of the measures to be statistically significant, and all of them indicate that greater industrial specialization is associated with greater instability.

Finally, the Herfindahl index is a very commonly used measure of industrial diversity. Simon and Nardinelli (1992) and Izraeli and Murphy (2003) both use this approach. Simon and Nardinelli (1992) find that in all years studied, except during the Depression years of 1930 and 1931, more industrially diversified cities experienced lower unemployment. They attribute this to the portfolio effect, or in other words, workers can find employment more easily when there are a greater number of industries in the region.[2] During 1930 and 1931, more diversified cities

[2] This portfolio effect is similar to the notion of agglomeration economies. A large number of geographically concentrated economic activities, usually spread across multiple industries, allows labor to be reallocated more efficiently when one industry experiences a downturn.

actually experienced higher unemployment. The authors speculate that wages adjust downward more quickly in specialized regions, therefore preventing lay-offs, because of the limited probability that workers will quit and change industries. Only during these two years though, did the wage adjustment effect outweigh the portfolio effect.

Similarly, Izraeli and Murphy (2003) find that a lower Herfindahl index (indicating higher industrial diversification) is associated with lower unemployment; supporting their thesis that diversification can reduce unemployment. They rely on state-level data and according to their results, a 10-point decrease in the Herfindahl Index is associated with almost a tenth of a percentage point decrease in the unemployment rate. Therefore, the authors support state policies targeting a more diversified industrial base as a means to provide more employment security during economic downturns.

Every measure of industrial diversity used in the literature and reviewed above has its advantages and disadvantages. The measure chosen for this paper is the Herfindahl index, which is most similar to the entropy index in terms of how it is calculated. Because the Herfindahl index is a more comprehensive measure of the diversity issue of interest, this paper uses the Herfindahl index as Simon and Nardinelli (1992) and Izraeli and Murphy (2003) do. Furthermore, this study most closely follows Izraeli and Murphy in terms of the explanatory variables used in the full parametric estimation section. However, instead of examining unemployment, the dependent variable here is the duration of state recessions.

3. Nonparametric Analysis

This paper employs duration methods based on Kiefer (1988) and Greene (1993).[3] In general, duration analysis is very useful for studying the lengths of certain events or the

[3] For the purposes of this paper, duration analysis basically involves estimating the conditional probability that a recession will end in period *t* given that it has not yet ended in period *t*-1.

probability that an event will occur given that it has not already occurred. The literature in economics has drawn from that of other fields in which duration data have been used to study such things as the useful lives of electronic components, the survival times of organ transplant recipients, and the probability of natural disasters occurring. In economics, duration analysis has most commonly been applied to research on the lengths of unemployment spells.

The key concept in duration analysis is that this statistical method does *not* involve the unconditional probability of an event taking place (e.g., the probability of an unemployment spell ending at exactly 6 weeks independent of all other time periods) but rather the conditional probability of an event happening (e.g., the probability of an unemployment spell ending at 6 weeks given that it did not end at 5 weeks). Unconditional probabilities are the emphasis when specification is in terms of probability distributions, but the hazard function specification explained below emphasizes the conditional probabilities (Kiefer 1988). As Kiefer points out, individuals tend to reason in terms of conditional probabilities anyway, so duration analysis better links the theory to the econometric estimation.

There are two types of duration analysis conducted here. The first is nonparametric analysis, which provides information as to the behavior of the conditional probability of interest. The second type of analysis, conducted below, is full parametric analysis, which considers the determinants of the conditional probability of interest. In this paper, our duration analysis basically involves examining the conditional probability that a recession will end in period t given that it has not yet ended in period t-1. The conditional probability function, or the hazard function, is defined as

$$\lambda(t) = f(t) / [1-F(t)], \qquad (1)$$

where $F(t) = \Pr(T \leq t)$ is the cumulative distribution function and $f(t) = dF(t)/dt$ is the corresponding density function (Kiefer 1988). T is a random variable denoting duration and t can be viewed as the realization of that variable. Thus $F(t)$ is the probability of a duration T ending at time t. Then $f(t)$ is the associated density. The hazard function, then, is a conditional probability, indicating the likelihood of a recession ending at time t, i.e. $f(t)$, given that the recession has "survived" until time t, i.e. $[1-F(t)]$.[4]

The behavior exhibited by the hazard as t increases provides clues as to the likelihood of events ending after a particular length of time. For instance, if $d\lambda(t)/dt > 0$, then the function is upward sloping and indicates positive duration dependence, meaning the probability of a recession ending increases as the length of the recession increases. If $d\lambda(t)/dt < 0$, then the function is downward sloping and indicates negative duration dependence, meaning the probability of a recession ending increases as the length of the recession decreases.

