THE CASE *for* GROWTH CENTERS

How to spread tech innovation across America

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Table of contents

Executive summary	3
1. Introduction	10
2. The entrenched geography of America's innovation industries	16
3. The costs of hyperconcentration	25
4. Why markets alone won't solve the problem	32
5. Why place-based intervention is essential—and how it can succeed	42
6. Countering regional divergence through growth centers	47
7. Spreading tech hubs across America: A proposal	52
8. Candidates to be America's next top innovation hubs	62
9. Addressing objections and concerns	67
10. Conclusion	71
References	72
Endnotes	75
Appendix A	85
Appendix B	88
Appendix C	90
Acknowledgements	92

Executive summary

It has become clear that while the future of America's economy lies in its high-tech innovation sector, that same sector has widened the nation's regional divides—a fact that became starkly apparent with the 2016 presidential election.

Dependent on intense agglomerations of highly skilled workers and based on winner-take-most network economies, the innovation sector has generated significant technology gains and wealth but has also helped spawn a growing gap between the nation's dynamic "superstar" metropolitan areas and most everywhere else.

Neither market forces nor bottom-up economic development efforts have closed this gap, nor are they likely to. Instead, these deeply seated dynamics appear ready to exacerbate the current divides.

This is why the nation needs a major push to counter these dynamics. Specifically, the nation needs—as one initiative among others—a massive federal effort to transform a short list of "heartland" metro areas with compelling strengths into self-sustaining "growth centers" that will benefit entire regions.

The present paper, therefore, proposes that Congress assemble and award to a select set of metropolitan areas a major package of federal innovation inputs and supports that would help those areas accelerate transformative innovation-

sector scale-up. Along these lines, we envision Congress establishing a rigorous competitive process by which the most promising eight to 10 potential growth centers (all not geographically located near existing successful tech hubs) would receive substantial financial and regulatory support for 10 years to get "over the hump" and become self-sustaining new innovation centers. Such an initiative would not only bring significant economic opportunity to more parts of the nation, but also significantly boost U.S. and innovation-based competitiveness, including in the competition with China.

What follows is a discussion that situates the nation's divergence problem, and highlights a set of relevant findings and recommendations.

THE PROBLEM

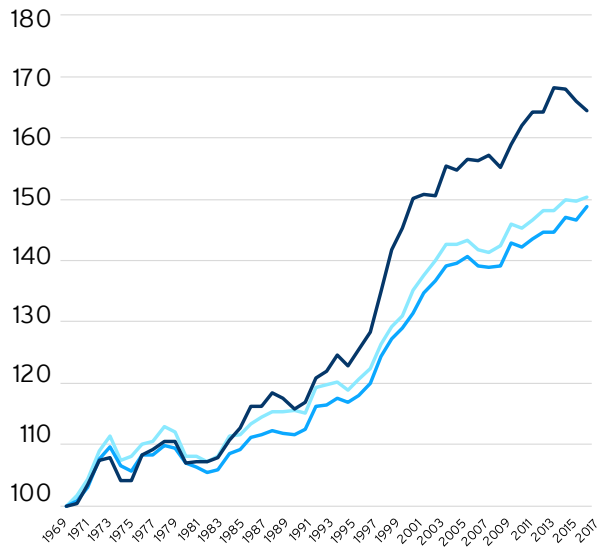
Rather than growing together, the nation's regions, metropolitan areas, and towns have been growing apart. That has been a shock, including for an economic and policy mainstream that has long trusted the self-regulating, welfare-enhancing nature of the regional economics market.

For much of the 20th century, market forces had tended to reduce wage, investment, and business-formation disparities between more- and less-developed regions. By narrowing the divides, the economy ensured a welcome "convergence" among communities and regions.

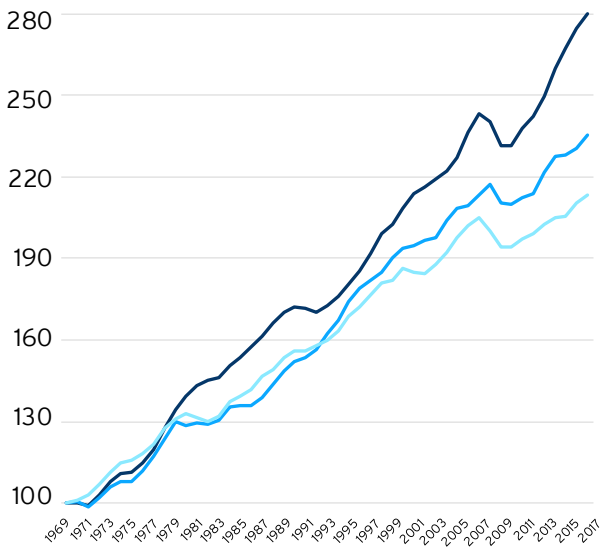
However, in the 1980s, that trend began to break down as digital technologies and innovation moved to the center of economic activity. Intense new demands for talent and insights increased the value of "agglomeration" economies, unleashing self-reinforcing dynamics that increasingly benefited big, coastal core regions, often to the detriment of cities and metro areas in other parts of the nation.

Amid these conditions, the convergence trend gave way to "divergence," as a top tier of big, tech- and innovation-heavy metro areas such as Boston, San Francisco-San Jose, and Seattle began to consistently outperform less-tech-

Indexed average annual wages
1969 - 2017 (1969 = 100)



Indexed employment level
1969 - 2017 (1969 = 100)



Bottom third of metro areas — Median metro areas — Top 2% of metro areas

Source: Brookings analysis of BEA data

based places on measures of innovation-driven prosperity.

The result is a crisis of regional imbalance. Among the superstar metro areas, the winner-take-most dynamics of the innovation economy have led to dominance but also livability and competitiveness crises: spiraling real estate costs, traffic gridlock, and increasingly uncompetitive wage and salary costs. Meanwhile, in many of the "left-behind places," the struggle to keep up has brought stagnation and frustration. These uneven realities represent a serious productivity, competitiveness, and equity problem.

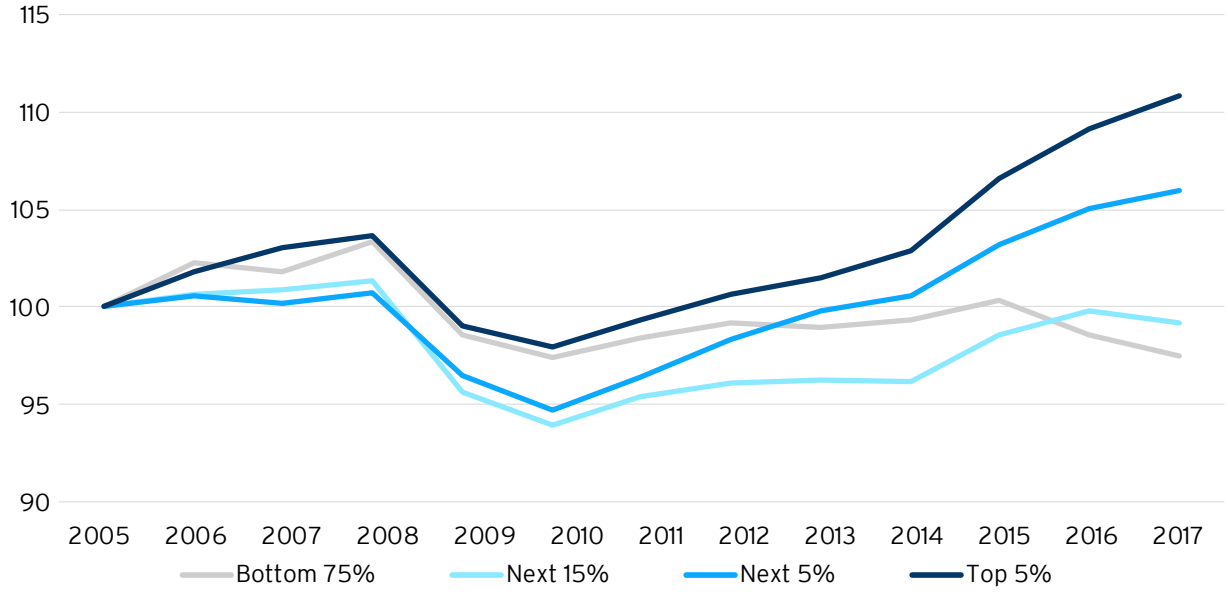
FINDINGS AND RECOMMENDATIONS

Assuming that nonchalance is no longer tenable, the present report presumes that the time has come for the nation to offset the pull-away of the innovation superstars with a concerted intervention to support the emergence of new tech stars in new places. Along these lines, the report draws a number of conclusions and recommendations in the process of laying out what a federal innovation-based growth centers program might look like. These takeaways include the following:

1. **Regional divergence has reached extreme levels in the U.S. innovation sector.** The innovation sector—comprised of 13 of the nation's highest-tech, highest-R&D "advanced" industries—contributes inordinately to regional and U.S. prosperity. Its diffusion into new places would greatly benefit the nation's well-being. However, far from diffusing, the sector has been *concentrating* in a short list of superstar metropolitan areas. Most notably, just five top innovation metro areas—**Boston**, **San Francisco**, **San Jose**, **Seattle**, and **San Diego**—accounted for more than 90% of the nation's innovation-sector growth during the years 2005 to 2017. In this fashion, they have increased their share of the nation's total innovation employment from 17.6% to 22.8% since 2005. In contrast, the bottom 90% of metro areas (343 of them) lost share.

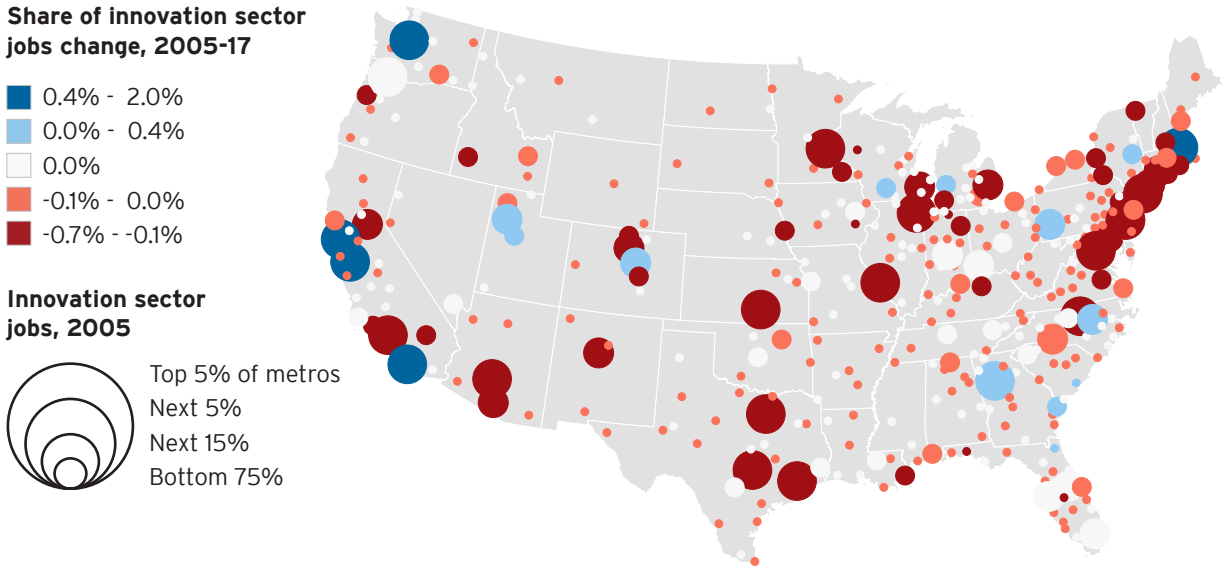
Innovation sector job creation has been strongest in metro areas that already have the largest sectors

Innovation sector employment index (2005 = 100), 2005-17



Note: Percentage "bins" reflect cohorts of metro areas, ranked in each year. The "top 5%" includes 20 metros.
Source: Brookings and ITIF analysis of Emsi data

Metros by change in share of total innovation sector jobs



Source: Brookings and ITIF analysis of Emsi data

As a result, the U.S. innovation industry has become heavily entrenched in just a few places. Fully one-third of the nation's innovation jobs now reside in just 16 counties, and more than half are concentrated in 41 counties.

