BUILDING RESILIENT REGIONS
A MACARTHUR FOUNDATION RESEARCH NETWORK

[working paper]
Regional Economic Capacity, Economic Shocks, and Economic Resilience

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I.   Introduction

A.   Objective

The objective of this paper is to explore whether regions (metropolitan areas) have or can develop resilience capacity that makes them more likely to resist economic shocks or to recover quickly from them. We will pursue this question by examining whether a measure of resilience capacity developed by Foster (2012) is related to economic resilience. By observing capacity prior to the onset of a downturn, we are looking for evidence to support the claim that capacity is instrumental in achieving resilience.

B.   The Regional Economic Capacity Index (RECI) and Economic Resilience

The work on which this study is based originally appeared in a recent publication released by the Brookings Institution Press, volume 4 of Urban and Regional Policy and Its Effects. The book examines several facets of regionalism and resilience.

A chapter by Kathryn A. Foster, "In Search of Regional Resilience," introduced the concept of regional economic capacity as an index measure of characteristics that we might reasonably expect to lead to economic resilience. The regional economic capacity index (RECI) consists of four components -- income equality, economic diversification, regional affordability, and business environment. [1] She was attempting to characterize the reasonably stable aspects of capacity, so she used variables that are expected to change very little, if at all, from year to year. Variables were observed at a single point in time, to come up with a single measure of capacity per region.

Another chapter in this volume studied economic resilience empirically. Once a metropolitan area experiences a downturn in the economy, how long does it take to get back to its previous growth trajectory, if at all? Which characteristics of a metropolitan area are associated with resilience?[2] Regional economic resilience is the ability of a region to recover from an economic downturn within a relatively short period of time. Economic resilience can occur because the region's economy simply bounces back (e.g., because of favorable shifts in the demand for its products), the structure of predominant industries or occupations undergo change, or firms find a way to improve their competitive position (e.g., existing firms adopt better technologies or organizational forms or produce new products). This study will not explore why or how a region recovers; rather it will try to identify the conditions in the region prior to the beginning of the downturn that are associated with resilience.

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[1] Regional economic capacity is one of three dimensions of a broader concept, regional resilience capacity. The other two dimensions are socio-demographic capacity and community connectivity capacity. We focus on the RECI because it is conceptually the most closely tied to economic resilience. We also include educational attainment, contemplated by Foster as a socio-demographic characteristic.

[2] Edward Hill, Travis St. Clair, Howard Wial, Harold Wolman, Patricia Atkins, Pamela Blumenthal, Sarah Ficenec, and Alec Friedhoff collaborated on the chapter "Economic Shocks and Regional Economic Resilience." This study started with the concept that metropolitan areas experience shocks, from time to time. An economic shock can be caused by any combination of a downturn in the national economy, downturn in industries that constitute a notable component of the region's export base, and local events that disrupt economic activity. A shock does not necessarily lead to a downturn, but by definition, a downturn always occurs in response to a shock. In this paper, we only consider downturns, ignoring shocks that fail to knock the metropolitan economy substantially off its growth path.

The major contribution of this paper is to examine whether there is a relationship between resilience and various measures of economic capacity some time *before* the onset of the downturn. If so, then our results would point to the need for policy to address regional characteristics that we find empirically to be relatively stable. Our findings would also help us to understand which regions might need more ambitious policy interventions to right themselves when a shock occurs.

C.   How the paper is laid out

The next section describes the data we used, and how we used it. Because we were not able to match many of the variables used in the original RECI, our decisions on how to operationalize the concepts take on an added importance. Univariate and bivariate analyses establish a baseline for understanding the scope of each of the variables and how they relate to each other. Multivariate analysis relies on logit regression to model the probability of resilience as a function of each of the potential capacity characteristics. This initial round of study points to many potential next steps.

II.   Methodology, Scope, Data

A.   Research question

Does regional economic *capacity*, prior to the onset of a downturn, affect regional economic *resilience* to that downturn, in terms of employment? To answer this question, we look at regional economic capacity indicators in existence *prior* to each downturn to see whether those regions are resilient or not.

B.   Methodology

With the ultimate objective of looking for evidence to support the claim that capacity is instrumental in achieving resilience, we address the generally accepted criteria for causality. None of our techniques will allow us to prove that capacity leads to resilience; such a finding is beyond the scope of inferential statistics.