Whether or not the data exhibits positive or negative duration dependence is an empirical question (but one that has significant ramifications for full parametric analysis – discussed below). To investigate the behavior exhibited by our recession duration data, we follow Kiefer (1988) and construct an empirical measure of our hazard, $\hat{\lambda}(t)$, in the following way. First, the recessions (of sample size n) are ordered from shortest duration to longest duration, $t_1 < t_2 < t_3 \ldots < t_k$. The number of completed durations k is usually smaller than n due to some observations having the same duration length. For example, there are 17 recessions in our dataset that lasted for three quarters. For this particular dataset, n equals 148 and k equals 23.

Then let h_j be the number of recessions that ended before duration t_j, for $j = 1,\ldots,k$. Let n_j be the number of recessions that did *not* end before duration t_j:

[4] 1-F(t) is often referred to as the survivor function, typically labeled S(t), in that is measures the probability of a recession lasting or "surviving" until a certain quarter *given* that it did not end in the previous quarter.

$$n_j = \sum_{i \geq j}^{k} h_i \qquad (2)$$

Thus, a convenient sample estimator for $\hat{\lambda}(t)$ is:

$$\hat{\lambda}(t) = h_j / n_j \qquad (3)$$

The above expression measures the number of recession completions at t_j over the number of recession "survivors" at t_j, thereby mimicking a standard hazard function.

In principle, one could plot $\hat{\lambda}(t)$ but, as a matter of practical application, in many instances this yields little direct insights, particularly with relatively small samples. Instead, the estimated survivor function, S(t)=1-F(t), is calculated and is interpreted in the opposite way of the hazard function. A downward sloping survivor function indicates positive duration dependence while an upward sloping survivor function indicates negative duration dependence.

The corresponding "empirical" survivor function is then:

$$\hat{S}(t_j) = \prod_{i=1}^{j} (1 - \hat{\lambda}_i) \, . \qquad (4)$$

Following (Kiefer 1988), this survivor estimator is obtained by setting the estimated conditional probability of a recession ending at t_j equal to the observed relative frequency of recessions ending at t_j.

Finally, the integrated hazard, defined as $\Lambda(t) = \int_0^t \lambda(t) \, dt$, and calculated from our data as

$$\hat{\Lambda}(t_j) = \sum_{i \leq j} \hat{\lambda}(t_i) \, . \qquad (5)$$

is also commonly investigated since the resulting plots are smoother and thus easier to interpret

that the hazard estimate itself. If the integrated hazard is increasing at an increasing rate, then the series exhibits positive duration dependence, if it appears to be increasing at a decreasing rate, then the series exhibits negative duration dependence.

The calculated survivor and integrated hazard estimates are depicted in Figures 1 and 2 respectively.[5] From the survivor function, it appears that our data exhibits positive duration dependence, suggesting that a recession is less likely to "survive" the longer it lasts. The integrated hazard appears to be increasing at an increasing rate over most of the range and so confirms positive duration dependence. This would seem a logical outcome for an economy encountering cyclical downturns. However, near the end of the integrated hazard function, the integrated hazard's slope, while still positive, appears to be increasing at a decreasing rate, indicating that after a certain point, the longer a recession lasts, the more likely it is to continue rather than end. While it is beyond the scope the current paper to test for certain, this might then be suggesting that for these states, the downturn may not be so much cyclical but more structural in nature. The two very long recessions at the right end of the graph are the two censored observations for Hawaii and Alaska that were pointed out earlier.

While this information is beneficial, it would be much more complete if characteristics of the state economies could be included to explain variation in recession length. Such analysis requires full-parametric maximum-likelihood estimation with an appropriate underlying probability distribution so as to interpret the direction and magnitude of each variables impact on recession duration. We now turn our attention to such estimation.

4. Full-Parametric Estimation

The exponential, Weibull, and log-logistic are the most commonly employed

[5] For completeness, the numerical calculations are presented in Table A2 of the appendix.

distributional functions in duration analysis (Kiefer, 1988). Each exhibits different hazard function behavior. The hazard function of the exponential distribution, for instance, is constant over time and therefore reflects no duration dependence. The hazard function of the Weibull distribution is either monotonically increasing (exhibiting positive duration dependence) or decreasing (exhibiting negative duration dependence). Finally, the hazard function for a log-logistic distribution, is non-monotonic and therefore, duration dependence varies based on duration itself.[6]

While figures 1 and 2 suggest positive duration dependence indicating the Weibull may be the best underlying distribution to employ, for the sake of robustness, we estimate our empirical models using each of the three distributions.