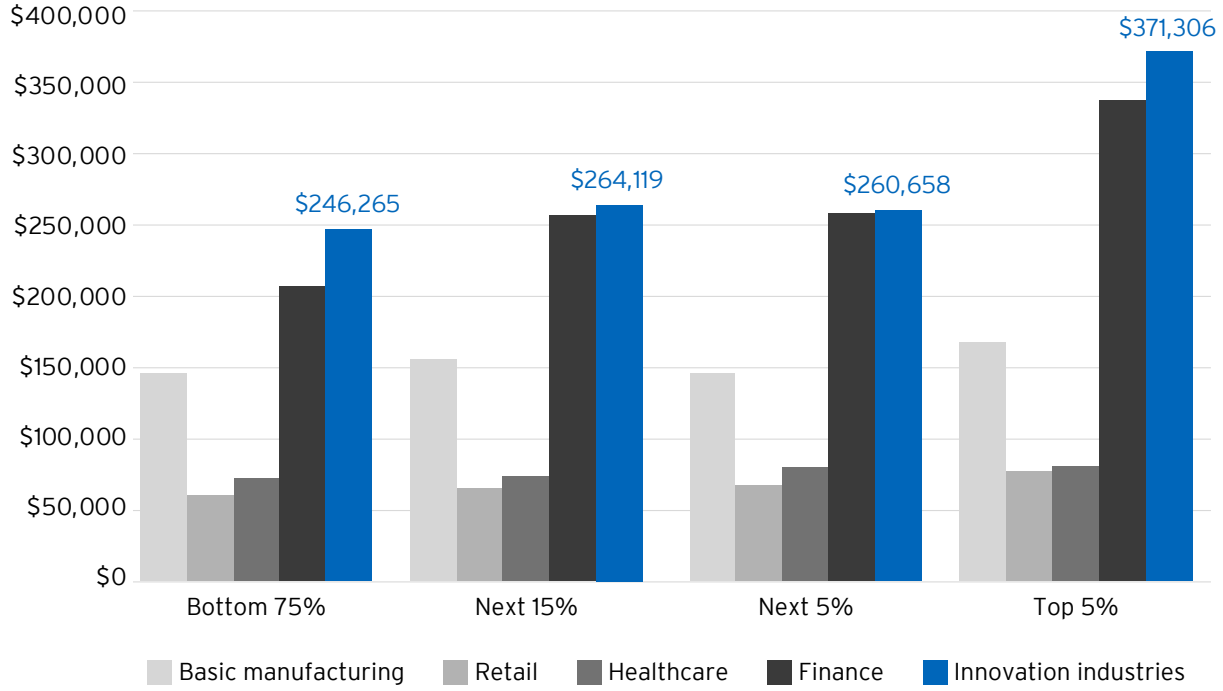
All of this points to the extent to which innovation-sector dynamics compound over time, leaving most places falling further behind.

2. **Such high levels of territorial polarization are now a grave national problem.** At the economic end of the equation, the costs of excessive tech concentration are creating serious negative externalities. These range from spiraling home prices and traffic gridlock in the superstar hubs to a problematic "sorting" of workers, with college-educated workers clustering in the star cities and leaving other metro ares to make do with thinner talent reservoirs. As a result, whole portions of the nation may now be falling into "traps" of underdevelopment. Of concern here is the stark gap between the productivity of the relatively few metropolitan areas with high shares of innovation industries and the many more with less. These patterns are hurting the country's innovation-based competitiveness, since the skyrocketing costs of the most successful tech hubs mean that tech investment is often made in other places—but not in other parts of America, given the shortage of vibrant lower-cost hubs. The result is that investments flow to places such as Bangalore, Shanghai, Taipei, or Vancouver, rather than Indianapolis, Detroit, or Kansas City.

Equally concerning is the fact that the nation's divergence is unfair. So many Americans reside far from the opportunities associated with the nation's innovation centers, undercutting economic inclusion and raising social justice issues. Regional divergence is also clearly driving "backlash" political dynamics that are exacerbating the nation's policy stalemates.

Localization economies make innovation industries clustered together more productive

Avg. output per worker by industry group, 2017



Note: Percentage "bins" reflect cohorts of metro areas, ranked in each year. The "top 5%" includes 20 metros.
Source: Brookings and ITIF analysis of Emsi data

3. **Markets alone won't solve the problem; place-based interventions will be essential in ameliorating it.** When the economy was "converging," it was easy to assume that any problems of regional unevenness would naturally resolve themselves. Indeed, until very recently, self-correction remained the expectation of mainstream economists, with their embrace of traditional doctrines of "allocative efficiency," "equilibrium," and "welfare-maximizing" spatial results. However, the rise of newer innovation-oriented economic theories has thrown more attention onto the power of local "agglomeration" effects, by which large benefits accrue to firms when they locate together in urban areas. Substantial evidence now suggests that agglomeration brings with it strong self-reinforcing tendencies that not only do not support the "spread" of development, but are likely to exacerbate its concentration. Moreover, "bottom-up" technology-based economic development efforts cannot significantly change these patterns by themselves, in part because the resources states and cities can bring to bear are limited. Accordingly, the U.S. needs not just nation-scaled solutions for its regional imbalances but *place-based* ones.

4. **The nation should counter regional divergence by designating eight to 10 new regional "growth centers" across the heartland.** The time is right for, among other initiatives, a 21st century comeback and update of "growth pole" strategy—the 1960s and 1970s emphasis in regional economic planning that called for focusing transformative investment on a limited number of locations to catalyze the takeoff of those regions and the nation. What is needed in this respect will be: *Generous awards of key*

federal innovation inputs (including support for scientific and engineering research, regulatory benefits, and supports for high-quality placemaking) coupled with a *rigorous and competitive selection process* to identify the most promising locations for intervention.

Along these lines, the federal government should:

- ***Assemble a major package of federal innovation inputs and supports for innovation-sector scale-up in metropolitan areas distant from existing tech hubs.*** Central to this package will be a direct **R&D funding** surge worth up to $700 million a year in each metro area for 10 years. Beyond that will be significant inputs such as **workforce development funding, tax and regulatory benefits, business financing, economic inclusion**, and federal **land and infrastructure supports**. The increasing preference of innovative people and companies for mixed-use downtowns, waterfront areas, and urban "innovation districts" means that federal contributions to **urban placemaking** also should be prominent.

  Overall, a rough estimate of the cost of such a program suggests that a growth centers surge focused on 10 metro areas would cost the federal government on the order of $100 billion over 10 years. That is substantially less than the 10-year cost of U.S. fossil fuel subsidies.

- ***Establish a competitive, fair, and rigorous process for selecting the most promising potential growth centers to receive the federal investment.*** To distribute its supports, the proposed growth center program would select for awards the **eight to 10 metropolitan areas** that had best demonstrated their readiness to become a new heartland growth center. The process would employ a rigorous competition characterized by an **RFP-driven challenge**, **goal-driven criteria**, and an **independent selection process**.

5. **Numerous metropolitan areas in most regions have the potential to become one of America's next dynamic innovation centers.** Skeptics may doubt that eight to 10 metro areas worthy of growth center investment can be identified and catalyzed for "take off" and self-sustaining growth. However, even a fairly restrictive list of eligibility criteria yields plenty of potential candidates. Based on a demonstration in this report, some 35 potentially transformative metro areas surface as candidates for growth center designation. Candidates are situated in at least 19 states, lie in multiple regions (especially the Great Lakes, Upper South, and Intermountain West), and exist often at far remove from the coastal superstars.

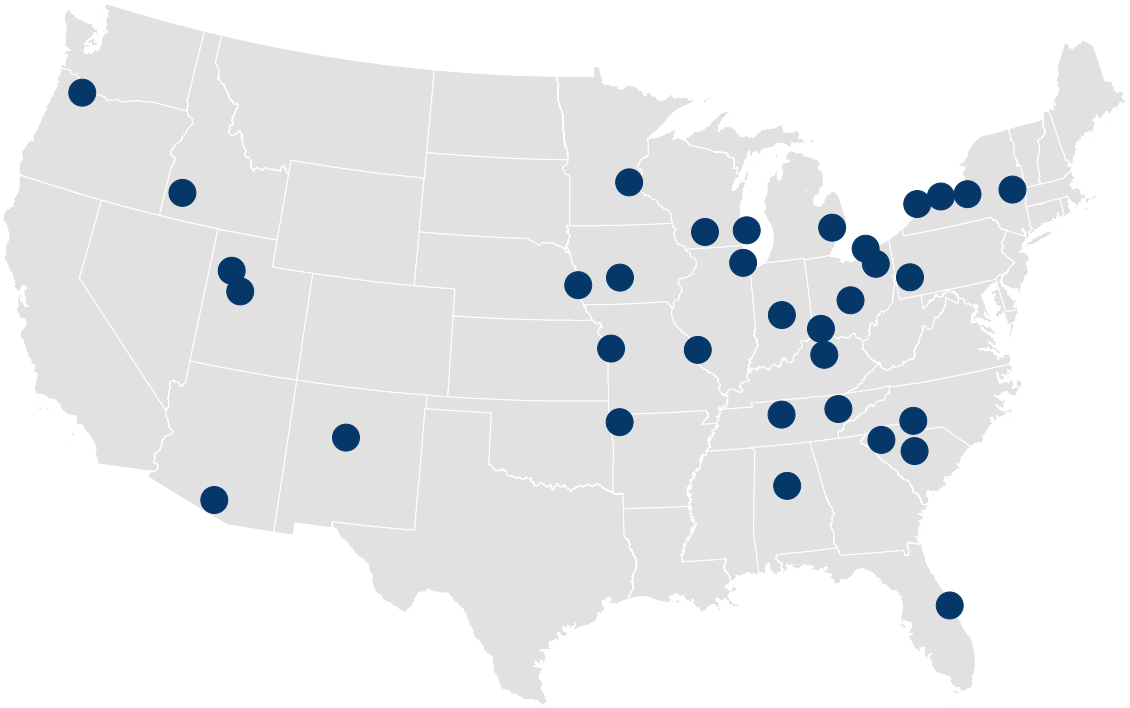
   Many more promising metro areas exist. There is likely a score of "up-and-coming" metro areas that hold a solid capacity for countering the nation's regional divides by bringing tech-based development closer to the nation's left-behind places.

*

To be sure, there will be objections. Some will say the present proposal goes way too far, while others will say it doesn't go far enough.

To the first point, many conventional economists will argue that any such push to promote regional equity will come at the expense of efficiency. However, because of both the negative externalities from growth in booming tech hubs and the positive externalities of growth in targeted emerging hubs, intervention can help underperforming metro areas turn the corner, escape a cumulative causation trap, and add to the nation's total welfare, including its global competitiveness. Other critics will deny the ability of the federal government to effectively pick regional "winners" or reject that the emergence of existing clusters had anything to do with government efforts. But one has only to examine the history of U.S. technology hubs such as Boston, the Bay Area, and North Carolina's Research Triangle to see that the federal

Strong potential candidates for Growth Center designation appear across the country



Source: Brookings and ITIF analysis of Emsi data

government has often played important, if not decisive, roles in helping new tech centers attain critical mass.

To the other point, others may say that a growth centers push does not sufficiently "change capitalism" or address the full crisis of America's smaller cities, towns, and rural areas. And certainly that is true. There is much more that needs doing, especially for the most deeply struggling communities. But the proposed innovation surge would absolutely begin to transform the nation's spatial malaise. Most notably, it would bring new vitality closer to more struggling communities, allowing for smaller towns and counties to benefit through supply chain relationships, commuting, and other interdependencies with the growth centers. In that spirit, then, the present initiative is best viewed as but one component of the full federal agenda needed to ameliorate the nation's unbalanced economic geography.

As such, a concerted growth centers surge—while not a total solution of the nation's now-acute set of regional imbalances—would represent a major break with past inaction and demonstrate that federal action can not only bring technology-based opportunity to more parts of the nation, but also spur more innovation and increased U.S. economic competitiveness.

Introduction

The stark facts of the widening regional divide in America finally hit home in the aftermath the 2016 presidential election.

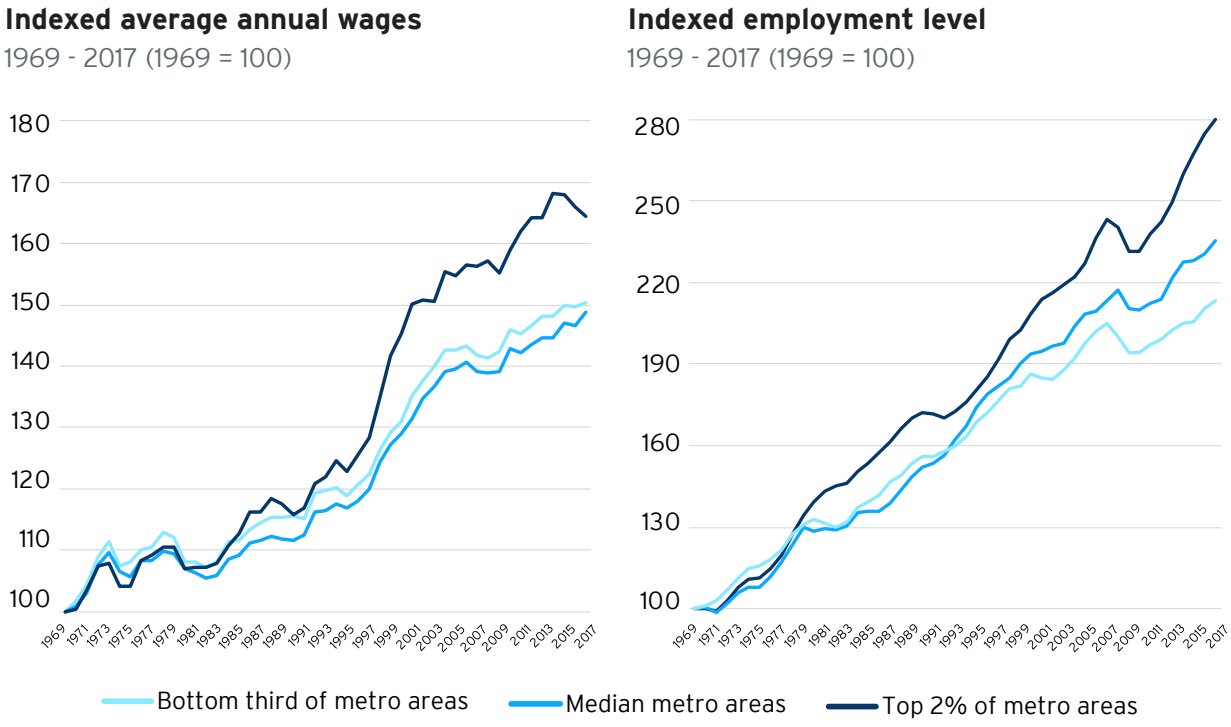
As nothing before it did, the election exposed a deep fault line: the widening gap between two separate Americas, one centered in the nation's dynamic, high-tech "superstar" metropolitan areas, and the other encompassing pretty much everywhere else.