The first criterion for causality is empirical evidence of a relationship between an independent variable and the dependent variable. We will calculate and test for the significance of bivariate associations between resilience and each of the potential measures of capacity.

The second criterion is temporal priority; the explanatory variable must precede the outcome. To establish temporal priority, we observe the explanatory variables in the year prior to onset of the downturn. We only lag the variables that we believe have potential to cause resilience. We also include a number of control variables, allowing us to address the third criterion of causality. The third criterion requires us to rule out the influence of other variables. Multivariate analysis allows us to control for many observed and quantified effects, but we must acknowledge that many, many other potentially causal influences are left out of the model. For instance, we do not model policy decisions that could alter a region's growth trajectory. We also do not model political leadership, formal and informal regional governance, or structural arrangements for local autonomy, vis-à-vis the state. Yet the literature gives us evidence that all of these characteristics can be important for the economic well-being of a region.

To support a claim of causality. we also need to make the case that a causal mechanism exists and is at work. We do not undertake any form of qualitative research that could further our understanding on a theoretical link between capacity and resilience. We refer broadly to the work of others.

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C.   Data and variables

Due to time and resource constraints of this study (at least in this round), we chose to rely exclusively on data available in the BRR data set. The BRR data set provides constant-boundary, metropolitan-area level data for the entire study period.

1.   Resilience measure

We examine 1,067 downturns occurring in any of 361 metropolitan areas between 1978 and 2007. Each observation is the point of resolution of a downturn in a single metro area in a single year. We find that in 369 instances, the region is not resilient to the downturn. In the other 698 instances, it is.

The outcome is a simple dichotomous variable, indicating resilience or non-resilience. To operationalize resilience, we must first operationalize a downturn.

We define a downturn as a single-year, two percentage point drop in the rate of employment growth, relative to the average employment growth rate for the preceding eight years.[3] Downturns are defined uniquely for each metro area and are modeled as discrete events, even though some of the downturns may have been trigger by common circumstances.

From the point at which the downturn occurred, we look for the growth rate to return to its previous path in any of the next four years. If the downturn ends within four years, we say that the metro area was resilient to that downturn. If at the end of four years it has not returned to its previous growth path, then we say that it is non-resilient. However, if the metro area experiences another downturn within that four-year period – that is, it experiences another single-year two percentage point drop relative to the growth of the previous eight years - the clock starts ticking, again. Applying this rule means that we observe many more downturns than resolutions. And any one resolution could apply to more than one downturn.

2.   Capacity measures

The regional economic capacity index (RECI) consists of four components -- income equality, economic diversification, regional affordability, and business environment. The index was calculated using relatively recent cross-sectional data. As a starting point, we attempted to match Foster's variables. Because we want to project the concept backwards in time, before the start of a downturn, we needed to locate longitudinal data that could stand in for the original concepts. Data covering income equality and economic diversification were readily available. Data for regional affordability and business environment were less so.

Below we list the four components of Foster's economic resilience index along with her reasoning for including each concept. We then describe the variables that we incorporate into our study, and acknowledge where we are unable to match Foster's work.

Income equality: Income equality measures how evenly income is distributed across a population. Foster cites research by Cutter et al. (2010), making the claim that the more equal a region's distribution of economic resources, the more cohesive the response to disturbance.[4] We use the 80/20 ratio, which

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[3] An adjustment is made for the few instances when the prior eight-year growth rate is 4.0 percent or higher. In these cases, the growth rate in the base year must decline by a number of percentage points equal to more than half of the prior eight year growth rate. For instance, if the prior eight-year growth rate is 6.0 percent, then the threshold for a downturn is 3.0 percent.

[4] Susan Cutter, Christopher G. Burton, and Christopher T. Emrich. 2010. "Disaster Resilience Indicators for Benchmarking Baseline Conditions," Journal of Homeland Security and Emergency Management 7, no.1: 1-22

is a ratio of upper middle class (per capita income (PCI) at the 80th percentile) to poor (PCI at the 20th percentile).   We expect that a lower ratio, indicating a smaller gap between the income of the poor and the income of the upper middle class, would correlate with an increased likelihood of resilience.