5. Model Specification and Data

Based on similar existing studies, mainly Izraeli and Murphy (2003), we conjecture that a number of factors will likely affect the duration of a recession in a particular state. The factor of particular interest in this research effort is industrial diversity. Traditional Ricardian trade theory suggests that a state should specialize in one or more industries in which it has a comparative advantage (Armstrong and Taylor,2000) . However, this leaves a state susceptible to developments in those industries that occur outside the state and therefore outside its control. For example, the price of energy and other inputs may change, environmental policies may be tightened, or new innovations may reduce the competitiveness of a particular industry. Therefore, greater industrial diversity, rather than specialization, would theoretically help insulate a state from the economic influences outside of its control by giving it a wider array of industries to rely upon for stabilizing demand and employment.

[6] See Kiefer (1988) and Greene (1993) for details as to the implementation of each maximum likelihood estimation, including how explanatory variables are introduced for parameter estimation.

The following general specification includes industrial diversity along with other factors that are expected to influence the duration of recessions.

$$\text{DURATION}=f(\text{DIV},\ \text{DIVCH},\ \text{U},\ \text{RPICH},\ \text{NWT},\ \text{TEEN},\ \text{OVER65},\ \text{POP},\ \text{POPCH},\ \text{DENS}) \quad (7)$$

DURATION is the length of time over which a state recession lasts, measured as the number of quarters. The state recession data used in this analysis come from Crone (2002). Crone calculated his state coincident indexes based on Stock and Watson (1989).[7] According to Crone, the advantage of the Stock and Watson method is that it provides a single measure of a state's economy by combining several monthly indicators. Crone specifically bases his measure on four indicators: (1) nonagricultural employment, (2) the unemployment rate, (3) average hours worked in manufacturing, and (4) real wage and salary disbursements. These coincident indexes are particularly useful for comparing the length, depth, and timing of state recessions because they utilize consistent economic measures across all 50 states and they are available at a greater frequency than gross state product, for example, which is only available on an annual basis.

The coverage of our model is restricted to Crone's data. This data is quarterly and covers the period 1979:1 through 2002:4. Our industrial diversity measures (DIV and DIVCH – discussed below) uses industry level employment data. Problems arise, then, due to the fact that industry data based on the Standard Industrial Classification (SIC) runs through to 1997. For the periods 1998 to 2002, industry classifications are based on the newly implemented North American Industrial Classification system. Since this will significantly disrupt the DIVCH time

[7] Stock and Watson's index is the latent factor estimated in a dynamic single-factor model using the Kalman filter.

series, we will estimate our model covering the recessions recorded between 1979 and 1997.

DIV is the level of industrial diversity in a state in the year prior to the start of the recession. Industrial diversity is measured by the Herfindahl index, which is defined as $\Sigma(E_{is}/E_s)^2$, where E_{is}/E_s is the employment share of industry *i* in state *s*. These indexes were calculated from the employment shares for each industry by state over time and these data are provided by County Business Patterns, the Census Bureau's annual report on business activity. Table A1 in the appendix lists the full Web site addresses of all sources. A higher Herfindahl index indicates a less industrially diverse state while a lower index indicates greater industrial diversity. A priori, it is expected that states with greater industrially diversity can better weather an economic downturn and therefore experience shorter recessions.[8]

DIVCH is the change in industrial diversity from the year prior to the start of the recession to the year in which the recession occurred.[9] Both the change in diversity as well as the level of diversity are included in the estimating equation because the two variables capture different effects and both could have important influences on recession duration. We hypothesize that increases in industrial diversity should have a negative effect on the duration of recessions. Since the Herfindahl index decreases when diversity increases, a state that experiences a decrease in its Herfindahl index will experience shorter recessions. Thus, a positive sign on DIVCH is expected.

U is the state unemployment rate in the year prior to the start of the recession and comes from the Bureau of Labor Statistics. The one-year lagged value for unemployment is necessary

[8] Izraeli and Murphy (2003) and Simon and Nardinelli (1992) both use this approach. Izraeli and Murphy (2003) find that a higher Herfindahl index (indicating higher industry concentration) is associated with higher unemployment, supporting their thesis that diversification can reduce unemployment. Similarly, Simon and Nardinelli (1992) find that in all years studied, except during the depression years of 1930 and 1931, industrially more diversified cities experienced lower unemployment.