Rather than growing together, the nation's communities are growing apart—and that has been a shock, especially for an economic and policy mainstream that has long trusted the self-regulating nature of the market.[1] For much of the 20th century, after all, market forces tended to reduce regional disparities in employment, wages, investment, and business formation. By narrowing these divides, the economy ensured a welcome "convergence."[2] Midsized and smaller cities, as well as once-lagging regions such as the South, were catching up with richer, bigger places.

However, in the 1980s, that trend began to break down.

As innovation moved to the center of economic activity, the advance of digital technology increasingly rewarded the most talent-laden local clusters of skills and firms. Intense new demands

Figure 1. Since the 1980s, wage and employment growth convergence among metro areas has broken down



Source: Brookings analysis of BEA data

for talent and insights increased the dominance of "agglomeration" economies, unleashing forces that benefited big, coastal core regions—often to the detriment of the midsized cities and smaller "heartland" towns that had found manufacturing-based prosperity in the 20th century.

Amid these conditions, convergence gave way to "divergence." Over time, a fortunate upper tier of big, techy metro areas (about 20 in all) began to consistently grow faster than the median and less-prosperous ones.

By the 2010s, a clear hierarchy of economic performance based on innovation capacity had become deeply entrenched.[3] Large innovation hubs such as Boston, San Francisco, and Seattle—along with smaller hubs including Austin, Denver, Raleigh-Durham and San Diego, as well as financial and content-oriented megamarkets such as New York and Los Angeles—have pulled away and secured themselves as America's core domain of advanced industry activity.[4] These places enjoy the benefits of what economists call cumulative causation, through which their earlier knowledge and firm advantages now attract even more talented workers, startups, and investment, creating a gravitational pull toward the nation's critical innovation sectors while simultaneously draining key talent and business activity from other places.

TERMINOLOGY

"**Advanced industries**" are America's 50 high-R&D, high-STEM manufacturing, energy, and services industries, ranging from aerospace and automobile manufacturing to solar electricity generation to internet publishing to bio-tech.

"**Innovation industries**" are a subset of advanced industries that include the 13 most STEM- and R&D-intensive industries.

"**Superstar cities**" are the 20 metropolitan areas with the largest absolute number of jobs in innovation industries. These mostly coastal, high-tech metro areas represent about 5% of the nation's metropolitan areas and are almost all growing relatively rapidly.

Source: Mark Muro and others, "America's Advanced Industries: What They Are, Where They Are, and Why They Matter." (Washington: Brookings Institution, 2015).

In contrast, most midsized cities and smaller towns (let alone rural areas) have struggled to make progress in amassing critical innovation industries, with many falling farther behind. For most of them, "innovation" or advanced-industry-sector employment and incomes have declined. Many such places have been left to cope with brain drain, the hollowing out of the labor market, and industrial decline.

As a result, few can now deny that the imbalanced geography of America's current economy is spawning disturbing negative externalities—or side effects—that cry out for response.

Among the superstar metros, the "winner-take-most" dynamics of the innovation economy have led to dominance thanks to their deep pools of talent, advanced firms, and capital. But those dynamics have also spawned tumultuous livability crises: spiraling real estate costs, traffic gridlock, and homelessness.[5] Firms in these metro areas increasingly move activity elsewhere, or launch it in other places, although too often the move is to lower-cost overseas tech hubs, rather than equally cost-competitive centers in the United States. Such dynamics represent true diseconomies of scale and drags on U.S. competitiveness.[6]

For the many metro areas that are going sideways or declining, the struggle to keep up has brought a mood of desperation as their fears of stagnation have been realized. Public officials, working families, and business and development leaders in these places are often deeply frustrated and at a loss for what to do to get onto the prosperity track—in part because many of the most well-intentioned local interventions, such as tech-based economic development programs, have proven incomplete on their own. Indeed, since these efforts are all chasing a limited amount of innovation activity, they almost all are falling short in their quest to reach the needed "critical mass" to succeed, while the less fortunate of them face the corrosion of drift, brain drain, and lost capacity.

And for the nation as a whole, finally, the juxtaposition between a few dominant innovation stars and the many other places trending sideways or downward raises broader problems. For the aggregate economy, there is the likelihood that while the importance of star agglomerations remains unquestionable, too much is being sacrificed through the underperformance of so many less successful regions.[7]

At the same time, civic and political leaders have grown deeply concerned about the social and political side effects of such unevenness.[8] For some, the isolation of millions of people from the dynamic innovation economies of superstar metro areas is a justice issue.[9] For others, the fear looms that the widening gap between the superstars and everybody else is eroding the national ideal of equal access to opportunity.[10]

All of which raises the question of what ought to be done about the concentration of the innovation sector, and the regional imbalances it entails.

Historically, the convergence trend of the economy minimized worry about the nation's uneven economic geography. Wage convergence—companies in high-wage areas moving to lower-wage ones—supported the belief that regional imbalances would naturally even out, thanks to the inherently efficient and welfare-maximizing nature of the market economy. However, more recently, other voices have noted the powerful positive links of innovation and agglomeration, and warned that efforts to reduce variation across places might be detrimental to the innovation sector's ability to drive national productivity.[11]

Accordingly, mainstream economists have until recently remained largely unphased by the nation's spatial divides and thus skeptical of ideas to counter it.[12] Such scholars would have the nation rely mainly on spurring migration from lagging to leading regions, ignoring the fact that most leading regions are already bursting at the seams—not to mention that many Americans retain deeply rooted ties to their home places.

In recent years, however, the heightened awareness of regional imbalances, especially in the innovation sector, has prompted new responses. Economists, investors, politicians, journalists, and economic development leaders are all beginning to reassess the costs of inaction after decades of exactly that.[13] No longer does nonchalance about the pull-away of superstar tech cities and the drift of most everywhere else seem tenable. Instead, a growing number of voices are concluding that a new set of viewpoints and policies are needed to actively respond to the imbalances of today's innovation map—not only to heal geographic divides, but to advance the U.S.'s innovation-based global competitiveness.

> "Few can now deny that the imbalanced geography of America's current economy is spawning disturbing negative externalities—or side effects—that cry out for response.

And yet, for all of that, few specific and substantial ideas for countering the winner-take-most dynamics of the innovation sector have been forthcoming. To the extent any are offered, they mostly resemble lectures on self-help, based on the opinion that if local leaders were just a bit more creative, they could overcome the powerful forces of cumulative causation on their own.[14]

Which is where this report comes in. Concerned that the divergence of U.S. metro areas has become self-reinforcing and destructive, the discussion that follows presumes that the time has come for the nation to offset the domination of innovation superstars with a concerted intervention to support the emergence of at least a few new stars in new places. As such, this brief urges the federal government to undertake a major new effort to counter divergence with a robust set of carefully targeted innovation, business-development, placemaking, and related investments of a type only it can deliver systematically. This effort would at once add to the nation's net innovation effort (as is sorely needed), spur global competitiveness, and push back against the nation's dangerous economic divides.[15]

> The transformation of even a short list of metro areas in new, interior areas could be expected to improve the fortunes of whole regions

In pursuing this vision, the report assumes that while the innovation economy can be more geographically dispersed, not every place can become an advanced industry hub. In fact, the following discussion suggests that only a modest number of places are likely to be able to transform themselves into self-sustaining tech hubs with large-scale (but temporary) help from the federal government, if for no other reason than the innovation economy is not big enough to act as the engine of growth for an extremely large number of places. At the same time, the transformation of even a short list of metro areas in new, interior areas could be expected to improve the fortunes of whole regions, opening up new possibilities for intraregional worker mobility and deeper supply chain ties. This transformation should be vigorously pursued, because it will affect not only the targeted cities but surrounding communities as well.

Accordingly, the paper urges the federal government to update a forgotten 1960s and 1970s strategy—growth poles—for transforming promising places by fusing it with modern methods. Metropolitan areas would compete to win massive in-flows of federal research, business development, and placemaking inputs and benefits in exchange for implementing bold innovation, economic growth, and transformation strategies.

In that vein, the discussion here begins by reviewing the entrenched nature of America's concentrated innovation sector and why it is a problem. After that, the report explains why markets acting alone won't solve the divergence problem, and proceeds to argue why robust intervention will be necessary.

From there, the report plays out one possible response to the excessive concentration of U.S. innovation activity in superstar cities: a plan for building up dynamic new growth centers in a set of promising metropolitan areas that have modest but not dominant existing strengths. Section 6 of the report articulates a vision for updating the concept of "growth poles" as a theory for creating more innovation centers across the nation, and Section 7 lays out what a federal, innovation-based growth centers program might look like, including how the government might select eight to 10 promising metro areas and provide them with a host of innovation inputs in order to become strong, self-sustaining technology hubs.

After that, Section 8 shows how one possible set of selection criteria for growth center contestants presents an array of up-and-coming locations whose accelerated emergence could improve on the nation's imbalanced geography. Section 9 anticipates and responds to the possible objections, and Section 10 concludes the report.

To be sure, ours is not a strategy for mitigating the full enormity of the nation's regional imbalances, or for jump-starting scores of worthy metro areas (that is the even more expansive vision espoused in Jonathan Gruber and Simon Johnson's book, Jump-Starting America).[16] Our "growth centers" proposal, rather, is focused on accelerating the growth of the most promising yet lagging metropolitan areas in the nation's interior, rather than on saving the most distressed cities and towns across the vast totality of America's economy. That too needs doing, but that work lies beyond the scope of this proposal. Instead, we focus here on the dangerous core problem of the hyperconcentration of the innovation and advanced industries economy, accepting that even on that narrower front it is simply not possible to "target" everywhere at once.

The focus of this report is on distributing high-quality economic development more widely across the United States, in part by stimulating new innovative activity in the most promising metro areas proximate to more places in the country's interior. Such an innovation surge is only one part of the needed push to counter the nation's regional divergence, but it should be counted as an important element of such a campaign. Such a campaign has a good chance of beginning to stem the epidemic of inequality in the nation by helping places beyond the immediate targets of action, which would likely benefit from the program through supply chain, labor market, and other spillover gains.

In sum, this report argues that the moment is urgent and the prospects favorable for launching a major national push to counter regional divergence—and with it, the nation's current crisis of economic and social inequality. Both a feasible strategy and promising potential participants exist for spreading innovation-driven growth farther across the nation's map. Individual metro areas, whole new regions including smaller nearby communities, and the nation as a whole would benefit from such an initiative. Moreover, if America is to avoid ceding its innovation lead to China, it is vital that we create more innovation hubs in America, if for no other reason than to give advanced technology firms in the United States an alternative to places like Shanghai and Shenzhen for their future growth.

The same is true if we are going to cease growing apart and begin to grow together again. Accelerating the emergence of 10 new growth centers in the heartland would help with that. It is time, then, for Congress and a farsighted administration to embrace the present challenge and opportunity.

2. The entrenched geography of America's innovation industries

The steady narrowing of economic disparities among U.S. regions through most of the last century licensed a strong confidence among economists that regional gaps would "naturally" close.[17] Initially as a fact and then as a reassuring orthodoxy, the conventional wisdom assumed that even seriously lagging regions would "catch-up" to leaders through natural equilibrium processes, as the "costs" of success—such as increased labor or real estate costs—accumulated and eventually motivated firms and workers to relocate to lower-cost regions.

As the U.S. production system grew after World War II—powered by nationwide telephony, the interstate highway system, air travel and, importantly for the South and West, air conditioning—manufacturing and corporate functions that had historically been centralized in the Midwest and Northeast now had many more options for where they could locate. Given that many of the mass production industries of the time had evolved to compete primarily on costs, it made sense that as costs increased in some regions, industry would grow faster in less-expensive regions, which would then "catch-up."

For years, regional trends comported with such neoclassical theory. From 1880 to 1980, incomes across states "converged" at a rate of 1.8% a year.[18] In other words, low-income states grew faster than high-income ones. Wages in poorer metropolitan areas likewise grew 1.4% faster than those in higher-wage metro areas between 1940 and 1980.[19] These trends, coupled with the simplistic, cost-based version of neoclassical economics that many economists subscribed to, licensed great optimism about the self-regulating nature of the nation's regional dynamics.

Nor has that hands-off view of regional imbalance fully dissipated, even as convergence broke down in recent decades. Right up to the election of President Trump, most economists seemed to have assumed that market forces would still correct for harmful variations among places and lead to greater regional balance, at least in time.[20] At most, they held, the federal government could provide free bus tickets for auto workers in Flint, Mich. to move to Silicon Valley, where they could be retrained as software engineers.

And yet, market forces *haven't* reduced such gaps in recent decades, and especially not when it comes to the geography of the nation's innovation sector. Nor has the problem been a lack of bus tickets. Instead, the welcome reality of convergence has been faltering and in fact shifting towards divergence—the polarization of places. Several careful researchers have looked across the economy and tracked dramatic *declines* of income and other measures of prosperity across states and metropolitan area in the years 1980 until now.[21] This should not be surprising, given that the innovation industries of the last 40 years largely do not compete on cost but rather on the richness of the local innovation ecosystem, where success begets more success. But the change, while slow to be fully recognized, has at last been recognized as an emergency.

DIVERGENCE AT WORK IN THE INNOVATION SECTOR

The geography of the nation's most important industries—its core "innovation industries," which are a key portion of its 50 most "advanced" industries—epitomizes the new dynamic.[22] America's innovation sector has, in truth, seen few triumphal "catch-up" stories and very little diffusion into new places. In fact, despite four decades of state and local technology-based economic development policies, what we call the U.S. "innovation sector" (ranging from pharmaceutical manufacturing and aerospace products to software publishing and data services) has remained strikingly immobile and highly concentrated in a short list of "superstar" metropolitan areas for many years.

