The Spatial Mismatch Between Innovation and Joblessness

by

Edward L. Glaeser

Harvard University and NBER

and

Naomi Hausman

Hebrew University

April 9, 2019, Very Preliminary Draft, References Incomplete

Abstract

American technological creativity is geographically concentrated in areas that are generally distant from the country's most persistent pockets of joblessness. Should innovation policy attempt to engender more innovation is distressed areas? The primarily inventive parts of innovation policy, such as N.I.H. grants, can aid underperforming areas, possibly through health improvements that reduce the share of people on Disability Insurance, without any spatial reallocation. Moreover, since research funding is presumably already designed to maximize knowledge production, spatial reallocation may come at a considerable cost. The educational aspects of innovation policy, such as Pell Grants, work-study and Federal overhead reimbursement on grants, can reflect regional realities better and do more to encourage employment in distressed areas. Lifting the cap on H1B visas in poorer places can also enhance local human capital. Finally, there is particular scope for geographically targeted entrepreneurship policy, such as eliminating the barriers to new business formation near universities and in distressed places. Spatially targeted employment subsidies can also encourage more labor-intensive innovation in depressed areas.

I. Introduction

Between 2000 and 2015, more than 140,000 patents were granted to residents of Santa Clara County, more than triple the number granted to any other U.S. county. More than forty percent of the families in Santa Clara County earn more than 150,000 dollars annually, and about eighty-percent of 25 to 54 year-olds are employed. Over the same fifteen-year period, exactly two patents were granted to residents of Clay County, Kentucky, where only two-percent of families earn more than $150,000 and only 45 percent of 25 to 54 year-olds are employed. Santa Clara County, which includes much of Silicon Valley, seems decades and continents away from the Appalachian isolation of Clay County.

Section II of this paper reviews the enormous spatial disparities in innovation, and the spatial mismatch between the locations of joblessness and technological dynamism. Section III discusses the key economic changes that have led to the spatial separation of innovators and ordinary workers. Innovation now builds on an increasingly large body of existing knowledge, which raises the benefit for innovators from being enmeshed in a research-intensive region, filled with people who have that knowledge. Innovation also leads to far less employment of less-skilled workers, except in the publicly supported healthcare sector. Less-skilled Americans work overwhelming in services, and demand for services is both local and relatively limited in poorer places with few viable exports.

America's spatial inequities seem to cry out for policy action, but neither economic theory nor past experience support boundless optimism towards place-based policies. Appalachia has been the target of place-based Federal support through the Appalachian Regional Commission for over 50 years, and the results are modest at best.[1] Sections IV, V, and VI discuss place-based innovation policy, and we split the innovation process into education, invention and entrepreneurship.

[1] The modest results quite possibly reflect the relatively modest spending over a region that was defined to be vast for largely political purposes.

Education helps scientists to become skilled, enables entrepreneurs to understand the science of new technologies, and produces workers who can implement entrepreneurs' visions. Invention is the actual process of generating new technologies, and it occurs both in private sector firms and in universities. Entrepreneurship transforms new inventions into products and employment. In this paper, we explore the case for geographic targeting of innovation-related policies -- from N.I.H. research funding to local land use controls.

Traditionally, place-based policies emphasized infrastructure, such as the mountain-crossing highways that were built to end Appalachia's isolation, and tax subsidies, like those offered by today's Opportunity Zones. But the extreme success of innovative regions, like Silicon Valley, has led some to support place-based innovation policies, such as special economic zones, spatially-targeted Federal research funding, and state-specific Research and Development Tax Credits, as in Gruber and Johnson (2018). Such place-based innovation policies could be justified either as aid for less innovative places or as enhancing long-run innovation nation-wide, potentially by boosting successful clusters.

In Section IV, we discuss the economics of place-based policies and the difficulties facing place-based invention policy. The three core arguments for place-based policies are (1) location-related externalities mean that relocating activity can improve social welfare, (2) place is correlated with poverty so targeting place can enhance equity, and (3) heterogeneous local conditions imply that uniform national policies are suboptimal. Even when urban economists accept the existence of location-related externalities, including agglomeration effects and human capital externalities, uncertainty about the exact nature of those externalities weakens the first argument for place-based policies. More human capital is good for both California and Appalachia. Would the relocation of skilled workers from California to Appalachia be a good or bad thing for the country as a whole? Our limited knowledge about the shape of the local production function for invention also makes it hard to argue in favor of spatial reallocation of invention on purely efficiency grounds.

The second case for spatial intervention is inequality. Helping Appalachia may help some poor Appalachians. But innovation policy is particularly poorly suited to be a tool for redistribution.

Innovation is often done by the most well-educated and well-compensated members of society. Economists have long argued that helping poor people directly is more effective than aiding poorer places.

The strongest case for place-based policies occurs when heterogeneous local conditions make one-size-fits-all national policies seem nonsensical. Should housing policy be the same in Seattle and St. Louis? Similarly, policies that penalize employment, such as Disability Insurance, may have far more adverse effects in eastern Tennessee than in eastern Massachusetts. Austin, Glaeser and Summers (2018) argue that heterogeneous labor supply elasticities justify wage subsidies targeted towards distressed areas and spatial reforms so that social insurance penalizes work less in places with more joblessness.

Economists' traditional skepticism towards place-based policies reflects both optimism about market forces, like the natural migration of people from poor to rich areas, and pessimism about the public ability to manage economic geography. Today, optimism about the status quo seems less tenable as migration rates across the U.S. have decreased by a third and regional convergence has stalled. Widespread joblessness is endemic in much of America, and for men, not working is associated with individual misery and larger social costs. Given current technological trends, widespread economic dislocation seems likely to spread and cause further rifts in American society and government.

Section IV also makes three points about invention policy, which includes both research and development tax credits and research subsidies administered by the National Institutes of Health (N.I.H.) and the National Science Foundation (N.S.F.). First, when subsidies are targeted by peer review and corporate incentives, there is little reason to think that redirecting research dollars based on coarse locational boundaries will improve national output of new ideas. Second, the existing track record of place-based policies within the N.I.H. does not suggest benefits from expanding these programs. Third, there are ways to ensure that N.I.H.-funded research will do more to help depressed regions without moving that research to those regions. For example, the N.I.H. could focus more on medical technologies that move people off of disability insurance.

In Section V, we turn to education policy, where there is far more scope for spatial targeting. Federal overhead payments can provide more incentives for better local technology transfer in distressed areas. Work-study grants for students in distressed areas can be oriented more towards the research process to promote marketable skills. Vocational training in distressed areas can be provided nimbly and competitively after school, on weekends, and during the summer by non-traditional providers who are evaluated based on the skills their students learn. Human capital can also be increased in distressed areas by raising the cap on H1B visas for local firms and by reducing state court enforcement of non-compete clauses.

Section VI turns to entrepreneurship policies that aim to promote employment particularly in distressed regions. We discuss eliminating the barriers to entrepreneurship near research hubs, both in distressed areas and elsewhere. One particular downside of education is that it appears to produce regulations that make it difficult to build housing or even start businesses. Reducing regulatory barriers to entrepreneurs could be done by establishing "entrepreneurship zones" that offer one-stop permitting and eliminate occupational licensing.

We also discuss targeted employment subsidies that promote job creation in distressed areas, and social insurance reform for these areas to make work more attractive. If these policies reduce the effective cost of labor in places with high levels of joblessness, they will also increase the incentive for entrepreneurs to innovate to create productive tasks for the less skilled who live away from successful cities. By contrast, Universal Basic Income (U.B.I.) is an income shock that seems likely to reduce the willingness of low income people to work, and that should lead to even less innovation that employs the less skilled. Section VII concludes.

II. The Spatial Mismatch between Innovation and Joblessness

In this section, we compare the geography of innovation with the geography of joblessness. The central point is that innovation occurs in places that are far from America's most troubled local economies.

The Geography of Education, Invention, and Entrepreneurship

To illustrate the landscape of innovation, we focus on multiple aspects of the innovation process. Upstream invention reflects technical discoveries that often lead to a patent. Downstream entrepreneurship typically involves either the implementation of a technical discovery or a non-technical idea that can potentially generate profits, such as reapplying the burger restaurant franchise model to sell fried chicken. Both types of creativity depend on human capital, and both are a function of other local influences. Human capital is formed both in-school and on-the-job, but we focus primarily on formal schooling.

We first measure inventive activity using patents. This measure has the advantage of relative consistency over a long horizon and is applicable to many fields of knowledge, such that it can provide an overview of inventiveness in the U.S. Of course, patents miss some important inventions, like those in finance, which aren't patentable. And they don't, on their own, capture the importance of an invention: most patented inventions are never used. Where possible, we thus incorporate importance by using citation-weighted patents (Trajtenberg (1990); Hall et al. (2001)).

Figure 1 shows the geography of citation-weighted patents in the United States in 2000. We use an earlier date so that the patents are old enough to have a plausible period for being cited. The map shows that patenting is extremely highly concentrated within the U.S. There is one massive cluster running along the eastern seaboard from Washington, D.C. up to Boston and a second massive cluster along the Western seaboard.

In 2015, eight counties together produced 406,645 patents, which is more than one-fourth of America's entire patenting activity. Six out of those eight counties are in coastal California, and the other two include Seattle, WA, and Cambridge, MA. Between 2000 and 2015, only one county entered and left that top eight list (Seattle entered, Boise, Idaho left). The top eight counties in 2000 produced only 17,137 patents, which was 20.1 percent of U.S. patenting activity. Patenting activity is wildly concentrated within the U.S. and the level of concentration appears to be increasing rather than decreasing.

Figure 2 shows the growth rate in the number of patents granted per capita between 1980 and 2015. In this case, we use the number of patents rather than citation-weighted patents to

permit a longer time frame. There are non-coastal metropolitan areas, like Atlanta, that have experienced significant increases the total level of patenting activity. Yet many of the faster growing places are the coastal areas that begin with the most innovation in 1980. There is little evidence to suggest that patenting activity is smoothing itself out over space.

A second important component of innovation comes from the entrepreneurs who bring new ideas to life. High growth entrepreneurship is likely reflected in venture capital investments, which are concentrated in similar parts of the country. Figure 3 indicates that while most counties in the country in the three-year period around 2015 received no VC investment at all, areas in California and the east coast chain of clusters received up to $6,535 per capita per year in VC dollars. It makes sense, given the wealth of evidence on local knowledge flows, that this type of business activity would be co-located with invention, as measured by patents. New ideas from universities and from larger firms – which generate the majority of patents – are frequently spun out and developed in start-ups (Shane (2004); Agrawal et al (2014)). More generally, one can consider patents and startups as two expressions of the wealth of new ideas in these knowledge-intensive places.

Innovation is also correlated with density, which we think facilitates local knowledge flows and spurs idea production. Figure 5 shows the correlation between patents granted and population density across counties in 2000. In order to illustrate the variation among most counties, this graph omits outlier counties such as the densest, highest innovation counties in NY, as well as San Francisco county and Suffolk county, MA.

Figure 4, like Figure 2, suggests that knowledge is only becoming more concentrated. Growth in VC investments per capita between 1995 and 2015 has been most pronounced in initially strong clusters, such as those in California and Massachusetts. A closer look at the map reveals, in addition, relatively high VC investment growth in Seattle, Portland, Provo, Albaquerque, Austin, Little Rock, Atlanta, Raleigh, Pittsburgh, Ann Arbor, Chicago, and Madison – all of which are urban, and many of which house top research universities.

Overall new business activity follows a different pattern than patents and venture capital funding. Figure 6 uses data from the Business Dynamics Statistics of the Census Bureau to show

2015 establishment birth rates, which accounts for the fact that some states have higher overall levels of economic activity than others. Unfortunately, we must make do with coarser state level data for overall business activity. With a few exceptions, such as Florida and Missouri, the western U.S. has higher birth rates. This outcome reflects to some extent state and local regulatory environments. For example, states that more stringently enforce non-compete agreements (NCAs) in employment contracts have lower establishment entry (Figure 7).[2]

General education, as measured by the share of population with a college degree and shown in Figure 8, is far more widespread than patenting and high-growth entrepreneurship. Nonetheless, education is closely connected to both invention and entrepreneurship. Figure 9 shows the positive correlation between share of adults with college degrees and the number of citation weighted patents in 2000 (correlation 0.52). A wealth of literature documents that entrepreneurs are disproportionately educated, are more likely to start firms in more educated places, and are more successful the more educated they and their local areas are (Acs and Armington 2004; Doms, Lewis, and Robb 2010).

But while patents and venture capital spending are concentrated in a small number of coastal areas, commercial technology adoption seems to be more widespread geographically. Figure 10 shows the Forman, Goldfarb, and Greenstein (2012) data on the fraction of firms in each county that had adopted advanced internet applications by 2000, the end of a five-year period of massive commercial technology investment. While there is some geographic heterogeneity in adoption, high adoption rates are not found only on the coasts. The new technology seems to be prevalent in many central parts of America – not just urban – presumably because it handles complex logistics challenges for geographically dispersed firms.

The consumption benefits of technology improvements are even more widespread. Broadband internet is highly diffused across the country according to five-year-average data from the American Community Survey (ACS), 2013-2017 (Figure 11). Only modest parts of south east and south central regions have distinctly lower rates of broadband penetration. Similarly, patients nationwide benefit from pacemakers originally developed in Minneapolis and teenage

[2] Four outlier states are excluded from this graph: Florida, Missouri, Utah, and Nevada.

boys everywhere play Fortnite, developed in North Carolina's Research Triangle (72.4% penetration among U.S. boys in 2018). The combination of the maps in Figures 1-4 with those in Figures 10 and 11 suggests that innovations are highly localized, while the benefits of innovations are far more dispersed.

But these consumption benefits need to be set against the employment-related returns to innovation, which exhibit geographic heterogeneity similar to that of innovation itself. Figure 12a shows that per capita income grew most in the most innovative places through 2000. The northern part of the eastern heartland performed poorly while the southern part seems to have fared decently well. Figure 12b shows that the western heartland did well between 2000 and 2010. Although southern Appalachia seems to do ok between 1980 and 2000 as far as per capita growth, this measure masks important changes in employment. These changes – a large increase in the chronically non-employed in certain parts of the country – are the topic of the next subsection.

The Geography of Joblessness

America has experienced enormous economic disruption over the past 30 years, and it has not been evenly distributed across space. We focus on joblessness (one minus the ratio of employment to population) rather than unemployment, because the primary secular shift is due to men leaving the labor force entirely. The available evidence (Austin, Glaeser, and Summers, 2018) suggests that these men are not happily fulfilling home production, but rather that they are unhappy and disconnected from larger society.

We focus on male joblessness, rather than female employment, because female labor force participation is a far more complex topic. Women who do not have formal employment are far less likely to say that the unsatisfied with their lives than equivalent men. Moreover, for much of the past 50 years, the female employment rate has been rising, unlike the male employment rate.

The map in Figure 13 shows the distribution of joblessness in the United States in the years around 2015. Some parts of America regularly experience joblessness rates over 25 percent, while others have joblessness rates that are under five percent. The most notable feature of this map is the swath that runs from Louisiana and Mississippi through Appalachia up to the cities of the rust belt. We refer to this area as the Eastern Heartland and note that it is also the area of the U.S. where employment and income growth is lowest, and where male life expectancy has declined.

The eastern heartland has three features that help explain its particularly poor employment performance. The northern part of the heartland was disproportionately industrial fifty years ago, and it has since suffered from declining manufacturing jobs for men. In the past, high wages from industrial jobs reduced the demand for formal schooling (Goldin and Katz, 2009) and this region was far less educated historically than the western heartland. Low levels of schooling were also a feature of the southern heartland states during their Jim Crow past. Finally, this region appears to have weaker political institutions, at least as measured by the levels of corruption (Glaeser and Saks, 2005, Liu and Mikesell, 2014).

Of course, manufacturing jobs are not the only ones to have become obsolete. More generally, "routine jobs" that involve a variety of rote tasks have been replaced by computers and offshored to cheaper sources of labor. Figure 14 maps the Autor and Dorn (2013) data on the share of routine employment by commuting zone in 1980, before the period of widespread computer adoption and open trade with China. In 1980, the eastern heartland had particularly high shares of employment in soon-to-be obsolete routine jobs.

Note that the innovation-intense places featured in Figures 1-4 also tended to have high routine shares in 1980, but these places were highly skilled due to top universities and generations of educational investments. They went in a different direction when routine jobs were mechanized and offshored, using workers with technical skills in a more innovative capacity. The data indeed support a bifurcated response to advances in technology among the places with a high routine employment share in 1980. To illustrate this phenomenon, we start by taking the component of the 1980 routine employment share that isn't correlated with the

subsequent share of IT worker hours in 2015. In Figure 15a, we graph 2015 jobless rates against this residualized routine employment measure and find a strong positive correlation. Large non-employed populations have grown in places that were initially dense with routine employment that didn't subsequently specialize in innovative industries.

Autor and Dorn (2013) argue that places with lots of routine employment had disproportionate incentives to adopt worker-replacing computer technologies. Indeed, the 1980 routine employment share explains 33 percent of the variation in the 2015 information technology worker hours share across commuting zones. The remaining 67 percent of the variation presumably reflects the presence of innovative, highly skilled, technology-intensive industries. That residual share is strongly negatively correlated with local joblessness, as shown in Figure 15b. Figure 16 shows a similar negative relationship between patenting and non-employment.

The joblessness in Figure 13 is not simply a mirror image of the innovation depicted in Figures 1 and 3. High joblessness areas do tend to have less innovation, but there are many areas, especially those in the western heartland, where low innovation is not associated with higher levels of joblessness. Joblessness heterogeneity provides a new twist to old regional disparities that strengthens the case for policy intervention. Employment generates sizable positive fiscal externalities because employed workers pay taxes and non-employed workers receive benefits. Pigou (1913) argued that this fiscal gap creates a case for subsidizing work. Similarly, this fiscal externality strengthens the case for revisiting spatial policies – potentially including innovation policies – that might reduce joblessness.

A further reason for revisiting spatial policies is that market forces do not seem to be eliminating these joblessness gaps on their own. Blanchard and Katz (1992) famously reported that unemployment rates at the state level in 1975 were uncorrelated with unemployment rates in 1985, suggesting that economic dislocations were temporary. Figure 17 shows the correlation between the non-employment rate in 1980 and the non-employment rate in 2015 across Census Public Use Microsample Areas (PUMAs). The r-squared of this regression is over sixty percent and the coefficient is more than one, meaning that joblessness has become a permanent part of many areas.

America has long had spatial heterogeneity in economic outcomes and by many measures that heterogeneity has fallen. In 1950, Mississippi was the poorest state and there were eighteen states with incomes that were twice as high. Today, Mississippi is still the poorest state, but there are no states with incomes that double those in Mississippi. Mississippi has caught up with many states, which reflects the long-standing pattern of economic convergence of regions within the United States (Barro and Sala-I-Martin, 1992).

Yet while income convergence was the norm until 1980, it seems to have largely disappeared since that time. Berry and Glaeser (2006) document a substantial decline or even disappearance of regional convergence at the sub-state level. Ganong and Shoag (2018) show a similar end of convergence at the state level. State income gaps, like joblessness, have become far more permanent. In the next section, we discuss possible reasons for declining regional convergence, which can help in considering place-making policy.