[9] For recessions that spanned more than one year, the values for those variables are averages of all years during which the recession lasted.

because recession duration, the dependent variable, is constructed using the current unemployment rate. The effect on duration here is actually ambiguous. On the one hand, a higher state unemployment rate may prompt longer recessions as a larger portion of the labor force is seeking fewer work opportunities. Hence, many people may be out of work longer. Due to the immediate costs of migrating in the short run, unemployed workers are more likely to stay where they are rather than to move to find employment. This keeps the unemployment rate higher and contributes to longer recessions. On the other hand, it's possible that the deeper a recession is the quicker an economy can "snap back." Therefore, higher unemployment rates may be associated with shorter recession events. Empirical verification is thus necessary.

RPICH is the change in real per capita income at the state level from the year prior to the start of the recession to the year in which the recession occurred. The data for this variable come from the Regional Economic Information System (REIS), a subdivision of the Bureau of Economic Analysis. The change in state income is expected to be negatively related to recession duration as increasing incomes would be more likely to lead to shorter recessions while decreasing incomes would likely lengthen recessions. The change in income rather than the income level is used because it is more consistent with how recessions are defined. At any given point in time, the income level varies greatly among states, but this does not necessarily determine which states are experiencing recessions versus expansions. The measure that matters more is whether income is increasing or decreasing.

Following Izraeli and Murphy (2003), three demographic variables are included in the model to account for different population characteristics among states. All three are calculated from U.S. Census data.

NWT is the percentage of the working age population that is non-white. More -

specifically, this is calculated as the percentage of 15- to 64-year-olds who are of any race other than white. This variable is expected to be positively associated with recession duration since this group tends to experience higher unemployment rates (Izraeli and Murphy 2003).

TEEN is calculated as the percentage of 15- to 64-year-olds who are 15 to 19 years of age. The expected effect of TEEN on recession duration is unclear. Like non-white workers, teenage workers tend to experience higher unemployment rates than the general population, so TEEN could be positively related to duration. On the other hand, a larger proportion of teenage workers means a smaller labor force, which should lead to a lower unemployment rate and thus a shorter recession.

The third demographic variable, OVER65, is included to represent the proportion of the total population that is 65 years of age or older. The a priori expectation for its effect on duration is also unclear. The per capita income and consumption level of this population group is relatively low, so this could contribute to longer recessions given the weaker demand. On the contrary, a higher proportion of retired individuals means a smaller labor force, which would likely cause lower unemployment and shorter recessions.

Finally, measures of state population (POP), population change (POPCH), and population density (DENS) are added to the model. POP is the log of total population in each state in the year prior to the start of the recession. The data for total population are reported by REIS, and this variable could affect the length of recessions in different ways. A higher population could be an indicator of economies of scale, making a state's businesses more competitive and thus its recessions shorter in duration. In contrast, population could be associated with a higher cost of living and/or more generous welfare payments, which would contribute to longer recessions.

POPCH is simply calculated from population as the log difference in a state's total

population from the year prior to the start of the recession to the year in which the recession occurred. It is expected to be negatively associated with recession duration because the in-migration of people tends to increase the proportion of a state's labor force that is likely to be employed.

DENS represents population density or the average number of persons per square mile in a state. It indirectly reflects production costs because a higher population density can lower transportation, communication, and labor costs, for example. If production costs are lower, then state's industries can be more competitive and contribute to shorter recessions. Conversely, areas with sparse populations are more likely to have higher production costs as well as fewer businesses to absorb laid-off workers. So a priori, the sign on DENS is expected to be negative, meaning a higher population density is associated with shorter recessions.[10]

The sample size equals 145 recessions instead of the original 148 because upon examining a scatterplot of duration against diversity, three observations appeared to be skewing the results. Nevada's industry is very highly concentrated and thus has a much higher Herfindahl index relative to the other 49 states. While Nevada's Herfindahl index values were very high, their recession durations were relatively short and it was clear that these three observations were outliers. Therefore, Nevada's three recessions were dropped from the dataset for the full parametric analysis, leaving 142 state-level recessions. These 142 observations represent all state-level recessions that occurred between 1979:1 and 1997:4 regardless of the state. In other words, there is no set number of recessions per state. For example, one state may have had only one recession during this time period while another state may have had five.

Table 2 lists some descriptive statistics for these recession data. There are two recessions

[10] More detailed descriptions of the data sources for each variable are listed in Table A1 of the Appendix.

with durations of 30 and 52 quarters (for Hawaii and Alaska respectively), well in excess of the others in the sample, While this suggests these observations to be outliers, Crone (2002) provides no information as to when these recessions actually ended, if ever. Therefore, instead of removing them from the sample as would typically be done with outliers, they are treated as censored observations.[11] Censoring is a problem that is typically unavoidable in duration analysis so procedures have been developed to address such issues (Kiefer, 1988; Greene, 1993), and our estimation accounts for this censoring.