This concentration is important because the innovation sector—consisting of 13 of the nation's highest-R&D industries (at the four-digit NAICS code level)—matters inordinately for the nation's competitiveness and prosperity, given that innovation industries encompass the nation's "tech" sector at its most dynamic, competitive, and valuable.[23] As a group, these 13 industries—which also include chemicals, computer equipment manufacturing, telecom, and R&D services— inordinately contribute to U.S. prosperity. While innovation industries account for just 3% of the nation's jobs, they generate 6% of the nation's GDP, a quarter of its exports, and two-thirds of business R&D expenditures. They also support solid economic multipliers in their regions (and nationally), and provide especially well-paying jobs even for workers without a bachelor's degree.[24]

Which is why it would be extremely beneficial if more of the nation's innovation activity was diffusing outward, so that more metropolitan areas were joining the nation's assortment of

"INNOVATION INDUSTRIES" AND "SUPERSTAR METRO AREAS" DEFINED

The "**innovation sector**" as discussed here is an especially high-tech subsector of the "advanced industries" sector, an earlier delineation of America's highest-value industries by the Metropolitan Policy Program at Brookings.

"**Innovation industries**" encompass America's 13 highest-tech, highest-R&D industries. Selected from among the 50 advanced industries, the 13 innovation industries represent a cohort whose R&D expenditures exceed $20,000 per worker and have a STEM-worker share of 45%. The 13 innovation industries include:

- Basic chemical manufacturing
- Pesticide, fertilizer, and agricultural chemical manufacturing
- Pharmaceutical and medicine manufacturing
- Computer and peripheral equipment manufacturing
- Communications equipment manufacturing
- Semiconductor and other electronic components manufacturing
- Navigational, measuring, electromedical, and control instruments manufacturing
- Aerospace product and parts manufacturing
- Software publishers
- Satellite telecommunications
- Data processing, hosting, and related services
- Other information services
- Scientific research and development services

"Superstar metro areas" are the 20 metropolitan areas with the largest absolute numbers of jobs in innovation industries. These mostly coastal, high-tech places represent about 5% of the nation's metropolitan areas and are almost all growing relatively rapidly. The 20 superstar metro areas are:

- New York-Newark-Jersey City, NY-NJ-PA
- San Jose-Sunnyvale-Santa Clara, CA
- Los Angeles-Long Beach-Anaheim, CA
- Seattle-Tacoma-Bellevue, WA
- Boston-Cambridge-Newton, MA-NH
- San Francisco-Oakland-Hayward, CA
- Dallas-Fort Worth-Arlington, TX
- Washington-Arlington-Alexandria, DC-VA-MD-WV
- San Diego-Carlsbad, CA
- Chicago-Naperville-Elgin, IL-IN-WI
- Philadelphia-Camden-Wilmington, PA-NJ-DE-MD
- Phoenix-Mesa-Scottsdale, AZ
- Minneapolis-St. Paul-Bloomington, MN-WI
- Houston-The Woodlands-Sugar Land, TX
- Portland-Vancouver-Hillsboro, OR-WA
- Atlanta-Sandy Springs-Roswell, GA
- Austin-Round Rock, TX
- St. Louis, MO-IL
- Denver-Aurora-Lakewood, CO
- Miami-Fort Lauderdale-West Palm Beach, FL

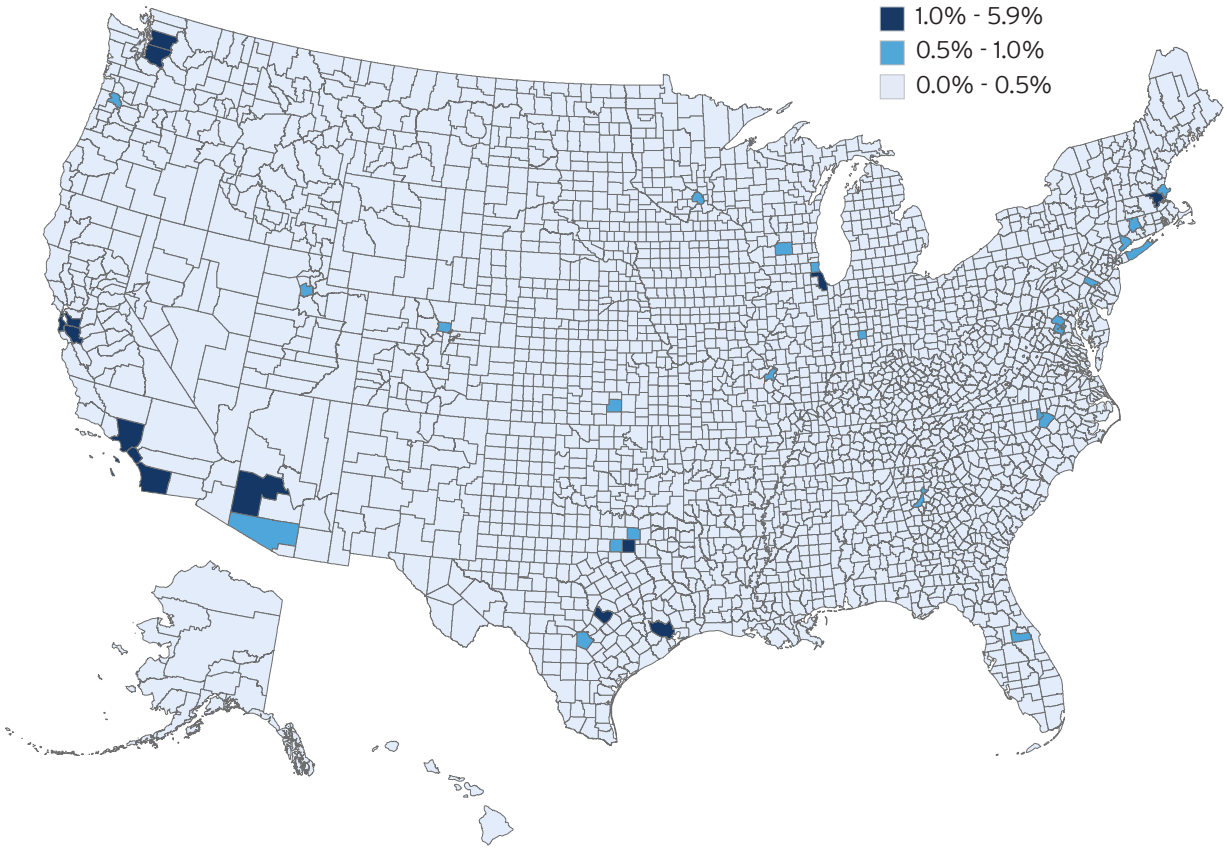
Source: Mark Muro and others, "America's Advanced Industries: What They Are, Where They Are, and Why They Matter." (Washington: Brookings Institution, 2015).

innovation hubs. However, that's not what has been happening. Instead, strong centripetal forces—the so-called "localization" and "urbanization"[25] dynamics of agglomeration—have produced a remarkably entrenched innovation sector geography in the United States. Two industry-level examples are the nation's world-class life sciences and digital services sectors, which have remained extremely concentrated in a relatively short list of metropolitan areas.[26] Because firms in such innovation industries compete on the basis of product and process innovation rather than cost-minimization, and are more reliant on knowledge than other industries, they tend to cluster in large metropolitan areas where they can tap specialized workers, suppliers, and institutions (localization), and take advantage of dense air and ground transport links (urbanization).

Map 1 illustrates the strength of agglomeration in the innovation sector. Fully one-third of the nation's innovation jobs reside in just the 16 counties (those shaded dark blue) that contain 1% or more each of the nation's innovation employment.

For that matter, more than half of the nation's innovation jobs are concentrated in just the 41 counties with at least 0.5% of the jobs in the innovation sector. That these counties account for less than 27% of the nation's aggregate job total underscores the strong tendency of innovation industries to cluster in select large regions where related activity is already taking place.[27]

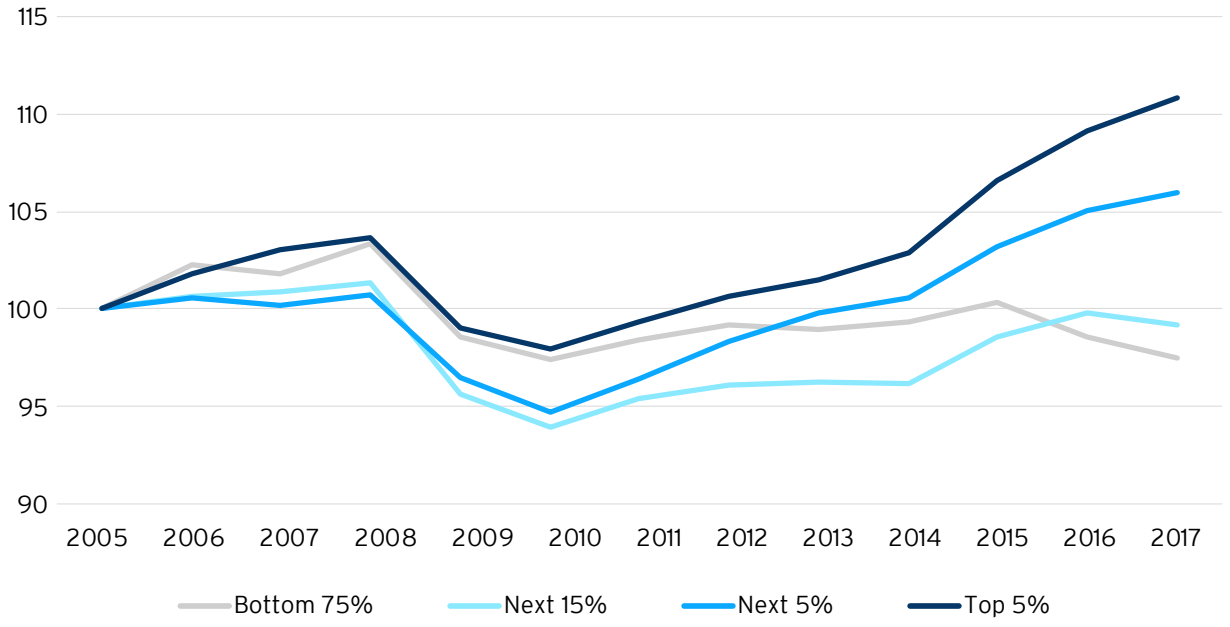
Map 1. U.S. counties by share of total innovation sector jobs, 2017



Source: Brookings and ITIF analysis of Emsi data

Figure 2. Innovation sector job creation has been strongest in metro areas that already have the largest sectors

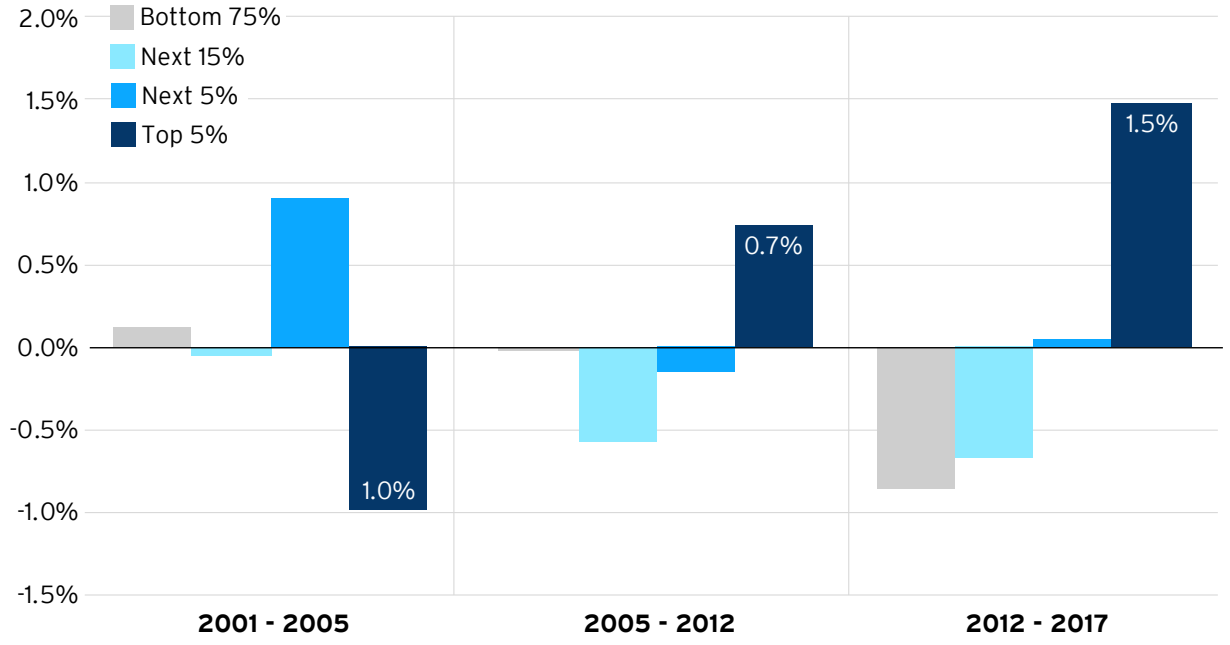
Innovation sector employment index (2005 = 100), 2005-17



Note: Percentage "bins" reflect cohorts of metro areas, ranked in each year. The "top 5%" includes 20 metros.
Source: Brookings and ITIF analysis of Emsi data

Figure 3. Innovation industries became more geographically concentrated since the start of the century

Change in share of all innovation jobs in metros, 2001-17



Note: Percentage "bins" reflect cohorts of metro areas, ranked in each year. The "top 5%" includes 20 metros.
Source: Brookings and ITIF analysis of Emsi data

Looking beneath the snapshot furnished by Map 1, Figures 2, 3, 4, and 5 explore the underlying innovation sector dynamics driving the nation's remarkable degree of agglomeration at the metro-area level.

