RESILIENCE AND THE U.S. LABOR MARKET:

A CROSS-SCALE ANALYSIS ON THE ROLE OF INDUSTRIAL DIVERSITY AND SPECIALIZATION

by

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To my supporting family and academic committee,

you have made me who I am today and

form who I am becoming tomorrow.

ABSTRACT

This thesis examines how the effects of industrial diversity and specialization vary across geographical scales and classification levels. The notion of a robust institutional design, in conjunction with a regional resilience framework, is used to model how diversity and modularity affect unemployment through-out economic cycles. We use fixed effects models on employment data from the Bureau of Labor Statistics and Census Bureau in all available U.S. counties from 1998-2015. Key results suggest the optimal structure of industrial composition varies across scale, namely, that fine levels of industrial diversity are beneficial at higher levels of geographical scale (regions), whereas a broad type of industrial specialization is ideal for localities (counties/cities). This work is unique as it brings together notions of regional resilience and robustness and conducts analysis across multiple scales in attempts to identify the role of modular structure on the resiliency of a locality.

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PART I: INTRODUCTION

> It is adaptive rather than allocative efficiency which is the key to long-run growth. Successful political/economic systems have evolved flexible institutional structures that can survive the shocks and changes that are a part of successful evolution. But these systems have been a product of long gestation. We do not know how to create adaptive efficiency in the short run.
> -North, 1994 (North 1994)

Contemporary regional economics is increasingly interested in evolutionary and adaptive economic processes characterized by resilience. Moreover, understanding the formation of these processes which could then be captured to the benefit of society. Although such interests lay closely to that of the founders of Economics such as Adam Smith, John Stuart Mill, David Ricardo, and Thomas Malthus, it has not been until more recently that a resurgence in structural evolution has once again become a central theme in the discipline. For reasons to be discussed, progress in developing a greater understanding in this domain was conceptually placed at the peripheral for over a hundred years.

This thesis presents the reasonings and justifications that permitted this gap and seeks to explore the modern day advances made by both regional economists and economic geographers in understanding formation processes. We offer a contribution to these field's resurgent effort by analyzing the structural role of industrial diversity and specialization in the United States labor market. We primarily build on the work done by Martin and Sunley regarding regional economic resilience and link it to the conceptualization of robust institutional design by Bednar(Martin and Sunley 2014; Martin et al. 2016; Bednar 2016). By interconnecting the two frameworks, this analysis points to a possible explanation of why some local labor markets are more resilient than others. Namely, we determine if the features of a robust labor market improve the resilience of local employment.

The thesis is broken down into the following parts. Part II reviews major themes in the literature relating to neo-classical economics interpretations of the economy and its implications on the direction of research (Section 1.2). The neo-classical framework is contrasted to more recent developments of complexity economics, (Section 1.3). This thesis settles somewhere in between these two literatures, that being, regional and economic geography. Regional economic resilience is discussed in (Section 1.4).

Section 2 primarily reviews the regional economic resilience process, an application of the greater economic resilience framework, in preparation for the empirical portion of the thesis. Section 3 develops and transforms Bednar's robust institutional design conceptualization into an analogous complement as applied to the labor market. We then connect the two aforementioned processes in order to formulate the proposed research question.

Part III constructs the mathematical and statistical representation of the research question. Section 4 reviews the data used in the study. Section 4 also formulates a novel algorithm which counteracts data loss (due to privacy restrictions) and therefore in increases the consistency across levels of industrial specificity. Section 5 introduces the empirical indices to be used in section 6, which discusses the model design and expected theoretic results.

Part IV presents the results which are broken into two sections. Section 7 displays insightful sample statistics and section 8 reports model output. Part V provides a synthesis of the results and considers limitations and policy implications of the study, section 9 and 10. We conclude with final remarks and direction for future research in section 11.

PART II: LITERATURE REVIEW

1 Economic Resiliency Frameworks

1.1 Origin and Scientific History of resilience

Resilience stems from the strict Latin root, *resilire*, meaning to leap or spring back; to rebound or recoil. The concept implies a returning to some position or form after a perturbation. The resistance to, and speed of recovery from, such perturbations is perhaps the most simplistic form of *resilire*. More recently, the evolution of resilience as technical jargon has been altered to fit the needs of the respective field and in recent years, the idea has gone through multiple iterations of transformation. It appears that a common theme amongst scientists, economists, and civic leaders is that of wondering what causes one system to break down and another one to rebound and excel (Zolli and Healy 2013). The broad base of interest has brought about complaints by various practitioners whose concerns lay with the potential prospect of the term becoming convoluted and 'fuzzy' in its definition. This is due to attempts of generalizing resilience theory across disciplines which have the potential of blurring the original use of the term in ecology (Brand and Jax 2007).

Others have voiced the importance of the development of resilience theory across domains (a resilience theory grounded in discipline-specific needs (Martin et al. 2016)). One underlying argument for discipline-specific needs focuses on the differentiation between social systems and physical systems, where physical systems are thought to be without normative value judgments as opposed to social systems which are fundamentally self-determining and normative[1].

[1] The additive complexity of social systems requires the incorporation of the knowledge that, due

Within economics, resilience is augmenting the study of how economic systems respond to shocks, also known as ‘booms and busts’ in business cycle theory. Economies have long been known to experience perturbations - taking the form of recessions, technological innovation, major policy changes, and natural disasters. These events are thought of as unexpected and out of the ordinary and often impact the functionality of the system (negatively).[2] However, even within the field, the nature of resilience is debated. Here, we provide a brief sketch of two perspectives and their respective relationship to resilience theory: mainstream/neo-classical and complexity/evolutionary frameworks.

First, we introduce the mainstream, or neo-classical, interpretation of the greater economy's functionality, which includes concepts relating to equilibrium, rationality and the motives of economic agents. Second, we present the complexity approach which generally recasts the interpretation of economic behavior into an adaptive, non-equilibrium system where agents are bounded in their rationality, which suggests the possibility of multiple potential states of equilibrium (or lack thereof).

1.2 Equilibrist Framework

Figure 1 provides a stylized response to a major economic shock according to the neo-classical conceptualization. This example shows a shock that has moved the economy off its growth path, with resilience measuring how sensitive the economy is the shock and the rate/rapidity of response. We see the economy's recovery as a V-shaped (or possibly a U-shaped), which is in line with the underlying equilibrist framework of the economy returning to its ‘natural’ operation. This is further explained by mainstream economist Milton Friedman, who explains,

to imposing normative values, social systems can evolve into undesirable and dysfunctional states that are not sustainable. In this scenario, resilience is a negative quality that prevents a reorientation onto a new growth path.

[2]Statistical physicists have studied various attributes relating to economic shocks, i.e. their frequency, shape (V-shaped or L-shaped), depth, and breadth. These scholars seek to discover common underlying patterns in the system's dynamics from a statistical frequentist perspective.

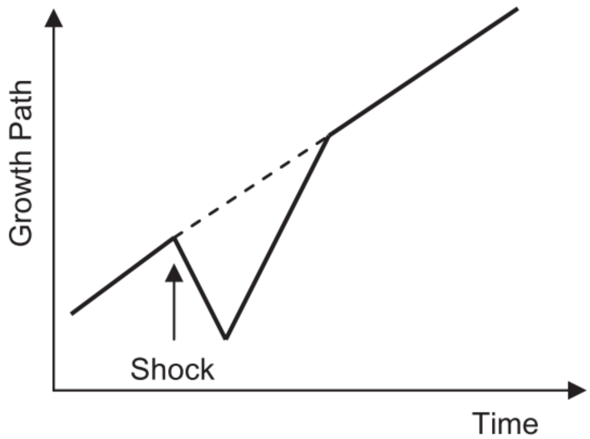

Figure 1: Response to Major Economic Shock: Mainstream Framework

> The cycles are symmetrical about their troughs: each contraction is of the same amplitude as the succeeding expansion [recovery]. But there is no necessary connection between the amplitude of an expansion [recovery] and the amplitude of the succeeding contraction ... Expansions [recoveries] would be uncorrelated with succeeding contractions, but contractions would be correlated with succeeding expansions [recoveries] ...to complete the analogy, we can suppose the board to be tilted to allow for trend (Friedman 1988).

This interpretation makes major economic shocks minor issues, as these ‘short-run’ anomalies will ultimately not affect the long-run performance of the economy.

The neo-classical conceptualization of the economy is fundamentally equilibrating, which has direct implications on the interpretation of what resilience is in relation to an economy, that being, the ability of an economy to either return to a pre-existing stable or equilibrium state or to move quickly to a new one (Simmie and R. Martin 2010). This is linked to the ecological interpretation of ‘engineering resilience’, defined as resistance to disturbance and rapidity of recovery to a pre-existing state (Holling 1973; Pimm 1984). This could be thought of as some minor force (or ‘shock’) stretching out an elastic band such that when the force ceases, the band quickly snaps back into form, without experiencing any major structural changes (Garnsey and McGlade 2006).

The stated conceptualization of resilience is a byproduct of neo-classical economic theory studying systems in behavioral equilibrium (systems that would induce no further reaction) (Arthur 1999). This approach originated nearly two centuries ago and has largely focused on solutions that result in no further behavioral adjustments. Its development was in accordance with the overarching themes of science during this time. Reality was conceptualized through a deterministic, deductive logic which allowed the researcher to suppose the world to be continuous and well ordered and that all matter had a 'natural' function towards which it tended. Alfred Marshall did much to develop the logical implications of this framework to the field of economics, casting much of the perceived economic phenomena into calculus. His famous epigraph "nature makes no jumps" speaks to the underlying - smooth function - assumptions in which minds of the age interpreted reality (Marshall 1982).

Under this framework, economists gravitated toward studying averages and aggregate measures as these statistical tools related to the general tendency of the economy. These measures were supposed to be composed of rational agents whose 'nature' was consistently self-interested and utilitarian in a manner that allows for meaningful interpretation of statistical empirics and justified the use of a closed-form set of equations that provide suitable explanatory power in understanding causality. Further, this assumed behavior implies the economy will converge towards a steady state, in the absence of exogenous shocks, in a linear fashion.

Leon Walras was a notable contributor to such methodology and developed a mathematical model called general equilibrium theory in 1874. While the theory has undergone significant development over the years, the broad claim remains that in the absence of "external" forces the supply and demand for all markets will clear in the long run. This belief can be noted as he states, "The market is like a lake agitated by the wind, where the water is incessantly seeking its level without ever reaching it." (Hadley and Walras 1889)

The Walrasian methodology became the neo-classical vision of a set of solvable systems of equations that captures the full interrelationships of the economy which can then be used for top-down planning and analysis. Walrasian models philosophically subscribe to a resultant phenomena perspective, where macro entities are the result of linearly aggregated micro behavior (Colander 2006). This methodology assumes agents are homogeneous thus allowing the separation of the micro and macroeconomy. Such assumptions make it logically feasible to cast macroeconomic phenomena into a set of solvable Equations. Additionally, the Walrasian methodology assumes an intervention to mechanically lead to cause-and-effect process. This implies the ergodic hypothesis, where the economy cannot adapt to interventionist behavior but will efficiently respond in accordance with the model's predictions.

Standard economic theory views the economy as functioning in an ordered, well-defined problem space where deductive rationality can analytically lead to solutions. This enables a researcher to cast reality into elegant systems of equations with analytical solutions. The commitment to such methodology is best expressed by Schumpeter:

> Multiple equilibria are not necessarily useless but, from the standpoint of an exact science, the existence of "uniquely determined equilibrium (set of values)" is, of course, of the utmost importance, even if proof has to be purchased at the price of very restrictive assumptions; without any possibility of proving the existence of uniquely determined equilibrium-or at all events, of a small number of possible equilibria-at however high a level of abstraction, a field of phenomena is really a chaos that is not under analytic control.
> (J. A. Schumpeter and E. B. Schumpeter 1954)

The resulting analytical problem space of an equilibrium-based perspective is, therefore, most concerned with engineering type optimization. Typically these are allocation problems relating to general equilibrium models, trade, and asset pricing. By placing allocation type problems in the forefront, mainstream economics has pushed other features of the economy to the periphery, namely, understanding economic formation processes relating to temporal dynamics, institutional and market organization, and structural change. In consequence, these phenomena are dealt with as corollaries. Thus, much of mainstream economic research orients itself toward technological progress and long-run economic growth and views resilience research as a lesser subject (Krugman 1999). Therefore, the mainstream conceptualization of economic phenomena (i.e general equilibrium, rational agents, and linear dynamics) ultimately downplays in the role of resilience theory as a research area of major importance.

1.3 Complexity & Economic Resilience

Complex and evolutionary economies are considered to be the aggregation of simultaneous macro/micro-interactions and the resultant shocks these interactions produce. Parsing out how the system responds to a certain shock, in the midst of a constant barrage of microshocks, becomes an overwhelmingly daunting task. Further, there is an infinite number of possible initial conditions and "accidental" perturbations along the way that can generate non-linear and often nearly chaotic effects from the bottom-up, which are unique to that moment. This makes learning information from a specific shock which can then be extrapolated into a testable theory nearly impossible.

This alternative view is contrasted to the mainstream perspective which places heavy deterministic assumptions on reality in attempts to be able to control and, in effect, engineer the economy. Complexity views the economy as unfit for such modeling and favors the study of emergent structures that arise from the interactions of low-level building blocks. More specifically, complexity economics views economies as path-dependent and contingent on the indeterminate evolutionary process which requires sensemaking of the economy's functionality (Arthur 1999). The complexity framework offers a different way to conceptualize the economy and, as with the mainstream framework, guides the researcher to answer questions that coincide with its underlying assumptions.

Similarly to how the historic formalization of economic theory built upon the premise of general scientific thought of the late 1800's which led to the development of the mainstream, so too the recent re-formalization of economic theory has built on the more current developments in science. Complexity economics has been birthed out of non-linear dynamical systems perspective, a complex system that endogenously does not tend asymptotically to a fixed point, a limit cycle, or an explosion (Day 1994). More recently, non-linear dynamical systems have been absorbed into the greater complex adaptive system terminology.

A complex adaptive system (CAS) (in this case the economy) is built up from a group of agents that change (adapt) over time. This is in contrast to non-adaptive physical systems which contain certain unchanging properties, such as the boiling point of a group of water molecules. Within a CAS the agent is simultaneously influenced by the aggregate and influences the aggregate, making the system both top-down and bottom-up. A CAS is considered to be non-linear as agent interactions are conditional, in other words, interactions rely on if-then statements (Holland 2014). As a result, the interactions between the aggregate and the agent are constantly adapting and altering, creating internal complexity. This feature causes the behavior of the aggregate to not be the sum of the agent actions, also known as *emergence*, where the interplay between the top-down organization of the macro-structure does not reflect the different individual's motives. The emergent property prevents the economy from ever reaching an equilibrium and serves to act as a continual flow of economic shocks. These perturbations can be either endogenous or exogenous to the system, although the boundary of a CAS is often difficult to define. An outcome of the non-equilibrium condition is the inability to achieve an optimality criterion, in the mathematical sense. However, CAS theorists do employ alternative approaches to determine the health of the overall system.