6. Estimation Results

Estimation results are presented in Table 3.[12] The signs and significance are nearly identical between the results for the exponential and Weibull distributions, but they are somewhat different for the log-logistic distribution. The table lists each coefficient with its t-statistic in parentheses.[13]

The joint hypothesis that all coefficients are jointly equal to zero can be rejected because the Wald χ^2 statistic, indicating goodness of fit, is statistically significant. A significant Wald χ^2 statistic indicates that the coefficients on the independent variables are *not* all jointly equal to zero. This discussion of results focuses on the Weibull distribution for reasons explained in the prior section and because the Weibull distribution results in the highest Wald χ^2 value. In addition, the estimated "shape" parameter, $\rho > 0$, which measures the degree of duration dependence in the Wiebull formulation, of 1.86 is statistically significantly different from one, indicating that the Weibull distribution is more appropriate than the exponential and that the

[11] Censored observations are those that have either an unknown beginning time prior to the observation period or an unknown ending time after the observation period.

[12] The regressions have been corrected for heteroskedasticity as using White's correction. STATA 8.0 was used to perform the analyses.

[13] For comparison, ordinary least squares regression analysis was performed on these data also and the results regarding diversity were the same. That is, DIVCH was positive and significant while DIV was not statistically significant. These results are available upon request.

series exhibits positive duration dependence.[14]

Interestingly, and contrary to much of the literature, the level of diversity (DIV) was not a significant factor in determining recession length. This result is robust in that even if the change in diversity variable (DIVCH) is removed from the model, the level of diversity does not turn out to be significant. However, the change in diversity (DIVCH) is positively associated with recession length. Recall that the Herfindahl index is higher when industrial concentration is higher. These results indicate that when industrial concentration is increasing over the year prior to the start of a recession, the duration of the recession is longer. When industrial diversity is increasing, recession durations are shorter. So according to these results, it is not the initial level of industrial diversity that matters but whether industrial diversity is increasing or decreasing.[15]

At first glance, the results with respect to the level of diversity may appear to be inconsistent with previous research. For example, Izraeli and Murphy (2003) report that the level of diversity reduces unemployment. With unemployment being a key ingredient of a recession, one might expect that the level of diversity should reduce the duration of recessions, however, our results find an insignificant influence.

However, there is an important difference between this study and previous research, including Izraeli and Murphy. Most previous research examine one continuous time period of

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[14] The variable ρ is a parameter defined in the hazard function for the Weibull, where $\lambda(t) = \lambda p(\lambda t)^{p-1}$, and is empirically estimated in the maximum likelihood estimation process. It can be shown that if $\rho = 1$, the resulting hazard function exhibits no duration dependence, suggesting the exponential function is a reasonable density to employ. If $\rho > 1$ ($\rho < 1$), then the function exhibits positive (negative) duration dependence. See Kiefer (1988).

[15] It should be pointed out at this juncture that there are two common means of estimating duration models. One method is to estimate the hazard function directly. When this is done, the resulting coefficients reflect the marginal impact each one has on the conditional probability of an event occurring given that it has not occurred as of yet. Had we done so, we would have gotten a negative coefficient on DIVCH, for instance. That is, reduced diversity reduces the likelihood of a recession ending in period t given that it lasted until t. Alternatively, one could estimate the survivor function directly – which is more closely akin to notion of duration. Given our specific interest in duration, and given that the resulting marginal effects are essentially the reciprocal of the first method, we chose to model the survivor function directly.

business cycles while this paper isolates the recessionary periods only. There is evidence that economic agents behave differently during recessions than during expansions. For instance, unemployment during expansions is dominated by new entrants and reentrants into the labor market while unemployment during recessions is dominated by lay-offs (for this and other examples, see Chapters 5 and 6 of Davis et al., 1996). In addition, Owyang et al. (2004) find that industrial mix affects growth rates differently depending on whether they examine recessions or expansions. Thus, the finding that diversity level is an insignificant influence may stem from which time periods are included in the analysis. The result may be different for expansionary time periods.

Other variables were also found to be significant determinants of recession duration. The change in real per capita income (RPICH) is statistically significant and is negatively associated with duration. In other words, when real income is increasing, recessions are shorter in length. This result is expected since the change in income is an indicator commonly used to define and date changes in the business cycle. If incomes are increasing, then an economy has most likely reached its turning point in a recession.

A variable found to have a significant determinant of recession length is the percentage of the working-age population that is non-white (NWT). As expected, it is positively associated with longer recessions. The non-white population tends to experience higher levels of unemployment, as Izraeli and Murphy (2003) find in their study also, and this contributes to longer recessions.