Economic diversification: Economic diversification measures the degree to which economic activity is spread across sectors of an economy. When economic activity is concentrated in relatively few sectors, the overall regional economy is more vulnerable to problems in any of those sectors.

Two measures allow us to characterize the diversity of the local economy. The Herfindahl index measures market concentration. Consequently, we expect a lower Herfindahl index to coincide with regional resilience. Using the same logic, we can expect that having more major export industries is associated with a greater likelihood of resilience.

Regional affordability: Affordability compares the cost of housing to the level of income available to pay for that housing. Foster cited the work of Pendall, Theodos and Franks (2011)[5] hypothesizing a link between a household's level of precariousness, measured in part by its housing cost burden, and resilience. Spending more income on housing leaves less income available for investments and savings, both of which can help the household ride out difficult times. We could also suppose that more affordable markets are attractive (and realistic destinations) to a wider range of people, suggesting that a higher level of mobility is possible, and workers are better able to move to opportunities that suit them. We were not able to locate data that provides a consistent measure of affordability at the regional level for the entire study period.

Business climate: The business climate characterizes the various conditions that render an area more favorable to business. A more favorable business climate would render a regional economy more resilient. One variable in the BRR dataset captures an aspect of the business climate. Right-to-work indicates whether the state has laws that prohibit employment agreements between employers and labor unions from requiring participation in a union.

We have also incorporated some variables that characterize the existence of potential sources of economic activity. First, research institutions support some level of knowledge creation, presumably by a well-educated labor force. The creation and diffusion of knowledge provide fodder for economic activity. A higher number of research institutions denotes a potentially higher level of economic activity. Second, we observe the percentage of the adult population that has at least a high school education. Education is a source of human capital, needed in the work place. A high school diploma specifically is a needed credential for entry-level positions.

Finally, four additional variables capture the share of employment in each of four key export industries - durable and nondurable manufacturing, healthcare and social assistance, and tourism.

Control variables: We also include a number of control variables that might help us explain the likelihood of resilience but are not necessarily causally related.

- Eight-year growth rate prior to the downturn
- Employment in the previous year
- Wages per employee, adjusted to 2005 dollars
- Percentage of metro population living in central city

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[5] Rolf Pendall, Brett Theodos and Kaitlin Franks, 2011, "Vulnerable People, Precarious Housing, and Regional Resilience: An Exploratory Analysis," Building Resilient Regions Working Paper 2011-02

- Age of Metropolitan Area

3. Preliminary Analysis

The logical first step in our inquiry was to look for a relationship between the original RECI and our concept of resilience. Using an independent samples t-test, we tested for a significant difference in the mean RECI values across our findings of resilience and non-resilience. Contrary to our hypothesis, we found that capacity is not associated with actual resilience. For the 369 instances in which we find that a region is not resilient to a downturn, the RECI is just above the mean (0.03 standard deviations above the all-metro average). But for the 698 downturns to which the region is resilient, the RECI is below the mean (0.07 standard deviations below the average). The difference is significant.

One possibility is that economic capacity may not be related to actual resilience, as we measure it. Another possibility is that the economic capacity measures used may not be valid. Of course, both of these interpretations could be right at the same time.

The same counterintuitive findings emerged in the original paper on resilience (Hill, et al.), namely that regions with high manufacturing and low-skilled workers tended to be most resilient and vice versa. This is because most of the shocks they experienced were cyclical shocks. When the economy went into a national economic downturn, regions producing manufacturing goods, particularly durable capital goods, experienced downturns as demand for their products - the purchase of which consumers can defer until they are in better financial shape - dropped. However, as the national economy recovered, so did most of these regions. Detroit up until about 2000 is a good example. The region recovered not because they had in place any notable "resilience capacity." They recovered simply because the national economy recovered.

We can take this finding as confirmation that more work needs to be done to shed light on the nature of the relationship of the capacity and resilience.

III. Univariate and Bivariate Analysis

A. Descriptive Statistics

Within the study period, we observe 1,726 downturns, ie, years in which the employment growth rate in a metro area dropped at least two percentage points below the average of the preceding eight years. The distribution of downturns is displayed in the figure below. We can see that every year, including years of national economic prosperity, at least a handful of regions experienced a downturn. The number of metro areas experiencing a downturn in any one year ranges from six in 1983 to 209 in 1990. All 361 regions experience at least one downturn during the study period.