CAS theorists discuss 'robustness' as a characteristic of a system to be unaffected by perturbation by maintaining a consistency of function (Whitacre 2012). In this conceptualization, robustness allows for changes in the internal structure of its components in order to maintain functionality in response to perturbations. Thus, robustness is less concerned with the inner behavior of the system and more concerned with its general preservation and continuity of functionality. Under this framework CAS theorists have investigated the benefits of 'redundancy' within a system and the degree of 'modularity', both terms relating to distributed computer networks commonly used for Internet services and will be discussed in subsequent sections. In general, the developing framework views a robust system as one capable of undergoing successful changes in order to preserve greater functionality.

When viewing the economy as a CAS the simultaneous interaction between the aggregate and the agent, and inter-agent emergent behavior, prevent equilibrium from occurring. This results in macroeconomic patterns being the emergent property of microeconomic phenomena. Rational behavior is replaced by the evolving behavior of agents who allow for evolutionary processes of differentiation, selection, and amplification. Agents have limited information and face high costs of information processing and thus use the sub-optimal heuristic-based approach, which balances the trade-off between gaining perfect information and the cost of obtaining that information (Beinhocker 2007). The CAS conceptualization focuses more on understanding the formation of the economy and its resulting system dynamic than engineering the economy according to an optimal allocation theory.

1.4 Regional Economic Resilience Intro

In this thesis, we use a synthesized view of the two preceding camps. Martin et al. (2016) have done the seminal development and synthesis of these two views and have developed a framework in which to conceptualize the measure of resilience to shocks, that being regional economic resilience (Martin et al. 2016). Regional economic resilience relates economic shocks to an evolutionary resilience process and studies the impact on the regional economy's structural formation. We suggest that limiting regional economic resilience to 'short and fast' economic shocks is necessary to maintain distinctive meaning and stay distinguishable from the more general on-going regional economic development (Martin et al. 2016). It has been suggested that short and fast shocks on the economy can lead to structural breaks, sudden changes in the structure of the economy, in which the behavior of the economy does not return to its pre-shock state but is pushed into a new phase or state (Cross 1993; Setterfield 2009). These shocks can be either exogenous or endogenous to the system at hand.

Alternatively, we could take the inverse of this shock type, a 'slow-burn' process. A 'slow-burn' process is, as the name suggests, a gradual and long-term process, for example, climate change. These processes are analogous to the "constant barrage of microshocks" from complexity economics. The 'slow-burn' is more akin to a Schumpeterian process where adverse developments accumulate over time, putting consistently increasing/decreasing pressure on the system, bringing about 'creative destruction' and 'industrial mutation' dynamics. Here, resilience is the measure of how economies respond to such gradually changing pressures. Generally, if an economy is non-responsive to microshocks, the system may begin to fall behind and become at risk of failure. Left unchecked, the adaptive inertia will lead to collapse. In other words, the 'slow-burn' process grows additively and has the potential to lead to a disruptive shock after a certain critical threshold is reached. At this point, a tipping point is crossed which leads to a potential phase transition which leads back to the more familiar economic shock. Thus, a short and fast shock has the potential to be caused by a 'slow-burn' process. This type of shock is analogous to an internal shock typically associated with emergent phenomena where internal contradictions or evolving interactions lead to unexpected and non-linear outcomes. Limiting the study of resilience in response to a ‘slow-burn’ shock is open for further investigation and requires detailed analysis of time horizon, underlying characteristics, and nature of the process. We intentionally limit the definitional scope of resilience to exclude such phenomena in order to mitigate the risk of losing clarity and consistency of our analysis.

In this thesis, we limit our attention to short and fast shocks dealt solely in terms of economic recessions. Such top-down exogenous shock allows for observation of the structural diffusion over the totality of the economic system.

The risk of a shock is interpreted as a measure of stability for the current state of the system. A high-risk state implies less stability (more exposure to volatility). In response to such a state, a policymaker would have to consider if the current conditions are favorable for the whole of the system. If so, it might prove reasonable to enact some policy that seeks to maintain current functionality. On the other hand, if the operation of the system is seen as unfavorable, a policymaker can use a system induced shock to allow for a phase transition into a new stable state.

The multi-equilibrium approach interprets the reaction or the depth of a shock similar to the mainstream approach in which a shock can be observed to a point after-which intervention may be deemed necessary. Recovery, however, is the key difference between the perspectives. Evolutionary economists suggest that the recovery of the system, the new steady-state, is indicative of the system’s resilience. A positive, or better than before, response to a shock indicates a resilient system and if the system is worse off the system is thought to not be resilient.

Is it a plausible assumption that during phases of stable dynamics, the system will appear to behave in a linear fashion while possessing the capability to adapt to internal/external phenomena in a non-linear fashion. This draws on the idea that a

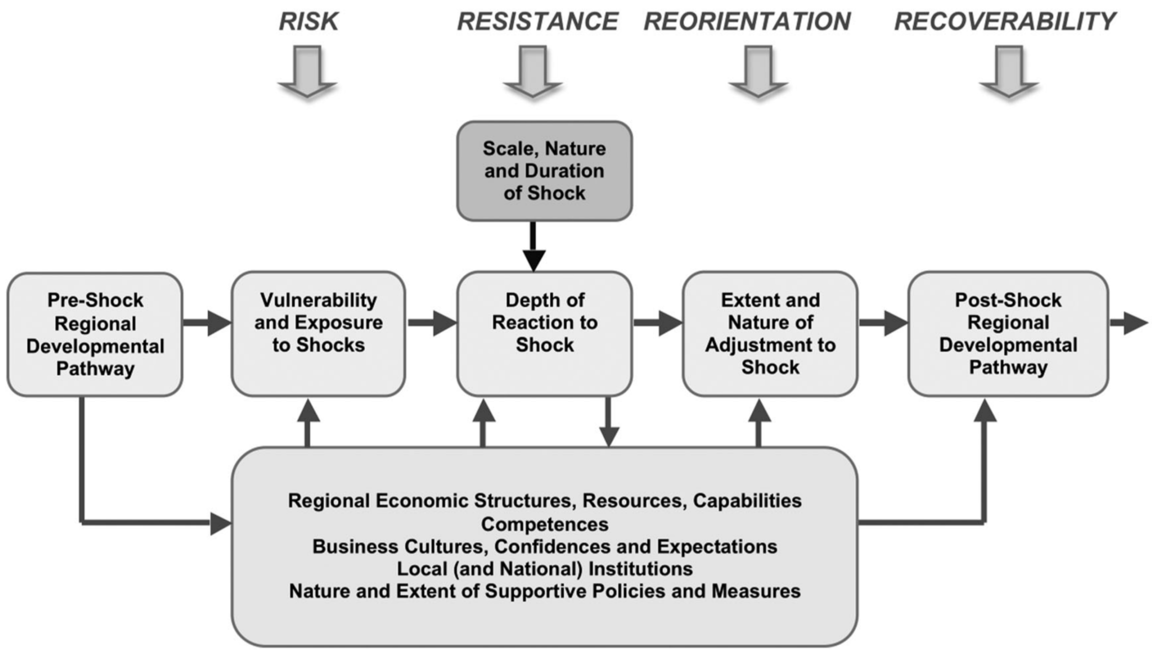

Figure 2: Regional resilience to recessions, Source: Martin et. al 2016

system tends to operate under stable conditions for, otherwise, the system would fail to function. The interplay then becomes the need for the system to remain in a stable state and how adaptive the system is too new states, further leading to questions of how frequently can the system evolve and adapt before becoming too chaotic to continue functioning. In other words, what is the spectrum of sustainable functionality?

Simmie and Martin present economic resilience through a panarchy model. The panarchy model stems from ecological science and suggests a four-phase, cyclical, adaptive pattern for the organization of capital accumulation and development of resilient behavior within an economic system (Simmie and R. Martin 2010). Here, the definition of resilience is interpreted to be an "evolutionary dynamic [that] is periodic in nature, in which episodic shocks cause a system to adapt from one 'regime of stability' to another." In this framework, a resilient economy would be one that successfully adapts and mutates in response to the Schumpeterian 'creative destruction process. While the panarchy model itself seems to be limited the authors do provide a thorough analysis of various definitions of resilience. Simmie and Martin (2010) point to the traditional ecological definition, 'engineering resilience,' analogous to the mainstream economic use of equilibrium (Simmie and R. Martin 2010). Engineering resilience is the ability of the system to resist disturbances and rapidly return to its pre-shock state of equilibrium. However, this definition discounts the evolutionary nature of the economy due to its restrictive underlying ergodic assumption.

Holling (1973) suggests that resilience "refers to the magnitude of the shock that can be absorbed before the system changes its structure and function and becomes shaped by a different set of processes."(Holling 1973) Ultimately this definition converges to the prior as the more resistant a system is to change the more resilient it would be. Foster (2007, 14) defines "regional resilience as the ability of a region to anticipate, prepare for, respond to, and recover from a disturbance."(Foster 2007) Thus, regional resilience is a broad idea of how well a system recovers its original form and position.

2 Regional Resilience Process Framework

2.1 Overview

In this thesis, we define regional economic resilience as a multifaceted process composed of distinct while interconnected stages. These stages are risk, resistance, reorientation, and recoverability, Figure 2 (Martin et al. 2016). We briefly develop this multifaceted framework to show the theoretical importance of economic structure as a driving factor in the behavior of a local economy's resilience. In this analysis, the evolutionary process is observed through one minor (2001) and one major (2008-2009) recessionary shock. As stated, the scope of an economic shock is intentionally limited to recessions at the national level. This ensures that shocks are simultaneously experienced across space which is conducive to analysis. It is

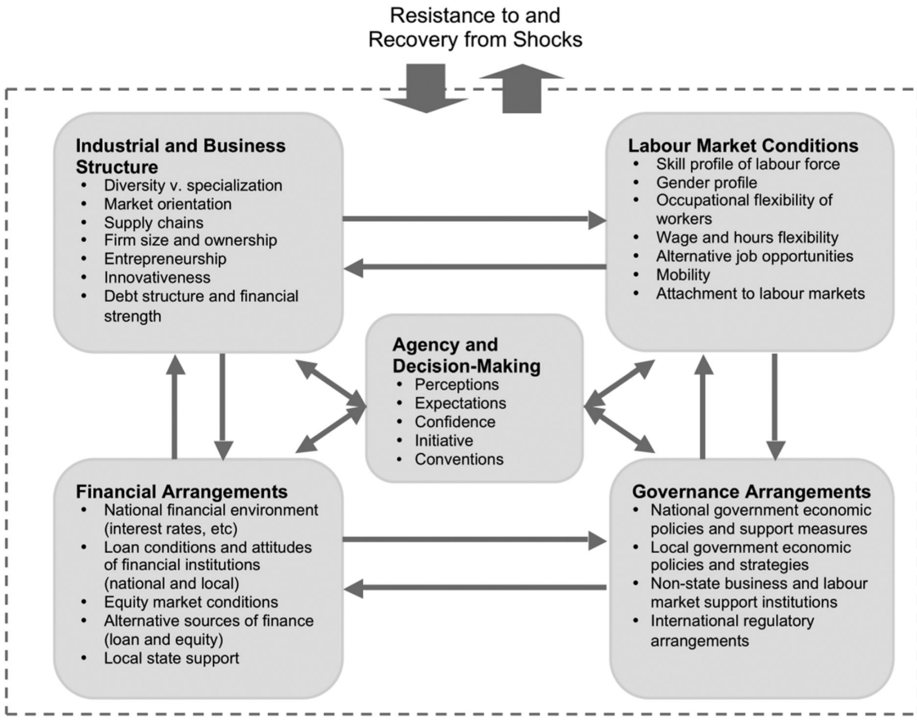

Figure 3: Determinants of regional economic resilience, Source: Martin et. al 2016

hypothesized that industrial diversity and specialization influence the vulnerability to recessionary shocks as well as the economy's reaction and adaptation. To gain insight into the phenomena we first develop a theoretical framework through which, in subsequent sections, we conduct our analysis.

Martin and Sunley (2014) conceptualize how regional ecological resilience evolves over time in relation to large economic shocks. Here, resilience transitions away from the ability to rebound to its original state and also diverges from the complexity economics definition of robustness (the ability of an economy to maintain certain functionality despite perturbation). Rather, the regional resilience process theorizes that resilience is, in fact, an evolutionary algorithm.

The first stage of the process is: risk, and refers to the degree of exposure, or vulnerability, a local economy is to a recessionary shock. Namely, risk deals with the likelihood of a shock and, if a shock were to occur, what is the degree of exposure in a given region. The second, resistance deals with the depth and duration of a shock on the region's economy. Depth and duration are separated, to account for heterogeneous responses to a simultaneous shock. Reorientation addresses the adaptive capacity and efficiency of adaptation of the locality. This can be thought of as an information update that enables the region to alter endogenous variables to resume primary functionality. Finally, recoverability refers to the new development pathway of the economy post-shock.

2.2 Risk

Risk refers to the degree of exposure, or vulnerability, a locality's economy is in a recessionary shock. This degree of exposure is determined by the culmination of risk given the locality's institutional structure, political organization, industrial composition, and labor demographics and behavior. We omit from the risk component analysis in this thesis.

2.3 Resistance

Resistance refers to the depth and duration of an economic shock. If 'risk' is how likely a shock will occur, resistance seeks to measure the impact should a shock strike? This is more closely related to the robustness of the system, to be discussed in the next section. Figure 3 presents various factors that are possible determinants of the ability of a locality to resist an economic shock. This thesis primarily focuses on diversity and specialization as key features of resistance.

2.4 Reorientation

The third stage refers to a locality's adaptive capacity in response to a shock. More specifically, "the ability...of the region's firms, industries, workers, and institutions to undergo the adjustments and adaptations necessary to resume core functions and performances.(Martin et al. 2016)" We suggest the need for a clarification of "core functions and performances." Further, a clear measurement of an appropriate rate of reorientation would be helpful in quantifying expected adaptability of a locality. One possible solution is to take as counterfactual the rate of reorientation of the nation and compare this to specific localities. This would allow the researcher to observe which areas tend to reorient (adapt) more quickly in lieu of a recessionary shock. This strategy is in-line with other regional economic, see (Fingleton, Garretsen, and Ron Martin 2012; Hans and Goetz 2013)

2.5 Recoverability

Recoverability, the last stage of the resilience process, refers to the resulting state of a local economy post-reorientation. Some areas are expected to be better off while others worse. Areas that have sufficiently evolved in response to the shock will then tend toward a more positive growth path and conversely for those who are insufficiently evolved. The resulting growth path of the locality is a key measurement of outcome for the adaptive process. However, since a recessionary shock is not the sole instigator of evolutionary forces on the economy it is difficult to parse out the true effect. Martin et. al (2016) suggest a counterfactual approach that can be seen in the Methodology section, Equation 7.