Finally, both population (POP) and population change (POPCH) are statistically significant factors, but their coefficients have opposite signs. The opposite direction of their signs is an interesting result. A large total population in the year prior to the start of a recession

is associated with shorter recessions, but when the state's population is increasing, recessions are longer. The sign on total population was expected since a larger population may be an indication of economies of scale in a state, making its businesses more competitive. The sign on population change was not expected since a growing population is sometimes seen as a sign of a thriving economy. It is possible though that a state might not have enough jobs to accommodate in-migration and thus increases in population contribute to longer recessions. The signs on total population and population change are opposite of what Izraeli and Murphy (2004) report, but again, this can likely be attributed to the fact that recessions are isolated here in which all recessions and expansions were used in their study. Furthermore, when one continuous time period is examined, expansions comprise a larger proportion of time than do recessions.

The one-year lagged unemployment (U) is the only variable that turns out to be significant in regressions based on the exponential and log-logistic distributions but insignificant in the regression based on the Weibull distribution. The positive sign on unemployment was in line with a priori expectations. A higher unemployment rate is associated with a longer recession. Unemployment, like real per capita income, is another indicator that is commonly used to define and date changes in the business cycle. If unemployment is low, an economy is most likely near the end of its recession.

In general, these results follow the a priori expectations. The sign on population change is one exception. The results also generally support the idea that diversification is a reasonable goal because increased diversification appears to be associated with shorter recessions.

7. Conclusion

The objectives of this paper were i) to test whether state-level recessions are more likely or less likely to persist as they increase in duration, and ii) to discover what factors and

characteristics of state economies influence the duration of recessions, testing the influence of industrial diversity in particular. Regarding the first goal, the main finding is that most recessions are *more* likely to end as their duration increases given that they have not ended already. With respect to the second objective our empirical results indicate that numerous factors have statistically significant influences on the duration of recessions. These factors include the change in industrial diversity, unemployment, the change in real income per capita, the proportion of non-white workers, total population, and the change in total population.

The most interesting and noteworthy finding of this study is that the initial level of industrial diversity in a state is not what significantly influences recession duration. Rather it is whether or not industrial diversity is increasing. In states where diversity is increasing, recessions are shorter in duration. In states where diversity is decreasing, recessions are longer in duration. This research finding is a hopeful message for states that are relatively more concentrated since it seems to indicate that their initial level of diversity is not as important as their change in diversity. Therefore, this could mean that as long as a state can accelerate its industrial diversification, they may be able to reduce the duration of their recessions.

Precisely how to increase diversity, though, is a challenging policy dilemma. Aiming to decrease a state's most prominent industry in order to even out industry proportions is of course, not very logical. Nor is it logical to attempt to foster industries for which a state does not already have some related potential and capabilities. As a simplistic example, a state should not try to increase its mining industry if it does not already have minerals abundantly available. There may be a good reason why some industries are very small in proportion. Each state should assess its strengths and capabilities when deciding which industries to target for expansion. Similarly, each state should identify which industries are most likely to contract, assuming that

not all of the new employment in the expanding industries will come from in-migration. Then, in order to ease the reallocation of labor, policy initiatives such as job training could be pursued.

Before promoting active policy intervention, however, it is important to recall the results of the non-parametric analysis in context with the classical argument against the use of policy. The non-parametric analysis suggests that a recession is more likely to end the longer it persists. Therefore, a state should evaluate how long their recession has already lasted and consider whether policy intervention is necessary.

Targeting diversification though, does not appear to have a downside in terms of real per capita income tradeoffs, according to Izraeli and Murphy (2003). This finding, in addition to the general view that diversification reduces instability (Wundt 1992), suggests that a policy aimed at diversifying a state's industrial base is not likely to have negative repercussions even if the recession should happen to end before the policy takes effect. This cannot be said with certainty however, unless expansionary periods are researched as well.

Thus an important direction for future research would be to perform a similar duration analysis on expansionary time periods rather than recessionary periods. If job creation and destruction vary considerably over the business cycle as Davis et al. (1996, p. 83) suggests, then industrial diversity may have different influences over the business cycle as well. It may be that an entirely different model may be necessary as determinants of expansion duration may differ from determinants of recession duration. Even so, it would still be interesting to see a comparison between recessions and expansions in terms of how diversity influences the duration of the downturns and upswings in the economy.

To continue the theme of industrial diversity and its influence on regional economic performance, we are currently investigating small firm formation at the state level. Industrial

diversity along with several other factors will be included as potential determinants of new firm formation rates. Just as a better understanding of recession duration is useful to policymakers, a fuller understanding of the motivating forces behind small firm formation can be valuable as well.