We have many more downturns than resolution of downturns because we allow that a new downturn can start before the previous downturn has been resolve. More than one-third of these downturns (659) occurred before the previous downturn had been resolved.

Number of regions that experienced a downturn in this year

Year	Number of regions that experienced a downturn in this year
2006	30
2005	7
2004	9
2003	21
2002	56
2001	148
2000	176
1999	33
1998	27
1997	25
1996	19
1995	30
1994	23
1993	8
1992	14
1991	39
1990	209
1989	106
1988	35
1987	8
1986	18
1985	54
1984	33
1983	6
1982	57
1981	203
1980	98
1979	199
1978	35
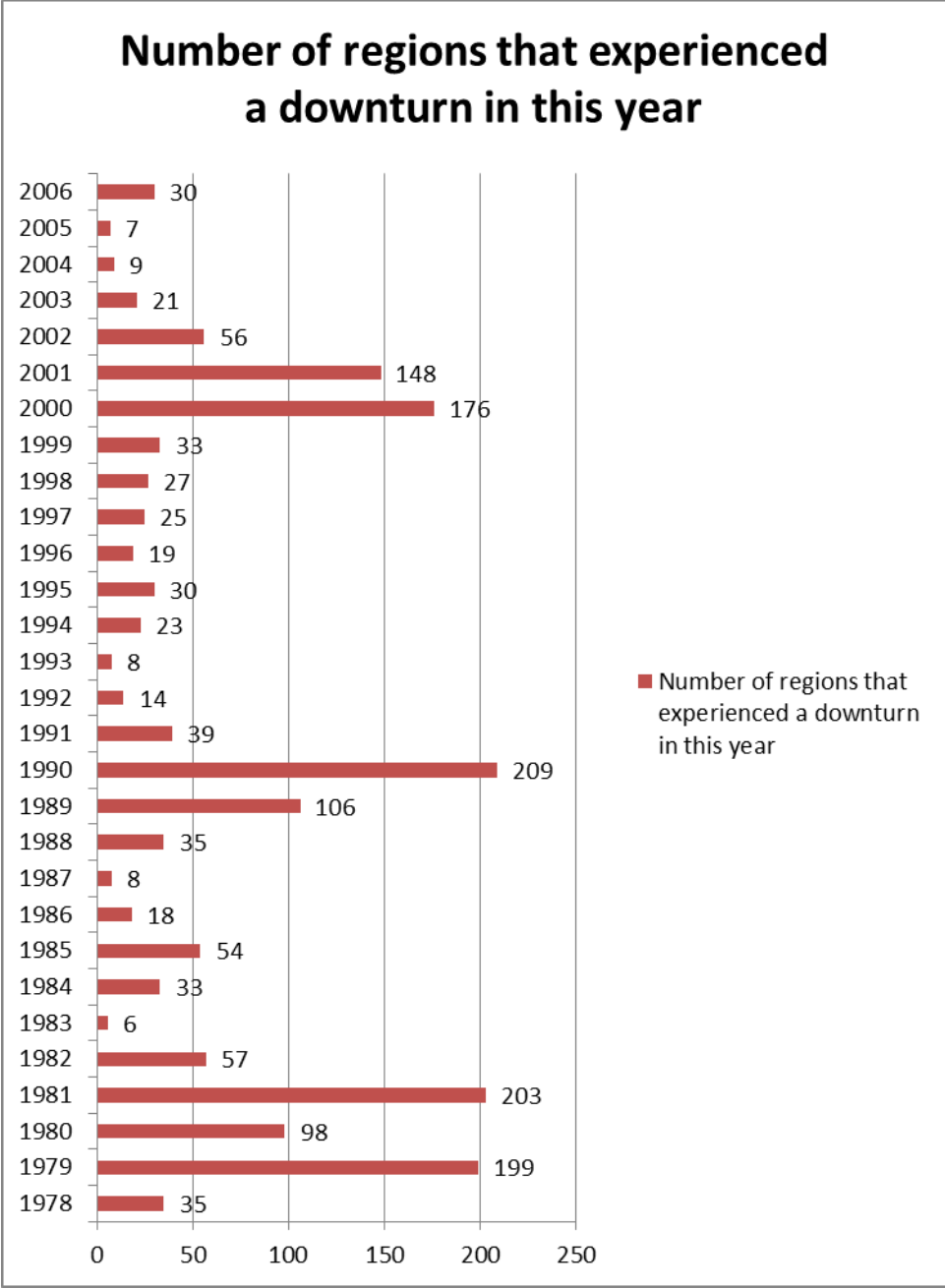
The table below displays the range (minimum and maximum), mean and median. Figures for the minimum and maximum establish that circumstances across metro areas vary greatly. For almost all variables, the mean is greater than the mode. Some observations are outliers, i.e., levels are more than three standard deviations above the mean. These observations can be problematic because they do not follow the same pattern as the other observations. Descriptively, we interpret these findings to man that some regions have substantially greater capacity for economic resilience than most others.