To begin with, the line chart in Figure 2 makes clear the innovation sector's concentration has become self-reinforcing and divergent over time, to the extent that the innovation "rich" are getting richer as the metro areas with the largest sectors steadily gained additional innovation employment while most metro areas went sideways.

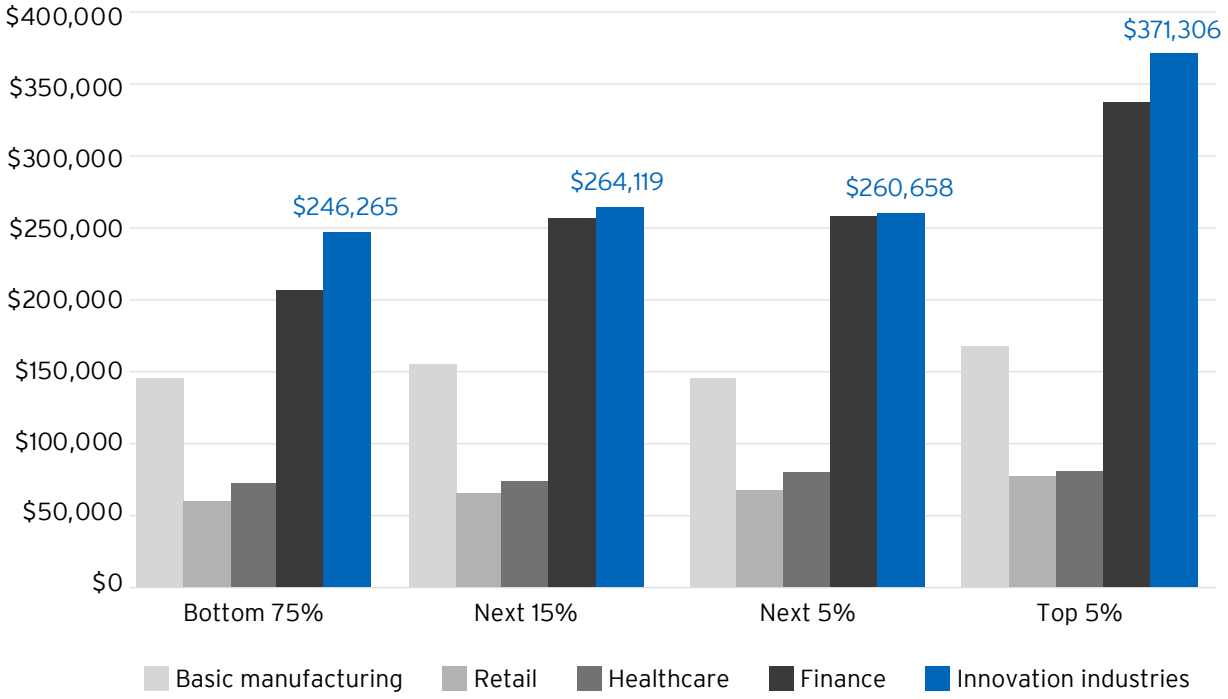
Far from catching up, most metro areas have been slipping farther behind. This tendency has been strong and sharpening in the last 15 years. Since 2005, as the line chart indicates, the geographic divergence of tech-sector employment across metro areas has been widening—driven in particular by the pull-away of the top 10% of innovation-job-rich metro areas. For the 90% of metro areas with fewer innovation jobs, however, total employment has effectively remained unchanged in the last 12 years.

The following bar chart (Figure 4) puts a finer point on this divergence by looking at changes in the share of total innovation jobs by metro-area echelons.

The top 5% of metro areas by innovation jobs, depicted in dark blue, have increased their share of the nation's total innovation employment since 2005 while all other size cohorts have drifted or lost share (the 1 percentage point loss of innovation employment share in the 2001 to 2005 period largely reflects the bust of the 2001 tech "bubble").

Figure 4. Localization economies make innovation industries clustered together more productive

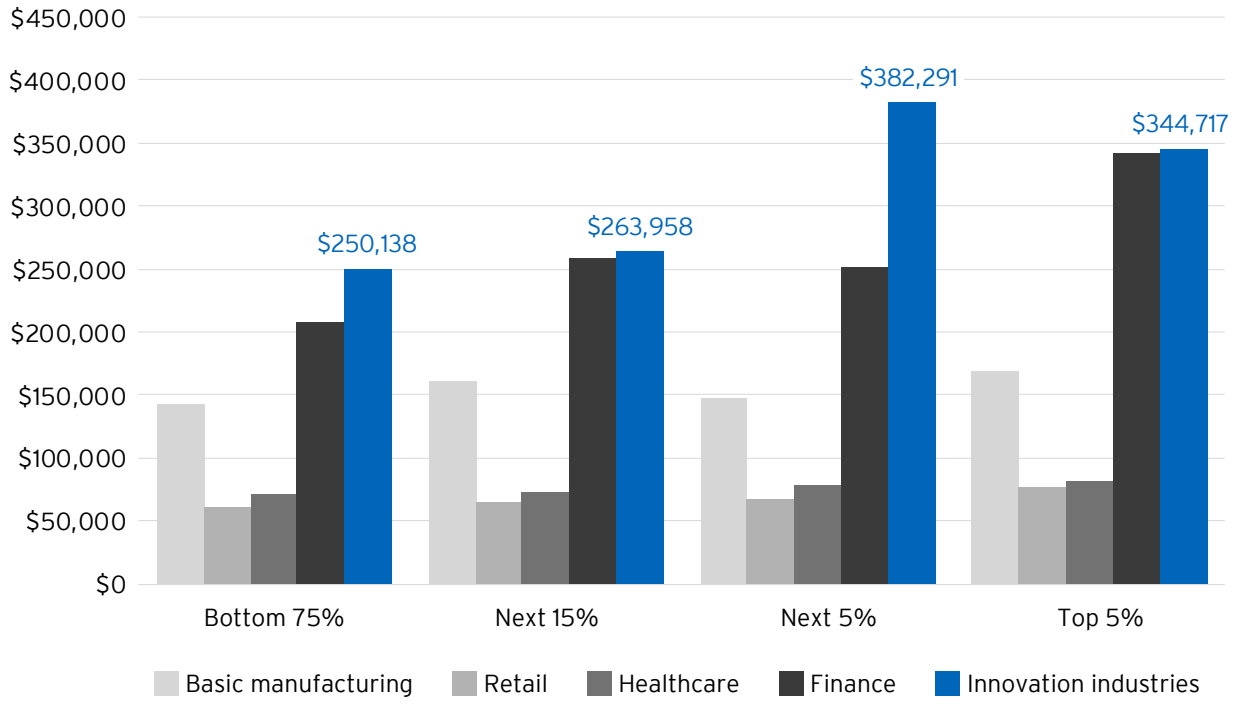
Avg. output per worker by industry group, 2017



Note: Percentage "bins" reflect cohorts of metro areas, ranked in each year. The "top 5%" includes 20 metros.
Source: Brookings and ITIF analysis of Emsi data

Figure 5. Urbanization economies benefit innovation industries located in larger markets

Avg. output per worker by industry group, 2017



Note: Percentage "bins" reflect cohorts of metro areas, ranked in each year. The "top 5%" includes 20 metros.
Source: Brookings and ITIF analysis of Emsi data

The top 20's share of all metro-area innovation jobs rose from 59% to nearly 61% in the period since 2001, even though they accounted for only 45% of metro-area jobs across all industries. Moreover, the gains among second-tier metro areas in the early 2000s were more than offset by innovation sector employment concentration in the top 20 between 2005 and 2017—a 2.2 percentage point increase among the top 20 at the expense of the bottom 90% (equal to 343 metro areas). By 2017, two-thirds of innovation sector output originated in those same top 20 metro areas, once again pointing to the clear productivity advantages they continue to confer on firms there.

Figure 4 and Figure 5 show the underlying productivity dynamics driving this remarkable degree of agglomeration at the metro-area level.

Among metro areas, the average output per worker in innovation industries rises with both the absolute number of jobs in the sector in a given metro area (Figure 4, reflecting "localization" economies) and the total number of jobs in the metro area overall (Figure 5, reflecting "urbanization" economies).

Average innovation sector labor productivity in the top 5% of metro areas with the most innovation sector jobs—plotted to the far right, reflecting a mere 20 places—is more than 50% higher than it is in the 75% of metro areas plotted to the left, which have the fewest innovation jobs and encompass 287 different metro areas. The magnitude of this sector-level disparity is similar when metro areas are grouped by total employment.

By contrast, this relationship appears much weaker for less innovation-centric industry groups such as basic manufacturing and health care (with the exception of finance, another traded service sector).

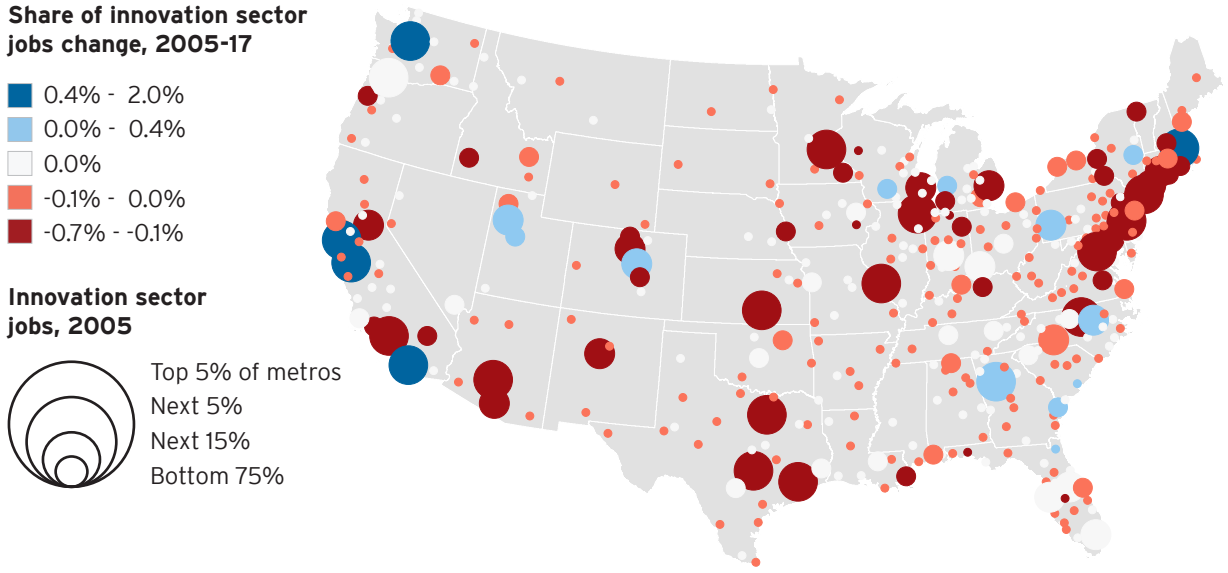
Mapping some of these patterns further highlights how a truly small set of "superstar" cities has been determining the nation's innovation geography. In this vein, Map 2 shows that a very short list of large coastal metropolitan areas has substantially increased its preeminence in innovation industries since 2005, while a very long list of metro areas actually lost ground. (For metro-area statistics see Appendix A).

Overall, just five "superstar" metro areas—**Boston**, the **San Francisco Bay area** (**San Francisco** and **San Jose**), **Seattle**, and **San Diego**—accounted for some 90% of all U.S. innovation-sector growth between 2005 and 2017. These gains mostly transpired in the digital and biopharmaceutical expansion of the last decade. As such, the five metro areas collectively increased their aggregate share of the nation's innovation jobs by 5.2 percentage points, from 17.6% in 2005 to 22.8% in 2017. More broadly, some 40 of the largest 100 metro areas increased their share of the sector, although the gains were miniscule outside the top five.

By contrast, 60 of the largest metro areas *lost* ground, with many seeing quite dramatic shrinkages of their participation in America's innovation economy. In this respect, no fewer than 224 out of 382 U.S. metro areas have seen their share of the national innovation sector *decline* since 2005. What's more, 191 metro areas actually shed innovation sector jobs during the time period. For instance, absolute local employment in the innovation sector fell by over 20% between 2005 and 2017 in **Colorado Springs, Colo.**, **Providence, R.I.**, **Sacramento, Calif.**, **Albuquerque, N.M.**, and **Wichita, Kan.** To be sure, several interior metro areas such as **Madison, Wis.**, **Raleigh, N.C.**, **Atlanta**, **Denver**,

Map 2. Only a handful of superstar metro areas have seen their share of innovation jobs increase since 2005

Metros by change in share of total innovation sector jobs



Source: Brookings and ITIF analysis of Emsi data

Salt Lake City, and **Provo, Utah** have increased their share of U.S. innovation jobs even as the superstars boomed. But even so, most metro areas have gone sideways or lost innovation share. In the Midwest and South, multiple metro areas with solid industry, university, and workforce assets such as **Des Moines**, **Iowa**, **Charlotte, N.C.** and **Minneapolis** have added innovation jobs, but failed to increase their share of the national sector, while metro areas such **Chicago** and **Wichita** have both shed innovation jobs and national share. More broadly, most of the nation's major business hubs—including **Los Angeles**, **Dallas**, **Washington, D.C.**, **Philadelphia**, **New York**, and **Houston**—have lost purchase in the sector.