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Table 1. Recession Duration Data (measured in quarters)

	All Observations	Without Outliers
Mean	7.05	6.58
Median	5	5
Maximum	52	21
Minimum	2	2
Standard Deviation	5.95	4.25
N	148	146

Table 2. Descriptive Statistics

Variable	Mean	Std. Deviation	Minimum	Maximum
DURATION	7.08	6.00	2.00	52.00
DIV	318.00	47.14	236.64	470.77
DIVCH	0.03	0.05	-0.08	0.36
U	5.96	1.83	2.22	12.43
RPICH	-0.01	0.03	-0.17	0.04
NWT	12.74	10.51	0.74	63.95
TEEN	12.72	1.70	9.13	16.10
OVER65	11.54	2.10	2.83	18.27
POP	14.92	0.99	12.91	17.24
POPCH	0.02	0.02	-0.01	0.11
DENS	170.41	239.95	0.71	1050.85
N	*145*			

Table 3. Full Parametric Maximum-Likelihood Estimation Results

Parameter	Exponential	Weibull	Log-logistic
DIV	0.00 (1.01)	0.01 (0.79)	0.00 (0.81)
DIVCH	3.57** (2.13)	3.60** (2.17)	2.78* (1.65)
U	0.06* (1.66)	0.05 (1.48)	0.06* (1.90)
RPICH	-3.86* (-1.74)	-4.34** (-2.15)	-2.68 (-1.13)
NWT	0.01* (1.86)	0.01** (2.26)	0.01 (0.95)
TEEN	0.01 (0.20)	0.01 (0.37)	0.00 (0.03)
OVER65	0.05 (1.52)	0.05 (1.53)	0.03 (0.78)
POP	-0.14** (-2.15)	-0.15*** (-2.53)	-0.10 (-1.26)
POPCH	15.71*** (4.83)	13.32*** (4.81)	16.43*** (5.75)
DENS	0.00 (1.22)	0.00 (1.22)	0.00 (1.50)
N = 142			
Wald χ^2	45.84***	64.45***	51.74***
shape parameter		*p = 1.86*	$\gamma = 0.34$

*** *indicates significance at the 1% level*
** *indicates significance at the 5% level*
* *indicates significance at the 10% level*

Figure 1: Survivor Function.

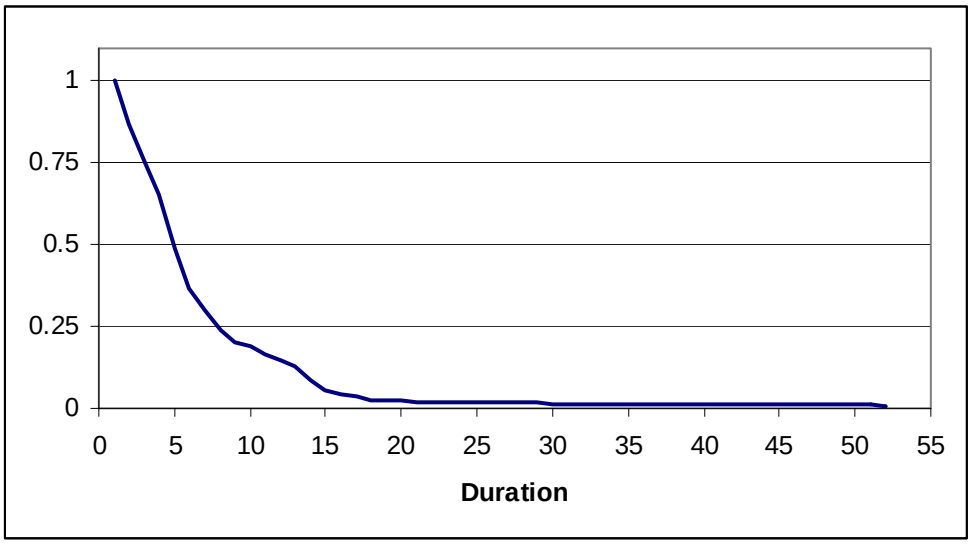
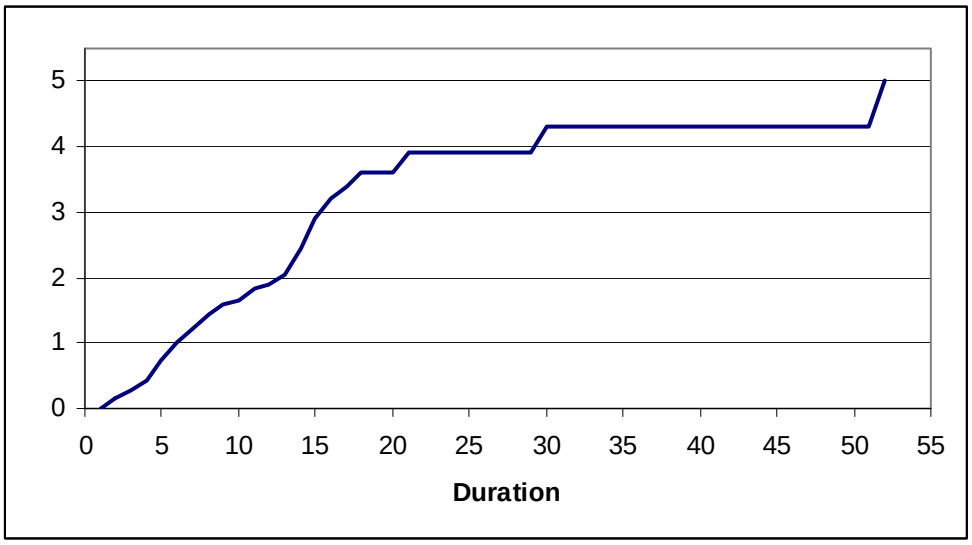