III. Why is there a spatial mismatch between innovation and joblessness?

We now turn to the causes of this persistent mismatch. First, we note the decline in the geographic mobility of capital and labor. Historically, factor flows across space would ameliorate spatial gaps in productivity and income. Second, we discuss changes in the nature of innovation, technology, and work that interact with the location of firms and the geographic sorting of more and less skilled workers. Finally, we suggest what we call the O'Neill Corollary, that in the long run "All Jobs are Local," by which we mean that global markets for traded goods generate strong incentives to reduce variable labor costs with fixed capital costs, and so the remaining demand for unskilled labor will come from the service sector.[3]

We highlight several historical facts. Innovation has always depended on geography because local knowledge helps forge new ideas, because local markets demand or inspire certain products, and because local labor determines production possibilities. As ideas have become more complex, the type of knowledge required may have become more advanced, more

[3] The O'Neill Corollary honors former House Speaker Thomas "Tip" P. O'Neill who famously declared that all politics is local.

connected to universities, and more connected to technologically advanced industry and skilled workers. If these demands concentrate skill in innovative areas, then innovators responding to local market forces and local production possibilities will increasingly be geared towards skilled workers' consumption preferences and labor availability.

In addition, changes in information and communication technology (ICT), in trade, and in transportation costs have fundamentally changed the geography of production possibilities. As a result of these innovations, both the type of labor and the location of labor used in production has changed. The global market for ideas has increased returns to geographic concentrations of skill, where local knowledge flows create cascades of ingenuity. Meanwhile, any low skilled labor input that doesn't have to be both human and physically co-located with the consumer (as in some service sector jobs) can be sourced more cheaply by employing either a machine or a developing country worker. Communication, transportation, and institutional (trade) barriers no longer protect less-skilled American workers from the competition of their foreign counterparts. Any remaining difficulties in mechanizing and offshoring work are only going to be eliminated by the future innovation of skilled workers.

Declining Mobility of Labor and Capital

From 1880 to 1980, per capita income differences across space converged steadily (Barro and Sala-I-Martin, 1992), partially because of the movement of both labor and capital. After World War II, manufacturing firms relocated to states with cheaper labor, especially when they also embraced right-to-work laws (Holmes, 1997). While there is some migration of technology companies to the most well-educated parts of the sunbelt, such as Austin, Texas, there is little movement to less educated places where labor is even cheaper. Low cost, unskilled labor has far less appeal to technology firms than it did for industrial firms.

Labor and capital now seem much less likely to move in response to geographic differences in wages. The inter-country migration rate never fell below six percent during the forty years before 1992. That rate has never risen above four percent during the past decade. Ganong and Shoag (2018) show that while poor people often moved from poor places to rich places

before 1980, that process has ended. The migration of the poor no longer helps to iron out differences in income or employment across space.

Why has migration slowed, especially from poor places to rich places? One explanation emphasizes the changing nature of housing supply (Ganong and Shoag, 2018). In previous epochs, Americans could easily move to places with economic opportunity with few barriers to building. Balloon-frame homes were easy to build on the frontier. There were few barriers to tenement construction in the cities of 1900. Today, new construction is enormously difficult in the country's most productive areas, from Silicon Valley to New York City, primarily because of land-use restrictions. While we believe that this phenomenon cannot on its own explain the decline in regional convergence, the high cost of housing surely helps to explain why more poorer people don't move to the centers of American innovation.

Eliminating these barriers to building would enable more people to receive some of the employment benefits coming from the innovation economy, but encouraging out-migration from distressed areas also carries costs. Austin, Glaeser and Summers (2018) report that a large skill gap exists between people who stay in less advantaged areas and the people who leave. More emigration would mean an even larger "brain drain" which could make conditions even worse for those left behind. Land use regulations in high innovation areas may be seriously reducing American productivity, as suggested by Hsieh and Klenow (2018), but reforming those regulations will not be easy and will not solve the underemployment problems of the eastern heartland.

Yet barriers to building cannot on their own explain the end of regional convergence. America's growing geographic sclerosis is surely also related to fundamental changes in the nature of innovation, technology, and work. We turn to those next.

The Changing Nature of Innovation

For at least 250 years, the innovation economy has destroyed old jobs and created new jobs. The machines of the early industrial revolution, such as Arkwright's water frame and Cartwright's power loom, were meant to eliminate the labor needed to spin and weave.

Luddites destroyed those machines precisely because they feared a reduction in demand for their skilled labor.

But the industrial revolution eventually led to a massive increase in the number of factory workers, at least in Europe and the U.S.[4] As mechanization proceeded, prices fell and the total quantity of industrial goods increased. While Jevons (1865) focused on how improvements in the efficiency of coal-burning engines increased total usage of coal, his point also applies to labor-saving industrial technology during his own era. As 19th century watch factories replaced traditional watchmakers, more people ended up making watches, because lower prices induced a much larger share of the world carried a watch. As long as the percentage decline in the amount of labor per unit output is less than the percentage growth in total output, then labor-saving technology lead to an increase in labor demand.

The industrial revolution also created new products which generated more demand for less skilled labor. Gas lighting, steam locomotives, and Portland cement are just three of the many new products invented during the early industrial revolution. Mass produced automobiles may have been the ultimate, employment-creating innovation of the late 19th century. Ford's automated assembly-line factories were massively more efficient than the technology they replaced, but low car prices still ultimately relied on a massive supply of relatively low cost labor.[5]

Geography mattered to these early breakthroughs. Innovations drew heavily from local influences, including fortuitous knowledge transfers over an ale or ancient traditions of production in related crafts. The lawsuit over Arkwright's patent claimed that he had learned about roller spinning through a conversation with John Kay, who had been working for another inventor: Thomas Highs. James Watt's early steam engines needed the metal-making expertise of Birmingham that had been developed over centuries. Detroit's automobile production seems almost pre-ordained given the area's earlier focus in wagon-building, which

[4] It is harder to account for the reduction in cotton work in India, much of which was in the home, because it was displaced by England's industrial cotton exports.
[5] Ford's enormous productivity edge also enabled him to pay for five dollar days.

employed General Motors' Billy Durant, and in manufacturing boat engines, which employed Henry Ford.

Moreover, the location of the innovator had long-lasting employment impacts. One of Arkwright's largest mills was built at Shudehill Hill in central Manchester, and that city would subsequently explode in size as the world's Cottonopolis. Detroit would be synonymous with automobile production for decades after Ford's first Model T was produced in the city in 1908. In both cases, thousands of less skilled workers came to these industrial meccas to operate the machines that were designed to use their labor.

While long-term joblessness was rare in the pre-modern era, innovators would often live near less skilled workers. Most 19th century entrepreneurs didn't need help from a university (Watt was an exception), but they did need low cost labor. Innovators came from both urban and rural areas. Many, like Edison, McCormick and Rockefeller, moved to large cities, but that was where the low wage workers were moving as well.

Through the early 1920s, labor in the U.S. remained relatively inexpensive because labor unions were weak, immigration to the U.S. was unfettered and there was little social safety net, so working at any wage was better than starving.[6] In the decades after the great recession, the incomes of poorer Americans experienced a "great convergence" (Goldin and Margo, 1993). Immigration was restricted. Labor unions were empowered. A modest safety net meant that workers could be a bit choosier about their jobs. Higher labor costs may have motivated innovators towards skill-biased technological change (Acemoglu, 1996).

As capital deepening replaced more expensive labor, the geography of production also changed. Henry Ford's early plants had about 200 square feet of space per worker, which is comparable with many typical urban occupations, including office space and retail trade. More modern factories can have two or three thousand square feet per worker, largely because machines are doing the work. Since cities offer proximity at the cost of expensive land, factories naturally relocated outside of urban centers (Glaeser and Kahn, 2003). Improvements

[6] We mean that labor was inexpensive relative to the returns to capital, not that labor was cheaper in the U.S. than in other countries.

in transportation technology and infrastructure also encouraged this transition (Glaeser and Ponzetto 2007).

Innovators became less interested in employing less skilled workers, and innovations became vastly more complicated as knowledge became deeper. Computers and medicine relied on large research and development labs, such as those at I.B.M., Bell Labs and Pfizer. University scholars, like those at Stanford and M.I.T., became natural partners for entrepreneurs.

In the age of Henry Ford, massive economies of scale were reaped by combining highly skilled inventors with masses of less skilled laborers. In the era of Bill Gates and Mark Zuckerberg, skilled inventors hire highly skilled computer programmers. Large scale manual work is handled by machines or off-shore labor. These changes help explain why innovative activity no longer locates near less skilled workers, but they do not explain, on their own, why joblessness has risen so dramatically within the United States.

The Changing Nature of Work, and the Rise in Joblessness since 1969

Between 1940 and 1960, the total number of non-agricultural workers in the U.S. rose from 32 million to 54 million. Non-agricultural employment rose to 90 million in 1980 and 132 million in 2000. From 1940 to 1980, jobs grew by an astounding 2.6 percent annually. Between 1980 and 2000, employment was still increasing at 1.9 percent per year, which is still quite healthy. But since 2000, the number of jobs has been growing by only .7 percent per year, which at least suggests that America's economy has stopped innovating in ways that generate mass employment – at least on American soil.

Throughout most of the 1960s, the male jobless rate hovered around five percent. For much of the past decade, the jobless rate has been over fifteen percent. Abraham and Kearney (2018) "conclude that labor demand factors, in particular trade and the penetration of robots into the labor market, are the most important drivers." Autor, Dorn, and Hanson (2015) illustrate the substantial impacts of both trade and technology on areas that are exposed to Chinese import competition and computerization, respectively. Male employment, especially the employment of the less educated, has disproportionately dropped in those areas that were once heavily oriented towards manufacturing, as shown in Figures 12 and 13. This fact

supports that view the trade and technological change have reduced the role of men in making goods.

Between 1969 and 1993, the share of non-farm employees who worked in manufacturing industries dropped from 26.3 percent to 15.1 percent. From 1979 to 1993, the absolute number of manufacturing workers fell from its high point of 19.5 million to 16.7 million. But while manufacturing was switching from labor to capital and retrenching, service sector employment was expanding enormously, from 64.9 million in 1979 to 88.6 million in 1993. This shift was bemoaned by many who argued that "good," unionized factory jobs were being replaced by lower wage, non-unionized service sector jobs, but it is hard not to be impressed by the share scale of service sector growth from 1970 to 2000.

From 1980 to 2000, service sector employment rose by 2.4 percent annually, from 66 to 107 million. This growth employed millions of women entering labor force, and muted the adverse effects of declining industrial employment. Autor and Dorn (2013) show that local labor markets with high initial shares of employment in routine tasks computerized at higher rates and reallocated low-skill labor into service occupations, which saw greater wage growth than middle-skill occupations in these years. Since 2000, service employment has growth only by about one percent per year.

Before 1980, employment growth was pushed along by shifts in labor supply, most notably the entry of women into the formal labor market. Yet wage growth was far healthier during those decades than it has been since 2000, which suggests that much of the change has come from a slower growth in the demand for new forms of work. One fundamental policy question is whether changes to innovation policy could increase growth in labor demand, especially for less skilled Americans.

Increases in labor supply mean that limited labor demand leads to joblessness, not merely low wage labor. Long-term joblessness for men was rare prior to the New Deal, because any wage was better than starvation. Even in the 1960s, the bottom of the male wage distribution was lower than today, and yet men still worked. Men seem less willing to work at extremely low

wages today because a more generous private and public safety net – especially disability insurance – makes it easier to survive without working.

The private safety net also enables prime aged men to survive without working. Austin, Glaeser and Summers (2018) report that one-third of prime-aged men who have been jobless for over a year live with their parents. In the 1960s, homes were far smaller and parents were far poorer. When the non-employed rely on in-kind transfers from friends and relatives, then they are less able to move to places with greater job opportunities, which is one explanation for why joblessness has become so geographically persistent.

Joblessness is particularly acute in former manufacturing hubs where industry has left. Joblessness is less problematic in large cities, where there is more service sector employment. Indeed, if service sector jobs are to provide work for less skilled Americans, then it is even more valuable for more and less skilled people to live close to one another even if the result is wage polarization, as shown in Autor and Dorn (2013). Wage polarization is likely to be less destructive than joblessness because of the large negative externalities of the latter.

Yet the changing nature of innovation and work has led to more rather than less segregation by skill across the U.S. (Berry and Glaeser, 2006). Many of the greatest innovators since the 1970s have relied on highly skilled workers and been extremely segregated in the clusters of Silicon Valley and Seattle and other highly educated cities. Some of the innovations have affected productivity in other industries (Microsoft Office, Apple and creative fields like architecture), and in some cases, these innovations may make both unskilled and skilled workers redundant. Of course, in many cases, these advances vastly increase the productivity of skilled workers and feed clusters like those in which they were developed. Other innovations, like Google and Facebook, provide services directly to consumers and sell consumer attention to other firms in the form of advertising. These internet giants are notable because they impact the lives of billions, but they employ only a modest number of generally highly skilled workers who benefit from proximity to each other. They have little need for less-skilled workers.

This fact provides another explanation for the decline in regional convergence. The technology hubs, which are among America's highest-wage areas, don't actually need large numbers of skilled workers to produce, so they don't need to relocate to areas with lower wages. Their skilled employees would like to hire more service workers, but limitations on housing supply ensure that housing prices are extremely high and make migration to high wage areas less attractive.

There is an open question about whether the geographic isolation of the technology innovators actually influences the nature of their innovations. We have ample evidence that new idea production in the modern era requires local depth of knowledge. Local consumers may also influence new product ideas, and local labor availability may affect an innovator's perception of production possibilities. If these innovators lived near more low-skill workers, would they produce more inventions that would employ those workers? Certainly, there is some track record of innovators creatively responding to the needs they see around them. But today's innovators know that almost any low-skilled labor they'll need in production will be sourced cheaply abroad. Innovating to increase demand for local low skill workers thus requires creating tasks that must be performed locally.

For example, Uber is a technology company that provides work for the less skilled. Uber was born – in part – because Travis Kalanick was in San Francisco and saw the need for a service that could connect car service providers with car service users. The car-sharing service, Zipcar, has a similar founding story. If innovation requires some direct knowledge, then it may be a problem that the technology sector is geographically isolated from the places which contain America's larger economic problems. If rich people aren't going to move to poorer areas, like the eastern heartland, and the poorer residents of these places find San Francisco too expensive, then is it possible to imagine service sector innovation that reduces American joblessness?

The O'Neill Hypothesis: Will All Jobs be Local?

Not every American innovator works primarily with computers and skilled computer programmers. The American job market, especially the job market for the less skilled, is

dominated by services. Much of the shape of this service economy was formed In the 1970s and 1980s, when service-sector innovators massively increased employment.

Glaeser and Ponzetto (2019) argue that the rise in service sector employment is the natural side-effect of vast global markets for traded goods. If firms can reduce variable labor costs by paying fixed capital costs, then firms with larger markets will pay those fixed costs. As the size of the global market expands, then fewer and fewer unskilled workers will produce traded goods. Consequently, the remaining demand for unskilled labor will be in non-traded, local, service-sector jobs.

This hypothesis is compatible with events of the past 50 years, where first manufacturing firms mechanized, and then innovation switched to products which enjoyed a global reach because they only existed in hyperspace, like Facebook. These hyperspace products require almost no labor per user. Skilled labor is still needed to pay the fixed costs of managing machines and coding software, but it is possible that machines will eventually replace even those human inputs. Yet it seems likely that people will continue to enjoy buying coffee from a barista with a pleasant smile, and the service sector will continue to employ less skilled Americans.

America's service sector is dominated by four large industrial groups: education and health services (23 million workers), wholesale and retail trade (22 million workers), professional and business services (22 million workers), and leisure and hospitality (17 million workers).[7] Over the past twenty years, education and health service employment has been growing steadily and independently of the business cycle. Both leisure and hospitality and professional and business services are growing robustly, but with substantial setbacks during the great recession. Wholesale and retail trade experienced serious declines during the recession and little overall growth during the past twenty years.

This stagnation is in sharp contrast to the 1980 to 2000 period when retail and wholesale trade grew dramatically, along with the other service sectors. Healthcare's expansion was a natural response to the public funding that flowed from Medicare and Medicaid. Professional and business services provided external technical expertise in an increasingly complex world.

[7] https://www.bls.gov/emp/tables/employment-by-major-industry-sector.htm

These services were disproportionately urban and skilled, and their links with other businesses mirror the increasing links between businesses and universities.

America's vast fast food industry begins in Kansas with White Castle in 1921. White Castle offered burgers with buns, and fast service, but the restaurants were not franchises. They were and are owned directly by the company. Starting in California in the 1950s, McDonald's achieved much greater scale with a similar production model and a franchise system, which borrowed from earlier franchise operations, like Coca-Cola and Rexall. Kentucky Fried Chicken borrowed the McDonald's model but applied it to a regional cooking style. American food entrepreneurs have shown a steady ability to generate employment in different regions by borrowing and adapting ideas from elsewhere.

Moreover, the fast food entrepreneurs have managed to generate local employment in the corporate headquarters that is sustained by sales elsewhere. Nine of America's twelve largest fast food chains (by number of stores) are headquartered close to their original founding locations. McDonalds, Pizza Hut and Baskin Robbins are three prominent exceptions. In most cases, these companies have changed hands, sometimes repeatedly, but new owners have maintained a regional affiliation, or in the case of Kentucky Fried Chicken, returned to the region.

Even retail and wholesale trade expanded dramatically during the 1980s and 1990s, as malls expanded and America bought more. Today, a combination of e-commerce and improvements in the logistics of selling raises the possibility that employment will now stagnate or decline. There will surely continue to be demand for skilled human salespeople pushing the sales of high margin products, such as luxury goods and real estate, but the number of salespeople who just move products and man the register in shops seems sure to continue to fall.

Healthcare and much of education primarily serve the local market and thus have limited scope for expansion. The country's top hospitals and universities are exporters, but this group is a small sliver at the top end of the market that is highly concentrated in the country's most educated regions. While the healthcare and education sector employ a vast number of Americans and often expands with innovation, this sector is largely public in nature and seems

unlikely to provide a dynamic basis for future regional export-based growth in less educated parts of the U.S.

By contrast, professional and business services, which include lawyers, advertising agencies, accountants and management consultants, are a dominant sector in many high human capital cities and many of these are export-oriented. While Madison Avenue emerged first because of demand from New York-based businesses, New York advertising agencies soon supplied a global roster of firms. While education and healthcare is protected from technological disruption partially because of public funding, professional and business services generally involve both creative thinking and face-to-face contact, which are harder to reproduce in a robot.

Business and professional services are far less likely to generate future employment gains in depressed areas because these services require the high levels of education that are generally lacking in those areas. The Big Four accounting firms that dominate corporate business in the U.S. aren't even headquartered in the U.S. The management consulting industry is dominated by New York and Boston. Architectural firms are more dispersed geographically, with large and successful companies in St. Louis (HOK), Omaha, and especially fast-building states, like Texas. Ultimately, the business service model involves selling highly skilled labor to global companies, which can only be a viable model for places that have an abundant supply of highly skilled labor.