Concept	min	max	mean	median
Herfindahl Index - LAGGED	2.4	38.1	5.0	4.0
# Export Industries - LAGGED	0.0	14	5.3	5.0
80/20 ratio - LAGGED	30.4	76.0	41.6	41.0
Research Universities - LAGGED	0	13	0.5	0.0
Growth Rate prior to downturn (percent)	-2.0	14.0	3.0	3.0
Percent with a high school-level education or less (pop 25+) - LAGGED	22.6	85.0	58.9	59.5
Right-to-work - LAGGED	0	1	0.4	0
Lagged Employment Variable	5.9	8479.6	255.7	82.4
Wages per Employee (000s of 2005 dollars)	18.5	87.3	30.5	29.7
% Durable Manufacturing - LAGGED	0.0	43.2	10.1	8.2
% Nondurable - LAGGED	0.0	38.1	6.8	5.3
% Healthcare and social - LAGGED	0.8	29.3	8.1	7.9
Tourism-related industries - LAGGED	2.4	37.9	8.2	7.6
% of metro population living in central city	9.8	100.0	43.4	42.5
Age of Metropolitan Area	0.0	210.0	51.6	40.0

B.   Bivariate analysis

Bivariate analysis gives us a fairly simple way to talk about the differences among regions that in a particular year according to whether they are resilient to a downturn. Analytically, we consider each of the explanatory variables in turn and test for significant differences among downturns by outcome, ie, resilient or non-resilient.

The table below presents means for two groups of observations. "Mean when non-resilient" displays the average of each explanatory variable (capacity and control) in 369 instances when the region does not bounce back from a downturn. "Mean when resilient" does the same for the 698 instances when the region does bounce back from a downturn.

Is there a significant difference in the capacity measures across regions that are resilient or non-resilient? Mostly, yes. The percentage of the population living in the central city is also not significantly associated with resilience, suggesting that the (population) dominance of a central city does not make a region any more or less likely to be resilient. The 80/20 ratio, which quantifies income disparities, is also not significant. Failing to find evidence to support the relevance of these factors only tells us that they are not consistently related to resilience. These variables remain in the multivariate analysis so that we can explore whether they are influential in some sets of circumstances.

	Mean when non-resilient (n = 369)	Mean when resilient (n = 698)	Signif
Herfindahl Index - LAGGED	4.5	5.3	✓
# Export Industries - LAGGED	5.1	5.5	✓
80/20 ratio - LAGGED	41.4	41.8	no
Research Universities - LAGGED	0.7	0.4	✓
Growth Rate prior to downturn (percent)	3.5	2.8	✓
Educational Attainment - LAGGED	53.8	61.5	✓
Right-to-work - LAGGED	0.3	0.5	✓
Lagged Employment Variable	370.7	194.9	✓
Wages per Employee (000s of 2005 dollars)	32.3	29.5	✓
% Durable Manufacturing - LAGGED	9.2	10.6	✓
% Nondurable - LAGGED	5.7	7.3	✓
% Healthcare and social - LAGGED	8.7	7.8	✓
Tourism-related industries - LAGGED	8.6	8.0	✓
% of metro population living in central city	43.8	43.2	no
Age of Metropolitan Area	60.4	47	✓

Most characteristics are associated with resilience as we would expect. More economic diversity, a higher number of export industries, right to work, and higher shares of employment in durable and non-durable manufacturing.