3 Robust Labor Markets Features

3.1 Overview

Robustness is the ability of an object, institution, or any other form, to maintain functionality despite perturbations (Jen 2005). A robust labor market stems from the economic sub-discipline of industrial-organizational. Major emphasis has been placed on the design of a robust internal structure of the organization so as to best facilitate efficient and adaptive behavior especially in the face of unexpected negative events (North 1994). A robust system necessitates both a maintained effectiveness and a degree of flexibility conditioned upon an evolving environment. The design of such a system ought to preclude excessive lock-in effects, due to path-dependent tendencies of organizations, while simultaneously sustaining operational goals. This inherently prefers long-term interests over that of short-term gains and seeks to benefit from outside forces in order to increase the probability of survival. Further, a robust system will seek to take full advantage of spillover effects, the ability to learn from another's mistake or success, and have the ability to efficiently internalize advancements made in surrounding institutions. To this end, three characteristics have been identified as static features of a robust institution: diversity, modularity, and redundancy.

In this thesis, we theorize a robust labor market will possess these same key features. While the feature remains some adjustments need to be made to account for application differences. Diversity is re-conceptualized as a quasi-inverse of specialization, in accordance with Martin and Sunley (Martin et al. 2016). Modularity is adjusted to allow for differing strategies of organization across scales. Redundancy acknowledges the impossibility of perfect replication and instead suggests the satisfactory suitability of comparable firms and organizations with similar inputs and outputs. These adjustments take into account the anthropocentric nature of the labor markets and suggest similar analysis to that of portfolio theory as related to stock markets. The following develops a description of a robust labor market and links together these features to the greater resilience process.

3.2 Modularity

Modularity is related to the role of system structure, where the system is classified on a spectrum between self-similar and specialized. Self-similar systems are fractal in nature and reflect the whole at any level of scale, i.e. snowflakes. Specialized systems are those whose modules possess unique and distinct characteristics at each respective level, i.e. the human anatomy. Modularity would suggest that a self-similar labor market would allocate equal portions of industries, or maintain the same proportion of industrial diversity, across scales. This system would produce great stability at the cost of efficiency. Alternatively, a specialized labor market would segment the market across scale akin to taxonomic ranks (i.e. domain, kingdom, phylum, class, order, family, genus, species). This system would produce great efficiency at the cost of stability. While these extreme cases can be easily conceptualized in the abstract such organization of labor is both infeasible and unsustainable in the actual.

A binary classification of a modular system works well for strictly natural or (some) mechanical systems, however, we suggest that anthropocentric systems rest somewhere on the spectrum between self-similarity and specialization and can vary across scales. Levels of scale in conjunction with labor markets can be thought of as employment structures in counties, states, regions, and nations. As an example of variation across the same level of scale observe that each county possesses a unique combination of self-similar and specialized industries. Self-similar industries would be those necessary to any county such as petrol stations or grocery markets. Specialized industries would be those that are above average in the concentration of employment relative to some level of scale, such as oil fields in certain areas in Montana or the technology industry in San Fransisco. As an example of a variation of structure across different levels of scale consider a city that is specialized in a specific industry, however, the proportion of specialization will fall once aggregating to the state level.

Another example is that of a car engine. It is a specialized component, made up of specialized components. However, at the level of automobiles, it is just one component of the overall self-similar vehicular machine. So as to say, a degree of specialization (or self-similarity) at one level does not imply the same degree of specialization (or self-similarity) across levels of scale. Rather, each level within a system must be considered distinguished from and enfolded into, the whole to understand its modular role in the system structure.

3.3 Diversity

Diversity facilitates the role of natural evolutionary forces of mutation, selection, and amplification. An organization orients itself toward higher adaptive capacities as diversity increases. A helpful analogy to this might be Fisher's fundamental theorem, which states the "rate of increase in fitness of any organism at any time is equal to its genetic variance in fitness at that time." This makes intuitive sense as organizations that experiment more often are more likely to generate innovative solutions. Such an idea harkens back to Schumpeter's concept of "creative destruction", where the "process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one." Thus, diversity can be thoughts of as a conduit for the creative destruction process within the organization.

Diversity also becomes an incessantly disruptive force within the organization and possesses the bi-product of becoming a destabilizing force on political lock-in effects in the hierarchical system. The great difficulty then lies in channeling the benefits of experimentation and knowledge generation while still utilizing existing knowledge and functional forms to maintain some degree of stability. Lietaer provides a balanced perspective on the role of diversity in generating sustainable systems by suggesting that diversity does much to increase the resilience of a system, for reasons already discussed, but comes at the cost of loss in efficiency (Lietaer 2011). This is due to the constant inflow of evolution and adaptation destabilizing the system preventing efficient processes from forming. These benefits prevent lock-in effects but at the cost of leaning towards the edge of chaos which easily ensues in loss of information and efficiency. On the other hand, too little diversity generates a streamlined system but is also rigid and incapable of adapting in the wake of new challenges. Lietaer also suggests pursuing the balance between the two poles to bring about a sustainable organization.

In relation to labor markets, industrial diversity is the bundle of industries present within a locality. As in organizations, diversity in labor markets drives adaptation which inherently creates chaos while concurrently providing new opportunities for industrial expression. Industrial diversity mitigates the effects of recessionary shocks which typically affect only a subset of industries on a locality. The benefits of diversity would suggest an associated cost and in this case, that is a reduction in efficiency. A less efficient labor market would expect to have a higher rate of unemployment as creative destructive processes prevent stable employment and curtail streamlined processes of labor allocation.

3.3.1 Dissimilarity and Specialization

In this thesis, we use dissimilarity and specialization synonymously in that the more specialized a locality becomes the more dissimilar it is from the whole. Further, the role of specialization is theorized to be inversely related to diversity according to Martin et. al (2016). Traditionally, specialization refers to the Smithian concept of division of labor which concentrates each worker on a single stage in the production process to increase productivity above that of if each worker carried out the whole task single-handedly. Industrial specialization in labor markets refers to an unusually high level of a single, concentrated, production process relative to the proportion of the equivalent industry at a higher level of scale. The division of industry into specialized geographical clusters has been shown to increase productivity in urban settings and is known as the benefits of agglomeration economies.

However, in at the national level this is not necessarily the case. For example, Venezuela, as a nation, is rich in oil and thus has chosen to specialize in oil production processes. The result has to lead to economic instability and overall collapse of the labor market. This is not uncommon for resource-rich countries and has become commonly known as the paradox of plenty phenomena (Karl 2010). The non-uniform effects of specialization across scale have been the subject of much research within regional and geographical economics and have found contradictory evidence.

3.3.2 Industrial Migration

As agglomeration economies form and clustering effects emerge so does the ability to migrate between similar industry. For example, one would expect that an unemployed person from food manufacturing will find it more difficult to gain employment in telecommunications than, say, in some other manufacturing type job. This is due to skill requirements being similar amongst similar industries and, conversely, dissimilar across dissimilar industries. As a result, highly specialized localities would expect to experience an increase in the ability (or opportunity) of labor migration. Conversely, highly diversified localities would expect to experience a decrease in the ability (or opportunity) of labor migration as there are fewer compatible jobs types for each industry.

During a recessionary shock, the ability to transition to other similar industries might prove useful in decreasing the unemployment rate. As unexpected layoffs occur in one specific sub-industry labor may be more efficiently reallocated into the neighboring industry. However, more often the case is that all interrelated industries are negatively affected by the economic shock, leading to a larger cascading failure. Since specialization provides greater opportunity for cross-pollination and knowledge spill-over it would seem that this features facilitates some heightened degree of interconnectedness. Specialization's exact role in causing a dense network of interconnected industries, thus affecting the ability of a laborer to industrially migrate during an economic shock, is open for future investigation.

3.4 Redundancy

Redundancy refers to the repetition of components or sub-systems within a given system. Isomorphic modulation allows for one component or parallel sub-system to fail without the risk of system-wide failure. Subtle mutation variation within the parallel processes or components further enhance the benefits of the risk mitigation strategy. Minute differences between redundant components allow for distinct reactions to a negative shock thus decreasing the likelihood of equivalent reactionary failure. As a result, the system increases the probability of continued functionality, the first goal of robustness.

Within labor markets robustness can be thought of as competitors within an industry each producing extremely similar products yet utilizing different production processes. This ensures that, given a recessionary shock, should one firm fail the production of the good or service will continue. This can be thought of within a given locality or across locality. Within would refer to the benefits of redundancy producing stable functionality of the individual component. Across would refer to the overall maintained functionality of the system. With this in mind, redundancy typically refers to a more system-wide health and is less concerned with the well being of a specific locality. For this reason, we omit this feature of robustness from the study as we are mostly concerned with the health of the labor market at the county level.

3.5 Connection Between Robust Labor Markets and the Resilience Process

In this section, we link together the two discussed frameworks: regional resilience process and features of a robust labor market. We discuss the theoretical interplay between these frameworks and discuss expected outcomes of the empirical analysis. It should be noted that the current resilience literature makes room for diversity and dissimilarity, although the role of modularity and redundancy is less clear. We consider how breadth and depth of industry affect a local economy's ability to allocate labor during times of expansion and recession. Modularity is concerned with how the labor market structure across scale affects an economy's ability to resist and recover from economic shocks. Redundancy regards the maintained functionality (survival) of the system over time by placing repetitive industrial counterparts in geographically separate locations. The three features of robustness coupled with the four-stage resilience process suggest a multi-scale heterogeneous strategy for the optimal allocation of labor.

3.6 Diversity Effects on Resilience

Diversity, in relation to the resilience process, is concerned with how the breadth and depth of industry affects an economies ability to resist and recover from economic shocks. A key advantage of a high degree of diversity is the ability of a system to mitigate the risk of complete ruin by promoting a plethora of mutations and adaptations thereby spreading out exposure to harm. While the theoretic roll of diversity in relation to risk analysis is intuitive, the literature suggests an assortment of findings. Martin et. al (2016) state,

> According to some economic geographers, industrial specialization is the major driver of regional economic growth (Storper 2013; Storper et al. 2015). Others, however, argue that it is the diversity - the complexity - of a region's or a city's economic structure (its industries or its products) that imbues it with higher growth and greater stability (Hausmann and al.] 2013). Still, others argue that what matters for regional economic growth and stability over the long run is 'diversified specialization' (Farhauer and Kroll 2012), while yet others emphasize what they call 'related variety' (Frenken, Oort, and Verburg 2007)

It seems ironically fitting that the topic of diversity would have such a diverse set of opinions. We put forth that during periods of recession highly diverse localities would expect to have a lower rate of unemployment compared to that of less diverse localities. However, this result hinges on a weakly connected network of industries within a locality. If the network is heavily interconnected, say through secondary or tertiary dependencies, then an economic shock would cascade more easily through the local labor market. Thus, we suggest that the degree of interconnectivity is a confounding factor in the previous analysis. While the degree of interconnectivity within the U.S. labor market is beyond the scope of this thesis the effects of diversity during recessions on unemployment can point to possible evidence regarding its extent.

3.7 Modularity Effects on Resilience

Modularity, in relation to the resilience process, is concerned with how labor market structure affects an economies ability to resist and recover from economic shocks. As discussed, modularity addresses the role of system structure in fostering a robust system design. A key advantage of a high degree of modularization is the ability of distinct modules to evolve somewhat independently and serve as tiny experiments whose results can be back-propagated into the system. Further, the structure of modularity has direct implications for the processing and diffusion of exogenous shocks. A perfectly self-similar modularized system, as previously explained, would diffuse the shock equally across the system's levels of scale having broad but system-wide effects. Conversely, a perfectly specialized modular system would channel the shock toward those modules most susceptible, having extreme but localized effects. To understand the role of modularization in the reaction of labor markets to economic shocks we must first develop a mental framework of the modular structure of labor markets. To do so we suggest that one possible explanation of the modular structure of the labor market is, in fact, analogous to a financial portfolio.

Consider financial stocks as akin to specialized localities which are a part of a mutual fund (semi-diversified regions) which are a part of a greater index fund (diversified nations) managed by a trader (the labor market). At the local level, we expect to have specialized industries to be more beneficial than a broad industrial base and more economically rational as industries respond to resource and agglomeration incentives. The labor market at the national level is less exposed by the diverse set of industries while maintaining the benefits of specialization at the local level. This strategy undoubtedly increases the risk of being heavily affected by an economic shock if a locality is heavily invested in the affected industries.

However, the role of modularity reduces the spillover so that highly specialized industries unrelated to the origin of the shock will be far less affected, reducing some degree of damage to the whole.

3.8 Redundancy Effects on Resilience

Redundancy, in relation to the resilience process, is concerned with how the repetition of industry affects an economies ability to resist and recover from economic shocks. A key advantage of a high degree of redundancy is the ability of a system to easily endure the negative shocks by having multiple firms perform similar tasks thereby increasing the likelihood of maintained functionality should one or more fail. Redundancy does not mitigate risk of or exposure to shocks but is more concerned with minimizing the depth of impact caused by the shock. This can be thought of as increasing the resistance capacities of the system and serving as a validation instrument through which true shocks can be vetted (Bednar 2016). Redundancy eases the reorientation phase of resilience by seeking to guarantee maintained functionality making it less evolutionary in purpose.

As mentioned above, redundancy is omitted from our analysis but is subject to future research. The primary reason is redundancy is mostly concerned with maintained system-wide functionality and less with component functionality. Future research could explore the possibility of developing a metric through which testing for a true shock signal is tested through the response of redundant quasi-independent firms, akin to a tsunami warning system. This could be done for both national and, more importantly, industry-specific shocks.

PART III: DATA

4 Data Sources & NAICS implicit information gain

We use employment data, as organized by the North American Industry Classification System (NAICS), obtained through the County Business Pattern (CBP), a branch of the U.S. Bureau of the Census. The annual series, from 1998-2015, provides county-level economic data by industry. County, state, division, and regional annual unemployment data was obtained through the Bureau of Labor Statistics. The U.S. Census Bureau provided demographic data which are included as covariates in the modeling portion of the thesis. Population estimates are represented in 10,000s. Population density is represented in 1,000s of people per square mile of land area. Estimated county-level median income was obtained from the Federal Reserve Economic Data (FRED) database and minimum wage data come from the Department of Labor. Median income is in terms of 1,000s of dollars.

NAICS two-digit, three-digit, and four-digit codes were used in the modeling process. The series contains over 3,125 counties over 55,000 total observations. Since some county distinctions have occurred over the course of the period of observation it became a requirement that only the counties that existed during at least one recessionary shock were included in the analysis. Further, some of the counties in the report had extreme small populations ($\lesssim 200$) leading to highly leveraged data points. This is due to small changes causing large differences in the statistical measure, it was decided to remove them as outliers.

The CBP annual report reflects the number of establishments and employment during the week of March 12. Industries with few (approximately less than 50) employees have their data protected using cell suppression methods. We develop an algorithm to combat this loss of information at finer levels of NAICS codes.

We suppose,

$$\text{NAICS}_{ic}^{\text{digit}\,n} = \sum_j \text{NAICS}_{jc}^{\text{digit}\,(n-1)}, \qquad \forall j \in i$$

where the n^{th} NAICS digit in industry i at county c equates to the to the summation of all j sub-industries in i in the same county c. If this equality does not hold then a loss of information has occurred.