Leisure and hospitality is more plausibly a dynamic source of employment growth, even in areas with lower human capital. Wealthier Americans will spend on leisure in places that they don't live, and they are also willing to pay for a more luxurious labor-intensive leisure experience. The question is how many residents of depressed areas can really work in leisure and hospitality and how many of these areas can be turned into leisure destinations, or into exporters of local cuisine.

The changing nature of work means that less-skilled Americans have been working disproportionately in service jobs, not in manufacturing or other routine jobs, for decades. This shift into service sector jobs in response to improvements in trade and technology helps explain

the spatial mismatch between joblessness and innovation, and it makes that mismatch harder to address. Manufacturing workers didn't need to live near their eventual customers. More service sector workers do.

The need for low wage workers drew manufacturing firms into low wage areas. There are very few technology firms that would benefit from hiring large numbers of high school dropouts. Their workers might benefit from cheaper service workers, but that gain is unlikely to be enough to offset the productivity losses from moving to a less educated locale.

IV. Spatial Innovation Policy: Invention

The spatial mismatch between joblessness and innovation suggests that innovators believe the returns to creativity are lower in regions with abundant underemployed labor That belief suggests the geographic dilemma facing innovation policy. Should we target resources towards the most innovative places, or to the places that have the greatest need for job-generating innovation? If America is split between a creative zone and a jobless zone, then can improving the creative zone fix the jobless zone? The disparate geographies of invention, technology and employment motivate our discussion of spatial innovation policy.

This tradeoff is particularly acute because America appears to have both an innovation problem and an employment problem. The share of prime aged (25 to 54 year old) men who are not employed rose from five percent in the 1960s to over fifteen percent during much of the past decade. Gordon (2016) finds that American economic growth declined over the same time period, and reduced business dynamism may explain the rise in male joblessness. Okun's Law (1962) noted the link between low growth rates and unemployment over fifty years ago.

We take as given that innovation policy is aimed both at expanding the stock of knowledge and addressing other social problems, like America's growing joblessness problem, especially in the eastern heartland. If joblessness causes a reduction in tax revenues and an increase in social expenditure, then there is a fiscal externality from non-employment. Consequently, the

equilibrium level of joblessness will be too high, and reducing joblessness can raise social welfare.

Continuing with our division of innovation into education, invention and entrepreneurship, we now turn to spatial dimensions of policies that affect invention, like Federal research funding. The previous section's discussion suggests that geography matters for innovation policy because space helps shape the production function for new ideas, by determining the overall level of creativity, the problems that innovators address, and the means of producing the final good (input mix). The separation of joblessness and innovation may lead innovators to ignore the opportunities that exist among the jobless population. Geography may also determine the impact of creativity on outcomes, like unemployment and inequality.

In this section, we start by reviewing the three main arguments for place-based policies: heterogeneous agglomeration effects, redistribution (geography as "tagging") and differential impacts on social problems. We then argue that both theory and history suggest that these are better arguments for spreading education and entrepreneurship across America than for spreading invention. Enhancing the ability of poorer places to benefit from distant invention may be much easier than relocating invention itself.

The Logic of Place-Based Policies

Place-based policies can be justified in three different ways (Austin, Glaeser and Summers, 2018): spatial externalities, redistribution, and spatially heterogeneous impacts on social problems. Spatial externalities include agglomeration economies and local human capital externalities, and they typically imply that the relocation of activity from one place to another can increase aggregate outcome. In the case of innovation policy, these spatial externalities might include local increasing returns to scale from a massive research hub like Silicon Valley, or the spillovers from inducing a modest number of scientists to relocate from California to Kentucky.

In the case of overall economic activity, the literature accepts that while it may be likely that the exact population sizes of New York City and West Virginia are not optimum, it is not clear if we should be moving people from New York to West Virginia or vice versa. Perhaps cases exist

where a modest "big push" would propel a region into perpetual growth, but we do not know how to identify these cases in the U.S. today.

Similarly, a large body of work suggests that spatial spillovers are important in innovation (e.g. Jaffe, Trajtenberg and Henderson, 1993; Belenzon and Schankerman 2010), but it is hard to know the optimal location for additional innovative activity or whether the U.S. as a whole be more creative if invention were more concentrated or more dispersed.

The redistributive case for spatial targeting is that place may be a convenient tag for "poverty," so that by redistributing across place we can help poor people without destroying incentives to work. We can also think of insuring people against the adverse economic shocks experienced by their location. But place-based redistribution (unless it is based on place of birth) will distort location choice, and may increase housing costs in areas that receive transfers. Moreover, lower incomes may already be offset by lower prices. Perhaps the strongest argument against place-based redistribution is that the overwhelming share of income variation lies within states and counties rather than across states and counties (Austin, Glaeser and Summers, 2018).

Innovation policy is also not a natural tool for local redistribution. The best labs rarely employ high school dropouts. Attracting top scientists will only raise the costs of local housing. Technological breakthroughs, such as cancer-fighting therapies, may well benefit the poorest members of society, but they will not disproportionately benefit the poor who are living where the breakthrough occurs. The government has better tools for redistributing wealth than redirecting research to areas where it is likely to be less productive.

The third case for spatial policy is that social problems, like joblessness, may be more responsive to policy interventions in some places than in others. For example, we may want to reduce crime everywhere, but by targeting resources towards "hot spots", the effectiveness of spending can increase. While fiscal externalities from being non-employed may be the same in Seattle and Appalachia, there may be far more people on the margin of employment in Appalachia. Consequently, an employment subsidy that targets Appalachia may induce more

people to move from being jobless to being employed per dollar spent than would a spatially uniform employment subsidy.

We will treat joblessness as our primary social problem, but we recognize that there are many other market failures which vary across space. Treating joblessness as a market failure means that we reject the view that not working is merely a benign decision to consume more leisure. Austin, Glaeser and Summers (2018) also quantify the sizable fiscal externality that is associated with working because of paying taxes and not receiving benefits.

Austin, Glaeser and Summers (2018) discuss large happiness gap between jobless and employed men, and the connections between joblessness, suicide and marital disruption. The life satisfaction gaps between the employed and the non-employed, at least among men, are much larger than the gaps between the working rich and the working poor. If the goal of redistribution is to reduce happiness gaps across individuals, then reducing joblessness would be far more equity enhancing than redistributing income.

The case for spatially targeted action against joblessness emphasizes the vast differences across American labor markets. The right policies for Seattle are unlikely to be right for West Virginia. This point is obvious in housing markets, where subsidizing new construction through the Low Income Housing Tax Credit makes far more sense in Boston than it does in Houston or Detroit. Austin, Glaeser and Summers (2018) argue that local heterogeneity means that social insurance policy should penalize working less in West Virginia than in low joblessness areas, and that if we were to subsidize employment more aggressively, those subsidies should target areas with higher levels of joblessness.

The differential elasticity argument is generally less relevant in the case of targeted interventions, like N.S.F. grants, than with broader economic policies, such as employment subsidies. Since the peer review processes of the N.S.F. and the N.I.H. enable targeting on a project-by-project basis, there is little need to use additional spatial targeting to improve efficacy.

Still, to consider spatial targeting of invention more fully it is helpful to discuss between four classes of American locales: (1) highly successful research clusters in highly skilled regions (e.g.

San Francisco, Boston), (2) successful, smaller research cluster in skilled mid-sized areas (e.g. Rochester, Minnesota, Austin, Texas), (3) successful research clusters in more troubled areas (Lexington, Kentucky, Morgantown, West Virginia, and (4) less successful places with little existing research infrastructure.

Most of distressed America falls into the fourth category and it is hard to imagine that research funding in such areas would yield much fruit. Consequently, it makes little sense to think about using Federal research funding to fight joblessness in the most desperate parts of the U.S. Distorting innovation policy by targeting it towards poorer states will bring the largest benefits towards the richest residents in those states, who already benefit from low housing costs, and this targeting will-- if anything-- exacerbate local inequality. There is an equity-related case for focusing on education and reducing the barriers to entrepreneurship in poorer communities, but invention policy seems poorly targeted for the needs of these areas.

The case for redistributing resources from places in category (1) to places in category (2) must rely on the nature of the research production function. If we had confidence that an extra dollar in a mid-sized area would be more productive than an extra dollar in San Francisco, then this redistribution might make sense. The case for redistributing research resources from places in category (1) to places in category (3) is somewhat stronger, because even if the research is the same quality, more funding in category (3) places may actually reduce joblessness. In this case, we would need to know the tradeoff between the number of jobs created and the value of research that is lost.

Geography and the Invention Production Function

Gruber and Johnson (2019) argue that research and development should be subsidized in America's most distressed areas, primarily through the tax code. This policy can be justified either because research and development produce more valuable inventions in distressed areas, or because any given level of invention produces more employment in these areas. A similar logic can be used to justify added invention spending, through the National Science Foundation or the National Institutes of Health, in distressed areas.

To clarify the tradeoffs involved in spatially targeting invention subsidy and spending, we now turn to a highly stylized model of national innovation policy. We define innovation in locality j as $I_j(S_j)$, where S_j is the spending by the Federal government in locality j, which could represent either direct grant spending or tax credit support. National knowledge is $I_{US} = \sum_j I_j(S_j)$. Output in each locality is a function of both local innovation and national knowledge $F_j(I_j, I_{US})$, which is meant to represent a broadly defined measure of overall welfare. We assume that the national objective function is $\sum_j F_j(I_j, I_{US})$.

If the government allocates a fixed bucket of spending to maximize total national output, which equals the sum of local outputs, then the first order condition will set $I'_j(S_j)\left(\frac{dF_j}{dI_j} + \sum_j \frac{dF_j}{dI_{US}}\right)$ equal over space. This expression contains three elements. The term, $I'_j(S_j)$, represents the impact that spending will have on the total stock of knowledge and that might differ across space. The term $\frac{dF_j}{dI_j}$ reflects the impact of local knowledge on the local objective function, and that might be higher in distressed areas because there are more people on the margin of employment. The term $\sum_j \frac{dF_j}{dI_{US}}$ is common across areas and reflects the national benefit from expanding the stock of knowledge. Spending might be particularly targeted towards an area either because the marginal returns of spending on research, $I'_j(S_j)$, are particularly high in that area or because the impact of innovation on local output, $\frac{dF_j}{dI_j}$, is higher in that area.

If the review panels of the NSF and NIH are ideally allocating funds to the projects that generate the highest level of knowledge, then $I'_j(S_j)$ is constant across space without any explicit spatial policy. It is conceivable that there are dynamic impacts of spending that are not captured by either N.I.H. panels or the model, and in that case, it may make sense to spend more in underdeveloped areas to improve long-term innovation.

But given the detailed knowledge of the N.I.H. and N.S.F. review panels, the presumption must be that they optimize research output without spatial targeting and that any spatial program will reduce the quantity of knowledge produced. In the case of private sector research, companies presumably locate research in places that will maximize their stock of private usable

knowledge. Yet the existence of research and development tax credits suggests that there are also externalities from private research and development, presumably reflecting the fact that some knowledge spills over to others. To justify spatial targeting on knowledge-creation grounds, we would need to know that knowledge spillovers are larger for inventions made in more distressed areas.

Heterogeneity in $\frac{dF_j}{dI_j}$ reflects different spillovers from local research and development activity (Jaffe et al., 1993, Hausman, 2018). If current programs equalize $I'_j(S_j)$ over space, then spatial targeting towards places with a higher value of $\frac{dF_j}{dI_j}$ will trade local economic benefits against global knowledge creation. If the impact of local innovation on local activity, $\frac{dF_j}{dI_j}$, is dwarfed by the impact of the stock of knowledge on overall American welfare, $\sum_j \frac{dF_j}{dI_{US}}$, then skewing research for local employment purposes will reduce welfare. If $\frac{dF_j}{dI_j}$ is large and heterogeneous, then spatial targeting of research funding becomes more attractive.

Spatial invention policy therefore depends on empirical evaluation of $\frac{dF_j}{dI_j}$ and the shape of $I'_j(S_j)$. The evaluation of $\frac{dF_j}{dI_j}$ is complicated by the fact that the government is not simply a pure G.D.P. maximizer. Welfare is not equivalent to wealth, and public policy may have added objectives such as decreasing joblessness or inequality. These added objectives would push towards more research spending in areas where the impact of innovation on joblessness was higher, or where innovation would do more to reduce income inequality.

If invention expenditure is more likely to reduce joblessness in eastern Kentucky than in Silicon Valley, and if joblessness produces externalities, then Pigouvian public economics suggests a difference in tax subsidy across space which is equal to the difference in the joblessness that is eliminated times the benefit per person moved from non-employment to employment.[8] The case for skewing research and development tax credits needs more empirical work, but it

[8] If employment generates different externalities in the two places, then that too needs to be incorporated nto the formula.

seems stronger than the case for skewing the process of awarding research grants because it can be done in a small way that doesn't endanger an existing process for targeting spending, and because these tax credits are not already awarded on a case-be-case basis by a panel that can already consider the wider impacts of the research

Spatial targeting of research funding is particularly risky because we have existing funding models that are remarkably non-political by the standards of Washington. Skewing grant funding to privileged geographies opens the flood-gates for political maneuvering, as we will see in the next subsection. Without estimates of the spatial effects of innovation spending, it would be hard to have confidence in any particular view, and the downsides of abandoning a scientific approach to grant-making are considerable.

The Empirical Track Record of Spatially Targeting Invention Subsidies

Geography naturally matters for Federal entities aimed at engendering innovation and better economic performance. The Small Business Administration "provides free counseling and low-cost training to new entrepreneurs and established small businesses in over 1,800 locations," and maintains district offices in every state. This wide geographic spread does not reflect a conscious attempt to relocate small businesses or even to right geographic inequities, but rather just to ensure that their services are available to every American entrepreneur.

The geographic element of the National Science Foundation is somewhat more surprising, since knowledge can benefit all Americans even if it is produced in a small range of locations. Yet the 1950 Act founding the N.S.F. proclaimed "it shall be an objective of the Foundation to strengthen research and education in the sciences and engineering, including independent research by individuals, throughout the United States, and to avoid undue concentration of such research and education." No justification is provided for this goal, and no definition is given of "undue concentration," but this clause is the primary justification for the NSF's Established Program to Stimulate Competitive Research (EPSCoR) program.[9]

[9] Formerly the Experimental Program to Stimulate Competitive Research.

The EPSCoR program was founded in 1979 and it originally provided targeted funding for six states: Arkansas, Maine, Montana, South Carolina and West Virginia. Since 2016, there are 25 states that are eligible for EPSCoR funding, and a number of other Federal agencies, including the Department of Energy and NASA, have embraced the EPSCoR model. The National Institutes of Health has had its own "Institutional Development Awards" (IDEA) program for supporting research and education in 23 states.

The initial objective of this program was "enabling universities in every state to be able to compete for federal research funding," according to a 2013 National Academy of Sciences review.[10] This outreach spending could be justified even without the N.S.F.'s mandate "to avoid undue concentration," if the returns to education investment are sufficiently concave in the research production function, so that hidden talent emerges with a small amount of funding in Montana or Maine. The alternative interpretation is that the geographic spread is largely political, ensuring wider support for the National Science Foundation from a larger set of Senators.

The National Academy of Sciences report notes that over the years EPSCoR programs have been subject to mission creep with "other goals, such as enhancing innovation to stimulate economic development and entrepreneurship and expanding the diversity of the science and engineering workforce." While the National Academy of Sciences was charged by Congress with evaluating EPSCoR, their report notes that "the breadth and increasing complexity of the EPSCoR objectives have made it difficult to develop a rigorous assessment system with quantitative metrics." Consequently "the committee could not assess the effectiveness of ESPCoR with the necessary rigor needed to fully address Congress's charge."

Nonetheless, the "committee" came to the view that "several million dollars of funding and 5 years of effort were clearly not going to transform a state's research capacity," which is essentially rebutting the extra concaving case for targeted spending. The committee concludes that "EPSCoR has been in operation for more than 30 years and, over this period, the program has invested several billion dollars in capacity-building activities, yet the same 10

[10] https://www.nap.edu/read/18384/chapter/2

states that received the highest level of research funding in 1977 still top the list," and "EPSCoR-eligible states received roughly the same percentage of total federal research funding in 2012 that they had received in 1979."

EPSCoR, and the many related programs, have not redrawn the map of American innovation. This could mean that they were simply too small to have a visible impact or that this process was doomed from the start. Yet, we take this empirical track record as pushing against spatial targeting of invention policy. The EPSCoR problem doesn't appear to have generated strong results and we have abundant evidence for changing the geographic scope of its activity for presumably political purposes. Targeting innovation policies relating to education and entrepreneurship seem likely to be more effective tools for reducing local joblessness than relocating inventive activity.

Targeting Research for Distressed Regions

But research can aid distressed regions even if it isn't located in distressed regions. One plausible response to the joblessness in the American heartland is to subsidize innovations that will promote employment in that region, even if the innovators themselves remains in Boston or San Francisco. This view would be untenable if innovations had little impact outside of their region of origin, but most major innovations have nation and global reach, and some even drive employment in distressed areas.

Most obviously, American medical research is an innovation machine that generates procedures and prescription medicines that improve both longevity and quality of life. This innovation machine is funded directly by the National Institutes of Health. The public sector also funds research indirectly because Medicare and Medicaid will both pay for new procedures that confer some medical benefit. Unlike many European single payer systems, the American healthcare system provides something of an open-ended commitment to pay to use new innovation, which is an enormous spur towards corporate creativity.

That public research bonanza has helped healthcare to become the largest employment cluster in many poorer parts of America. The expansion in the number of medical techniques has saved many lives, but it has also increased the size of the sector. Nationwide, the Census

reports that 14 percent of employed persons in the U.S. work in the healthcare and social assistance.

In depressed areas, this share can be much higher, because there is fewer forms of other economic activity. Eighteen percent of employment in the state of West Virginia is in healthcare. In the city of Cleveland, that share rises to almost one-in five. The share of employment in healthcare and social assistance is only likely to increase with the number of innovative health-generate procedures created by the country's top medical research centers.

Since Medicare and Medicaid are both entitlements, these procedures lead to employment and spending in regions that have few other sources of earnings. Consequently, healthcare has become a dominant industry in many declining places. Future changes either in Federal healthcare policy or the labor intensity of medical provision have the capacity to deeply shape economic conditions in poorer parts of America.

Health care innovation has certainly generated vast numbers of jobs in less advantage parts of the country. Healthcare employees are employed themselves and provide demand for other local services. It is possible that the vast size of the medical sector has crowded out other activities that might lead to more export-related entrepreneurship in the long run, but we have little evidence to support such a claim. A more plausible view is that healthcare spending on new medical innovations seems like a short-term boon for disadvantaged economies, but not a basis for long run economic resurgence. Ultimately, a structure where Federal largesse pays for a clearly delineated set of procedures that are invented elsewhere seems likely to lead to employment but not entrepreneurship in distressed communities.

Is it possible to incentivize a broader set of innovations that might encourage entrepreneurship in distressed parts of America? In healthcare innovation, there is an obvious tool. If N.I.H. funding were dedicated to research that moved people from disability to being employable, that could have a major impact on the economy of these regions. Disability is the larger Federal program providing aid for non-employed prime-aged males (Autor and Duggan, 2005). If health innovations could specifically work at moving adults from disability to employability,

this might particularly benefit distressed parts of America by reducing the level of permanent joblessness.