All of this points to the extent to which the pull of agglomeration compounds over time in the innovation sector, leaving most places behind and putting those metro areas that lack a self-sustaining critical mass of innovation sector activity at an increasing disadvantage.

> No fewer than 224 out of 382 U.S. metro areas have seen their share of the national innovation sector decline since 2005.

3. The costs of hyperconcentration

Why, though, is this intense concentration of the nation's innovation sector such a problem? Might the nation's unbalanced degree of spatial concentration be the optimal, market-ordained, geographical configuration for maximizing innovation?

To be sure, intense, even extreme, geographic concentration has long been viewed as inevitable, benign, and mostly desirable for advanced economies.[28]

In recent decades, agglomeration economies—a feature of regional economics for more than a century—have been understood to be the focal points of national prosperity in an era of tech- and services-led growth.[29] At the same time, ameliorative subsidies or other interventions for places that lacked the right mix of size, skills, infrastructure, and amenities were seen—at least by federally oriented economists and policymakers—as impediments to the efficient movement of capital and labor into dense urban markets where they would receive their highest return.

In this regard, the work of building tech agglomerations has fallen mostly to state and local policymakers, who have made do with only small denominations of funding and programs that often ended with each political administration. At the federal level, meanwhile,

the proper role of policy was simply to facilitate factor mobility by focusing on eliminating frictions and lowering costs (especially housing) in the country's most productive metro regions.[30] Given the assumed big "trade-off" between efficiency and equity, to do anything else would be to compromise growth.[31]

The present decade has, however, seen the breakdown of this confident narrative, as scholars and policymakers have begun to recognize the untenable economic, social, and political costs of sustained territorial polarization and industrial concentration.

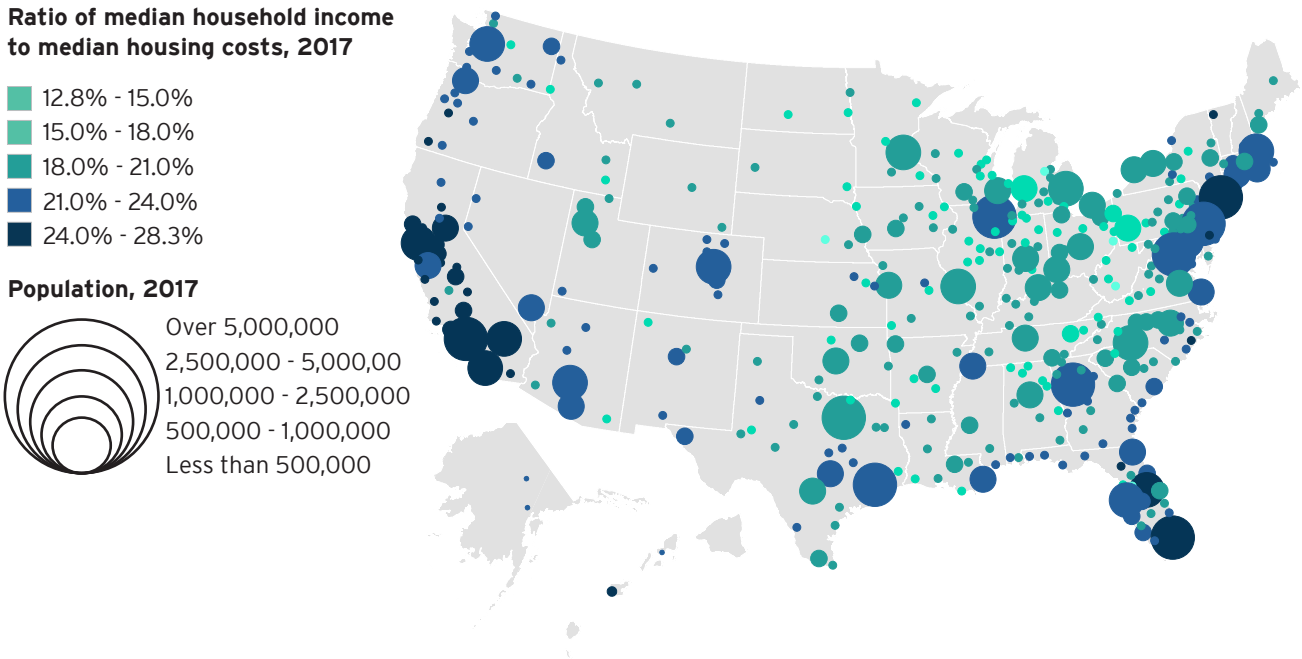
ECONOMIC COSTS

At the economic end of the equation, the costs of hyperconcentration in large innovation agglomerations are impossible to ignore. Since 2010, average commute times have nearly doubled in San Jose, Calif. and increased by two-thirds in San Francisco.[32] Over 30% of workers now commute more than an hour to work in San Francisco, San Jose, Seattle, and Boston, compared to just 6% in all metropolitan areas. Home prices have more than doubled in the Bay Area over the same period, with median rents for a one-bedroom apartment exceeding $1,500 a month in both San Francisco and San Jose.[33] Indeed, such high housing prices mean it is now not uncommon to find even software developers in the Bay Area living out of their cars or Winnebagos.[34] Such externalities represent sizable drags on regional and national efficiency.

At the same time, the current reconsideration of the laissez faire orthodoxy on geographical trends has been further driven by frustration with economic stagnation in so many of America's left-behind places. [35] In these places, shuttered plants, faded downtowns, and depopulated residential neighborhoods exemplify the economic and social costs of regional imbalance. As such, the "winner-take-most" ascent of the superstar

Map 3. Spiking housing costs are one major consequence of the hyperconcentration of innovation sector jobs

Metros by housing affordability



Source: Brookings and ITIF analysis of Emsi data

metro areas has increasingly been accompanied by the decline of virtually everywhere else.

This decline is now imposing "efficiency" costs both on communities and the nation. For starters, the divergent, striated economic map is beginning to affect the geographic sorting of workers, with negative impacts on the nation's overall welfare. While some economists believe worker migration from low- to high-productivity places will increase the nation's aggregate efficiency, recent scholarship emphasizes that geographic mobility has slowed, limiting its ability to erase regional productivity divides. Specifically, economists Elisa Giannone, David Autor, Peter Ganong, and Daniel Shoag have all shown that what migration has been occurring is now sharply segmented by education, with serious implications for non-college-educated workers' employment prospects.[36]

Consequently, a problematic "sorting" of workers has developed, as suggested by Table 1. College-educated workers have been clustering in fast-growing agglomerations with large innovation sectors (leaving behind other metro areas with thinner talent reservoirs), while noncollege workers increasingly remain in places with diminishing job prospects (both at home and in the distant, more vibrant cities) and slow or stagnant wage growth.[37]

These patterns ensure that the nation's overall labor market is becoming inefficiently and stubbornly ill-sorted. Metro areas heavily oriented toward innovation work are able to attract and retain high-skill workers from out-of-state and abroad, adding to their stock of human capital. By contrast, less innovation-oriented metro areas are losing their more mobile, high-skill workers (and the positive externalities they provide to other workers) while lower-skill, less-mobile workers remain behind. Over time, these crosscurrents have locked in place a dangerous striation of talent pooling that will be difficult to alter absent national-scale intervention.

Additional market problems result from the spread and persistence of economic underperformance across large swaths of the nation, raising the possibility that whole regions may be falling into "traps" of underdevelopment, whereby underperforming regions begin to lose the capacity to catch up to frontier regions at all.

Table 1. Innovation hubs draw in highly educated workers, while less-educated workers face declining employment prospects everywhere else

	Share of adults with at least a BA, 2017			Share not in labor force, 2017
Innovation sector jobs	**All residents**	**Out-of-state migrants**	**Foreign migrants**	**Prime-aged adults without a BA**
Top 5% of metros	39.0%	56.2%	55.6%	20.4%
Next 5% of metros	34.9%	47.7%	51.5%	20.7%
Next 15% of metros	32.0%	43.8%	44.7%	21.2%
Bottom 75% of metros	26.4%	35.7%	40.1%	23.4%

Note: Migrants relocated sometime in the preceding year. Prime-aged adults are ages 25 to 54.
Source: Brookings and ITIF analysis of IPUMS USA ACS 1-year microdata

> The "winner-take-most" ascent of the superstar metro areas has increasingly been accompanied by the decline of virtually everywhere else.

This concern is no longer academic. Since the mid-2000s, U.S. productivity growth has slowed considerably, with low- and middling-productivity metro areas seeing the biggest decelerations.[38] Central to this has been a stark gap between the productivity of the relatively few metropolitan areas with very high shares of innovation industries and the many more without them (a large local innovation sector correlates strongly with metro-wide productivity, even controlling for local employment and education levels). While metro areas most heavily specialized in innovation industries have maintained high productivity, most others are "stuck" at much lower levels of productivity. (See Figure 6).

As the scatterplot suggests, the employment-weighted average productivity of the 20 metro areas with the largest innovation sectors was $109,443 per worker, compared with just $82,243 per worker across all other metro areas. That these 363 "other" metro areas with lower productivity encompass nearly 60% of the American economy underscores the efficiency problem caused by the nation's unbalanced innovation map. At a minimum, the hyperconcentration of U.S. innovation activity in a short list of superstar core regions—while most other cities remain "stuck"—may be associated with a stubborn, potentially sizable gap in national output. Most metropolitan areas in America are going sideways.

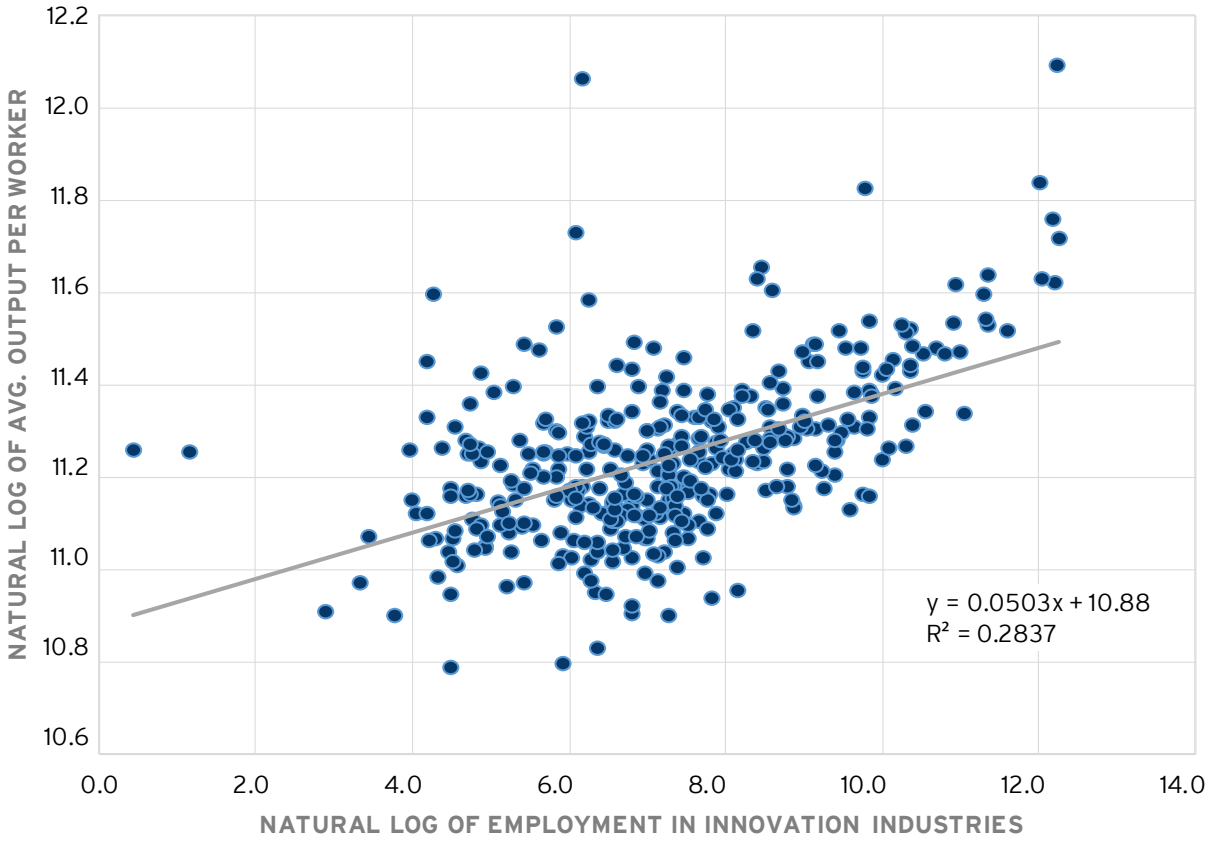
In short, both labor-market dynamics and industry location patterns are reinforcing the nation's regional imbalances and compromising economic efficiency. At a minimum, persistent regional disparities in economic activity and labor markets—most notably in "lagging" regions—mean that national productivity and wealth are lower than they could otherwise be.[39]

And then there is the fact that the current spatial pattern also harms U.S. competitiveness. While innovation industries do not compete principally on costs, costs are not entirely irrelevant. This is in part why Congress passed corporate tax reform in 2017. In any event, increased concentrations of technology output and employment in a small number of very high-cost places mean that the firms there (and their workers) will have a higher cost structures and lesser productivity than if some of this growth could be located in less expensive, but still viable, locations.