If,

$$\text{NAICS}_{ic}^{\text{digit}\,n} > \sum_j \text{NAICS}_{jc}^{\text{digit}\,(n-1)}, \qquad \forall j \in i,$$

then we assume the CBP has omitted data for privacy concerns. The data loss is reincorporated by generating the alternative sub-industry category,

$$\text{Other}_{ijc}^{\text{digit}\,(n-1)} = \text{NAICS}_{ic}^{\text{digit}\,n} - \sum_j \text{NAICS}_{jc}^{\text{digit}\,(n-1)}, \qquad \forall j \in i \tag{1}$$

The "other" category is then added to the dataset under a unique user-generated NAICS code. This is done to allow for easy data manipulation to subset the data in order to conduct robustness checks. If,

$$\text{NAICS}_{ic}^{\text{digit}\,n} < \sum_j \text{NAICS}_{jc}^{\text{digit}\,(n-1)}, \qquad \forall j \in i,$$

it is assumed that a human error has occurred and no further action can be taken. A boolean flag will accompany all industries where this logical error has occurred to give the researcher the option to exclude the data. Fortunately, this human error did not occur during the analysis and therefore was of no concern.

The above process was conducted for the two-digit onto the three digit and the three-digit onto the four digit. It was decided *a priori* to forgo a finer level of

NAICS (i.e. five and six-digit) as the variation between industry becomes subtle and nuanced. Since the foundation of the thesis is to explore various aspects of diversity, supposing marginal differences between sub-industries to be as equally important as substantial differences become dubious.

5 Indicator Construction

5.1 Introduction

Various indicators are constructed to represent industrial diversity, dissimilarity, and migration. Each indicator presumably captures unique aspects of the greater term diversity. Differing levels of scale utilize these indicators to capture the effects of the modular structure of the labor market. Three main levels of scale are incorporated, county, state, and regional with a fourth optional level, division, which is used as a robustness check for the regional level.

5.2 Diversity Formula

Industrial diversity is mainly concerned with number of industries within an area, weighted by the concentration of each respective industry. To accomplish this we define diversity according to Shannon's index, where for the number of employees, E, in industry i within locality l at time t,

$$\begin{aligned} \mathrm{DIV}_l^t &= \sum_i \frac{E_{i,l}^t}{E_l^t} \ln \left(\frac{1}{\frac{E_{i,l}^t}{E_l^t}} \right) \\ &= -\sum_i \frac{E_{i,l}^t}{E_l^t} \ln \left(\frac{E_{i,l}^t}{E_l^t} \right). \end{aligned} \tag{2}$$

This can be thought of as the proportion of employment-weighted by the natural log of the proportion. A second comparable index is a Herfindahl-Hirschman index

(HHI), defined as,

$$\text{HHI}_l^t = \sum_i \left(\frac{E_{i,l}^t}{E_l^t} \right)^2. \tag{3}$$

The HHI is the sum of the square of the proportion of employment, E, over industry i in locality l. The HHI similarly captures concentrations of employment as well as the number of unique constituents making it a viable alternative to Shannon's index.

Both indices are generated annually at the two-digit, three-digit, and four-digit NAICS code at the county as well as the state and regional level. The two-digit diversity metrics can be thought of as the diversity of major industry types. These are industries with minimal overlap in skill requirements and educational background. Four-digit diversity metrics includes finer levels of industry where both skill and educational requirements overlap. As an example of the differences between two-digit NAICS codes considers construction and manufacturing or public administration and arts, entertainment, and recreation.

The differences between a four-digit NAICS code can be equally as distinct, such as Flight Training and Vegetable/Melon Farming, or more similar, such as Grain Manufacturing and Sugar Manufacturing. At the broader level, we are capturing the effect of having diversity across industries. At the finer levels, we are capturing the effects of having diversity within industries. Thus, the changes in NAICS digits are the changes in the scope of diversity. As mentioned, we incorporate the diversity metric across different scales to capture the modularity of the labor market. County-level diversity simply captures the effects of diversity within a county. Likewise, with state and regional levels.

5.3 Dissimilarity Formula

Dissimilarity (or specialization) is defined as,

$$\text{DISS}_l^t = \sum_i \left| \frac{E_{i,l}^t}{E_l^t} - \frac{E_{i,L}^t}{E_L^t} \right|. \tag{4}$$

Just as with before, sum over all industries i at time t, for locality l. L is the greater encompassing locality that is referenced in the calculation. The index reflects the localities economic structure relative to that of the greater encompassing economy as a whole. The higher the index, the more dissimilar the locality is.

For example, choose the proportion of an industry in a county, l, referenced against the national proportion or referenced against, say, the state proportion, L, of the equivalent industry. Likewise, we can choose the state referenced against the, larger, regional or national industrial proportions. The changes in chosen and referenced levels will capture different aspects of specialization across scales.

In addition, we can also incorporate the incremental NAICS code digits just as with the diversity metrics. A two-digit dissimilarity index captures the general industrial specialization, whereas a four-digit captures more specific specialization of industry within a given locality. This interpretive difference, although nuanced, provide powerful insights into the role of degrees of specialization. Suggesting statistical evidence for the distinction between general industry specialized and specific sub-industry specialization.

5.4 Modularity

Modularity addresses the structural role in crafting a robust labor market. To do so Equations 8 - 11 are modeled across various levels of scale. The locality index l is modeled at the county, state, and regional levels. The response variable, unemployment rate, it kept at the county level throughout the analysis. This is done to understand the greater structural effects on country-specific labor markets. Thereby addressing issues of a county being embedded in a state, which is embedded in a regional, in a nation, and so on. Each subsequent layer is partially enfolded into the next and influences the unemployment rates of the bottom-most layer, the county. By addressing this issue we are able to suggest possible goals that those in the higher levels of scale hierarchy can accomplish that will help benefit local labor markets.

5.5 Lilien Index Formula

The Lilien index is given as,

$$\mathrm{LIL}_l^t = \left[\sum_i \left(\frac{E_{i,l}^t}{E_l^t} \right) \left(\Delta \log E_{il}^t - \Delta \log E_l^t \right)^2 \right]^{\frac{1}{2}}. \tag{5}$$

This index captures the changes in the sectoral share of employment from the previous to the current time period within a given locality weighted by the current employment shares. For reason beyond the scope of this thesis [3], we opt to use the modified Lilien index is given as,

$$\mathrm{LIL}_l^t = \left[\sum_i \left(\frac{E_{i,l}^{t-1}}{E_l^{t-1}} \right) \left(\frac{E_{i,l}^t}{E_l^t} \right) \left(\Delta \log E_{il}^t - \Delta \log E_l^t \right)^2 \right]^{\frac{1}{2}}. \tag{6}$$

The modified Lilien index incorporates the proportion of a specific industry in both periods, which is the equivalent to taking the average of the employment shares between time t and $t-1$.

The two-digit NAICS code version of the Lilien index captures shifts in employment between major industry sectors from the previous time period. Conversely, the four-digit NAICS code version captures shifts in employment between sub-industry sectors from the previous time period. It would be expected that major industry changes would be more difficult and, thus, would imply a greater restructuring of the economy than changes in employment shares within sub-industries. For a reference list of formulas see Table 1.

[3] The standard Lilien index is well known to have various empirical drawbacks, see (Ansari, Mussida, and Pastore 2013)

Table 1: List of Indices

Term	Formula	Description
Diversity	$\mathrm{DIV}_l^t = -\sum_{i,l} \frac{E_{i,l}^t}{E_l^t} \ln\left(\frac{E_{i,l}^t}{E_l^t}\right)$	The negative sum of all proportions of industry weighted by their natural log, an entropy measure. The higher the metric, the more diverse the locality.
Dissimilarity	$\mathrm{DISS}_l^t = \sum_i \left\lvert \frac{E_{i,l}^t}{E_l^t} - \frac{E_{i,L}^t}{E_L^t} \right\rvert$	The sum of all proportions of local industry compared to the national proportion. Ranges from 0 to 2. The higher the metric, the more specialized the locality.
Lilien Index	$\mathrm{LIL}_l^t = \left[\sum_i \left(\frac{E_{i,l}^{t-1}}{E_l^{t-1}}\right) \left(\frac{E_{i,l}^t}{E_l^t}\right) \left(\Delta \log E_{il}^t - \Delta \log E_l^t\right)^2\right]^{\frac{1}{2}}$	The sum of the average change in employment between industries from the previous time period. The higher the metric, the more inter-industry migration the locality.

6 Methodology

6.1 Introduction

This section discusses the methodology taken to quantify the effects of a robust labor market on the resilience process. We estimate the inverse relationship between diversity and specialization, at various geographic scales, and estimate their effect on the resistance and recovery stages of the resilience process. To this end, we use Fixed-effects models with county-level unemployment rates as the response variable. This choice follows from the decision to better understand the relationship between robustness and resilience in the confines of the labor market and follows after previous work done by Brown and Greenbaum (Brown and Greenbaum 2016).

An alternative measurement is the percent deviation from the expected change in the unemployment rate at time t for county c given,

$$\text{Deviation}_c^t = \frac{\Delta\text{Emp}_c^t - \Delta\mathbb{E}(\text{Emp}_c^t)}{|\Delta\mathbb{E}(\text{Emp}_c^t)|} \tag{7}$$

where,

$$\Delta\mathbb{E}(\text{Emp}_c^t) = \left(\frac{\text{Emp}_N^t - \text{Emp}_N^{t-1}}{\text{Emp}_N^{t-1}}\right) * \text{Emp}_c^{t-1}.$$

Equation 7 uses the percent change in the national unemployment rate, given by subscript N, as a counterfactual argument for what would be an expected change in the next time period. This, in effect, parses out the deviation from the national trend thereby capturing the portion of the change in unemployment not do to national trends. As a result, robustness features can be used to explain the remaining variance in employment changes.

While the stylized response variable follows after Martin and Sunley and is more robust the interpretation can be quite difficult and will be left to future research

(Martin et al. 2016). We opt for the primary inspection to be conducted using unemployment rates for the ease of interpretation and fitting in with the literature.

6.2 Diversity & Dissimilarity

To establish the inverse relationship between industrial diversity and dissimilarity on unemployment the following baseline models are used for comparison, where for locality l (which can take the form of county, state, or region) and county c at time t for NAICS digit n,

$$\text{Unemp Rate}_{ct} = \alpha_c + \nu_t + \beta_0 \text{DIV}_{lt}^{\text{digit } n} + \beta_1 \text{DISS}_{lt}^{\text{digit } n} + \beta_2 \text{LIL}_{lt}^{\text{digit } n} + D_0 \text{Recession}_t + \mu_{ct}. \quad (8)$$

The fixed effects model controls for entity and time fixed effects indicated by α_c and ν_t respectively.[4] It is important to take note that all variables are mean centered and thus interpretation is a deviation from the average. β_0 is the average effect of an area's industrial diversity on unemployment rates within the associated county. β_1 is the effect of an area's industrial dissimilarity on unemployment rates within the associated county. We include the Lilien Index to control for the secondary effects of industrial migration that the primary variables of interest may be capturing. D_0 is the corresponding coefficient to Recession, an indicator variable of the years the country's economy was in recession. The expected sign of each is given in Table 2.

Table 2: Expected sign of beta coefficients

Digit - n		
County	State	Region
$\beta_0 > 0$	$\beta_0 \approx 0$	$\beta_0 < 0$
$\beta_1 < 0$	$\beta_1 \approx 0$	$\beta_1 > 0$
$\beta_2 < 0$	$\beta_2 > 0$	$\beta_2 > 0$
$D_0 > 0$	$D_0 > 0$	$D_0 > 0$

To distinguish between resistance and recoverability, the recession indicator is interacted on the two main variables of interest, diversity and dissimilarity. The

[4]For equivalent models that do not control for entity fixed effects see the appendix.

Lilien Index is likewise interacted with recessionary shocks to account for dynamic behavior during these times. This set of variables is represented by the vector Z and gives the following functional form,

$$\text{Unemp Rate}_{ct} = \alpha_c + \nu_t + \beta_0 \text{DIV}_{lt}^{\text{digit}\, n} + \beta_1 \text{DISS}_{lt}^{\text{digit}\, n} + \beta_2 \text{LIL}_{lt}^{\text{digit}\, n} + D_0 \text{Recession}_t + \boldsymbol{\delta} \mathbf{Z}_{lt}^{\text{digit}} + \mu_{ct}. \tag{9}$$

The behavior of the interaction terms, given by $\boldsymbol{\delta}$, measures the impact of diversity, specialization, and (implicitly) modularity on the resilience process during recessionary shocks.

The model is then expanded to include a row vector of covariates, $\mathbf{X}_{ct}^{\text{digit}}$, which captures the following county labor market features:

- Population Density
- Population 15-24
- Population 25-54
- Population 55-64
- Population 65-85+
- Median Household Income
- Minimum Wage

Giving the equation,

$$\text{Unemp Rate}_{ct} = \alpha_c + \nu_t + \beta_0 \text{DIV}_{lt}^{\text{digit}\, n} + \beta_1 \text{DISS}_{lt}^{\text{digit}\, n} + \beta_2 \text{LIL}_{lt}^{\text{digit}\, n} + D_0 \text{Recession}_t + \boldsymbol{\delta} \mathbf{Z}_{lt}^{\text{digit}} + \boldsymbol{\nu} \mathbf{X}_{ct}^{\text{digit}} + \mu_{ct}. \tag{10}$$

Next, we expand Equation 10 to incorporate both county and state level variables, given as,

$$\text{Unemp Rate}_{ct} = \alpha_c + \nu_t + \boldsymbol{\beta} \boldsymbol{\Omega}_{ct}^{\text{digit}\, n} + \boldsymbol{\delta} \boldsymbol{\Theta}_{st}^{\text{digit}\, n} + \boldsymbol{\nu} \mathbf{X}_{ct}^{\text{digit}} + D_0 \text{Recession}_t + \mu_{ct}. \tag{11}$$

Where $\boldsymbol{\Omega}$ contains diversity, dissimilarity, and industrial migration and their respective interaction terms at the county level. Likewise, $\boldsymbol{\Theta}$ contains diversity, dissimilarity, and industrial migration and their respective interaction terms but for the state level. The final equation simply incorporates the regional level variables, $\mathbf{\Lambda}$.

$$\text{Unemp Rate}_{ct} = \alpha_c + \nu_t + \boldsymbol{\beta}\mathbf{\Omega}_{ct}^{\text{digit}\,n} + \boldsymbol{\delta}\mathbf{\Theta}_{st}^{\text{digit}\,n} + \boldsymbol{\gamma}\mathbf{\Lambda}_{rt}^{\text{digit}\,n} + \boldsymbol{\nu}\mathbf{X}_{ct}^{\text{digit}} + D_0\text{Recession}_t + \mu_{ct}. \quad (12)$$

6.2.1 NAICS Classification Interpretation

As mentioned, the general digit form in the superscript of the variables in the regression models above imply that these models will be estimated across varying degrees of NAICS codes: two, three, and four-digit. The accompanying interpretations are a follows.