A second possibility is that N.I.H. could spend more on researching remote delivery of medical services, which could be particularly valuable in lower density areas of America with fewer doctors. Delivering medical services over distances is already becoming a reality, and long distance health care could potentially improve the quality of care in distressed communities. The benefits could be even higher if the research targeted long distance delivery of healthcare for conditions that particularly afflicat isolated communities.

The N.S.F. also has programs that could encourage innovation in distressed areas. Most obviously, this could be done through the Engineering Directorate as part of the Division of Industrial Innovation and Partnerships. We suspect that trying to forecast which innovations will employ less skilled people in distressed areas is almost impossible. Consequently, ex post rewards may be the only option.

V. Human Capital for Distressed Regions

In Sections II and III, we documented the positive links between education and invention and the negative correlation between education and joblessness. These correlations suggest that distressed regions must improve their human capital levels in order either to become more inventive or to capitalize on new inventions through entrepreneurship. In this section, we first discuss the literature linking universities and local economic success and how universities might be strengthened in distressed parts of the U.S. Second, we suggest the possibility of bringing entrepreneurship into the education sector via competitive sourcing of vocational training for high school and community college students.

We then turn to two strategies for attracting human capital. One approach is to tilt immigration policy to favor distressed areas, such as issuing more H1B visas to companies that locate in distressed areas. A second approach is for localities to deliver local amenities that particularly appeal to inventors and entrepreneurs, such as freedom from non-compete

clauses. Naturally, more general amenities, such as safer streets and better schools, can also play a role in attracting talent, but such policies are beyond the scope of this paper.

Universities and Local Economic Success

Palo Alto was a near wilderness in 1894, when Leland Stanford founded his university there. Today, Palo Alto and Stanford are the epicenter of perhaps the most productive region in the world. Over the past forty years, Cambridge, Massachusetts has evolved from a decaying industrial town into a thriving innovation hub largely through the influence of its universities. In the often distresed eastern heartland, university cities, like Lexington, Kentucky, Columbus, Ohio, and Bloomington, Indiana, stand out as regional success stories.

The economic literature provides compelling evidence of the link between the presence of universities and local success. Universities are both educators and producers of new ideas (Henderson, Jaffe, Trajtenberg 1998), which are disproportionately transmitted locally (Jaffe, Trajtenberg and Henderson, 1993; Belenzon and Schankerman, 2013). Stephens-Davidowitz (2014) finds that people who are innovative not just in science, but also in art, entertainment, business, and politics come disproportionately from either big cities or university towns.

Hausman (2018) documents that when universities are given stronger commercialization incentives, employment grows disproportionately in industries most closely related to the nearby university's ex-ante innovative strengths. Corporate innovation also increases in these local university connected industries, suggesting the importance of universities not only in producing ideas but also in stimulating local corporate production and implementation of new ideas.

Indeed, early investments in higher education seem to produce benefits decades or centuries later. Moretti (2004) shows the sizable wage benefits of having a land grant college in a city prior to 1940.[11] Cantoni and Yuchtman (2014) show that the founding of medieval

[11] Kantor and Whalley (2014) show a rise in local wages in response to university endowment shocks. The increase is greater for research-intensive universities and in industries that, nationally, hire more college graduates and cite more university patents.

universities in Germany after 1386 had important long-term effects on nearby economic activity, possibly because their law students developed the legal and administrative institutions to facilitate markets.

One interpretation of the economic impact of universities is that they attract and retain smart workers, who then generate human capital externalities. Rauch (1993) and Moretti (2004) document the strong link between local human capital levels and wages. Local human capital also predicts subsequent growth in employment, population and earnings (Glaeser, Scheinkman and Shleifer, 1995, Glaeser and Saiz, 2004, Shapiro, 2005).

Over the past 60 years, human capital levels, as measured by the share of the population with a college degree, have been geographically diverging (Moretti, 2004, Berry and Glaeser, 2006) such that the initial skills advantage conferred by a university has only become more important over time. This divergence may reflect the tendency of skilled people to invest in amenities that the skilled like (Diamond, 2016),[12] or increasing restrictions on the supply of affordable housing (Ganong and Shoag, 2018). This divergence could also reflect the tendency of skilled workers to innovate in ways that demand the labor of other skilled workers (Berry and Glaeser 2006; Acemoglu 2002).

Human capital externalities appear tangibly in research parks that enable entrepreneurs to learn from nearby academic innovators. The success of the North Carolina Research Triangle or Stanford Industrial Park seems to suggest the existence of such spillovers. Partnerships of physically proximate scientists, like M.I.T.'s Robert Langer and Steven Zeitels of Massachusetts Eye and Ear Infirmary, to solve problems that appear locally, like Julie Andrews' botched throat surgery, further support the innovative impact of universities.

If the goal is to reduce joblessness in distressed parts of America, then universities can be nudged towards more local economic engagement. If universities were standard profit-making firms, then incentives would already be in place, but universities, especially public universities, may have different objectives. Stronger incentives for commercialization may also induce universities to allow their faculty members to benefit more from their innovations.

[12] Ganong and Shoag (2018) suggest that skills divergence may also reflect restrictions on building in more skilled places.

Lach and Schankerman (2008) show that royalty incentives increase faculty effort and the subsequent quality of inventions.

Fehder, Hausman, and Hochberg (2019) find that commercialization of university innovation is more common in large cities. This fact suggests that the presence of nearby human talent is an important ingredient in the technology transfer process. Consequently, cities and universities may end up being more complementary in the future, which may make it more difficult for rural universities to compete. This trend may also make it harder for universities to bring jobs to lower density areas. In principle, any system that rewards universities for generating jobs from their research can reward them more for jobs in places that are harder to reach.

For example, in distressed communities, a portion of the overhead might be designated for funding the technology transfer office that works to commercialize local innovation. Subsequent receipt of an expanded overhead rate could then be made contingent upon past performance in the commercialization of Federally funded research. If future overhead rates depend on the level of commercialization, then universities may increase royalty incentives to faculty members to increase the level of commercial innovation.

Another stronger tool is to offer priority to N.I.H. funding for scholars or labs that have a track record of producing innovations that lead to large scale employment of less skilled Americas. The scholar or lab would have to document such a track record. An N.S.F. panel would have to evaluate this claim. If the scholar had indeed generated jobs in the past, then she or he will probably be more likely to generate jobs in the future. It seems reasonable to grant this scholar a modest amount of extra priority or extra funding.

If the university's scholars generate a funding benefit for the university from a track record of successful commercialization, then the University should have an incentive to be more proactive in seeking out potentially commercializable discoveries from within the university. Mirelman (forthcoming) suggests that many University Technology Transfer Organizations are quite passive. University overhead rights from Federal grants could also be tied to past generation of employment, which would also create stronger incentives to commercialize

technology. These commercialization-geared policies seem more likely to generate growth than piling R&D dollars on sub-par research projects in these distressed places.

More generally, federal funding through Pell Grants and other programs for students going to schools in distressed areas could be increased and tied to performance. School aid could increase or decrease based on the students' subsequent fate in the labor market. For example, Pell Grant funding could be increased by one-third in distressed areas, but that extra funding might be made available only ten years after graduation in proportion to the share of that post-graduation decade in which the student had paid income taxes.

Work-study programs are a third area for reform in distressed areas. The Federal caps on work-study could be increased for students in these areas. Work-study aid could be targeted more closely towards working in fields that are likely to yield higher paying work after graduation. For example, being a research assistant in a science lab could be supported more aggressively than working in an administrative dean's office.

For many, learning-by-working is easier than learning-by-studying. Working with faculty members on research-related projects may be a particularly natural way for students from distressed areas to come to understand the innovation economy. Naturally, these programs should be subject to experimentation and evaluation, but there is surely room for experimentation with policies towards colleges and universities in distressed areas, in order to promote both the employment and future entrepreneurship of students and faculty.

Entrepreneurs for Education: Vocational Training outside of School

Many students in distressed areas do not attend college. They are the ones that are at greatest risk of long-term joblessness. Education policy should also do more to spur the development of usable skills before high school. One vision incorporates entrepreneurial skills delivery with traditional high schools.

In some cases, vocational schools operate well in the U.S., but often they do not. Boston's Madison Park High School has had a troubled history since its creation as Boston's magnet vocational school. One reason for its troubles is that students and their parents don't want to

accept that, at age 14, they are already tracked into a vocational path. Older, tenured teachers may also lack the skills needed to educate students for the 21st century economy.

One possible approach is to do more to teach vocational students after school, on weekends and over the summer. Currently, high school students who are children of less educated parents report doing less than 4.5 hours per week of homework and more than 20 hours per week of screen time, along with another 12 hours per week "hanging out."[13] Adding eight hours to the school week for vocational training does not seem like an impossibility, and more time could be spent over the summer.

Vocational training need not be provided by school faculty, although it would in most cases be provided in schools during off hours. Skills like plumbing and computer coding can be provided by specialized teachers. Ideally, these skills will be competitively provided by different would-be educators, which might include for-profit firms, labor unions, non-profit organizations and even existing vocational schools. An entrepreneurial model makes sense for vocational training because it is possible to evaluate whether the student has learned the skill and to make payment to the provider contingent upon skill acquisition. The economy's quickly changing demand for specific skills is another reason to involve entrepreneurs who keep their fingers on the pulse of American markets.

Entrepreneurially supplied vocational training could be Federally funded for all children who are deemed to be at risk, which can be defined based on a combination of parental and community attributes. Once again, the programs can be experimental, and even if they do become permanent, evaluation would be built into the process because of the pay-for-performance aspect of the training. Ultimately, the goal would be to encourage entrepreneurial educators to provide skills with market value.

Perhaps the hardest task is to determine the vocations that will be taught. While it may be straightforward to judge whether a carpenter is trained, it is not so easy to tell whether the economy has enough carpenters. One approach would be to begin with a small number of large occupations, which enjoy low levels of unemployment and reasonable wages, and then

[13] https://www.bls.gov/opub/mlr/2007/05/art4full.pdf

add new skills gradually over time, based on demand and performance. For this larger question, it would also be useful to have longer term data on the earnings and employment of children who go through these programs.

Importing Human Capital through Place-Based Immigration Policy

In 2013, Michigan's Governor Rick Snyder urged immigration reform "to welcome innovators, entrepreneurs and skilled workers from around the world" because "they can help our core industries - automotive, agriculture and tourism - continue to drive Michigan's comeback."[14] Governor Snyder's ideas "included an ambitious proposal to ask the federal government to use existing visas to bring 50,000 skilled immigrants to Detroit of the next five year; support for a state-sponsored EB-5 investor visa regional center; creation of a Michigan Office for New Americans within state government; and allocation of state resources for the national nonprofit Upwards Global to open a Detroit office to help skilled immigrants and refugees connect with meaningful careers in the fields of expertise" (Tobacman, 2014). Snyder echoed earlier proposals during the Great Recession to admit immigrants who would buy housing and boost prices in depressed regions.[15]

If human capital is a central ingredient in regional success, then the global supply of talent that wants to come to America appears as an almost miraculous solution for low human capital regions. Kerr (2018) documents the outsized role that skilled immigrants play in America's innovation economy. In recent years, numerous policy analysts have followed Snyder's lead and called for some form of increased legal immigration targeted towards distressed regions.

This enthusiasm is somewhat at odds with the national mood. In November 2018, more than one in five Americans told Gallup pollsters that immigration was America's largest problem.[16] Yet even if immigration may depress national wages for workers who are comparable to the immigrants (Borjas, 2003), there is little evidence immigration hurts wages locally (Card, 1990). Immigration flows do seem to boost local housing markets, which would certainly be seen as a plus by the homeowners of Detroit (Saiz, 2005).

[14] https://www.michigan.gov/formergovernors/0,4584,7-212-90815_57657-293976--,00.html
[15] https://www.wsj.com/articles/SB123725421857750565
[16] https://news.gallup.com/poll/244925/immigration-sharply-important-problem.aspx

The idea that spatially targeted immigration could increase entrepreneurship and innovation in distressed areas seems distinctly plausible, but what policy tools does the U.S. government have to determine where immigrants choose to locate once they come to the United States? The U.S. government could increase the H1B Visa cap for firms that are located in distressed areas. The U.S. government could also increase the size of the EB-5 investor program and the government could allow cities and towns to sponsor their own immigrants. To limit local antipathy, all spatial targeting might be contingent upon localities opting into the program.

The H1B Visa program is a reasonably easy program to expand for distressed areas. There is a nationwide limit on the number of H1B visas that are available. These are typically rationed through a lottery system. The natural reform is to lift the cap for employers that are located in distressed areas. This easing may allow these employers to expand their skilled workforces and potentially generate spillovers for other workers in the area.

The natural worry is that an increase in H1B Visas will crowd out existing workers. This concern seems unlikely in distressed areas, since H1B Visa recipients are typically quite well educated, while the average worker in the area is far less skilled. In many cases, the less skilled among the residents may benefit by the demand for services that will be generated by the more well educated H1B visa holders. Those downsides may also be limited by the requirement that the area has to select to enter the program.

One difficult part of the H1B Visa program is that the Visa is tied to the employer, which gives the employer some monopsony over the employee, limits the fluidity of the labor market, and potentially reduces the scope for knowledge spillovers. One way to make the H1B Visa program more fluid in distressed areas is that the Visa could be transferable to other employers in the same area or in other similarly distressed areas. The program would then be relatively more appealing to immigrants but perhaps less appealing to employers.

The EB-5 investor program grants visas and green cards to immigrants who invest in distressed areas.[17] This program has been in operation since the mid-1990s, and it seems less likely to lead to widespread migration, both because it requires sizable capital and because it is prone to

[17] http://icic.org/wp-content/uploads/2016/04/ICIC_EB5Impact_Report.pdf

manipulation. Many immigrants would prefer to invest in wealthier parts of America, and the target areas have been redefined over time to increase investor flexibility.

The investment requirement could be beneficial if the primary weakness of distressed areas were in physical capital, but in many of these areas, human capital is the greater need. Moreover, the supply of global immigrants with a million dollars to invest in America's eastern heartland does not seem to be large enough to plausibly change the region's skill composition.

A final idea that has been proposed is to allow places to apply for immigrant visas, just like companies can. This idea is appealing and could in principle lead to more skilled immigration going to depressed areas. Yet there are reasons why this program is harder to imagine than an expanded H1-B visa program. Many of the workers who come to depressed areas as part of this program will prefer living elsewhere. Consequently, it will be hard to ensure the connection between person and place. Even if the immigrant were to stay in place until she received her green card, the chance of subsequent mobility would then jump.

If there were a national mood to increase immigration, then it might make sense to increase the flow of visas to people who at least showed some willingness to move to depressed areas. It is harder to imagine political support for a large scale expansion of any standard program. A spatially targeted H1B program seems like it has the most likelihood of actually ensuring the skilled workers will end up in unskilled communities.

Attracting Talent and Non-Compete Clauses

The overall welfare consequences of the migration of skill workers and potential entrepreneurs into distressed areas are unclear. That migration may reduce the joblessness problem in those areas, but it may also reduce the current creativity in more successful areas. The competition for migrants, and job-creators, can be beneficial, when local governments focus on quality of life investments and good local management. If local governments spend too much time on targeted tax deals for large, the impact of competition may be less benign.

One natural way that distressed areas may attract talented workers is by refusing to enforce non-complete clauses in contracts, even when those contracts are signed in other states. Non-complete clauses in contracts make it easier for firms to trust employees with specialized

knowledge, but also limit the flow of that knowledge across the innovation sector. The enforcement of non-compete clauses is already place-based within the United States.

In some states, such as California, state courts refuse to enforce contractual clauses which bar future employment in competing firms. In other states, such as Massachusetts, these laws are enforced. Fallick, Fleishman, and Rebitzer (2004) found that stricter enforcement of non-compete agreements reduced mobility in computer manufacturing industries. In 1985, Michigan started to enforce non-compete agreements in a switch that seems almost accidental.

Marx et al. (2009) examine the impact of that change and found that stricter enforcement of non-compete agreements reduced inventor mobility, especially for those inventors with highly specific skills. Hausman (2019) looks over all states and similarly finds that inventors are less likely to leave firms in states with stricter enforcement of non-compete agreements. Non-compete agreements particularly deter inventors from leaving larger firms.

Enforcement of non-compete agreements does have the potential benefit of protecting employers against the loss of firm-specific knowledge, which may in turn lead them to hire more workers. Of course, sharing trade secrets can be and often is illegal in cases where non-compete agreements are not enforced. Nonetheless, non-compete agreements do grant the employer some added protection. Conversely, the reduce the flow of knowledge between firms and make the labor market generally less fluid.[18]

If non-compete clauses were enforced nationally, then it would be hard to know whether these clauses were benign or not. But local enforcement does not protect firms against losing their firm specific knowledge, since the worker can always relocate to California. That right was affirmed by the California Supreme Court in 1998 in the case Application Group, Inc. vs. Hunter Group, Inc. Local enforcement only ensures that any positive benefits from the weaker leaving will happen somewhere else.

If distressed states were to make non-compete agreements non-enforceable, perhaps especially for innovative sectors, then they might become attractive locales for inventors whose

[18] Typically, eliminating the ability to write contracts can rarely represent a Pareto improvement for all actors. It is at least possible that eliminating the ability to enforce non-compete clauses could be Pareto improving if the movement of workers across firms generates new ideas where generate external benefits.

contracts force them to leave other areas. Ideally, the non-enforcement could create a local eco-system of mobile inventors. At least, such a change would symbolically indicate an eagerness to attract outside talent.

Another even more complex legal institution that impacts innovation is patenting, which rewards innovation with a time-limited monopoly. The natural alternative to patenting is a fixed reward, as in Kremer (1995) or the rewards offered for solving the longitude puzzle (Sobel, 1994). When Oklahoma's Medicaid system agrees for a fixed price for access to a medication, regardless of quantity consumed, then the manufacturer is in a sense being rewarded with a fix fee rather than with monopoly pricing.

There may be cases where innovations can contribute to local productivity, such as prescription drugs that make it easier for disabled people to get back to work. In such cases, distressed states may consider buying out the patent locally, or paying a fixed fee for low unit costs, to reduce the underutilization that comes with high prices. This policy seems easiest to envision in the medical sector, but the same logic may hold with other innovations as well.

Another option might be for patent protection to depend on employment levels. If a patent is associated with significant numbers of less-skilled employees, then it could be extended by a year. If a patent leads to little employment, then it could be shortened. We are not recommending such a change, but just suggesting a rethinking of the connection between patent policy and employment.

VI. Spatially Targeted Entrepreneurship Policies

The spatial mismatch between the places in America that patent highly and the places in America where joblessness is high means that joblessness will decline only if some of the new ideas get implemented in places with higher levels of joblessness.

In this section, we discuss strategies for improving entrepreneurship in distressed areas. We start by discussing the many cases in which imported ideas have led to local employment. The case of Uber suggests that when work-creation in distressed areas is easier when it is flexible

and when the jobs avoid the mandated benefits that come with a formal employment relationship.