This is why many companies, including startups, look to diversify operations outside of the nation's high-cost hubs. Yet what one might think would be good for other U.S. metro areas and a force for convergence has not necessarily played out that way. Instead, these offloaded operations are often placed not in Syracuse but in Shanghai, not Boise but Bangalore, not Virginia Beach but Vancouver. As one Silicon Valley venture capitalist reported, his firm expects the startups they invest in to locate at least some activity in lower-costs foreign hubs if they are to be globally competitive.[40]

Why not go to other American metro areas?[41] Cost turns out to not be the factor in today's innovation economy. While the cost of living in Taipei is 16% less than in Austin, Indianapolis costs 14% less.[42] Shanghai is 35% cheaper than Boston, but Detroit is almost as cheap (34%). And while Tel Aviv is 23% cheaper than San Francisco, Kansas City is 41% cheaper. The reason, then, that companies in U.S. tech hubs go to these foreign hubs is not only because they are cheaper but also because they are tech hubs in their own right, with large pools of skilled workers, sizable innovation infrastructure, and rich ecosystems of suppliers and competitors. With the ability of global tech firms to locate anywhere in the world, in short, these affordable alternative hubs are increasingly outside the United States. As a result, enabling the creation of moderate-cost,

Figure 6. Large innovation sectors boost economy-wide metropolitan productivity, 2017



Source: Brookings and ITIF analysis of Emsi data

but still robust tech hubs in the heartland would not only help U.S. geographic balancing, but also foster technology competitiveness as firms would be more likely to choose Indianapolis over Taipei, Detroit over Shanghai, or Kansas City over Bangalore.

SOCIAL COSTS

Turning to the social welfare concern, there remains the simple fact that the nation's hyperconcentrated innovation sector and associated regional divergence is unfair. By that, we mean that tens of millions of citizens are currently being seriously disadvantaged with respect to job opportunities, income possibilities, happiness, or mental health outcomes simply by virtue of living in one region rather than another.[43] Where people live, after all, is a determinant of their economic opportunities, especially in a regionally unbalanced economy. Therefore, the distance between many Americans and the good job opportunities associated with the nation's vibrant innovation centers amounts to a kind of economic exclusion.

Such distance deprives millions of workers in the "wrong" places from the enhanced opportunities associated with the multiplier effects produced by innovation sector growth in the "right places."[44] Such distance, in like fashion, deprives millions of nondegree workers in the "rest" of America of the wage gains that have been shown to improve the welfare of those less-educated workers who reside proximate to concentrations of tech employment elsewhere.[45]

Nor is this a problem solely for those located specifically in poor-performing commuting areas. Workers isolated from superstar hubs lose out in broader ways. Because innovation centers generate sustainable economic growth—and with it, state tax revenues—workers in states without vibrant tech centers lose out on the benefits of fiscally healthier state governments. Likewise, workers in states far away from innovation jobs lose out on the supply-chain benefits that advantage more proximate workers.

In short, the geographic distance between the left-behind masses and the fortunate few in superstar hubs undercuts economic inclusion and contributes to national inequality.[46] Regional divergence is not just an economic problem, but also a profound social one.

> Enabling the creation of moderate-cost, but still robust tech hubs in the heartland would not only help U.S. geographic balancing, but also foster technology competitiveness as firms would be more likely to choose Indianapolis over Taipei, Detroit over Shanghai, or Kansas City over Bangalore.

POLITICAL COSTS

Here we must note that while the political side effects of these dynamics might seem remote or abstract, they are far from it. Economic and social divides—undergirded by economic divergence—have likely had tangible political impacts on the U.S., which suggests a final problem with the nation's hyperconcentrated innovation sector.

Most notably, the 2016 presidential election—which delivered a shocking backlash vote and President Trump's victory—sent a clear signal that many people are not happy with today's extreme levels of economic and social divergence. People and places that felt left behind by an elite cultural and economic order based in superstar metro areas used the ballot box to voice their displeasure, and voted for a candidate who stated that he understood their circumstances and would help.

To be sure, solid scholarship has suggested that the 2016 backlash was more immediately rooted in socio-cultural issues than economics.[47] With that said, numerous scholars have long stressed the constant influence of economic trends such as economic stagnation and inequality on social tolerance and political democracy.[48] To that extent, the 2016 vote reflected a new kind of "negative externality"—or side effect—of the agglomeration economy, as economic geographer Andrés Rodríguez-Pose has observed.[49] As it happens, the most disruptive political effects of excessive agglomeration came not from among its winners in superstar cities with skyrocketing rents and congestion, but from the people and areas "left behind," where frustrated workers and retirees who had witnessed long periods of decline in their towns sensed that the future lay elsewhere.

In that sense, the current populist revolt reflects, at least in part, geographical cleavages that now pose a very real threat to the hyperconcentrated innovation economy itself. To that extent, the recent revolt of the "places that don't matter," as Rodríguez-Pose puts it, represents one more reason the hyperconcentration of the innovation sector can no longer be accepted.[50] As former George H. W. Bush White House advisor Jim Pinkerton argues: "As U.S. history proves, we can live with...much 'inefficiency'...What we can't live with is...a country in which whole states are left behind, in the dust."[51]

Nor is this new political externality only cultural or a matter of sentiment. It's becoming material, as the current backlash portends less-supportive policy for the innovation economy, whether for R&D, workforce development, infrastructure, or immigration.[52] In this regard, Tip O'Neill's famous dictum about all politics being local surely applies. If few members of Congress believe that the voters they represent are benefiting from innovation and the innovation economy, they will be less likely to support measures to foster such activity—such as stronger STEM education and increased federal support for scientific and engineering research—and more likely to support measures to limit innovation, such as limits on self-driving trucks.

In sum, the end of regional convergence and the rise of divergence confront the nation with untenable economic, social, and political costs, signaling serious market and governance failures that require attention.

4. Why markets alone won't solve the problem

America's entrenched innovation geography certainly seems like it might merit a policy response. But it might not. In theory, it could be that the earlier forces of city "convergence" will reassert themselves, ensuring that the problem of hyperconcentrated innovation activity will resolve itself. And indeed, that expectation of self-adjustment has remained a leading forecast of many economists and policymakers, if only we wait long enough. However, as John Maynard Keynes famously noted, in the long run we are all dead.

Fortunately, however, that expectation is changing. Contemporary economic analysis has grown increasingly aware of an array of self-reinforcing tendencies of innovation-driven economies that likely preclude the desired self-correction of the city system.

THE OVERHANG OF NEOCLASSICAL REGIONAL THEORY

The expectation of automatic self-correction reflects the view of a majority of U.S. economists who subscribe to what can be termed "neoclassical" economics. Neoclassical economists hold several overarching principles that have long informed economic policymaking—and now limit its relevance.

The first principle is that ideal economic functioning will always maximize "allocative efficiency."[53] Allocative efficiency is the market condition whereby resources are distributed in a way that maximizes the net benefit attained through their use, while the quantity of goods produced is that which is most beneficial to society, as determined by price signals. This view makes it a cardinal sin to propose a policy that would alter the "natural" allocation of factors—capital, labor, and goods and services—produced by individuals and firms as guided by market price signals.

The second principle of neoclassical economics is that the economy tends toward equilibrium. Once again, the economy—given neoclassical doctrine—is simply a large market of goods and services that is generally in equilibrium and usually best left to itself. In this view, any spatial disequilibrium, such as a "bust" in one part of the country and a boom in another, will eventually even out.

Thirdly, the neoclassical mainstream holds that price signals are the most important drivers of these naturally occurring allocation mechanisms. This is premised on the theory that firms and locations compete on price. Businesses (and workers) seek out locations where they can maximize profits (and wages), and because of that, competition over time will even out. If one region declines and wage rates go down, while another region grows and wage rates go up, workers from the former region will move to the latter, bidding down wages there and raising them in the region they moved from. Firms, for their part, will also move from high-cost areas to low-cost ones. Over time, lagging regions rebound. As Harvey A. Goldstein and Michael I. Lugar say of neoclassical economic theory: "As long as there are no structural reasons for the original differences in production technology, the equilibrium outcome will be characterized by a set of locations that are identical in industry and skill mix, factor proportions, and other outcomes."[54]

And finally, in the neoclassical cannon, the whole market-based process of spatial allocation is viewed as inherently efficient and welfare-maximizing. As such, there is little or nothing society should do via regional policy to respond to market outcomes, other than to help workers in lagging areas to move to growing ones.[55]

In light of this presumption, it is unsurprising that moving assistance has been the favored adjustment of many economists who have tried to respond to the troubling dichotomy of superstar tech hubs and regions left behind. For them, regional inequality should not be treated as an economic problem in and of itself, but rather as evidence of either fundamental differences in the productivity and amenities of particular locations or market distortions leading to spatial factor misallocation. So even as neoclassical economists realize they can no longer ignore the need to address extreme regional imbalances, they have dusted off their long-standing view that the most efficient policy is to move people—not help places—principally by providing relocation assistance and relaxing zoning restrictions in leading metropolitan areas to make housing more affordable.[56]

Along these lines, Chang-Tai Hsieh and Enrico Moretti argue in a widely cited paper that there is a spatial misallocation of labor because expensive hubs such as San Francisco don't build enough housing, preventing workers from moving to where they are most productive, and thus significantly depressing national output.[57] Edward Glaeser and Joseph Gyourko echo Hsieh and Moretti, theorizing that housing supply constraints in high-wage cities have the effect of holding down wages for workers living elsewhere and increasing transfers to landowners.[58] And for their part, Ganong and Shoag have likewise estimated that housing restrictions reduced interstate income convergence by roughly 10% since 1980. All of these scholars suggest zoning reforms and increased building in the most productive superstar cities will restore migration and convergence.[59]

There are three problems with this focus on relocation and zoning. The first is that such an approach would likely exacerbate, rather than reduce, regional imbalances and further hollow out the heartland.[60] Such an approach would attract even more workers to thriving hubs, while reducing talent elsewhere—which could be calamitous for the nation's interior. The second problem with the zoning and mobility focus is that the logic that it would raise productivity is strained: Moving a retail clerk from Montgomery, Ala. to Boston won't by itself make her more productive.[61] Third, many of the target locations proposed for this solution, such as Boston and San Francisco, face geographical constraints to increased housing, unless someone comes up with a cheap way to build floating houses in the ocean. Nonetheless, the people-to-jobs doctrine remains prominent.[62]

There is another even more serious problem with neoclassical convergence theory. For most of the 20th century, when the theory was dominant, the U.S. economy was—for all intents and purposes—a national economy. Firms in a high-cost Northern state might move to a low-cost Southeastern state, which indeed happened, often en masse. But for the last four decades, the United States has become part of a deeply integrated global economy. Now, instead of firms in high-cost regions moving to the Southeast United States, they are more likely to move to Southeast Asia. This is one reason why over the last 40 years global incomes have converged while U.S. regional incomes have diverged.

So in one sense neoclassical convergence theory works—it's just that the geography region in question is now the world. But most American politicians see their job as maximizing the economic welfare of their district first, America second, and the world a distant third. Relying on convergence based on factor prices in a globalized world will only make the achievement of local and U.S. welfare goals more difficult. Ensuring U.S.-based convergence now requires leveraging more than market forces.

THE RISE OF INNOVATION-BASED THEORIES HIGHLIGHTS NEW CHALLENGES

It bears acknowledging, of course, that neoclassical regional theory—with its focus on cost-based production and natural resources industries, factor price interactions, and firm and worker mobility—once provided a better guide to policymaking than it does now.

However, neoclassical regional and location theories are much less relevant to today's innovation-based global economy.[63] As The Economist writes, "orthodox economics has few answers to the problem of regional inequality,"[64] and indeed, there is much wrong with the doctrine's framing, from an economic perspective. Most notably, the inconvenient truth that that many regions today are not, in fact, "catching up" underscores the theoretical shortcomings of the traditional view. So it's worth examining the observations of other regional development theories and schools that more accurately account for the particularities of an innovation economy—and fundamentally challenge standard thinking about the self-correcting nature of the economy. These lines of thought provide important insights into the origins of U.S. regional divergence and what kinds of interventions are best to counter it.

Cumulative causation challenges equilibrium theories

Let's begin with the theory of "cumulative causation." While institutional economist Thorstein Veblen first used the term "cumulative causation" in 1904 when discussing the accumulating effects of economic dynamics,[65] it was Swedish economist Gunnar Myrdal who fully developed the notion in 1957 as it applied to regional dynamics, drawing on previous work by the economists Knut Wicksell and Keynes.[66] A year later, noted international-development economist Alfred O. Hirschman reached

similar conclusions.[67] Around the same time, Henri Perroux's theory of growth poles added important arguments for rejecting the premise that the interplay of socio-economic forces have a naturally equilibrating tendency,[68] as did William Alonso in 1968[69] and Nicholas Kaldor in 1970.[70]

Unlike the dominant equilibrium-based spatial models, Myrdal's work argued that the dynamics of spatial growth often involved self-reinforcing interactions of economic, institutional, and demographic factors.[71] Cumulative causation theory holds that, in many cases, reality does not conform to the idealized vision of market-based adaptation and convergence. In fact, Myrdal and Kaldor believed that the market forces of trade and factor mobility would instead tend to aggravate inequalities as interrelated regional (dis)advantages compounded and reinforced each other over time. Any temporary balance that may be obtained between "backwash" effects (the adverse effects of growth in one region on others) and "spread" effects (the positive nonlocal effects of regional growth) was, according to Myrdal, an unstable position that could easily be tipped by an exogenous shock into an upward or downward cumulative movement. In sum, markets produce both lagging and leading places.