- Two-digit NAICS addresses effects relating to the macro-industrial composition
- Three-digit NAICS addresses effects relating to the meso-industrial composition
- Four-digit NAICS addresses effects relating to the micro-industrial composition

The industrial measures take into account differences between the specificity of industry and will, therefore, have a different interpretation of diversity and specialization metrics. For example, two-digit dissimilarity measures how specialized an area is in, for example, manufacturing, the four-digit level captures how specialization an area is in *grain* manufacturing. Similar, remarks can be said for four-digit diversity and Lilien indices.

Each respective NAICS code provides robustness checks on the adjacent regressions as well as offers a unique insight into the varying effects of industrial classification composition (in regards to diversity and dissimilarity). For example, an argument could be made that macro level industrial diversity provides clear benefits to a locality, but does this imply an equal benefit of possessing a high level of micro-level industrial diversity? Perhaps it is beneficial to be broadly diversified across major industrial categories but harmful to be heavily diversified within a specific industry. A similar thought exercise can be done with specialization.

PART IV: RESULTS

7 Sample Statistics, Plots, and Stylized Examples

Table 3 shows the sample statistics of all variables included in the modeling portion of the research. The superscript indicates the NAICS encoded digit and the subscript indicates the level of scale the variable measured. All variables are mean centered to reduce multicollinearity. The reader should note the reduction in the standard deviation as the geographic scale increases for each respective variable. The cause has two potential sources one, the reduction in the number of observations and two, the result of using a greater level of aggregation.

Figure 4, 5, and 6 present the inverse relationship between diversity and dissimilarity at the county, state, and regional levels. The change in color represents the change in a year of observation. Evidence supports the theorized inverse relationship most clearly at the county level. As the level of scale moves outward the suggested relationship between these two variables seems to diminish and then become non-existent. A possible explanation is the type of variable construction used to capture these effects, but more likely is the changing relationship between these two variables across scale. These figures imply a rethinking of the trade-off between industrial diversity and dissimilarity. With clear evidence supporting the theory at small county or city levels but not necessarily at higher regional or national levels.

Figure 7, 8, and 9 report the Lilien index at the NAICS two-digit code on a subset the years observed, from 2004 to 2015. In this case, the Lilien index measures migration between macro industry types. Each figure represents the measurements

Table 3: Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Max
Unemployment Rate	55,851	6.220	2.738	0.700	19.900
DIV_c^{digit2}	55,620	0.0	0.150	−1.784	1.156
DIV_c^{digit3}	55,620	0.0	0.177	−2.028	1.321
DIV_c^{digit4}	55,620	0.0	0.192	−2.207	1.408
DIV_s^{digit2}	55,851	0.0	0.022	−0.082	0.073
DIV_s^{digit3}	55,851	0.0	0.028	−0.091	0.079
DIV_s^{digit4}	55,851	0.0	0.040	−0.146	0.123
DIV_r^{digit2}	55,851	0.0	0.016	−0.033	0.039
DIV_r^{digit3}	55,851	0.0	0.021	−0.040	0.036
DIV_r^{digit4}	55,851	0.0	0.033	−0.074	0.051
$DISS_c^{digit2}$	55,620	0.0	0.064	−0.358	0.609
$DISS_c^{digit3}$	55,620	0.0	0.049	−0.278	0.397
$DISS_c^{digit4}$	55,620	0.0	0.035	−0.186	0.243
$DISS_s^{digit2}$	55,851	0.0	0.017	−0.082	0.115
$DISS_s^{digit3}$	55,851	0.0	0.016	−0.062	0.083
$DISS_s^{digit4}$	55,851	0.0	0.015	−0.057	0.054
$DISS_r^{digit2}$	55,851	0.0	0.006	−0.012	0.048
$DISS_r^{digit3}$	55,851	0.0	0.007	−0.022	0.048
$DISS_r^{digit4}$	55,851	0.0	0.007	−0.030	0.052
LIL_c^{digit2}	55,599	0.0	0.06	−0.437	0.870
LIL_c^{digit3}	55,595	0.0	0.06	−0.455	0.725
LIL_c^{digit4}	55,595	0.0	0.06	−0.458	0.738
LIL_s^{digit2}	55,851	0.0	0.0	−0.018	0.024
LIL_s^{digit3}	55,851	0.0	0.006	−0.022	0.031
LIL_s^{digit4}	55,851	0.0	0.006	−0.022	0.030
LIL_r^{digit2}	55,851	0.0	0.005	−0.011	0.037
LIL_r^{digit3}	55,851	0.0	0.005	−0.010	0.028
LIL_r^{digit4}	55,851	0.0	0.004	−0.009	0.022

c = county, s = state, r = region

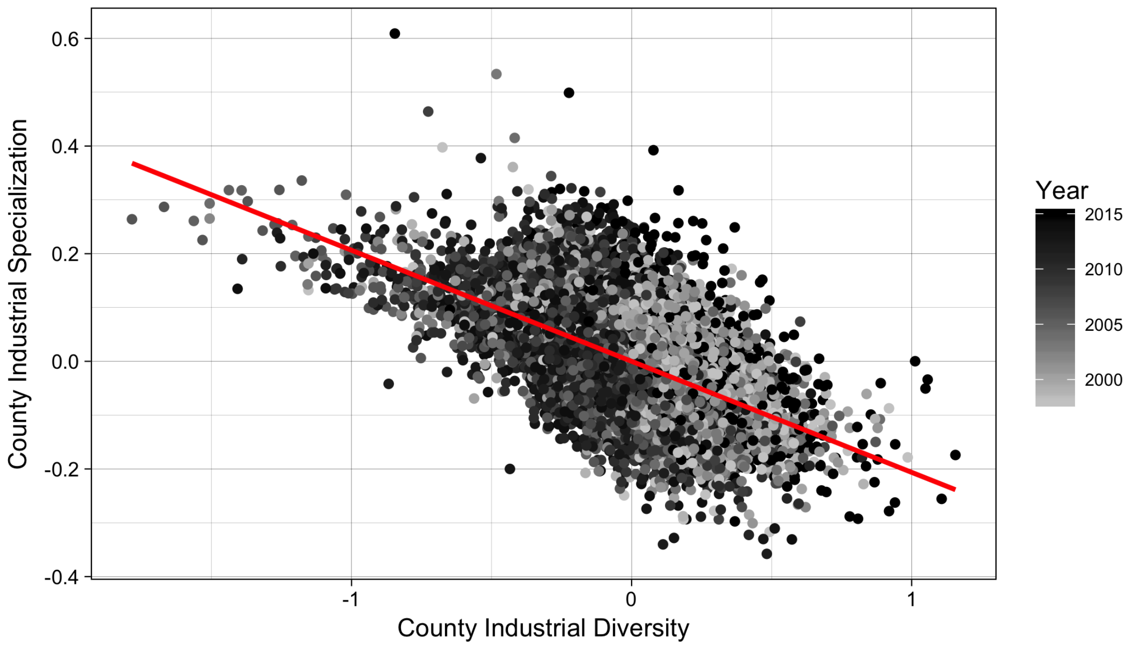

Figure 4: County Level Diversity and Dissimilarity Plot

taken at different levels of scale. Figure 8 is taken at the regional level and suggests the highest levels of macro industrial migration occurred immediately before, during, and immediately after the Great Recession. The result is confirmed at the state level as well. However, at the county level, the results are less clear through visual inspection and suggest alternative means to determine the relationship.

The figures show the possibility of the eastern half of the United States having a greater overall industrial migratory flux on labor compared to the western half. Idaho and South Dakota reported unusually high levels of industrial migration compared to the rest of the country which correlates the to fact that both states have been experiencing large industrial shifts in their economies in the past decade.

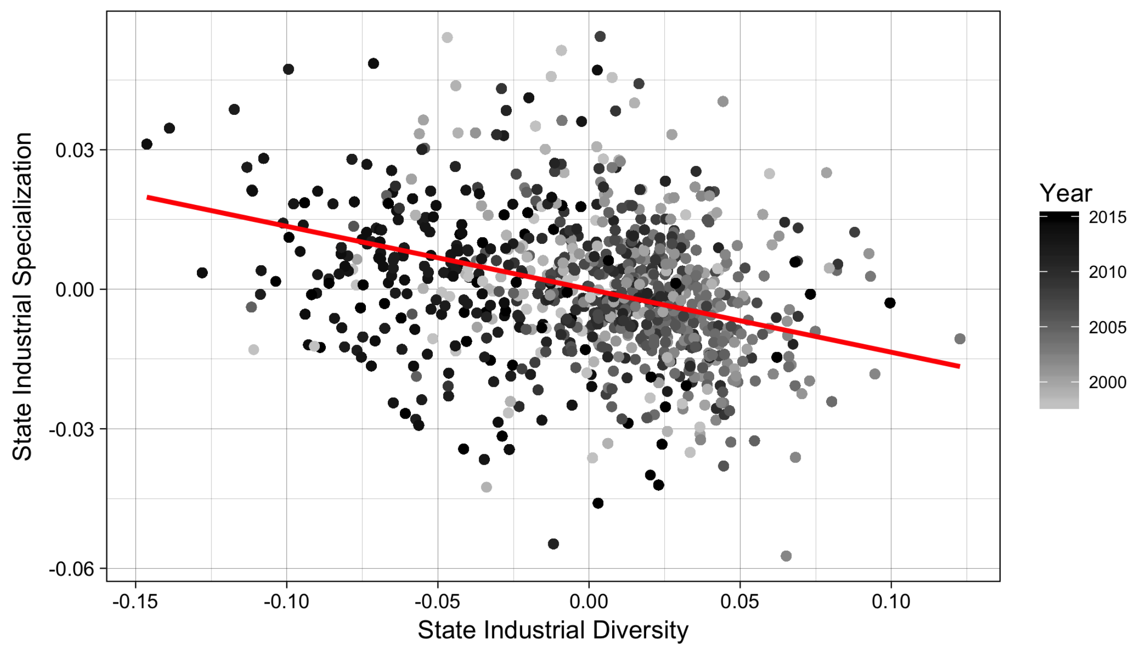

Figure 5: State Level Diversity and Dissimilarity Plot

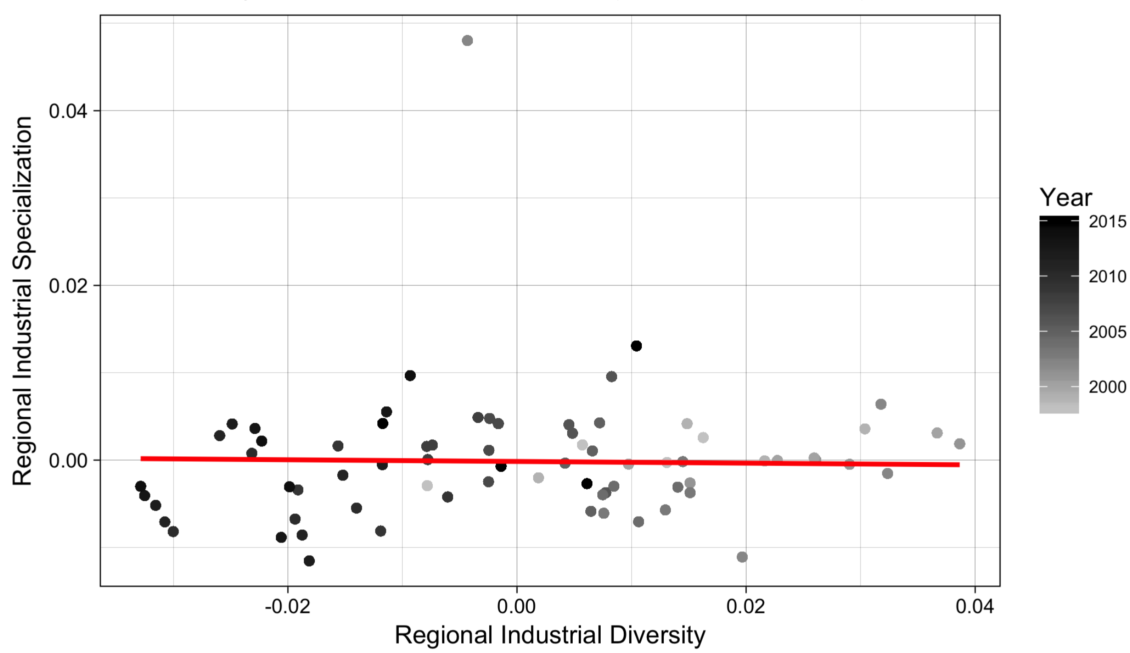

Figure 6: Region Level Diversity and Dissimilarity Plot

8 Panel Data

8.1 Four-digit

Table 4 reports the results of Equation 8 and 9 for four-digit NAICS at the county, state, and regional scale. The four-digit NAICS implies that the results should be interpreted in the context of micro-industrial differences. For example, industrial migration would entail migrating between similar industries, industrial diversity encompasses a finer resolution of differences as does dissimilarity. Recall all continuous independent variables are mean centered implying the interpretations of the coefficients are associated with the average of their respective variable. Diversity is statistically significant at the 1% level and contains the expected signs for the county level. Dissimilarity also has the expected signs for the county and regional level but county comes in insignificant. This result is to be expected since by Figure 4 diversity and dissimilarity are capturing similar portions of the variance in the unemployment rate. An alternative specification was run that excluded diversity which resulted in dissimilarity becoming significant at the 1% level, see appendix Figure 13.

Across scale, the Lilien index coefficient has a mixture of sign and significance. Generally, micro-industry migration is linked to lower unemployment rates during periods of recovery and higher unemployment rates during periods of recession, specifically at the regional level. Recessions have a stable coefficient and significance level suggesting an approximately 4% average increase in the unemployment rate during recessionary times.