Figure 2: Integrated Hazard Function



Appendix

Table A1 – Data Descriptions and Sources

Variable	Description	Source
DURATION	Number of quarters over which a state's recession persisted.	Crone (2002)
DIV	Industrial diversity in a state in the year prior to the recession. Calculated using the Herfindahl Index.	County Business Patterns, www.census.gov/epcd/cbp/view/cbpview.html
DIVCH	Change in industrial diversity. Calculated as the change in the Herfindahl index from year prior to recession to year of recession.	County Business Patterns, www.census.gov/epcd/cbp/view/cbpview.html
U	State unemployment rate in the year prior to the recession.	Bureau of Labor Statistics, www.bls.gov/
RPICH	Change in state real per capita personal income. Change calculated as log difference in real income from year prior to recession to year of recession. Real income calculated from nominal income using annual CPI based on All Urban Consumers.	Regional Economic Information System, www.bea.doc.gov/bea/regional/reis/ (income) Bureau of Labor Statistics, http://www.bls.gov/cpi/home.htm (CPI)
NWT	Percentage of a state's working-age population (15-64 years) that is non-white. Calculated from Census data.	U.S. Census Bureau, www.census.gov/popest/archives
TEEN	Percentage of a state's working-age population that is 15-19 years of age. Calculated from Census data.	U.S. Census Bureau, www.census.gov/popest/archives
OVER65	Percentage of a state's total population that is 65 years or older. Calculated from Census data.	U.S. Census Bureau, www.census.gov/popest/archives

Table A1 – Data Descriptions and Sources (continued)

Variable	**Description**	**Source**
POP	Log of total state population in the year prior to the recession.	Regional Economic Information System, www.bea.doc.gov/bea/regional/reis/
POPCH	Rate of population growth in a state. Change calculated as log difference in annual population from year prior to recession to year of recession.	Regional Economic Information System, www.bea.doc.gov/bea/regional/reis/
DENS	Population density. Calculated as persons per square mile.	Regional Economic Information System, www.bea.doc.gov/bea/regional/reis/

Table A2 – Recession Duration Data and Nonparametric Hazard, Survivor, and Integrated Hazard Estimates

Duration in Quarters t_j	Completed Recessions j_j	Uncompleted Recessions n_j	Hazard Estimate $\hat{\lambda}(t_j)$	Survivor Estimate $\hat{S}(t_j)$	Integrated Hazard $\Lambda(t)$
2	20	148	0.135	0.865	0.145
3	17	128	0.133	0.750	0.288
4	14	111	0.126	0.655	0.423
5	25	97	0.258	0.486	0.721
6	18	72	0.250	0.365	1.008
7	10	54	0.185	0.297	1.213
8	9	44	0.205	0.236	1.442
9	5	35	0.143	0.203	1.596
10	2	30	0.067	0.189	1.665
11	4	28	0.143	0.162	1.819
12	2	24	0.083	0.149	1.906
13	3	22	0.136	0.128	2.053
14	6	19	0.316	0.088	2.432
15	5	13	0.385	0.054	2.918
16	2	8	0.250	0.041	3.205
17	1	6	0.167	0.034	3.388
18	1	5	0.200	0.027	3.611
19	0	4	0.000	0.027	3.611
20	0	4	0.000	0.027	3.611
21	1	4	0.250	0.020	3.899
30	1	3	0.333	0.014	4.304
52	1	2	0.500	0.007	4.997