The other characteristics are more common in cases of non-resilience, including greater income disparities[6], more research institutions, less educational attainment, and higher shares of employment in healthcare and tourism.

The significance of the relationships between the control variables and the outcome tells us that these are potentially valid distinctions to make when sorting by resilience. These variables include the growth rate prior to the downturn, the size of the labor market, wages, and the age of the metropolitan area.

IV.   Multivariate Analysis

Multivariate allows us to get past the simple analytical construct of observing how two variables do or do not move together. Here, we can hold constant the influence of a wide range of variables.

The dependent variable is dichotomous, indicating that a metro area was or was not resilient to an observed downturn. When the dependent variable is dichotomous, we use logit regression. The logit procedure creates odds ratios, telling us the change in probability associated with a one-unit change in each of the independent variables.

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[6] As noted, the association between the 80/20 ratio and resilience is not significant, meaning that we cannot generalize. The observed relationship is descriptive only.

Overall, the results of the logit regression are modest.

- A one percentage point increase in the share of the population that has no more than a high school diploma or less is associated with a 5.4% increase in the odds of being resilient.
- Right-to-work states are 92% more likely than non-RTW states to be resilient.
- For every additional $1000 in wages per worker ($2005), we expect to see a 5.2% decrease in the odds of being resilient.
- For each additional percentage point share of workers in health industries, we expect to see a 6.9% decrease in the odds of being resilient.

We also find a significant but miniscule positive effect of the eight-year growth rate. None of the other variables do not contribute significantly to the odds of resilience.

We can offer several possible interpretations of these modest findings. We could surmise that capacity is measured incorrectly or incompletely. We do not model policies that could be instrumental in helping an area to recover from downturns, or even avoid downturns in the first place. We also do not model less readily quantifiable characteristics of a region that we could reasonably expect to make a difference, such as political leadership, formal and informal regional governance, or structural arrangements for local autonomy, vis-à-vis the state.

Another possibility is that resilience is measured incorrectly. We have defined success as returning to the growth rate of the preceding eight years, but in some case, this means no more than returning to a previous pattern of limping along. On the other hand, a two percentage-point drop in the growth rate might only mean coming down from a period of exceptional growth, and the "downturn" level is still adequate to sustain the region.

We also have to allow that capacity simply does not influence resilience. Characteristics of a region could be largely irrelevant in altering their own economic performance. The national (or global) performance of industries located within a region, or the business cycle at the national level could be more important.

We are not ready to come to any of these conclusions. On the contrary, this initial round of work points to the need for further inquiry.

V.   Next Steps

This baseline research points to many additional lines of inquiry.

- Drop the outliers. Exceptionally advantaged regions could behave enough differently to mask the influences in other regions.
- Respecify the outcome. We examine resilience as a dichotomous (yes-no) variable, but we could explore using levels of the growth rate.
- Use panel data methods that would allow us to use information about connections among observations. Potentially, we could recognize that some observations pertain to the same regions and some to the same years.
- Model time and history to acknowledge the chronology and succession of events.
- Differentiate between downturns before and after 2000, and update the data set. We model the rate of growth of employment, yet the national recessions since 2000 have led to "jobless" recoveries.

- Study the related concept of "shock resistance," which is the ability of a region to withstand downturns in the first place.

SOURCE: Urban and Regional Policy and Its Effects, volume 4; edited by Margaret Weir, Nancy Pindus, Howard Wial, and Harold Wolman (Brookings Institution Press, February 2012).

Worksheet 1 - variables

List of all variables we are including in the model, distinguishing between potentially causally related variables (which we will lag) and potentially correlated variables (which we will use as controls and not lag).