Magnitude of the coefficients is consistent with the size of the area measured. This implies a change in the structure of a region will have a much greater impact on a county than a proportional change within the county will have on itself. This is

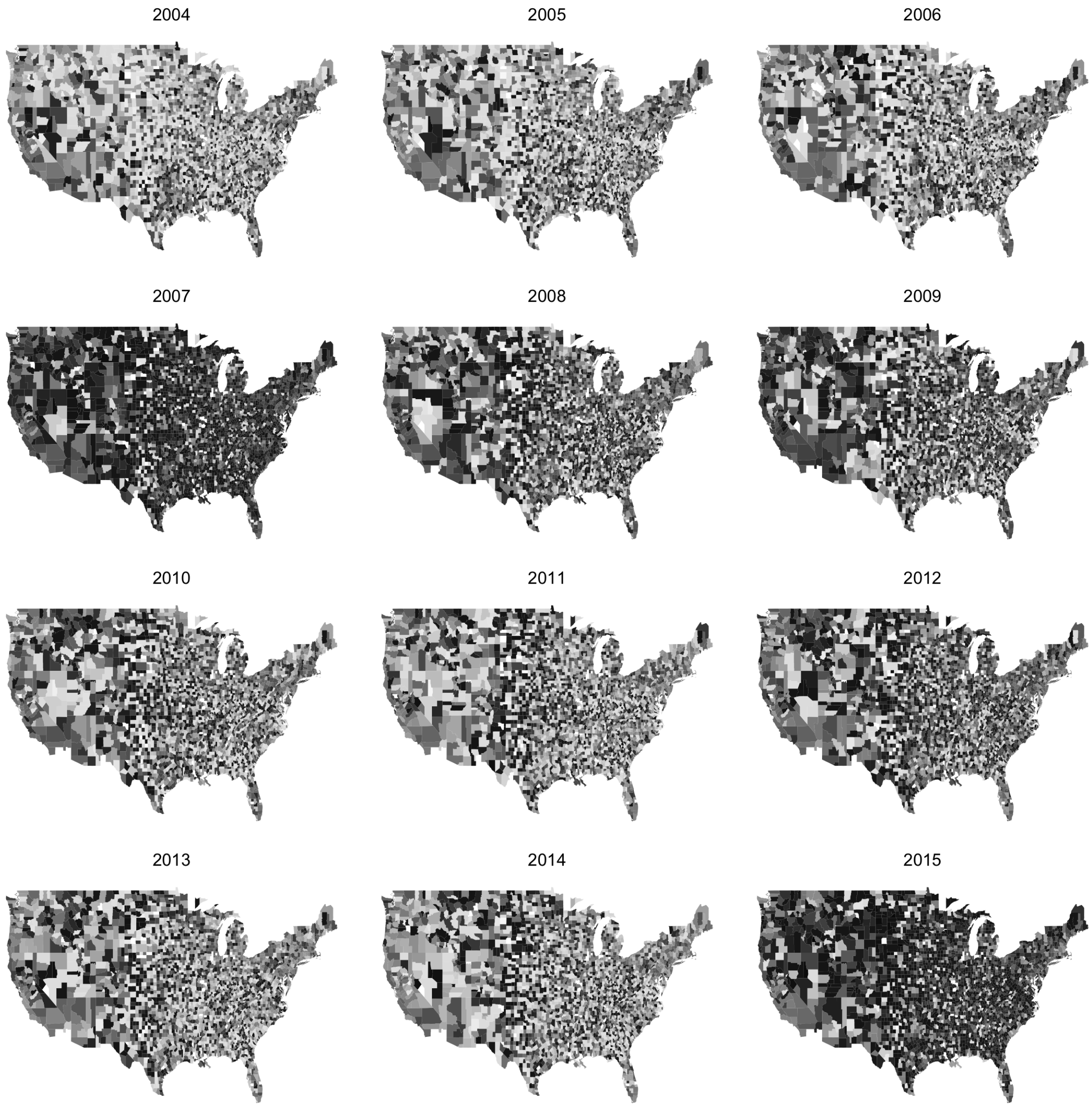

Figure 7: County Macro Industrial Migration high (black) low (white)

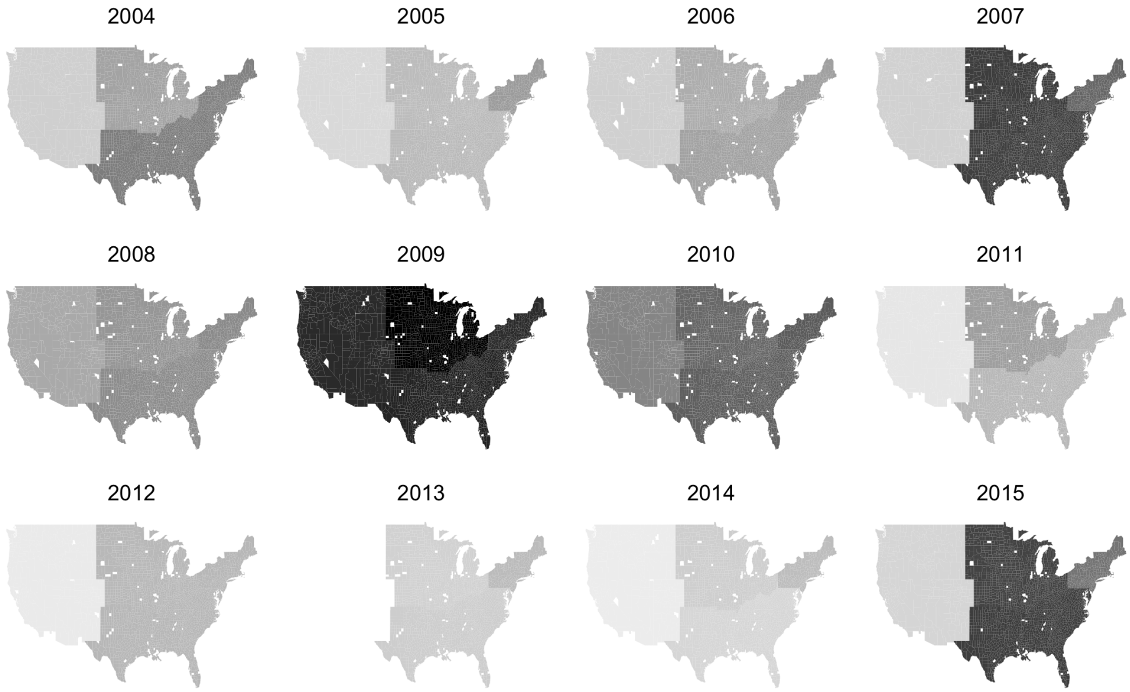

Figure 8: Regional Macro Industrial Migration high (black) low (white)

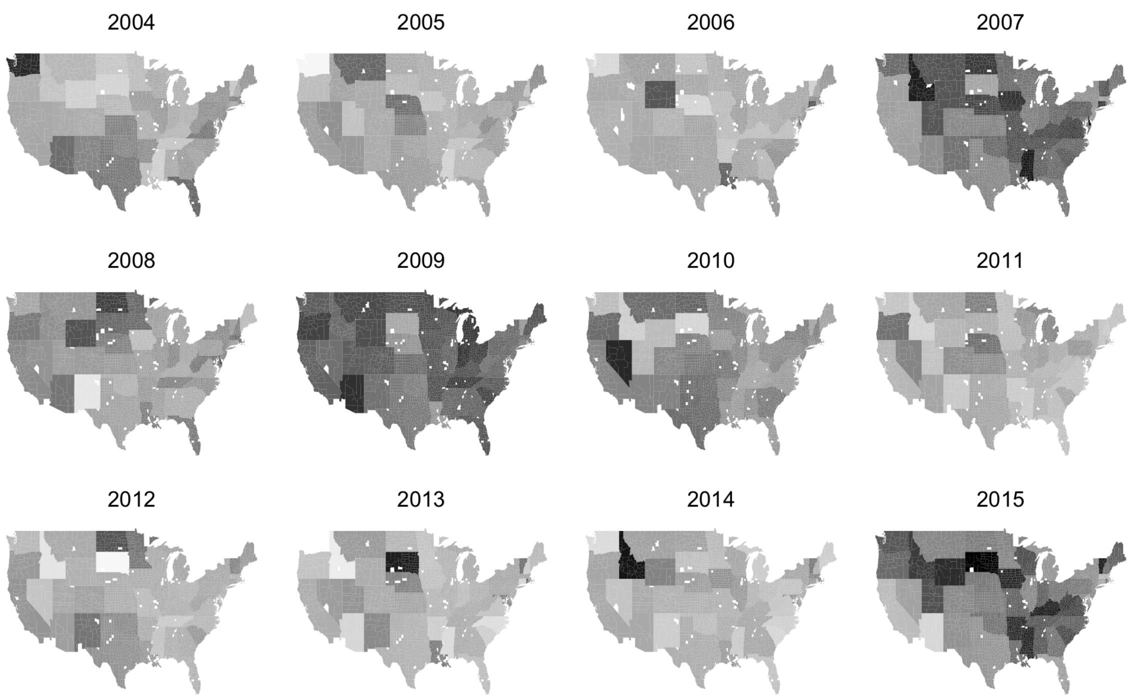

Figure 9: State Macro Industrial Migration high (black) low (white)

an intuitive result, as the degree of energy (or effort) to cause a unit change within a region is expected to be magnitudes larger. Further, we expect that each regression is suffering from omitted variable bias by not including the remaining geographical scales and covariates, remedied by Equation 10,11, and 12.

A Hausman over-identification test was conducted using robust errors clustered by the associated locality level (i.e. county, state, or region). The null hypothesis of using a random effects model was rejected at the 1% significance level for all specifications suggesting the use of the fixed effects model. Further, Hausman over-identification test was conducted for all estimated regression specifications found in the following sections. The null hypothesis was rejected for all regression specifications used in this thesis. As such, we choose to omit to report the result in the following sub-sections.

8.2 Three-digit

Table 5 reports the results of Equation 8 and 9 for three-digit, meso-level, NAICS at the county, state, and regional scale. The results at the meso-level represent a coarser differentiation between the industry types. County industrial diversity remains consistently linked to higher unemployment rates during both times of growth and contraction. County dissimilarity is now associated with lower unemployment rates suggesting that a certain degree of specialization is beneficial to the labor market.

The estimated coefficient for regional diversity suggests a lowering unemployment rate. However, dissimilarity does not seem to provide any assistance during periods of recession, a result that holds at the state and county level. The magnitude of specialization and diversity increases under this form. This can be seen in comparing county to state diversity during a recessionary shock. While each coefficient is statistically significant the state variable is an order of magnitude larger.

8.3 Two-digit

Table 6 reports the results of Equation 8 and 9 for two-digit NAICS at the county, state, and regional scale. The two-digit level aggregates the remaining within-industry variation and therefore represents only between-industry variation. The inverse effects of diversity and dissimilarity hold across geographic scales. The coefficients for dissimilarity for the state, column (3) and (4), come in insignificant which is in accordance with our hypothesis. Regional effects are also insignificant under this regression specification.

Perhaps the clearest result is the inverse relationship between county diversity and dissimilarity during periods of economic expansion. This regression specification points to clear evidence for an inverse relationship between the variables of interest. Here, specialization is an order of magnitude larger than its counterpart, diversity. County diversity during periods of resistance continues to be associated with higher unemployment rates while the effect from dissimilarity becomes insignificant.

The two-digit NAICS Lilien index is consistently linked to lower unemployment rates across geographical scale during periods of growth. This result inverts during recessions. Suggesting macro-industrial migration during periods of growth being a sign of a healthy labor market and conversely during periods of recession. Recession stays virtually unchanged across all levels and scales.

8.4 County Diversity and Dissimilarity

Table 7 reports the results of equation 10 across two, three, and four-digit NAICS. The inclusion of our covariates did little to alter the relationship between county diversity and dissimilarity. Diversity is consistently correlated with higher and dissimilarity to lower unemployment rates. The Lilien index no longer is significant (with an exception at the two-digit, column (1), during the recession) which

Table 4: Fixed Effects regression of unemployment rate on County variables, 1998-2015, NACIS four-digit

	County		State		Region	
	(1)	(2)	(3)	(4)	(5)	(6)
	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate
Diversity	0.516***	0.451***	7.488***	6.297**	-7.057	-5.983
	(0.0555)	(0.0574)	(2.787)	(2.752)	(5.027)	(5.398)
Dissimilarity	-0.100	-0.0868	2.966	4.159	4.638	2.939
	(0.265)	(0.267)	(5.854)	(5.987)	(4.722)	(4.468)
Lilien Index	-0.283*	-0.331**	2.246	-0.386	4.854	2.693
	(0.157)	(0.162)	(12.00)	(12.01)	(14.10)	(14.99)
Recession	3.940***	3.949***	3.713***	3.668***	4.021***	3.760***
	(0.0529)	(0.0530)	(0.393)	(0.369)	(0.584)	(0.484)
Diversity · Recession		0.409***		9.114**		-0.688
		(0.0939)		(4.115)		(8.586)
Dissimilarity · Recession		-0.215		-7.422		42.79**
		(0.466)		(6.291)		(12.94)
Lilien Index · Recession		0.381		16.15		85.05**
		(0.384)		(27.74)		(18.49)
Constant	5.121***	5.119***	5.256***	5.210***	5.076***	5.081***
	(0.0304)	(0.0305)	(0.208)	(0.216)	(0.384)	(0.381)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
County Effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	55595	55595	55851	55851	55851	55851
adj R^2	0.631	0.632	0.634	0.636	0.628	0.630

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

Table 5: Fixed Effects regression of unemployment rate on County variables, 1998-2015, NAICS three-digit

	County		State		Region	
	(1)	(2)	(3)	(4)	(5)	(6)
	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate
Diversity	0.601***	0.518***	4.195	1.965	-8.862*	-9.339*
	(0.0622)	(0.0642)	(3.728)	(3.506)	(3.165)	(3.419)
Dissimilarity	-0.563***	-0.644***	-2.157	-3.099	8.049	6.438
	(0.188)	(0.194)	(4.449)	(4.174)	(6.580)	(6.320)
Lilien Index	-0.162	-0.268*	3.275	-1.981	5.994	5.771
	(0.155)	(0.159)	(9.032)	(9.607)	(7.298)	(7.201)
Recession	3.957***	3.983***	3.884***	4.031***	3.735***	3.480***
	(0.0531)	(0.0534)	(0.355)	(0.370)	(0.474)	(0.515)
Diversity · Recession		0.532***		16.85***		12.25
		(0.108)		(4.818)		(9.686)
Dissimilarity · Recession		0.493		7.745		52.35
		(0.353)		(4.856)		(22.35)
Lilien Index · Recession		0.813**		31.61		102.2***
		(0.377)		(28.07)		(6.703)
Constant	5.119***	5.115***	5.188***	5.143***	5.186***	5.194***
	(0.0303)	(0.0304)	(0.162)	(0.168)	(0.323)	(0.321)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
County Effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	55595	55595	55851	55851	55851	55851
adj R^2	0.632	0.633	0.629	0.632	0.629	0.630

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

Table 6: Fixed Effects regression of unemployment rate on County variables, 1998-2015, NAICS two-digit

	County		State		Region	
	(1)	(2)	(3)	(4)	(5)	(6)
	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate
Diversity	0.410***	0.300***	6.073	4.613	-7.144	-8.333
	(0.0762)	(0.0781)	(4.436)	(4.347)	(11.31)	(11.96)
Dissimilarity	-1.227***	-1.281***	0.780	-0.249	13.46	11.20
	(0.167)	(0.172)	(3.907)	(3.755)	(9.820)	(11.05)
Lilien Index	-0.0719	-0.257*	-8.251	-23.05**	-4.063	-3.771
	(0.146)	(0.149)	(8.452)	(8.969)	(12.76)	(15.35)
Recession	3.936***	3.967***	4.123***	3.751***	3.864***	3.188***
	(0.0533)	(0.0537)	(0.367)	(0.372)	(0.415)	(0.218)
Diversity · Recession		0.748***		9.605**		5.053
		(0.144)		(4.675)		(6.832)
Dissimilarity · Recession		0.423		11.83**		76.75***
		(0.302)		(5.836)		(11.86)
Lilien Index · Recession		1.247***		111.2***		108.2
		(0.361)		(23.15)		(65.46)
Constant	5.133***	5.124***	5.047***	4.907***	5.141***	5.146***
	(0.0301)	(0.0302)	(0.148)	(0.155)	(0.297)	(0.313)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
County Effects	Yes	Yes	Yes	Yes	Yes	Yes
Number of obs.	55599	55599	55851	55851	55851	55851
adj R^2	0.633	0.633	0.629	0.635	0.628	0.630

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

suggests that this index was capturing other features in the labor market, namely local demographics. Similarly, the inclusion of population density controls for agglomeration effects that the Lilien index could have been capturing. The prevailing two-digit term of the Lilien index during recession suggests robust evidence for the connection between industrial migration and high unemployment rates at the county level. County-level specialization does not seem to have any impact on unemployment during recessions, while diversity is linked to higher unemployment rates.