We then turn to reducing the barriers that stop inventions from being turned into employment, both by reducing land use controls and overregulation of entrepreneurs near universities. We discuss entrepreneurship zones in more distressed areas. We also consider policies to encourage both inventors and entrepreneurs to focus on less skilled workers, such as employment subsidies and entitlement reform. We end by discussing a reconfiguration of national entrepreneurship policy.

Can imported innovations engender local entrepreneurship?

Much of the entrepreneurship in the developing world was initially imported, but usually the entrepreneurs have been manufacturers and often they had a captive local market. The Argentine industrial giant founded by Torcuato DiTella began when he started making gasoline pumps under license to the American Wayne Pump Company in 1923. DiTella perturbed the product for local conditions, and then expanded into a large range of industrial products. The East Asian car companies similarly borrowed technologies that were initially developed in the west.

One primary difference between the East Asian model (exemplified by Toyota or Hyundai) and the Latin American model (exemplified by DiTella) is that the East Asian entrepreneurs adapted the technology to local labor supply while the Latin Americans were more likely to focus on local demand. Korean and Japanese producers, at least after World War II, attempted to sell globally, relying on their low cost but high skill labor as a comparative advantage. The Latin American entrepreneurs were less likely to sell globally, and more likely to rely on local markets.

Such imitation and improvement also occurred with the U.S. Francis Cabot Lowell famously began the American industrial revolution with an act of industrial espionage, important English technologies into the U.S. Cyrus McCormick regularly sent agents throughout the U.S. to learn the ideas of competing producers of mechanical reapers. After World War II in the

U.S. context, low transportation costs and low tariffs prevented entrepreneurs from just copying goods or even production techniques for the local market.

In the U.S. after World War II, there have been service-industry entrepreneurs who borrowed ideas invented elsewhere, and then combined them with local knowledge or used them to supply services. For example, Clarence Saunders seems to have invented the self-service grocery with his Piggly-Wiggly chain in Memphis, Tennessee, in 1916. Despite his attempt to patent the idea, it spread widely and was improved. Fourteen years later in New York City, Michael Cullen then combined self-service with distinct food departments and discounted prices and founded perhaps the first true supermarket chain. The success of Whole Foods shows that there is still room for innovation in grocery stores, and grocery store employment has increased substantially in some states, including California, Massachusetts and Texas, over the past 20 years.

The KFC model is one plausible model of service sector entrepreneurship in distressed areas. The entrepreneur borrows and adapts technology from elsewhere, and first sells entirely to locals. The product develops and evolves and eventually is appealing enough to open branches elsewhere. Local entrepreneurs that adapt external ideas for local conditions and then exports their services provide one model for non-local ideas to generate employment in more depressed regions.

The second model involves external entrepreneurs bringing new firms of employment into depressed regions. Historically, this was done as factories moved from high wage rust-belt regions into lower cost right-to-work states. Manufacturing relocation has become less common because labor is a far lower share of manufacturing costs, and because low wage areas often lack the high levels of human capital that are needed for complex production processes.

Moving service sector jobs to lower wage areas is far less common since service providers need to be near customers, and there are fewer service customers where places are poor. providers are the obvious exception, who can build large employment center anyplace with an attractive climate, such as Orlando, Florida or Aspen, Colorado. Las Vegas, Nevada, is the most

obvious example of a metropolitan area, located in the middle of the desert, that expanded enormously based on employment in leisure and hospitality. The initial growth of that city, like Orlando's Disney World, was driven almost entirely by non-local entrepreneurs.

Uber provides another example of imported innovation providing employment, and services, in distressed communities. We have already noted the many thousands of drivers who live in distressed areas and make money through Uber. In some cases, those drivers make a harrowing two hour commute to wealthier cities. In other cases, the find work closer to home. Uber also provides a valued service for users in wealth and depressed places alike.

The Uber model is somewhat remarkable because unlike almost most major San Francisco technology start-ups, the App provides jobs for less skilled Americans rather than reducing the need for less skilled labor. This car-sharing service provides a model for labor-creating innovation that generates jobs far from the place of creation, even when the taxpayers aren't picking up the bill. Zappos also makes heavy use of non-technology workers in the customer service phone banks that are a major part of its business model, and call centers are at least one type of service that can be done long distance.

Uber has provided a different model of local service sector job growth based on non-local ideas and entrepreneurship. Uber requires a minimal local presence to make its platform available for use even in highly depressed areas. By avoiding formal employment status for Uber drivers, the fixed costs of operation are much lower and it is possible for the service to enable people to sell their labor even in areas that are quite far from the company's San Francisco headquarters and from any physical Uber presence.

It seems quite plausible that Uber, and other companies, may be able to provide service sector opportunities in poor places. Yet long-run economic success for a locality requires some form of an export industry, and local service provision does not generate export revenues. Is it possible for technological innovation, imported from somewhere else, to generate some way so that the residents of poorer places can sell their labor to the residents of richer places?

Plausibly, the online-matching model at the heart of Uber can generate a large number of jobs in a wide range of service tasks, from babysitting to gardening. Reducing the frictions that bar

service sector employment in depressed areas may generate sizable employment gains, but it will not turn these sectors around until these applications can lead to exports to other regions.

Uber has already provided a conceivable model for service exports in that it does allow drivers who live as far away as Sacramento to earn a living driving in the San Francisco region. This is an extraordinarily long commute, but it does seem possible that more services can be provided for the residents of successful east and west coast metropolitan areas by workers who live two to three hours away. For example, one could imagine painters coming into Washignton, D.C., from West Virginia, or gardeners traveling into Los Angeles from much further away. In some cases, the service could be virtual, but in that case Americans will need to compute with virtual service providers in far lower wage places, like India.

Uber proves that entrepreneurs based in San Francisco can provide work for the residents of West Virginia, but we don't know how far that model can expand. This model may expand into a wider range of services targeted at the local population. It seems harder, but not impossible, to expand the model so that the residents of poor areas provide services for people living in richer areas.

The largest industrial sector in many depressed parts of America—healthcare-- uses technology developed in America's most innovative places. Healthcare spending is often higher inn a per capita basis in depressed areas, and since other industries are minimal, healthcare stands out as a dominant employer. This helps explain why the share of employment in healthcare has had a strong negative correlation with population growth across cities (Glaeser and Shapiro, 2003). Imported innovations can certainly shape depressed local economies, but it is less clear if these technological imports in healthcare can become a self-sustaining engine of growth.

Perhaps the most natural public policy to support service sector entrepreneurship in distressed areas is to reduce the costs of hiring workers as discussed above. If healthcare costs are covered by the state, or the payroll tax is eliminated for younger workers, then it is easier to start a new fast-food restaurant in a distressed part of the U.S. Lower labor costs make service sector innovation distinctly easier given that service sector employees are typically quite low wage.

It is also possible to encourage the education of potential entrepreneurs in these areas. Local universities and colleges could have targeted programs that train would-be entrepreneurs to learn from external innovators but provide local employment. The Federal government could subsidize such programs, as long as they were subject to rigorous evaluation ideally with

Eliminate local barriers to the commercialization of research

If research funding generates spillovers that depreciate with distance (Hausman, 2018), then barriers to economic activity and to building near research universities will reduce the external benefits of Federal research funding. Relocating research funding towards distressed areas is one tool for potentially increasing the social benefits of innovation, but that benefit must be offset against the costs of not supporting the most productive researchers. An alternative is to make it easier for economic activity to emerge near research universities.

Universities, like Stanford and M.I.T., have incentives to partner with firms that would directly commercialize their research. The incentive to enable services that might sell to the workers in those firms are weaker. Moreover, even if an urban university is perfectly happy to see new service sector firms nearby that employ the less skilled, local regulations may prevent that from happening.

For example, Boston's Longwood Medical Area and Cambridge's Kendall Square are both places with abundant research. Kendall Square has particularly seen the emergence of a start-up ecosystem that surrounds M.I.T. But in both of these areas, the emergence of other businesses has been far more limited. Robust demand and limited supply mean that Kendall Square Commercial real estate often costs more than 40 dollars per square foot per month. An extremely restrictive permitting environment limits the ability to start restaurants and grocery stores.

For businesses that could benefit from proximity to a research center, the relevant restriction are local permitting rules and rules that make it difficult to construct more commercial space. For the larger population, restrictions on housing supply are the more important limit. Housing supply is limited by a web of rules including minimum lot sizes, growth control, historic preservation rules and wetlands protection. These rules are particularly stringent in research-

intensive metropolitan areas, including San Francisco, San Jose, Boston, and Seattle. They limit the ability of less-skilled people to take advantage of proximity to often Federally-funded innovative activity.

These issues do not appear just in the most successful cities. Educated people are more engaged politically, and education is correlated with enacting more stringent land use controls (Glaeser and Ward, 2009). Consequently, funding an educational institution almost guarantees a rise in local barriers to building which will limit the ability of others to take advantage of that building. Austin, Texas, for example, has become a more difficult building environment than the rest of Texas.

But while the case for enabling new business formation and population growth near research hubs seems strong, the appropriate Federal policy is not clear. Federal research funding could be directed more to areas that make growth and new business formation easier, but that would come at the cost of less efficient research targeting. Another option would be to tie research funding to improvements in the permitting environment, but neither researchers nor their schools have control over the permitting process.

One small might be for the Small Business Administration to work with the N.I.H. and the N.S.F. to develop policies that would enable businesses to grow near centers of innovation. A simple policy might be for the S.B.A. to fund one-stop permitting centers for new businesses near research centers if communities are willing to accept such a structure. This could be done, as discussed above, without legal reforms and could still smooth the process of permitting for small businesses.

A stronger and more fraught approach is to tie overhead rates on research grants to the construction of new housing or dormitory space. If universities are nudged to deliver more residential space, this might reduce the demand of students for housing in the outside community and that should reduce housing costs. Naturally, such requirements are difficult to impose with the permitting environment makes new construction extremely difficult, but a building requirement for universities that research over some significant threshold could still

send a message about the importance of delivering livable space near places that receive Federal funds for research.

Entrepreneurship Zones for Distressed Areas

Enterprise zones and innovation hubs, which are typically designed by state or local governments, are meant to attract and encourage innovation and business success. Universities and companies usually consider geographic proximity when designing their buildings and locating their researchers. Almost always, these clusters are devoted more to entrepreneurship than to invention.

When Peter Hall envisioned enterprise zones in the 1970s, he imagined rust belt England re-industrializing by imitating lightly regulated East Asia. But manufacturing seems less relevant in America today, and the large manufacturing plants are almost sure to receive a generous tax deal in distressed America already. The more relevant small service sector entrepreneurs cannot negotiate their own deals, and are more likely to need proximity to other successful firms. They are the natural target for entrepreneurship zones.

Such zones are most plausible near existing research institutions, and within poorer neighborhoods of cities that are not close to research clusters. It is harder to imagine the success of these zones in lower density areas that are far from centers of innovation, because it is hard to imagine that either technology or service sector startups can succeed in isolation.

The two most famous examples of university-oriented entrepreneurship zones are the Stanford Industrial Park, initially envisioned by Frederick Terman of Stanford, and North Carolina's Research Triangle Park. In both cases, the clusters were pushed by universities to encourage businesses who would benefit from proximity to academic researchers. Even though "Research" is in the name of "Research Triangle Park," the Park is better seen as a place where research embedded into entrepreneurship, rather than as a place to do basic research itself.

These parks are designed to enable the flow of ideas between academic and companies, and to generate a long-term eco-system that will generate larger economic growth for the region. Much like successful development of shopping malls and commercial skyscrapers, they represent a form of local real estate related entrepreneurship. One plausible interpretation is

that some of these clusters will succeed. Others will fail and the process of competition across places for talent is both fundamentally benign, and not really an appropriate area for national policy intervention.

By contrast, enterprise zones were originally envisioned by Peter Hall as a national economic meant to bring economic vitality to underperforming regions. In the 1970s, Hall observed the economic vitality of the lightly regulated East Asian Tigers, including Taiwan and Hong Kong, and thought that perhaps a similar approach might work for England's declining industrial towns. Hall's vision was the Nucleus for Margaret Thatcher's Enterprise Zones, which become Empowerment Zones in the U.S. These zones were meant to combine tax and regulatory relief, but in practice, enterprise zones have more typically specialized in tax support. Over the past 18 months, Opportunity Zones represent the latest iteration of providing tax breaks for investing in underperforming regions.

Busso, Gregory, and Kline (2015) document the positive employment and wage impacts of empowerment zones within the U.S., implying that subsidies can create localized jobs. It is less clear if this represented net job creation or simply relocation of employment. Still, if an employer relocates from a low unemployment region to a high unemployment region, this may still reduce joblessness overall, even if the firm hires the same number of workers in each location.

From a national perspective, zones are better justified as places of experimentation rather than places of permanent subsidy. For example, Peter Hall's original vision of a low regulation zone within a high regulation is a perfectly plausible model for an experiment. If the zone appears to spur entrepreneurship, especially among lower income residents, then it may be sensible to expand the zone to encompass a larger share of the urban area.

The success of technology hubs, like Silicon Valley, has led many local policy makers towards policies aimed at creating innovation corridors in their districts. But for many areas and many workers, Peter Hall's vision may be more relevant. Can policy-makers generate zones where entrepreneurs will find it attractive to employ less skilled workers, especially in the service industries? Hall's vision was to reduce tax and regulatory liabilities. The Busso et al. (2014)

evidence suggest that targeted tax subsidies can generate jobs in empowerment zones, but the high cost per job challenges the sustainability of such a generous subsidy-based employment model.

A light regulation zone designed to encourage service sector entrepreneurship provides a far more plausible model for transforming new ideas into jobs for less skilled individuals. There are many areas in which U.S. regulates high skill innovation more heavily than low skill innovation. Internet-oriented start-ups begin at least in an almost regulation free zone, where there is little oversight preventing the sale of a creative app that generates revenues through advertising dollars. By contrast, the number of regulations needed to start a small local grocery store can easily exceed ten.

One approach is to experiment more with low-regulation zones that don't give financial breaks, since such financial benefits are harder to recreate more widely Economists have long argued that many regulations do more to protect incumbents than to safeguard consumers, and that excess regulation retards entrepreneurship and job creation. One plausible model, adopted by the Devens Economic Commission in Massachusetts, is to have a single permitting entity that handles all of the aspects of business regulation within a jurisdiction. It is easier to hold a single permitting entity to account for delays than to blame one of a dozen different agencies each of which can hold up a new business.

The case for entrepreneurship zones that reduce regulation becomes even stronger when innovation is taken into account. Dealing with regulations is typically a fixed cost that must be paid whether or not any innovation is successful. Consequently, those fixed costs deter implementation of marginal ideas. A light-regulation zone would potentially allow ideas to be tested with fewer barriers on implementation. That zone would also attract innovators to the area because light regulations might enable something of a local laboratory of innovation.

These zones might hold for all industries, or they might permit entrepreneurship in particularly appropriate clusters. For example, Pittsburgh might want encourage the development of firms that combine robot and human delivery in the neighborhoods near to Carnegie-Mellon and the University of Pittsburgh. Most regulations, apart from those that protect worker and

customer safety, could be reduced within this area to encourage firms that use both human and robots.

This model of low-regulation entrepreneurship zones is particularly plausible within large, dense urban areas. A food service entrepreneur might be happy to implement first in a more disadvantaged area or San Francisco or Boston because customers could come from elsewhere. Local entrepreneurs in the area will also be tempted to start businesses when local regulations are lighter since they have always enjoyed a plausible customer base.

It is less clear whether a light regulation zone will actually induce service sector entrepreneurs to relocate to lower density parts of America, where demand is sparser. Unfortunately, in a world dominated by service sector employment, it is difficult to determine what people will do in places where demand is limited by lack of density and lack and income. In such places, the only plausible path may be to encourage job creation and hope for the best, even without any clear vision about what future jobs will do.

Place-Based Employment Subsidies and Social Policy Reform

Austin, Glaeser and Summers (2018) argue that joblessness generated negative externalities, because of foregone taxes and possibly larger social losses. These externalities occur everywhere, but the elasticity of joblessness with respect to wages seems to be higher in some areas than in others. In particularly, places with high levels of historic joblessness see their number of joblessness wax and wane more dramatically with the level of labor demand. This fact suggests that the elasticity of joblessness with respect to either wage subsidies or implicit taxes may be higher in those regions.

One implication of that logic is that if the U.S. has a fixed amount of resources to spend on employment subsidies, then these subsidies may be more effective if spent in West Virginia than in Seattle. The Earned Income Tax Credit (EITC) is America's long-standing employment subsidy program, but its incentives are primarily oriented towards single mothers. One plausible policy option is to expand the EITC so that it becomes relevant for jobless men, but to focus its benefits on regions with high levels of joblessness.

A similar argument suggests that social insurance programs might do more to encourage work in places where joblessness is more endemic. Policies like disability insurance, Medicaid and even SNAP assistance (Food Stamps) provide benefits to the jobless, and consequently generate incentives not to earn more money. The Bailey-Chetty optimal unemployment insurance formula, weighs the benefits of ameliorating adversity with the costs of deterring job search. If the elasticity of employment with respect to benefits is higher, then the program suggests that benefits should be made less generous.

This logic suggests that benefits program should do less to discourage work in areas where joblessness is more responsive to incentives. Disability insurance, for example, might reduce the base payment but allow disability recipients to earn more without losing their benefits. Similarly, SNAP Assistance and Housing Vouchers might offer a loser base payment In distressed areas, but might phase out more slowly with earnings. This social assistance reform can make payment in highly distressed areas more or less generous on average, or could keep the average benefit level the same while tilting those benefits towards promoting work.

This tilt highlights that while traditional place-based policy aimed at redistributing income towards poorer places, these policies are meant instead simply to recognize spatial heterogeneity. America has many labor and housing markets and one-size-fits-all policies are unlikely to be optimal. Housing policies that work for Boston are unlikely to be right for Houston. Similarly, generous social policies are more likely to generate long-term joblessness in less skilled places than in more skilled areas.

While these policies are aimed at reducing joblessness at once, they should have dynamic effects, at least if the government is able to commit to maintaining them. Both targeted employment subsidies and social insurance reforms should lower the wages that firms will have to pay for workers in distressed areas. In the short run, these lower wages should induce firms to hire. In the longer run, lower wages should induce firms to innovate.

As we discussed above, much nineteenth century innovation was targeted towards employing less skilled workers. In the late 20th and early 21st centuries, innovation seems targeted at reducing labor requirements or providing services directly to consumers. While it is impossible

to fully quantify the role that high mid-twentieth century wages played in that switch, lower wages will make innovations that use low skill labor more remunerative.

The spread of technology to low wage areas should be easy if those areas can produce goods that have a market. Unfortunately, the switch from a manufacturing economy to a service economy makes it hard to find that market. We turn to that challenge next.

Universal Basic Income

A large variety of technology entrepreneurs have embraced Universal Basic Income, or UBI, as a solution for a world in which technology has made low skill labor largely obsolete. The basic perspective of UBI's supporters is that robots will make mass joblessness inevitable. UBI will make this joblessness less terrible, because people will still have access to material resources.