Concept		Causally related?	Correlated?
Herfindahl Index (economic diversity)	herf_olag1	causal	
# Export Industries	number_exp_ind_olag1	Causal	
80/20 ratio	hincratio_80_20_olag1	Causal	
Research Universities	universities_olag1	Causal	
Growth Rate prior to downturn	eight_year_rate_metro_o		control
Percent with a high school-level education or less (pop 25+)	cbsa_phsless_olag1	causal	
Right-to-work	rtwstate_olag1	Causal	
Lagged Employment Variable	lagged_employment_o		Control
Wages per Employee	wagesperworker_o		control
% Durable Manufacturing	percent_durable_manu_olag1	causal	
% Nondurable	percent_non_durable_manu_olag1	causal	
% Healthcare and social	percent_health_olag1	causal	
Tourism-related industries	percent_tourism_olag1	causal	
% of metro population living in central city	percent_pop_princity_o		Control
Age of Metropolitan Area	msaage_o		Control

Worksheet 2 – descriptive statistics

Variable	n	mean	s.d.	min	0.25 quantile	median	0.75 quantile	max
herf_olag1	1032	5.01	3.22	2.41	3.31	4.04	5.41	38.08
number_exp_ind_olag1	1067	5.32	2.27	0.00	4.00	5.00	7.00	14.00
hincratio_80_20_olag1	1032	41.64	5.26	30.37	38.03	40.96	44.16	75.96
universities_olag1	1032	0.49	1.06	0.00	0.00	0.00	1.00	13.00
eight_year_rate_metro_o	1067	0.03	0.02	-0.02	0.02	0.03	0.04	0.14
cbsa_phsless_olag1	1032	58.85	11.93	22.62	50.08	59.50	68.04	84.96
rtwstate_olag1	1067	0.42	0.49	0.00	0.00	0.00	1.00	1.00
lagged_employment_o	1067	255.66	607.28	5.87	50.49	82.41	188.37	8479.63
wagesperworker_o	1067	30.48	5.83	18.53	26.54	29.73	33.06	87.29
percent_durable_manu_olag1	1067	10.12	7.56	0.00	4.79	8.20	13.51	43.21
percent_non_durable_manu_olag1	1067	6.75	5.46	0.00	3.06	5.31	8.86	38.07
percent_health_olag1	1067	8.13	3.05	0.82	6.21	7.93	9.91	29.27
percent_tourism_olag1	1067	8.19	3.57	2.35	6.32	7.56	8.95	37.89
percent_pop_princity_o	1067	43.40	17.06	9.81	30.79	42.45	53.92	100.02
msaage_o	1067	51.64	47.22	0.00	0.00	40.00	90.00	210.00

Worksheet 3 - results of logit regression

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------------------------------------------------------------------------------------
              resildum | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-----------------------------+------------------------------------------------------
            herf_olag1 |   1.077057   .0417287     1.92   0.055    .9982987    1.16203
    number_exp_ind_olag1 |    .9379665   .0369331    -1.63   0.104    .8683018   1.013221
    hincratio_80_20_olag1 |    .9759703   .0151482    -1.57   0.117    .9467274   1.006117
       universities_olag1 |    .9141663   .1210597    -0.68   0.498    .7051859   1.185077
    eight_year_rate_metro_o |    3.85e-17    2.04e-16    -7.14   0.000    1.21e-21
1.23e-12
       cbsa_phsless_olag1 |    1.054303    .0098039     5.69   0.000    1.035262
1.073695
          rtwstate_olag1 |     1.92929    .3223575     3.93   0.000    1.390508
2.676834
       lagged_employment_o |   1.000138   .0002245     0.61   0.539    .999698   1.000578
       wagesperworker_o |    .9475518    .0183941    -2.78   0.006    .9121772
.9842982
  percent_durable_manu_olag1 |    1.01632   .0134976     1.22   0.223    .9902061   1.043122
percent_non_durable_manu_olag1 |    .9663435    .018238    -1.81   0.070    .9312508   1.002759
       percent_health_olag1 |    .9307027   .0284025    -2.35   0.019    .8766669
.9880692
      percent_tourism_olag1 |   1.042399   .0255578     1.69   0.090    .9934909   1.093714
    percent_pop_princity_o |   1.005604   .0045471     1.24   0.216    .9967313   1.014556
                 msaage_o |    .9965481    .002017    -1.71   0.088    .9926028   1.000509
                  _cons |   4.195697   5.419035     1.11   0.267    .3337474    52.7461
------------------------------------------------------------------------------------
Odds ratio: odds of Y=1 when X increases by 1 unit. Look at the sign of the logit coefficients
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- If the OR > 1 then the odds of Y=1 increases
- If the OR < 1 then the odds of Y=1 decreases