The inclusion of the covariates resulted in an insignificant coefficient for the recession indicator variable. After further inspection, it was determined that median income paces with recessionary trends and thus captures similar effects. Recall that population variables are in terms of 10,000s. Population density is in terms of 1,000s of people per square mile of land area and median income is in $1,000s. When looking at the list of covariates we see that counties with higher median income are linked to lower unemployment rates and counties with more dense population are linked to higher unemployment rates. Intuitively, counties with high levels of youth and elderly are more likely to have higher unemployment rates and conversely for counties with higher levels of working age individuals.

8.5 State & County Diversity and Dissimilarity

Table 8 reports the results of Equation 11 across the three NAICS levels. The table is organized by grouping common variables on the same row and grouping geographical scale by column. For example, the first two columns of Table 8 is the result of Equation 11 for the four-digit NAICS. The first column is the portion of the equation related to state-level variables and the second column is the portions of the equation that is derived from county-level variables. The intended purpose of this arrangement is for easy visual pattern recognition. Additionally, the covariates

Table 7: Fixed Effect regression of unemployment rate on County variables, 1998-2015

	4-digit	3-digit	2-digit
	(1)	(2)	(3)
	Unemp. Rate	Unemp. Rate	Unemp. Rate
Diversity	0.446***	0.509***	0.405***
	(0.0529)	(0.0588)	(0.0710)
Dissimilarity	-0.268	-0.446**	-0.789***
	(0.243)	(0.173)	(0.152)
Lilien Index	0.0174	0.0335	-0.0368
	(0.155)	(0.153)	(0.142)
Diversity · Recession	0.394***	0.528***	0.651***
	(0.0923)	(0.106)	(0.142)
Dissimilarity · Recession	-0.241	0.349	0.0598
	(0.455)	(0.340)	(0.291)
Lilien Index · Recession	-0.0168	0.422	0.948***
	(0.375)	(0.370)	(0.358)
Recession	0.0274	0.0215	0.0252
	(0.0338)	(0.0338)	(0.0337)
Median Income	-0.119***	-0.118***	-0.117***
	(0.00393)	(0.00391)	(0.00389)
Population Density	1.127***	1.122***	1.100***
	(0.344)	(0.344)	(0.338)
Minimum Wage	0.0591**	0.0557**	0.0561**
	(0.0257)	(0.0257)	(0.0255)
Population 15-24	0.546***	0.543***	0.541***
	(0.0603)	(0.0604)	(0.0603)
Population 25-54	-0.189***	-0.187***	-0.185***
	(0.0282)	(0.0279)	(0.0277)
Population 55-64	-0.0497	-0.0509	-0.0492
	(0.0448)	(0.0443)	(0.0440)
Population 65-84+	0.151***	0.148***	0.142***
	(0.0466)	(0.0467)	(0.0466)
Constant	8.538***	8.523***	8.502***
	(0.194)	(0.193)	(0.192)
Time Effects	Yes	Yes	Yes
County Effects	Yes	Yes	Yes
Number of obs.	55541	55541	55545
adj R^2	0.657	0.657	0.657

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

are not reported for compactness sake, however, the reader can find the full regression report in the Appendix.

While evidence that state diversity is potentially related to higher unemployment rates during periods of growth it is much more clear that this relationship exists during periods of recession. State level dissimilarity is mostly insignificant which suggests that the benefits of specialization exist mostly at the county level.

An insightful result comes from the Lilien index at the two-digit NAICS. Here we see a statistically significant negative coefficient with a large magnitude. Once again, macro-industrial migration is associated with a healthy labor market during periods of growth. As a potential explanation, we suggest this is a restructuring of the labor market in response to the recessionary shock. Conversely, the Lilien index is also linked to much higher rates of unemployment during recessionary periods.

Table 8: Fixed Effect regression of unemployment rate on State & County variables, 1998-2015

	4-digit		3-digit		2-digit	
	State	County	State	County	State	County
	(1)		(2)		(3)	
	Unemployment Rate		Unemployment Rate		Unemployment Rate	
Diversity	5.145**	0.356***	1.253	0.497***	4.918	0.336**
	(2.264)	(0.0941)	(3.069)	(0.0973)	(3.444)	(0.134)
Dissimilarity	3.988	-0.544*	-1.912	-0.437*	0.186	-0.874***
	(4.724)	(0.323)	(3.311)	(0.241)	(2.902)	(0.166)
Lilien Index	0.749	0.0257	-0.995	0.0224	-18.02**	-0.0100
	(9.758)	(0.212)	(8.327)	(0.191)	(7.972)	(0.156)
Recession	-0.335		-0.191		-0.121	
	(0.211)		(0.169)		(0.211)	
Diversity· Recession	8.540**	0.276**	15.19***	0.384***	6.523	0.581***
	(3.806)	(0.118)	(4.392)	(0.129)	(4.189)	(0.159)
Dissimilarity · Recession	-6.882	-0.222	6.618	0.0994	9.722*	-0.0137
	(6.056)	(0.596)	(4.461)	(0.280)	(5.320)	(0.257)
Lilien Index · Recession	17.17	-0.0526	32.11	0.235	106.7***	0.701
	(27.12)	(0.407)	(27.24)	(0.437)	(22.01)	(0.424)
Constant	8.535***		8.454***		8.197***	
	(0.664)		(0.666)		(0.642)	
Time Effects	Yes		Yes		Yes	
County Effects	Yes		Yes		Yes	
Number of obs.	55541		55541		55545	
adj R^2	0.664		0.661		0.665	

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

8.6 Region, State, & County Diversity and Dissimilarity

Table 9 reports the results of Equation 12 across the three NAICS levels. In this last model, we are able to more fully detect the modular structure of the features of interest across geographical scales.

Diversity at the regional level is seen to be consistently associated with lower levels of unemployment, however only at the three-digit level is this relationship significant. Regional diversity during periods of recession is also connected to decreased unemployment levels with the most significant impact happening at two-digit NAICS. The opposite is true for state and county diversity across NAICS levels. During periods of both resistance and recovery state and county diversity is linked to higher rates of unemployment. This result is quite robust for the county level as the nearly all coefficients are significant.

Dissimilarity describes the inverse story. Here, dissimilar (specialized) regions during periods of recession are associated with much higher rates of unemployment, the paradox of plenty. However, specialized regions do not affect unemployment rates during years of recovery. Specialized counties are on average seen to have lower unemployment rates but this effect only seems to be during periods of economic expansion. This result holds across NAICS levels.

Overall industrial migration, during a recession, is connected to higher rates of unemployment. Conversely, two-digit NAICS industrial migration during years of recovery is suggestive of downward pressure on unemployment rates. A possible explanation is the restructuring of the labor market during years of growth.

As noted above, the Robust Hausman over-identification test was conducted using robust errors clustered by region. The null hypothesis of using a random effects model was rejected at the 1% suggesting the use of the fixed effects model.

These results do not reject the hypothesis that regional diversity and county specialization lead to lower levels of unemployment. This result holds at all levels of NAICS codes. However, the dynamics do not appear to hold during recessionary periods, with the exception at micro-industrial level. Regional diversity at the two-digit level places the strongest downward pressure on unemployment rates during recessionary periods, followed by state and county level specialization.

Table 9: Fixed Effect regression of unemployment rate on Region, State & County variables, 1998-2015 (covariates omitted)

	4-digit			3-digit			2-digit		
	Region	State	County	Region	State	County	Region	State	County
	(1)			(2)			(3)		
	Unemp. Rate			Unemp. Rate			Unemp. Rate		
Diversity	-6.761	6.206**	0.347*	-6.709***	2.299	0.484***	-7.804	5.473**	0.344**
	(4.037)	(1.887)	(0.125)	(0.388)	(4.001)	(0.0669)	(8.378)	(1.254)	(0.0919)
Dissimilarity	2.918	4.350	-0.493**	8.757	-2.288	-0.462	10.53	0.199	-0.851**
	(5.700)	(3.986)	(0.148)	(7.537)	(2.999)	(0.362)	(12.91)	(2.515)	(0.236)
Lilien Index	-2.997	1.022	0.0231	1.044	-0.192	0.0388	-5.702	-16.01***	-0.00681
	(15.32)	(1.970)	(0.172)	(7.850)	(2.780)	(0.160)	(14.86)	(2.222)	(0.0915)
Recession	-0.0777			-0.193			0.449		
	(0.474)			(0.0874)			(0.449)		
Diversity · Recession	-4.509	10.28***	0.254	-1.217	15.69*	0.326***	-17.51*	7.916	0.574*
	(4.485)	(1.618)	(0.112)	(7.189)	(5.260)	(0.0321)	(5.870)	(4.552)	(0.208)
Dissimilarity · Recession	49.22**	-8.108**	-0.460	42.56	5.979	-0.0213	57.25**	9.675	0.00453
	(12.68)	(2.519)	(0.649)	(19.57)	(3.734)	(0.285)	(16.29)	(4.947)	(0.0805)
Lilien Index · Recession	114.6**	1.705	0.0739	108.1*	28.94	0.310	86.47	105.6**	0.750*
	(35.79)	(19.10)	(0.300)	(35.02)	(33.47)	(0.205)	(38.49)	(29.32)	(0.296)
Constant	8.357***			8.421***			8.268***		
	(0.440)			(0.287)			(0.398)		
Time Effects	Yes			Yes			Yes		
County Effects	Yes			Yes			Yes		
Number of obs.	55541			55541			55545		
adj R^2	0.668			0.664			0.667		

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

PART V: DISCUSSION & CONCLUSION

9 Findings & Policy Implications

Generally, industrial specialization appears to be inversely related to diversity throughout the regression specifications, notwithstanding a correlation plot which suggests that such a result would not necessarily be the case, see Figures 4,5,6. A possible explanation could be that as the scale of geography increases the *structural* trade-off between industrial diversity and specialization become nonexistent. The results suggest that a region can be both specialized and diverse, but a county tends to be either one or the other. However, the effect of diversity and specialization on unemployment seems to stay consistently inversely related across scale.

During periods of recovery, county level specialization is linked with lower unemployment rates. However, this relationship becomes nonexistent during periods of recession. While it is theorized that industrial specialization reduces the exposure to economic shocks (however at the expense of added potential volatility) this is under the assumption that industries are relatively independent. However, according to these models, such theorized benefits do not appear to hold.

One result that does hold is the increased volatility due to specialization. This can be observed by regional specialization coefficients during periods of recession. These coefficients are an order of magnitude larger than the expansionary counterparts. This suggests an heightened volatility due to regional specialization. Further supporting the possibility that the benefits of specialization on unemployment are contingent on industrial independence.

High state level industrial migration between macro-industries is associated with a better performing labor market during periods of growth. A potential explanation is the restructuring of the labor market in response to a recessionary shock. Conversely, the Lilien index is also linked to much higher rates of unemployment during recessionary periods.

We find that the optimal labor market structure is neither strictly self-similar or specialized. The optimal structure is suggested to be self-similar at higher geographical scales and specialized at lower scales. Further, our results maintain the hypothesized role that diversity is a key actor in the regional resilience process and contributor in creating a robust market. However, diversity is seen to display different properties at different levels of scale. At the county level, diversity is consistently associated with higher unemployment rates both during times of economic expansion and contraction. The contrasting effects give potential insight into the requirements of industrial diversity crafting a robust labor market, primarily, that scale matters.

According to the estimated models the strongest resisting force against high unemployment rates during recessionary shocks is regional macro-industrial diversity. These regions benefit from having each major type of industry roughly equally represented within the region. The second strongest mitigating force is state and county specialization at the micro-industrial level, suggesting that counties and states benefit from agglomeration economies but regions do not. A possible explanation is agglomeration effects produce a natural bi-product of allowing laborers to migrate more easily between sub-industries, see the Lilien index in Table 9 column (1). Conversely, we find that county two-digit NAICS specialization is associated with higher levels of unemployment. For example, ceteris paribus, when comparing a county specialized in general manufacturing to one specialized in semiconductor manufacturing, the latter would be expected to have lower unemployment rates. Thus, a region with an equal representation of all major industries complemented by an extremely specialized county (or state) is the ideal labor market form for low unemployment rates.

Understanding the composition of labor market structure may lead policymakers to promote more (or less) diversity (or specialization) at a given scale. Local leaders may benefit from advocating for uniform industry distribution across regions and compete for sub-industry specialization within localities. Policymakers could use tax structure incentives to draw the desired type of industry composition. For example, national policymakers may incentivize multiple hubs of industry across the U.S. labor market. Likewise, local policymakers may draw sub-industries, through tax incentives, that are currently not agglomerated elsewhere. Further, putting in place relief funds for localities that are not proficiently specialized may be beneficial.

10 Limitations

We categorize two types of limitations: theoretical and operational. Theoretical limitations are those which pertain to the conceptualization of the framework(s) used in this analysis. Operational limitations are those associated with empirical, whether that be data, model choice, or design.

A primary theoretical limitation pertains to the decided exclusion of risk and reorientation from the analysis. Since the resilience framework assumes a co-evolving interconnected process, excluding these facets limits a greater understanding of industrial structure and composition. This decision was primarily due to the limiting structure of fixed effects models. It would be beneficial to develop a methodology that can interweave each facet of the framework in a single modeling procedure. Another conceptual issue is the decision to exclude local shocks. Local shock most certainly affects the evolution of a local economy which will have direct implications for future resistance to major economic shocks.

This thesis mainly addresses only two aspects of the regional resilience process, that being, resistance, and recovery. The dismissal of risk and reorientation could lead to a misrepresentation of the ideal combination of industries. 'Risk' would address the likelihood of which industries are more prone to recessionary shocks. Reorientation would address the role of diversity and specialization across scale on the adaptive capacity of a region. It is conceivable that reorientation and resistance may be at odds with one another, implying that what is helpful in resisting a recessionary shock may harm the locality's adaptability. Both topics are avenues for future research.

Operational limitations are less abstract. The data, as mentioned, intentionally omits portions that invade the privacy of firms. This leads us to use the implicit information gain algorithm. While this algorithm attempts to reduce the level of missing data it is still less desirable than the actual observations. Further, the use of county-level data might not be ideal. The ability for labor spill over between counties leads to the possibility of large portions of individuals working in one location while claiming employment in another (Brown and Greenbaum 2016).

The fixed effects models control for county and time effects and use a clustered error. However, these models do not include a spatial weights matrix. This omission will then not take into account any spatial auto-correlation that maybe exist in the data. The inclusion of such is left to future research.

Within the models state scale variables are often inconsistent across NAICS level. It is possible that the variables measured are not dependent on policy or other state unique factors and that the state boundary is not an ideal candidate for analysis. This is sometimes the case in some geographic economic analysis.