As we have discussed throughout this paper, massive joblessness seems more like a national policy choice than an inevitability. Service sector entrepreneur have produced millions of new jobs in a short period of time. They may well be able to do that again. Consequently, any analysis of UBI needs to consider not only its effect for a given level of joblessness but also its effect on the level of joblessness.

Universal Basic Income makes jobless people richer and that reduces the incentives to work. Moreover, UBI will have to be paid for by taxes on the working, and those higher taxes are also likely to reduce the supply of labor. The Negative Income Tax experiments of the 1970s provided poorer people with unconditional cash transfers, and found quite significant hours reduction of "between 5 and 25 percent" and "employment rate reductions from about 1 to 10 percentage points" (Robins, 1985). The negative effects of such transfers on working seem likely to be larger today, because there appear to be far more men on the margin of working or not working.

The downsides of UBI and the upside of employment subsidies become exacerbated once innovation is incorporated into the analysis. If UBI leads workers to expect higher wages, then innovation will tend to reduce the role of less skilled labor. If employment subsidies induce workers to accept lower wages, the innovators will see more upside in technologies that lead to

hiring workers. The short run impacts of the policies, whether to increase or decrease employment, will be exacerbated in the long run because of innovation.

A New National Entrepreneurship Policy

National innovation policy has a well-developed justification stemming from the public-good nature of knowledge. The theoretical case for national entrepreneurship strategy is far murkier, but we also spend far less on entrepreneurship. The Small Business Administration's budget request for 2017 was $834 million. The N.S.F.'s budget is almost ten times larger at seven billion dollars. The National Institutes of Health's budget is five times larger still.

The Small Business Administration's budget goes towards a loan guarantee program, entrepreneurship training and salaries for administrators. The loan guarantee program, which is split between disaster-related loans and standard loans, is justified partially because of allegedly credit market imperfections, and perhaps because of externalities related to new business creation, such as future tax payments or reduced the fiscal costs of the unemployed. The "Entrepreneurial Development Programs," can also be justified by pointing to the externalities of entrepreneurship or because of externalities from the development of entrepreneurial human capital.

If an entrepreneurship policy is to exist, then there is a far stronger case that it should be geographically targeted. The impacts of entrepreneurs will always be mediated by the condition of local markets, and so local economic conditions should always be considered when supporting entrepreneurship. The fundamental contributions of a bio-medical research team are far less entwined with local labor market conditions.

One plausible explanation for spatial heterogeneity in entrepreneurship policies is that credit market imperfections may differ across regions. Historically, small businesses were physically proximate to their lenders, and there was a much greater abundance of lenders in large financial centers. Yet over the past 30 years the average distance between borrower and lend has been growing (Peterson and Rajan, 2002), apparently because of improvements in information technology (DeYoung et al. 2011). As credit markets become nationalized, it becomes less plausible that lending support should be targeted towards areas with fewer

lenders. The nationalization of lending relationships also suggests that credit market imperfections are becoming less important more generally.

But while credit market case for the spatial targeting of entrepreneurship support is getting weaker, other arguments for such targeting are getting stronger. In a world of full employment, new enterprise formation may not generate any positive externalities. The customers receive benefits but pay for them. The new jobs just displace old jobs. There is little case for subsidy.

The situation looks quite different when joblessness is quite high. The fiscal externality associated with not working means that every person moved from joblessness into employment generates a benefit for all other taxpayers. People who are not working receive government benefits, including unemployment and disability insurance and SNAP assistance, while people who are working pay taxes. This fiscal benefit may be over $10,000 per worker, which is not internalized by entrepreneurs or other employers who make hiring decisions. If an entrepreneur is more likely to move people from joblessness to employment in West Virginia than in Seattle, then there is a case for stronger support for entrepreneurship in West Virginia.

The optimal size of the entrepreneurship subsidy depends on reliable estimates of both the impact of the subsidy on joblessness and the fiscal externality associated with reducing non-employment. Subsidies might be targeted towards firms that will employ more previously jobless workers, or be contingent upon the level of such employment. We do not have these estimates yet, but the strong possibility that employment effects differ across space makes it reasonable to start seriously considering a more spatially targeted entrepreneurship policy.

Imagine a new idea that requires 20 brilliant scientists to create and 2,000 ordinary workers to produce at scale. There is little advantage in trying to change the geographic location of the idea creation phase. Those scientists will be employed in any case. But those 2,000 extra ordinary jobs may reduce the numbers of jobless workers by 1,000 in West Virginia, but only 100 in Seattle. There is a public interest in geographically nudging the production phase, but not the innovation phase.

VII. Conclusion

Over the past 20 years, innovation has done a much better job at producing new technology pleasures – like sharing pictures or short messages online – than at generating new sources of employment. Future innovations are most likely to produce new jobs if they are oriented towards the service sectors. Health care innovation, which is already strongly supported by Federal policies, is likely to generate many jobs in depressed areas, but these jobs seem unlikely to spur longer-term dynamic benefits. Professional and business service innovations that generate more employment seem most likely to benefit already successful areas. In some places, leisure and hospitality innovations could provide more employment, and that could be dynamic, but we suspect that the number of places that could benefit from these innovations is small.

The geographic heterogeneity of America's economy is problematic because there are some regions that appear to be trapped in perpetual joblessness. Innovation is also low in those regions. But it does not follow that the path towards less joblessness is to induce innovators to relocate to high joblessness regions. A far more plausible path is to focus on ensuring that the ideas that are produced in innovative areas create opportunity in non-innovative places.

Policies that subsidize invention, including funding for the N.S.F. and the N.I.H. could target research that does more to benefit distressed areas, such as reducing the number of workers receiving disability insurance. Educational reform could focus on promoting employment in distressed regions, with more commercially oriented Federal aid to colleges and entrepreneurially provided vocational skills. Barriers to entrepreneurship can also be eliminated, especially in distressed areas.

References

Abraham, Katharine G., and Melissa S. Kearney. *Explaining the decline in the US employment-to-population ratio: A review of the evidence*. No. w24333. National Bureau of Economic Research, 2018.

Acemoglu, Daron. "A microfoundation for social increasing returns in human capital accumulation." *The Quarterly Journal of Economics* 111, no. 3 (1996): 779-804.

Acemoglu, Daron. 2002. "Directed Technical Change." *Review of Economic Studies*, 69:781-810.

Acs, Zoltan J., and Catherine Armington. 2004. "The impact of geographic differences in human capital on service firm formation rates." *Journal of Urban Economics*, 56:244-278.

Agrawal, Ajay, Christian Catalini, and Avi Goldfarb. "Some simple economics of crowdfunding." *Innovation Policy and the Economy* 14, no. 1 (2014): 63-97.

Austin, Benjamin A., Edward L. Glaeser, and Lawrence H. Summers. *Jobs for the Heartland: Place-based policies in 21st century America*. No. w24548. National Bureau of Economic Research, 2018.

Autor, David H., and David Dorn. "How technology wrecks the middle class." *The New York Times* 24 (2013): 2013.

Autor, David H., David Dorn, and Gordon H. Hanson. "Untangling trade and technology: Evidence from local labour markets." *The Economic Journal* 125, no. 584 (2015): 621-646.

Autor, David H., and Mark G. Duggan. "Distinguishing income from substitution effects in disability insurance." *American Economic Review* 97, no. 2 (2007): 119-124.

Barro, Robert J., and Xavier Sala-i-Martin. "Convergence." *Journal of political Economy* 100, no. 2 (1992): 223-251.

Belenzon, Sharon, and Mark Schankerman. "Spreading the word: Geography, policy, and knowledge spillovers." *Review of Economics and Statistics* 95, no. 3 (2013): 884-903.

Berry, Christopher R., and Edward L. Glaeser. "The divergence of human capital levels across cities." *Papers in regional science* 84, no. 3 (2005): 407-444.

Blanchard, Olivier Jean, and Lawrence F. Katz. 1992. "Regional Evolutions." *Brookings Papers on Economic Activity*, no. 1: 1–75.

Borjas, George J. "The labor demand curve is downward sloping: Reexamining the impact of immigration on the labor market." *The quarterly journal of economics* 118, no. 4 (2003): 1335-1374.

Busso, Matias, Jesse Gregory, and Patrick Kline. "Assessing the incidence and efficiency of a prominent place based policy." *American Economic Review* 103, no. 2 (2013): 897-947.

Cantoni, Davide, and Noam Yuchtman. "Medieval universities, legal institutions, and the commercial revolution." *The Quarterly Journal of Economics* 129, no. 2 (2014): 823-887.

Card, David. "The impact of the Mariel boatlift on the Miami labor market." *ILR Review* 43, no. 2 (1990): 245-257.

Diamond, Rebecca. 2016. "The Determinants and Welfare Implications of US Workers' Diverging Location Choices by Skill: 1980-2000," American Economic Review, 106(3) 479-524.

DeYoung, Robert, W. Scott Frame, Dennis Glennon, and Peter Nigro. "The information revolution and small business lending: The missing evidence." *Journal of Financial Services Research* 39, no. 1-2 (2011): 19-33.

Doms, Mark, Ethan Lewis, and Alicia Robb. "Local labor force education, new business characteristics, and firm performance." *Journal of Urban Economics* 67, no. 1 (2010): 61-77.

Fallick, Bruce, Charles A. Fleischman, and James B. Rebitzer. "Job-hopping in Silicon Valley: some evidence concerning the microfoundations of a high-technology cluster." *The review of economics and statistics* 88, no. 3 (2006): 472-481.

Forman, Chris, Avi Goldfarb, and Shane Greenstein. "The Internet and local wages: A puzzle." *American Economic Review* 102, no. 1 (2012): 556-75.

Ganong, Peter, and Daniel Shoag. "Why has regional income convergence in the US declined?." *Journal of Urban Economics* 102 (2017): 76-90.

Glaeser, Edward L., and Albert Saiz. *The rise of the skilled city*. No. w10191. National Bureau of Economic Research, 2003.

Glaeser, Edward L., and Bryce A. Ward. "The causes and consequences of land use regulation: Evidence from Greater Boston." *Journal of Urban Economics* 65, no. 3 (2009): 265-278.

Glaeser, Edward L., and Christopher R. Berry. "Why are smart places getting smarter." *Rappaport Institute/Taubman Center Policy Brief* 2 (2006).

Glaeser, Edward L., and Giacomo AM Ponzetto. *Did the death of distance hurt Detroit and help New York?*. No. w13710. National Bureau of Economic Research, 2007.

Glaeser, Edward L., and Matthew E. Kahn. "Sprawl and urban growth." In *Handbook of regional and urban economics*, vol. 4, pp. 2481-2527. Elsevier, 2004.

Glaeser, Edward L., and Raven E. Saks. "Corruption in America." *Journal of Public Economics* 90, no. 6-7 (2006): 1053-1072.

Glaeser, Edward L., JoséA Scheinkman, and Andrei Shleifer. "Economic growth in a cross-section of cities." *Journal of monetary economics* 36, no. 1 (1995): 117-143.

Goldin, Claudia Dale, and Lawrence F. Katz. *The race between education and technology*. Harvard University Press, 2009.

Gruber, Jonathan, and Simon Johnson. *Jump-starting America: How breakthrough science can revive economic growth and the American dream*. 2019.

Hall, Bronwyn H., Adam B. Jaffe, and Manuel Trajtenberg. *The NBER patent citation data file: Lessons, insights and methodological tools*. No. w8498. National Bureau of Economic Research, 2001.

Hausman, Naomi. "University innovation and local economic growth." *Hebrew University Working Paper* (2018): 0_1-63.

Hausman, Naomi. ""Non-compete Law, Labor Mobility, and Entrepreneurship." Hebrew University Working Paper 2019.

Fehder, Daniel, Naomi Hausman, and Yael Hochberg. "Cities and University Commercialization." Rice University Working Paper 2019.

Henderson, Rebecca, Adam B. Jaffe, and Manuel Trajtenberg. "Universities as a source of commercial technology: a detailed analysis of university patenting, 1965–1988." *Review of Economics and statistics* 80, no. 1 (1998): 119-127.

Holmes, Thomas J. 1998. "The Effect of State Policies on the Location of Manufacturing: Evidence from State Borders." *Journal of Political Economy* 106, no. 4: 667–705.

Jaffe, Adam B., Manuel Trajtenberg, and Rebecca Henderson. "Geographic localization of knowledge spillovers as evidenced by patent citations." *the Quarterly journal of Economics* 108, no. 3 (1993): 577-598.

Jevons, William Stanley. *The coal question: an inquiry concerning the progress of the nation, and the probable exhaustion of our coal-mines*. London: Macmillan, 1866.

Kerr, Sari Pekkala, and William R. Kerr. *Immigrant entrepreneurship in America: Evidence from the survey of business owners 2007 & 2012*. No. w24494. National Bureau of Economic Research, 2018.

Kremer, Michael. "Patent buyouts: A mechanism for encouraging innovation." *The Quarterly Journal of Economics*113, no. 4 (1998): 1137-1167.

Lach, Saul, and Mark Schankerman. "Incentives and invention in universities." *The RAND Journal of Economics* 39, no. 2 (2008): 403-433.

Liu, Cheol, and John L. Mikesell. "The impact of public officials' corruption on the size and allocation of US state spending." *Public Administration Review* 74, no. 3 (2014): 346-359.

Marx, Matt, Deborah Strumsky, and Lee Fleming. "Mobility, skills, and the Michigan non-compete experiment." *Management Science* 55, no. 6 (2009): 875-889.

Moretti, Enrico. "Estimating the social return to higher education: evidence from longitudinal and repeated cross-sectional data." *Journal of econometrics* 121, no. 1-2 (2004): 175-212.

Petersen MA, Rajan RG (2002) The information revolution and small business lending: does distance still matter? J Finance 57:2533–2570

Rauch, James E. "Productivity gains from geographic concentration of human capital: evidence from the cities." *Journal of urban economics* 34, no. 3 (1993): 380-400.

Robins, Philip K. "A comparison of the labor supply findings from the four negative income tax experiments." *Journal of human Resources* (1985): 567-582.

Shane, Scott Andrew. *Academic entrepreneurship: University spinoffs and wealth creation*. Edward Elgar Publishing, 2004.

Shapiro, Jesse M. "Smart cities: quality of life, productivity, and the growth effects of human capital." *The review of economics and statistics* 88, no. 2 (2006): 324-335.

Trajtenberg, Manuel. "A penny for your quotes: patent citations and the value of innovations." *The Rand Journal of Economics* (1990): 172-187.