Another limitation is that of the use of fixed effects models. It is not ideal to capture the evolving and potentially non-linear nature using this modeling strategy. Random forests or other machine learning models could be better off when detecting the impact of a recessionary shock on the resilience of a locality. Fixed effects models deal in terms of average effects, whereas the study of resilience is more naturally suited for non-linear effects. This is due to the possibility that only within certain thresholds of shock impacts are the effects of diversity and specialization valid. In areas that experience little to no impact from a recessionary shock, or conversely areas that experience tremendous effects, the countervailing forces of diversity and specialization may differ. These thresholds are more commonly known as tipping-points and are extremely important when inspecting the impacts of shocks on a system.

As is most often the case, increased data would prove helpful in determining the evolutionary nature of diversity and specialization. Since we were only able to obtain data dating back to 1998 it was decided to treat economic shocks and periods of resistance homogeneously. Had more data been available separate regressions could have been run to capture resistance to and recovery from multiple shocks and time periods. Finally, the metrics used are obviously subject to scrutiny as well. Surely more accurate measures could be used to measure diversity and specialization, this also is left to future research.

11 Conclusion

The aim of this thesis has been two-fold, one, to examine economic frameworks and their respective role in generating pertinent research questions and, two, utilize a middle-ground regional resilience framework to explore how industry composition and structure have impacted the recovery from and resistance to major economic shocks. It is clear that mainstream economic conceptualizations have systematically pushed understanding recessionary shocks to the peripheral. This has led to a lacking in research on the role of industrial composition and structure pertaining to regional economic resilience.

We have sought to contribute to remedying the situation by incorporating Martin and Sunley's regional economic resilience framework into our conceptualization of a robust labor market. The regional resilience framework is a dynamical process that occurs within a regional labor market in pace with economic cycles. The robust labor market framework puts forth a conceptualization of the structure of the regional labor market. By conjoining these frameworks we suggest that the structure of the labor market is a key factor in determining the resiliency of a local economy. Namely, that a robust labor market will reduce risk, increase resistance, increase adaptability, and achieve a higher future growth path.

The conjoined framework is applied to the U.S. labor market from 1998-2015. Namely, we inspect the dynamic roles of diversity/specialization and modularity across both geographic and industrial scale. We find regions with a roughly equal representation of all major industries complemented by county-level specialized industry clusters is, on average, the most resistant and recoverable structural form that cultivates low unemployment rates across economic cycles. As a result, the suggested optimal labor market structure is industrially diverse and self-similar at higher scales (nation/region) and specialized at lower scales (state/county). As an aside, during periods of economic expansion, industrial migration between major industries at the state level is seen to be correlated with lower unemployment rates. This result reverses during periods of recession, which suggests an evolutionary dynamic within the labor supply. Overall local levels of unemployment rates are strongly tied to the features of a robust labor market. Likewise, these features seem to comfortably fit within the regional resilience framework as possible determinants of system dynamics.

Future research could explore the characteristics of a robust labor market within the risk and reorientation portion of the regional resiliency process. In regards to risk, future research could be directed towards generating an index (or model) that gauges the vulnerability of a locality to a shock. This could be accomplished by determining which industries, skill sets, demographics and so on are most associated with high degrees of unemployment. Further, the incorporation of findings presented in this research such as the role of modular structures and industrial diversity within a region could be incorporated. Measuring which localities are at high risk of a recessionary shock could prove useful in policy-making discourse.

Future research investigating local resistance could focus on the degree of connectedness of a locality to the national network, with strong interlinkages suggesting a stronger reaction to a recessionary shock. Similarly, research regarding reorientation would seek to understand which areas *need* to adapt more desperately as compared to their constituents and why. In other words, what are the features of a locality that suggest they will have to adapt more radically than the average should a recession come? Is the need for radical adaptation positively correlated with weak resistance capabilities? Or can a locality be able to successfully resist a shock by drawing on extensive reorientation? Are their multiple successful strategies to create a positively evolving economy and, if so, is there an optimal strategy? Finally, how do we incorporate the features of a robust labor market into each of these analyses? All these questions are wide open for further investigation. The development of such research can bring further clarity into the importance of a robust labor market structure in a region's ability to positively evolve in the wake of economic cycles.

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APPENDIX A

Table 10: Regression of unemployment rate on County variable, 1998-2015, NAICS four-digit

	County		State		Region	
	(1)	(2)	(3)	(4)	(5)	(6)
	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate
Diversity	0.520***	0.393***	7.715***	4.690***	-6.524***	-6.718***
	(0.0556)	(0.0604)	(0.415)	(0.432)	(0.938)	(0.894)
Dissimilarity	-0.129	-0.201	2.769***	5.879***	0.856	-3.703***
	(0.268)	(0.282)	(0.830)	(0.901)	(1.268)	(1.212)
Lilien Index	-0.259*	-0.256	3.743**	5.807***	1.019	17.37***
	(0.157)	(0.197)	(1.833)	(2.244)	(2.581)	(2.780)
Recession	3.949***	3.963***	3.693***	3.623***	4.039***	4.790***
	(0.0535)	(0.0537)	(0.0581)	(0.0562)	(0.0680)	(0.154)
Diversity · Recession		0.789***		23.77***		10.86**
		(0.170)		(1.476)		(4.829)
Dissimilarity · Recession		0.255		-18.26***		78.66***
		(0.834)		(1.752)		(5.290)
Lilien Index · Recession		0.0745		-12.17		-258.8***
		(0.739)		(8.961)		(34.42)
Constant	5.105***	5.107***	5.261***	5.250***	5.054***	5.176***
	(0.0486)	(0.0492)	(0.0538)	(0.0549)	(0.0541)	(0.0524)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
County Effects	No	No	No	No	No	No
Number of obs.	55595	55595	55851	55851	55851	55851
adj R^2	0.307	0.307	0.307	0.314	0.304	0.306

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

Table 11: Regression of unemployment rate on County variables, 1998-2015, NAICS three-digit

	County		State		Region	
	(1)	(2)	(3)	(4)	(5)	(6)
	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate
Diversity	0.605***	0.454***	4.178***	-0.523	-9.425***	-7.689***
	(0.0623)	(0.0666)	(0.557)	(0.569)	(1.421)	(1.316)
Dissimilarity	-0.538***	-0.771***	-2.449***	-1.859**	4.216***	2.100
	(0.190)	(0.207)	(0.789)	(0.821)	(1.426)	(1.395)
Lilien Index	-0.139	-0.211	4.448***	7.919***	1.255	8.163***
	(0.155)	(0.191)	(1.514)	(2.060)	(2.221)	(2.187)
Recession	3.966***	4.011***	3.870***	4.339***	3.763***	4.622***
	(0.0536)	(0.0546)	(0.0554)	(0.0622)	(0.0597)	(0.168)
Diversity · Recession		0.960***		35.09***		-18.75***
		(0.199)		(1.750)		(3.587)
Dissimilarity · Recession		1.460**		-2.755*		8.457
		(0.632)		(1.615)		(6.172)
Lilien Index · Recession		0.622		-22.89***		-232.2***
		(0.729)		(8.173)		(39.84)
Constant	5.103***	5.103***	5.188***	5.234***	5.159***	5.209***
	(0.0486)	(0.0491)	(0.0507)	(0.0509)	(0.0490)	(0.0493)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
County Effects	No	No	No	No	No	No
Number of obs.	55595	55595	55851	55851	55851	55851
adj R^2	0.307	0.308	0.304	0.311	0.304	0.305

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

Table 12: Regression of unemployment rate on County variables, 1998-2015, NAICS two-digit

	County		State		Region	
	(1)	(2)	(3)	(4)	(5)	(6)
	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate	Unemp. Rate
Diversity	0.413***	0.204**	6.450***	3.740***	-5.584***	-4.888***
	(0.0763)	(0.0822)	(0.724)	(0.741)	(1.840)	(1.720)
Dissimilarity	-1.200***	-1.378***	0.614	0.360	9.329***	2.806*
	(0.168)	(0.181)	(0.825)	(0.839)	(1.713)	(1.561)
Lilien Index	-0.0495	-0.214	-5.936***	-29.69***	-8.332***	3.467*
	(0.147)	(0.174)	(1.578)	(1.827)	(2.185)	(1.957)
Recession	3.942***	3.999***	4.093***	3.565***	3.953***	5.373***
	(0.0539)	(0.0552)	(0.0568)	(0.0711)	(0.0638)	(0.248)
Diversity · Recession		1.419***		18.53***		-2.514
		(0.280)		(1.425)		(2.992)
Dissimilarity · Recession		1.290**		8.798***		55.21***
		(0.543)		(1.708)		(11.72)
Lilien Index · Recession		1.138*		169.4***		-190.1***
		(0.687)		(8.592)		(34.08)
Constant	5.119***	5.114***	5.056***	4.819***	5.088***	5.176***
	(0.0484)	(0.0486)	(0.0500)	(0.0515)	(0.0486)	(0.0486)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
County Effects	No	No	No	No	No	No
Number of obs.	55599	55599	55851	55851	55851	55851
adj R^2	0.307	0.308	0.304	0.312	0.303	0.305

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

Table 13: Fixed Effect regression of unemployment rate on County variables, 1998-2015

	4-digit	3-digit	2-digit
	(1)	(2)	(3)
	Unemp. Rate	Unemp. Rate	Unemp. Rate
Diversity	0.367***	0.393***	0.245***
	(0.0551)	(0.0608)	(0.0746)
Dissimilarity	-0.275	-0.709***	-0.954***
	(0.259)	(0.188)	(0.162)
Lilien Index	0.131	0.138	0.0374
	(0.184)	(0.182)	(0.162)
Diversity · Recession	0.744***	0.937***	1.296***
	(0.158)	(0.185)	(0.260)
Dissimilarity · Recession	-0.827	1.176**	0.732
	(0.749)	(0.572)	(0.493)
Lilien Index · Recession	-0.0956	0.406	1.051
	(0.684)	(0.679)	(0.644)
Recession	3.012***	3.063***	3.063***
	(0.110)	(0.111)	(0.111)
Median Income	-0.104***	-0.104***	-0.104***
	(0.00336)	(0.00335)	(0.00335)
Population Density	0.0166	0.0166	0.0165
	(0.0170)	(0.0171)	(0.0170)
Minimum Wage	1.034***	1.032***	1.033***
	(0.0531)	(0.0532)	(0.0531)
Population 15-24	-0.271***	-0.272***	-0.272***
	(0.0520)	(0.0520)	(0.0520)
Population 25-54	0.0541***	0.0548***	0.0551***
	(0.0173)	(0.0172)	(0.0172)
Population 55-64	0.367***	0.362***	0.361***
	(0.0731)	(0.0723)	(0.0722)
Population 65-84+	-0.134***	-0.133***	-0.133***
	(0.0432)	(0.0431)	(0.0431)
Constant	3.330***	3.330***	3.331***
	(0.288)	(0.288)	(0.287)
Time Effects	Yes	Yes	Yes
County Effects	No	No	No
Number of obs.	55541	55541	55545
adj R^2	0.457	0.457	0.457

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

Table 14: Regression of unemployment rate on State & County variables, 1998-2015

	4-digit		3-digit		2-digit	
	State	County	State	County	State	County
	(1)		(2)		(3)	
	Unemployment Rate		Unemployment Rate		Unemployment Rate	
Diversity	2.629	0.334***	-2.926	0.440***	3.790	0.196
	(2.534)	(0.0853)	(3.099)	(0.0870)	(3.866)	(0.119)
Dissimilarity	5.488	-0.462	-1.890	-0.603**	-0.624	-0.998***
	(5.390)	(0.318)	(3.511)	(0.266)	(3.109)	(0.168)
Lilien Index	12.53	0.117	15.30	0.0853	-20.08**	0.0675
	(13.75)	(0.217)	(13.31)	(0.201)	(9.520)	(0.153)
Recession	2.660***		3.272***		2.502***	
	(0.608)		(0.616)		(0.618)	
Diversity· Recession	23.84***	0.328	34.31***	0.519**	17.30***	1.167***
	(6.936)	(0.205)	(9.438)	(0.200)	(6.384)	(0.263)
Dissimilarity · Recession	-15.82	-1.071	-0.131	0.695	8.996	0.643
	(10.20)	(0.871)	(8.177)	(0.627)	(9.467)	(0.447)
Lilien Index · Recession	3.374	-0.0452	-1.998	0.335	174.6***	0.598
	(67.33)	(0.619)	(61.50)	(0.690)	(44.36)	(0.829)
Constant	3.653***		3.601***		3.140**	
	(1.149)		(1.187)		(1.248)	
Time Effects	Yes		Yes		Yes	
County Effects	No		No		No	
Number of obs.	55595		55595		55599	
adj R^2	0.466		0.464		0.467	

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$

Table 15: Regression of unemployment rate on Region, State & County variables, 1998-2015

	4-digit			3-digit			2-digit		
	Region	State	County	Region	State	County	Region	State	County
	(1)			(2)			(3)		
	Unemp. Rate			Unemp. Rate			Unemp. Rate		
Diversity	-7.323	4.108*	0.306	-8.124	-1.615	0.419***	-5.661	4.904*	0.180**
	(3.121)	(1.363)	(0.143)	(3.820)	(2.543)	(0.0558)	(9.453)	(1.625)	(0.0347)
Dissimilarity	-11.99**	6.670	-0.337	-3.554	-1.385	-0.588	-8.030	0.381	-0.990**
	(3.046)	(4.402)	(0.364)	(6.019)	(3.178)	(0.316)	(9.119)	(2.206)	(0.221)
Lilien Index	21.37***	10.64	0.140	9.792	15.20	0.119	9.808	-20.94	0.0891
	(3.442)	(11.27)	(0.107)	(4.479)	(14.00)	(0.0864)	(7.260)	(11.47)	(0.0535)
Recession	3.528**			2.774			2.993*		
	(0.997)			(1.546)			(1.085)		
Diversity · Recession	-26.29**	22.88**	0.355	-48.62**	35.68	0.481***	-45.78*	21.35*	1.086*
	(5.868)	(7.119)	(0.298)	(14.08)	(19.03)	(0.0773)	(17.86)	(8.560)	(0.375)
Dissimilarity · Recession	70.53*	-20.32**	-1.268	1.594	0.181	0.777	49.67	10.24	0.668**
	(26.69)	(4.182)	(0.715)	(15.14)	(4.811)	(0.471)	(51.98)	(6.375)	(0.172)
Lilien Index · Recession	-187.3*	11.31	0.0260	-92.14	19.10	0.420*	-147.5	182.3*	0.668
	(62.08)	(36.81)	(0.241)	(106.0)	(50.69)	(0.170)	(73.89)	(75.41)	(0.654)
Constant	3.442			3.413			3.116		
	(2.063)			(2.126)			(2.325)		
Time Effects	Yes			Yes			Yes		
County Effects	No			No			No		
Number of obs.	55541			55541			55545		
adj R^2	0.469			0.467			0.469		

Standard errors in parentheses

* $p < .10$, ** $p < .05$, *** $p < .01$