Figures

Figure 1

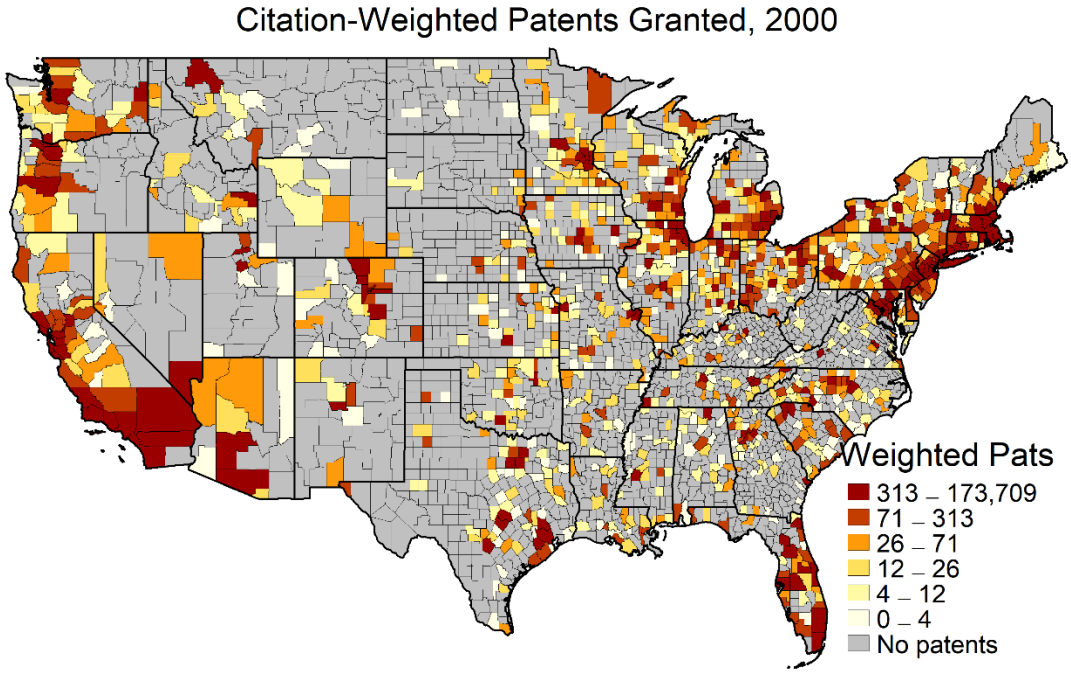


Figure 2

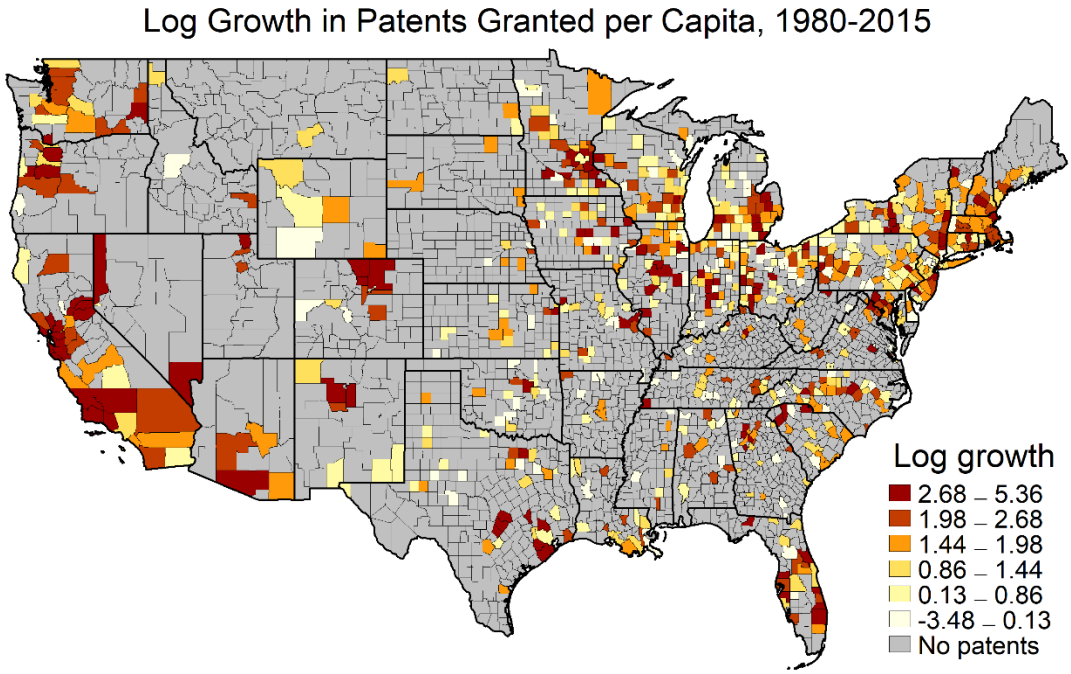
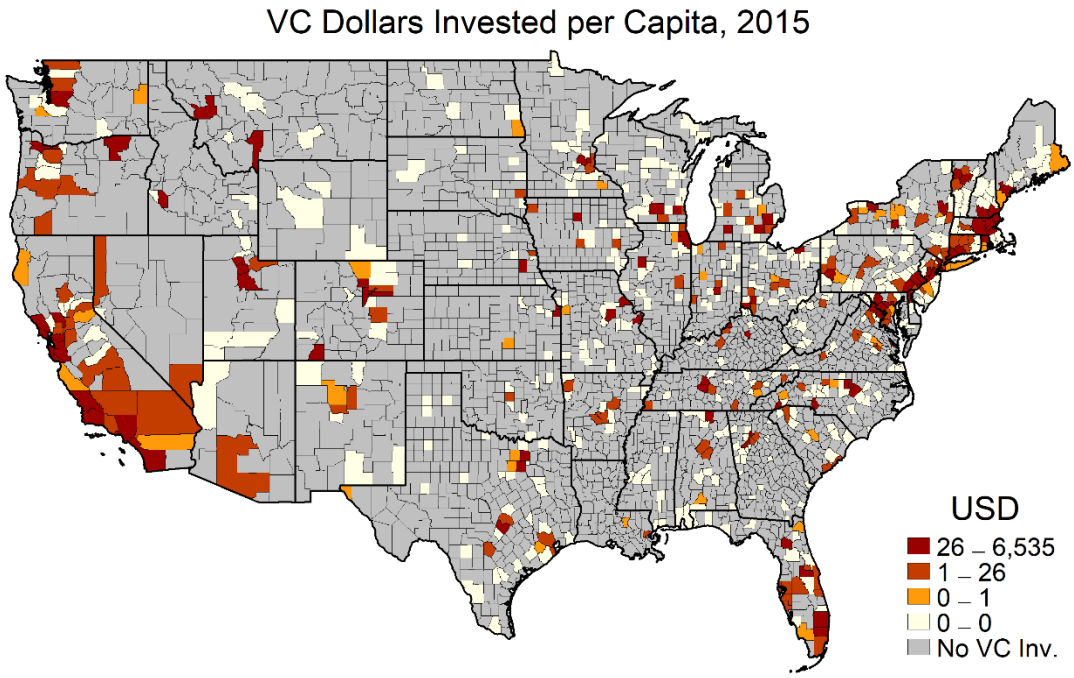
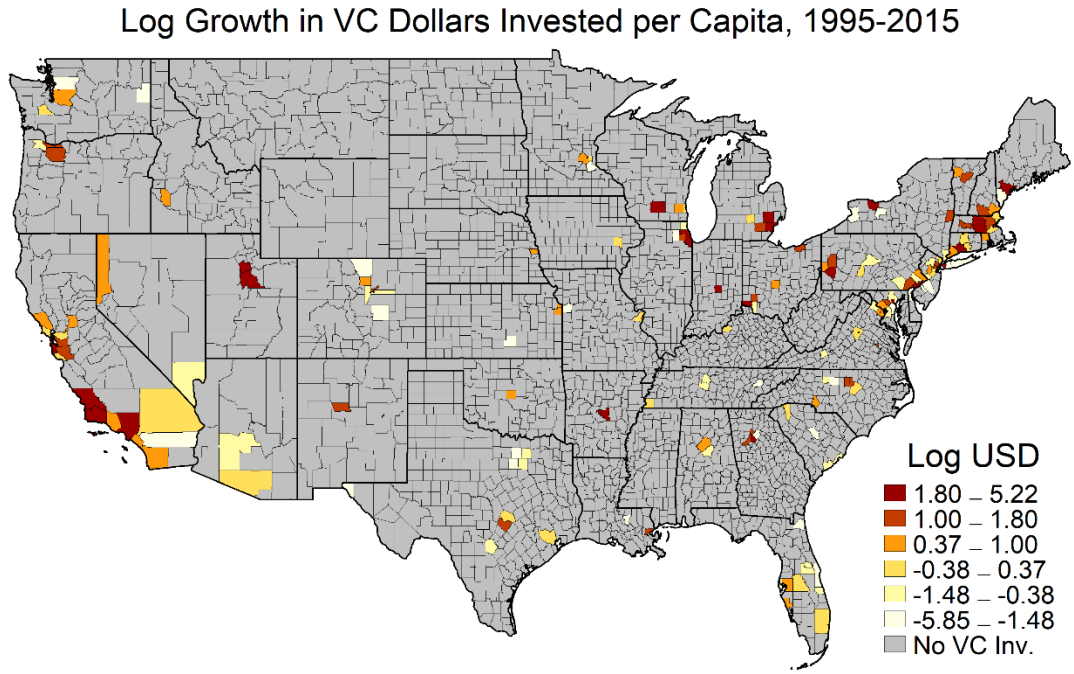


Figure 3



Source: VentureXpert

Figure 4



Source: VentureXpert

Figure 5

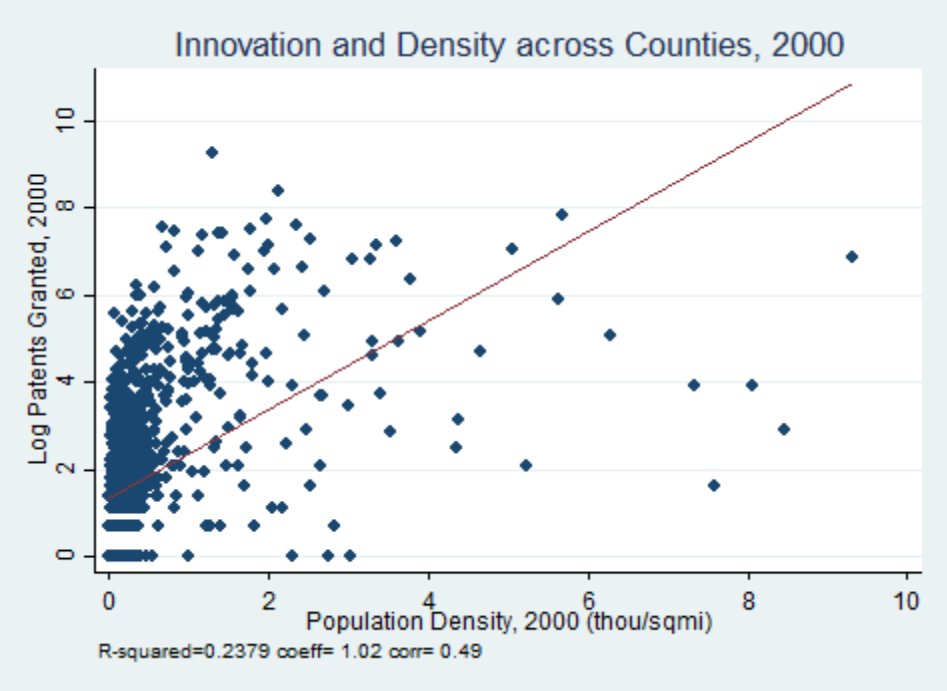


Figure 6

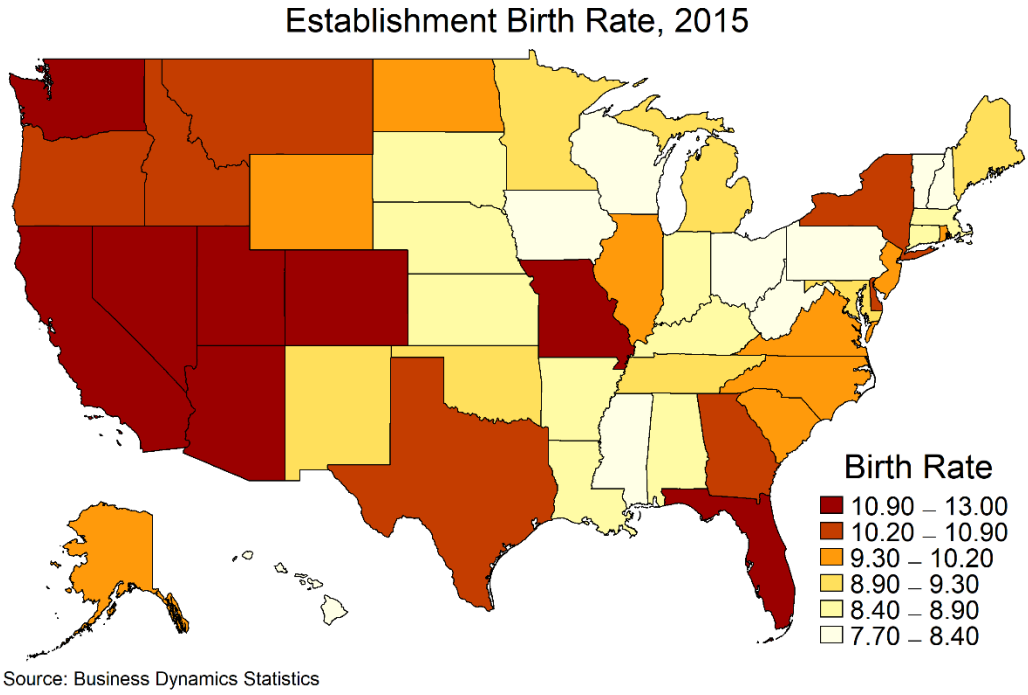


Figure 7

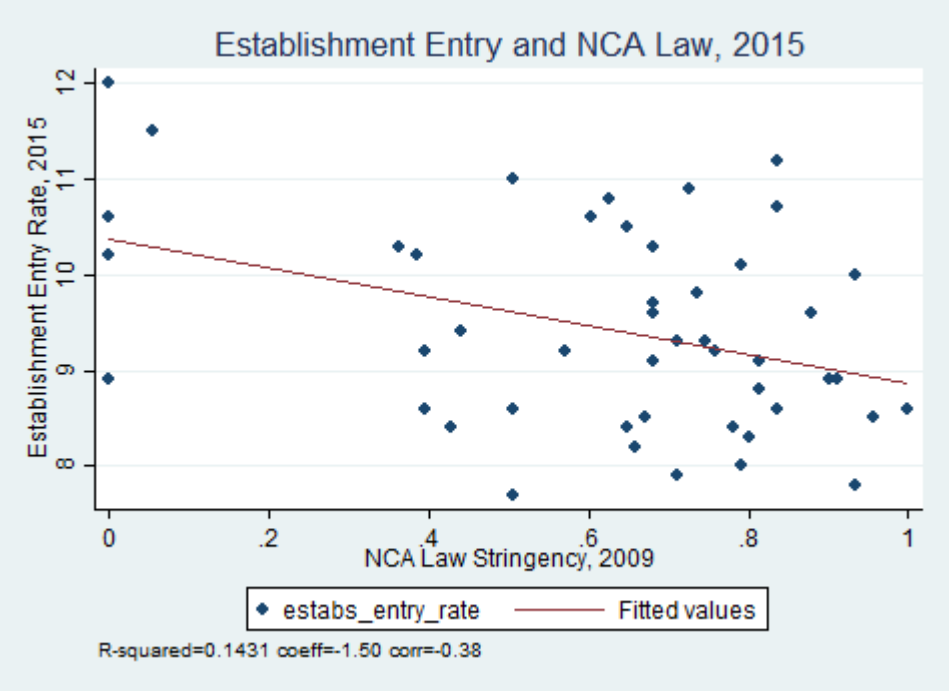


Figure 8

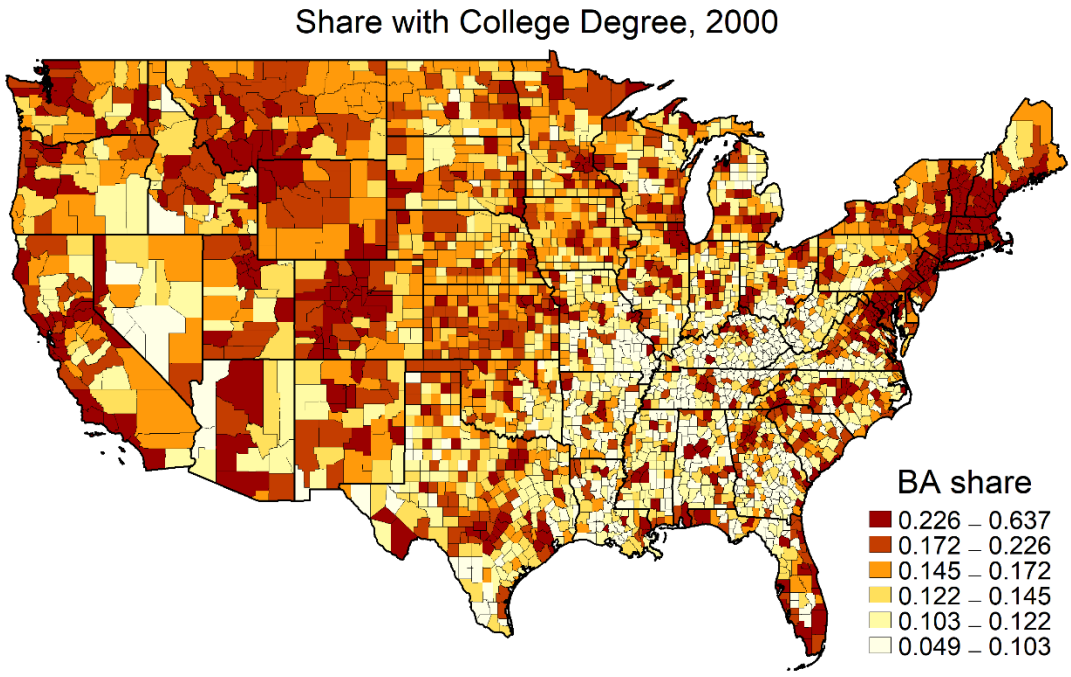


Figure 9

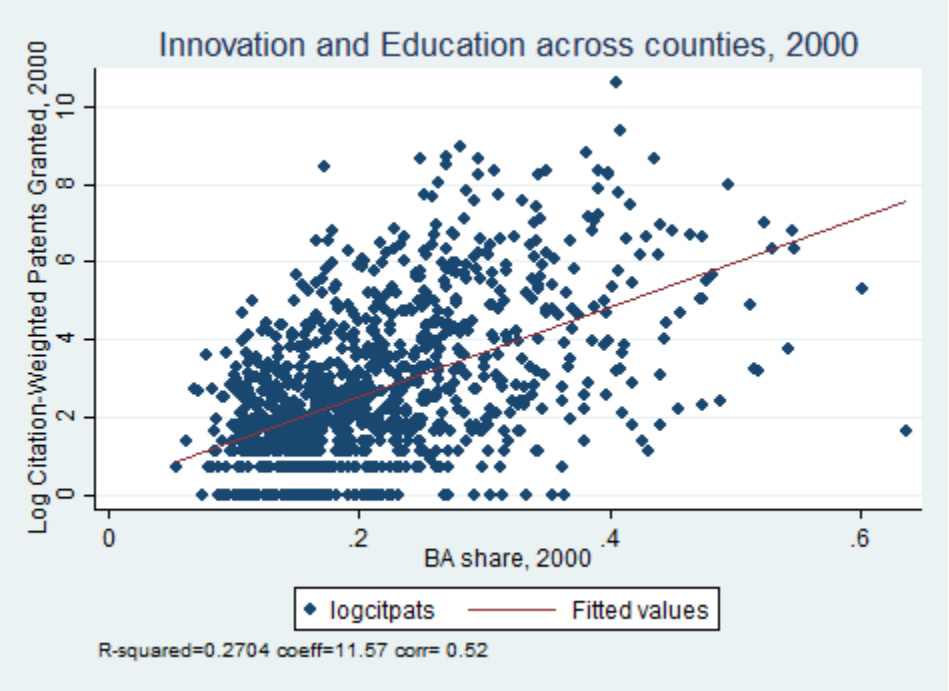


Figure 10

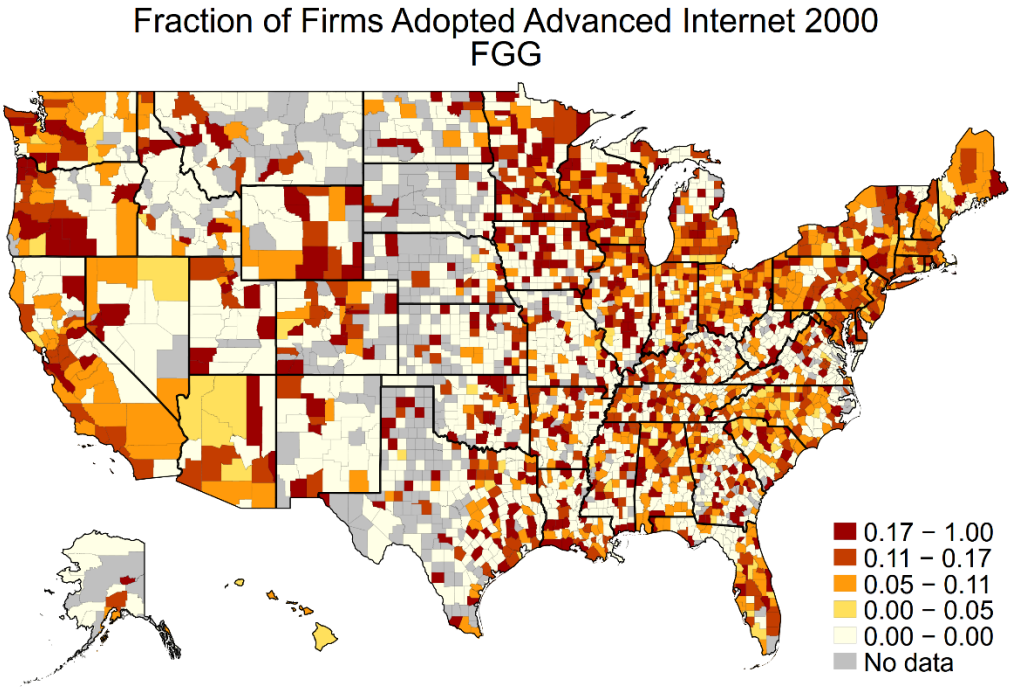
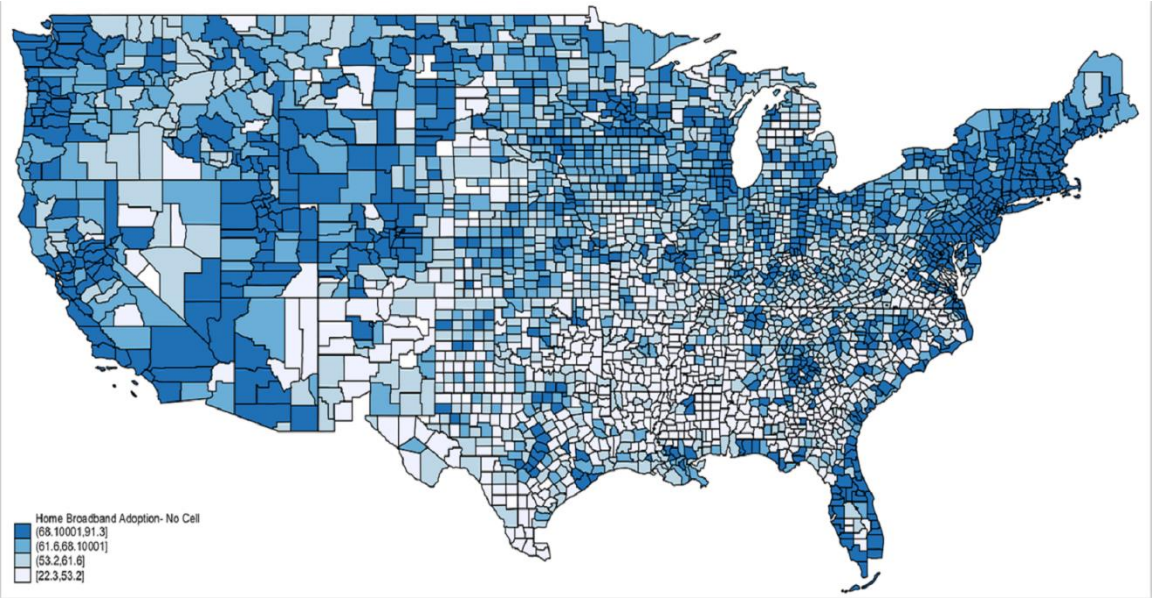
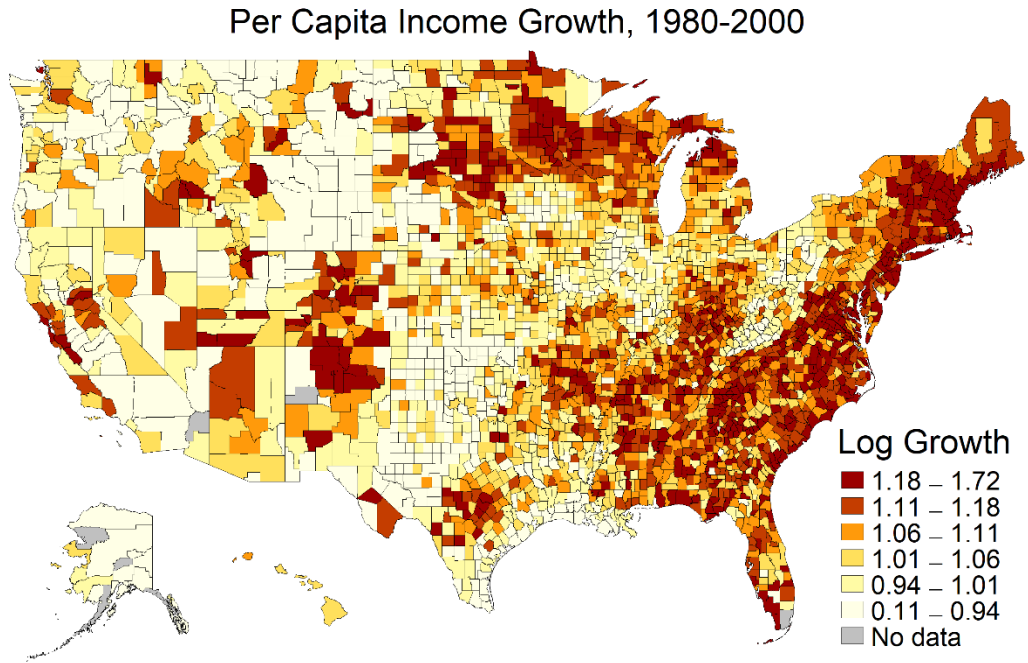


Figure 11: Home broadband subscriptions, any type (excluding cell only) 2013-2017 averages



Source: 2013-2017 ACS averages

Figure 12a



Source: Decennial Census, ACS

Figure 12b

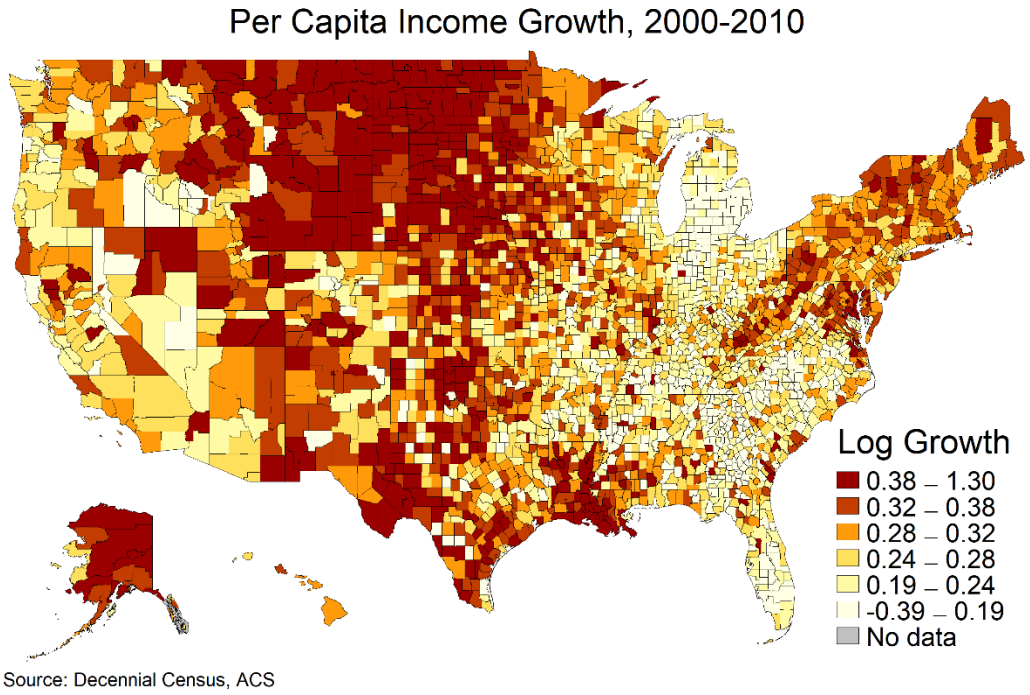


Figure 13

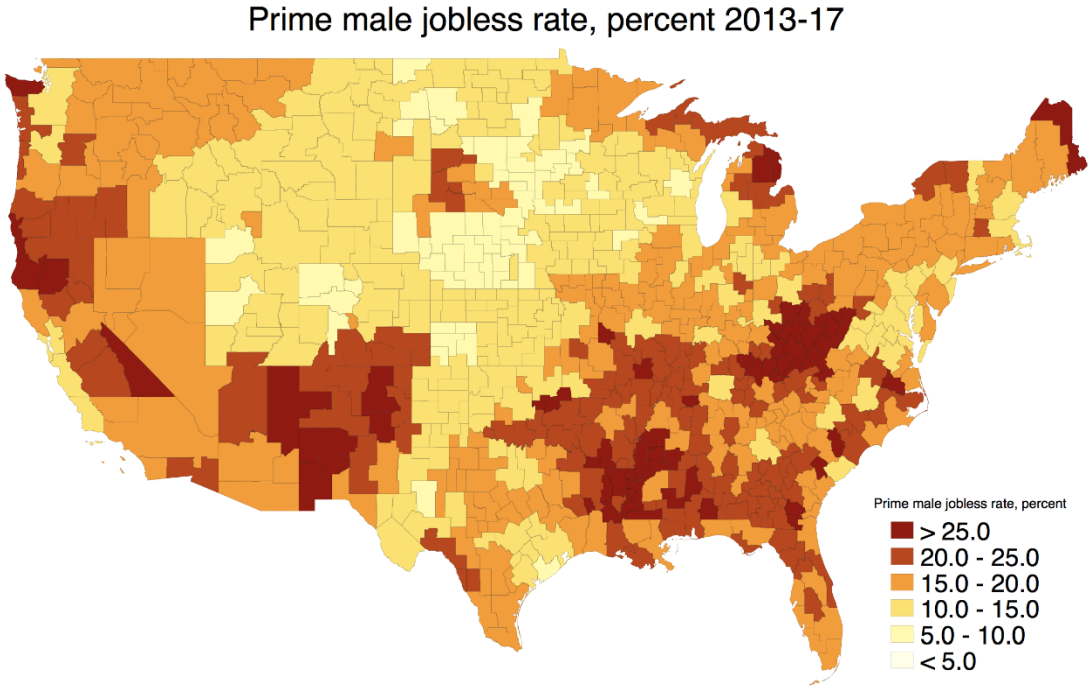


Figure 14

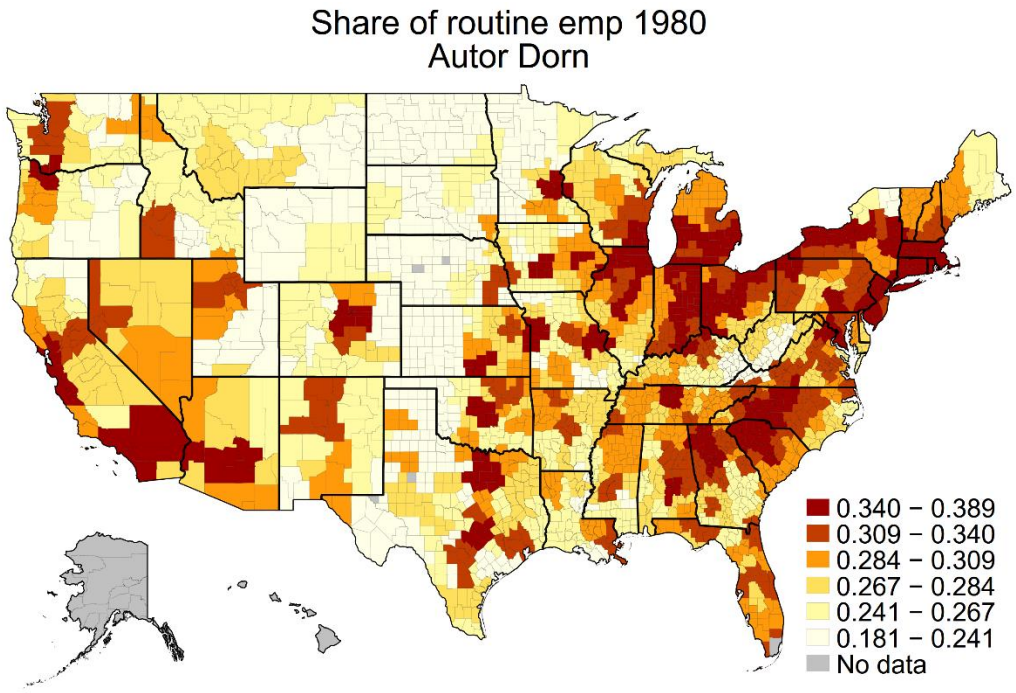


Figure 15a

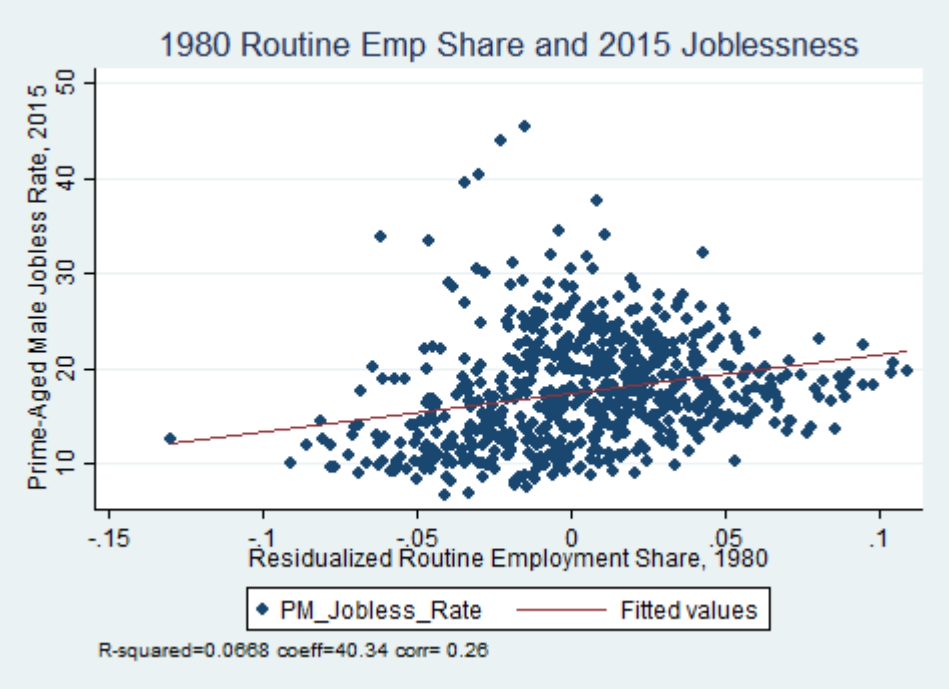


Figure 15b

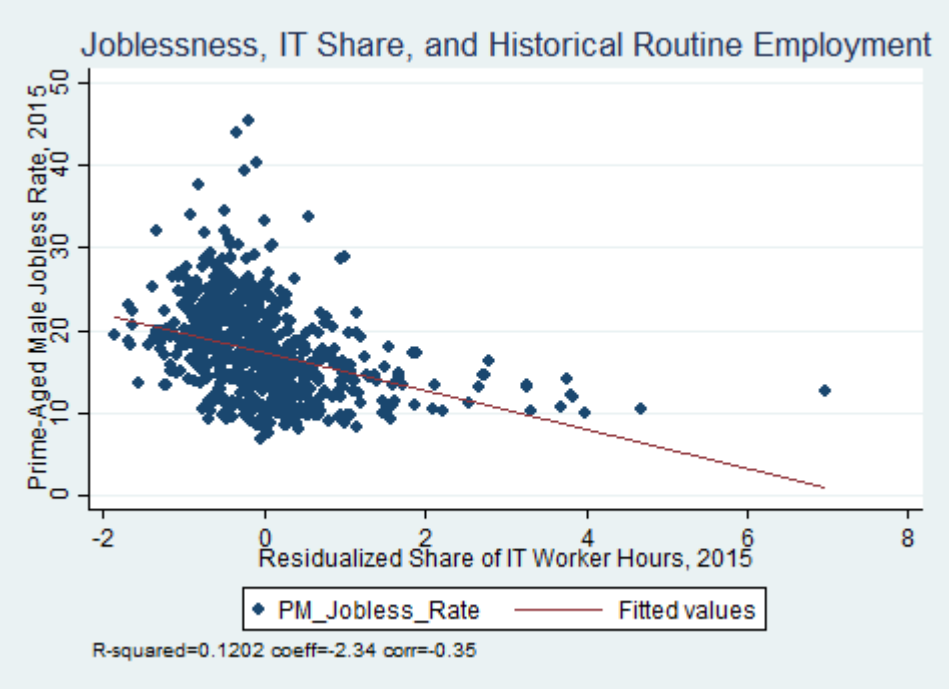


Figure 16: Prime Male Long-term (>12 months) Jobless Rate and Innovation
Coeff = -0.03, Rsq = 0.025

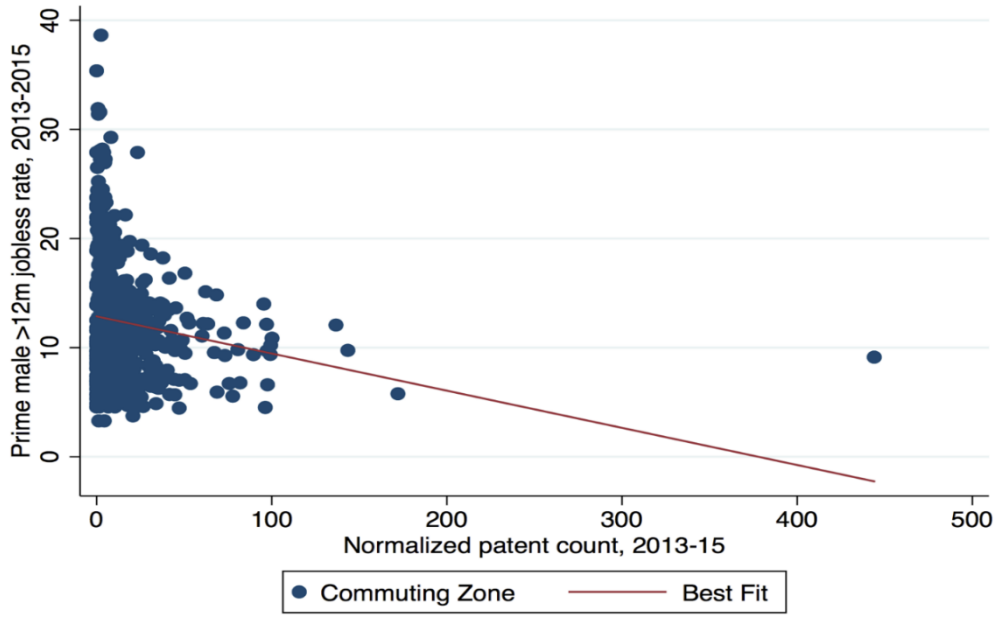
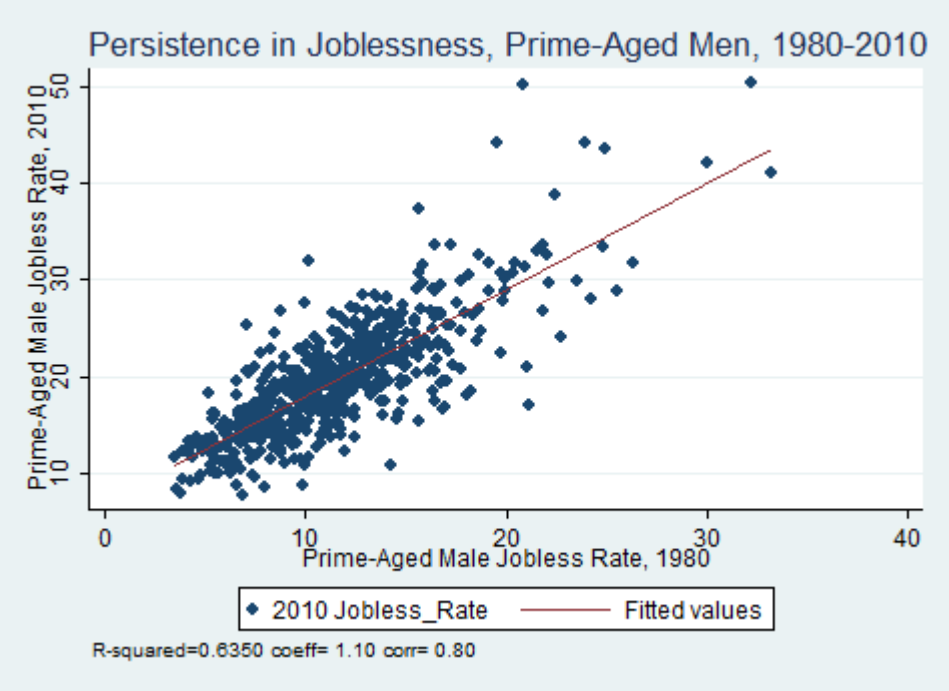


Figure 17


Persistence in Joblessness, Prime-Aged Men, 1980-2010
Prime-Aged Male Jobless Rate, 2010
10
20
30
40
50
0
10
20
30
40
Prime-Aged Male Jobless Rate, 1980
2010 Jobless_Rate
Fitted values
R-squared=0.6350 coeff= 1.10 corr= 0.80