To see this, consider the cumulative effects of a negative shock in a region and a positive one.

In the negative instance, play out the effects of a leading export-based employer pursing a faulty business strategy and closing. Unemployment rates go up as the firm and its local suppliers shutter or shrink. As a result, government revenues fall, leading to decline in spending on schools, infrastructure, and other government services. Next, service quality must go down, unless the jurisdiction increases taxes, which reinforces the negative cycle: As taxes increase and/or service quality goes down, firms are less likely to locate there and workers less likely to want to move there. Moreover, factors of production, such as the workforce, are "sticky," limiting "natural" adjustment factors. Workers have difficulty moving, in part because the value of their homes may have fallen or because they have family ties to the region. The quality of the local skills base can atrophy. Social dysfunction, including crime and addiction, can increase. All of which can lead even more firms to reduce production in the location. And indeed, all of this underscores a core failure of neoclassical theory: its tendency to discount "externalities," positive and negative.

Now turn to a positive case, that of a growing region that is home to a company beginning to gain market share, perhaps due to an innovation. Now the chain of cumulative causation is strongly positive: The growing firm will raise wages to meet new hiring needs, which draws in workers from outside the region, raises home values, and stimulates demand for local retailers and nontraded services. At the same time, firm success and population growth boost government revenues, which in turn enable higher spending on infrastructure and lower taxes, making the region even more attractive for businesses and residents.

At the same time, lagging regions may be further inhibited in their development by "backwash" effects from prospering places. Skilled workers, the well-educated, entrepreneurs, venture capital, and high-growth startups that may emerge in a lagging region are drawn elsewhere, seeking higher returns on their capital or labor.

In short, the centripetal forces in successful hubs can be extremely powerful, to the point that they can pull in key factors of production and innovative capacity—most notably talented people and capital—from lagging regions. While a new equilibrium may emerge, it will not likely be one of converging growth rates and incomes. Rather, lagging regions may continue to decline until only the workers and companies that must be there are left. As we will see next, these cumulative causation factors are even more pronounced in an innovation-based economy.

Innovation economics challenges cost-based theory

Conventional regional theory posits that competitive market dynamics maintain equilibrium in the economy through factor mobility in response to relative price changes or supply/demand shocks. Likewise, it assumes firms make location decisions to maximize profits, and being price-takers, that a principal way to do so is to minimize costs. Both concepts might provide a reasonable framework for understanding the workings of a traditional industrial economy, but when the economy is grounded more in innovation activities, they don't.

An innovation economy or region is one in which a not-insignificant share of output comes from innovation industries. Innovation industries have three key characteristics: First, they feature rapid and regular development of new processes, products, or services—many of them disruptive in nature—that are crucial to their competitive advantage. For example, the success of industries such as biopharmaceuticals and semiconductors depends not on making a particular drug or semiconductor cheaper, but on bringing to market the next-generation product with enhanced performance.

The second key component of innovation-based industries is that their marginal costs are significantly lower than their average costs. The software industry provides an example of this. It can cost hundreds of millions of dollars to produce the first software program, but additional copies can be produced at virtually no cost. Yet even "atom-based" industries, such as aerospace and life sciences, can have declining marginal costs. For example, Boeing invested almost eight years of development work and an expenditure of over $15 billion dollars before a single 787 Dreamliner was sold.72 That $15 billion dollars must be built into the overhead of every 787 that Boeing sells. Thus, these industries experience what economists call "increasing returns to scale," meaning factor productivity increases with the volume of output. And to be clear, not all industries exhibit this characteristic. A study by the European Commission of over 1,000 European companies found increasing returns to scale for high-tech firms but decreasing returns to scale for low-tech ones.[73]

Finally, innovation industries depend on intellectual property (IP) more than other industries. For example: Software depends on source code, life sciences depends on discoveries related to molecular compounds, aerospace depends on materials and device discoveries. That's why the European Commission study found that for non-high-tech firms, the contribution of knowledge capital to success was lower than the contribution of physical capital, but for high-tech firms it was higher.[74]

These three distinct characteristics of innovation industries—their reliance on constant innovation, their high fixed costs relative to marginal costs, and their dependence on IP—make the traditional cost-based neoclassical regional economics a poor guide to both understanding location decisions and making regional policy. In particular, the preeminence of innovation in today's high-tech economy places the ongoing evolution of the technological frontier—and the diverse positions of localities relative to that frontier—in the foreground of models of regional growth (much more than questions of equilibrium). As Thomas Farole, Andrés Rodríguez-Pose, and Michael Storper write about innovation-based regional theory, "The economy is seen as a restless search for new products and processes with high rates of return, but where the potential to do this is unevenly distributed across territories."[75]

In this light, the constant search for new products, increasing returns, and new ideas has magnified the importance of place, and of being in the locations where innovation, learning, and execution is easier. This has increased the significance of agglomeration dynamics, which in turn are generating powerful tendencies toward regional divergence across places.

Agglomeration elevates the stakes

Agglomeration economies refer to the external benefits that accrue to firms when they locate in urban areas. There are two kinds of agglomeration benefits, as we have seen: urbanization effects and localization ones. The former refers to effects that benefit all firms in a region, including good transportation systems, broad and deep labor markets, high-quality health care, an enjoyable quality of place, and other livability factors. For example, in a more globalized economy, having an international airport with an array of reasonably priced international flights is much more important than it was 40 or 50 years ago. And these urbanization advantages build upon themselves: A metropolitan region with a more robust international air hub, for example, attracts more companies whose workers travel internationally. That, in turn, leads airlines to provide even more flights, including nonstop flights, which draw in more companies valuing this factor, and so on.

Localization economies, in contrast, refer to factors that provide value for a particular industry. These include a specialized labor force, the ability to share machinery, access to specialized suppliers, regional research institutes, venture capitalists, and professionals (e.g. law firms) with specific industry knowledge, and the ability to learn from competitors through "knowledge spillovers." These industry-specific localization benefits are what people usually think about when they refer to the special vibrancy of tech hubs such as Silicon Valley, Boston, and Seattle.

And these benefits also multiply and yield cumulative advantage. For example, in Boston there is now an array of resources that have become incredibly valuable for biopharmaceutical firms, including world-leading biology and chemistry departments at universities, a large technical workforce, world-class research hospitals, a robust process for generating biopharma startups, specialized venture capital firms, state and local regulators who understand the industry, a plethora of skilled biopharma workers, and institutions that enable industry sharing of knowledge.

Along these lines, economists have come to realize the existence of extremely powerful agglomeration dynamics among regional economies that not only do not support the "spread" of development but are likely to exacerbate U.S. cities' divergence for the foreseeable future, absent policy intervention.

One of these effects pertains to perhaps the most important localization effect of all: the local supply of skilled technical workers.

Recently, David Autor and Nathaniel Baum-Snow, Matthew Freedman, and Ronni Pavan showed that, over the last thirty years, the wage premium college-educated workers receive for working in larger and denser regions has increased significantly relative to the wage premium offered to workers with less than a college education.[76] While this divergence owes in part to a modest rise in the urban wage premium for college-educated workers, such workers' dramatically increased relative advantage has resulted mostly from the collapse in wages available to urban noncollege workers and the workforce "sorting" discussed in Section 3. When workers with different credentials face equivalent pay advantages for locating in urban areas, as was the case as late as 1980, we would expect the educational mix of local workforces to converge regardless of regional population density, as workers move in search of higher wages at similar rates. Both Elisa Giannone and Rebecca Diamond, however, have found evidence that, since 1980, differential changes in the wage premia available to college and noncollege workers has been a significant contributor to regional divergence by local skill mix.[77] Christopher R. Berry and Edward Glaeser likewise find a strong correlation between the change in the percent of the population with a college degree and the initial share of the population with a college degree in the 1970s, 1980s, and 1990s across metropolitan areas.[78] In other words, labor-market sorting as a result of pay differentials related to education is creating dangerous path dependencies, with the well-

educated relatively more mobile than the less-educated. Thus, while the best-educated cities get more educated, the relatively less-educated and lower-wage parts of the country are tending to fall behind and languish.

Beyond compensation-driven effects, many highly skilled workers also find being in an advanced technology hub desirable, because such hubs provide them with a more diverse set of employment options—especially important considering that firms in innovation industries are a riskier proposition. On top of that, the presence of other workers with similar skills and interests helps them advance their human capital. Indeed, there is abundant literature that documents the interplay of agglomeration economies and human capital externalities.[79] Jorge De la Roca and Diego Puga argue that skilled workers move to certain metropolitan areas not just because they can earn more, but because they can learn more. In other words, because tech agglomerations are rich learning environments supported by dense social networking, workers in these areas can advance their careers more rapidly than workers in a metropolitan area with only a few companies in the worker's industry and occupation.[80] This too contributes to the self-perpetuating nature of human capital divides, and implies that less-dynamic locations become less-promising places for learning and networking. Adding all of this up, Pablo Fajgelbaum and Cecile Gaubert conclude that the current spatial distribution of the U.S. labor force is inefficiently sorted by education, since the positive spillovers from highly skilled workers outlined above are externalized.[81] Absent some intervention, they suggest, it is doubtful this labor mobility dynamic will reverse on its own.

Yet there is more. Substantial evidence suggests that agglomeration effects bring with them additional self-reinforcing tendencies, for good and ill.

On the positive side, greater proximity among firms and workers brings real benefits in the form of higher productivity, easier knowledge sharing, and improved public-goods provision.[82] Numerous geographers and economists have identified "circular and cumulative productivity advantages for regions that innovate or learn."[83] This effect can occur not only across metropolitan areas but in particular locations within them, as around Kendall Square near the Massachusetts Institute of Technology or at the south end of Lake Union in Seattle. In such places, interfirm learning is enhanced and cumulative benefits and greater market success accrues, all of which lead to even more interfirm learning and innovation.

And so the process intensifies: With more innovation there is more investment, which attracts more knowledge workers and more firms, enabling more resources to be invested, which leads to even more innovation. When regions possess an initial advantage, agglomeration effects can result in increasing innovation and investment in a positive cycle that ensures that favored regions and districts within them become even more innovative and attractive, intellectually and physically. This is one reason rich regions keep getting richer. Ultimately, some of these centers accumulate into a set of what regional economist Harry W. Richardson called "advanced autonomous growth centers."[84] Through the power of agglomeration economies and cumulative causation, the growth of a select group of urban regions can become autonomous, meaning that key city regions can continue to thrive based on their internal factors and dynamics in a self-reinforcing manner. Absent some external intervention or shock, these dynamics can become akin to a perpetual motion machine.

Along with these positive effects, though, agglomeration brings with it more troublesome dynamics: those of overheating on the one hand, and stagnation, disinvestment, and underdevelopment on the other.

The first set of problems revolves around the superstar status of regional winners and the "diseconomies of scale" they may contend with. Thanks to those diseconomies, roads gridlock in superstar cities, housing costs skyrocket, and

wages get too high. Nor should we expect an old-school, neoclassical price-adjustment response will fully equilibrate the city system by shifting economic activity to less-expensive places.

Costs can get so high that some activity moves, and other tech hubs can gain some of it. But there are two reasons why it would be unwise to count on this factor to work out favorably or generate sustainable tech hubs in the heartland. The first is that costs can get very high before a spatial response is triggered, because most of the innovation firms in these areas compete not on cost but on innovation. Second, for many (if not most) of these firms—even smaller and younger firms—their location choices are now, as noted above, global. If a firm feels that costs are too high in Boston, it may expand to cheaper but still vibrant tech hubs in other nations, such as Shanghai or Tel Aviv.[85] In other words, there is no inherent reason why that expansion (or relocation) to cheaper tech hubs would be in the United States. Instead, the diseconomies of the superstar cities—in addition to representing a drag on aggregate efficiency—could very well drive critical innovation activity out of the U.S. entirely.

At the same time, the concentration of economic activity in dynamic innovation hubs implies that while the most productive agglomerations grow faster than other places and attract the most mobile factors of production, slower-growing regions slide into even worse competitive position. These places may see their talented young depart, contend with slow growth, and watch their infrastructure and neighborhoods decline. And the process can and does go farther than that. Ultimately, these patterns can create their own destructive path dependences that leave entire regions in a state of persistent underdevelopment.

Along these lines, Farole, Rodríguez-Pose, and Storper highlight a troubling divergence in regions' capacity to engage in "catch-up" at all.[86] By this, they mean to say that the cumulative impact of the backwash effects from agglomeration—brain drain, falling public revenues, disinvestment in physical capital, deterioration of institutional capacity—can over time degrade places' ability to act fast enough to ever close the gap with regions at the productivity frontier. They write: "Many lagging regions are not simply failing to maintain the pace of growth and development being achieved in leading regions, they are [also] failing to make productive use of the resources available." This, the authors argue, is the problem of "persistent (or durable) underdevelopment—i.e. of regions producing consistently below their production possibilities frontier." At this point, spatial inequality becomes not merely a consequence of inefficient factor allocation, but structurally embedded and a threat to national efficiency.

In this fashion, it does not seem likely at all that the workings of the market—acting alone—will solve the problem of places left behind. Rather, the continued working of market dynamics seem more likely to reinforce divergence once it begins.

THE CONCEPT OF AUTONOMOUS ADVANCED GROWTH CENTERS

Perhaps the most compelling theory for explaining the nature and location of U.S. advanced industries is the theory of "growth poles" or "advanced autonomous growth centers" (AAGCs). First proposed by Harry Richardsonin 1985—building on earlier intuitions by François Perroux in the 1960s and 1970s—the theory conceptualizes the rise and dominance of preeminent innovation centers.[87]

In brief, the theory holds that once a series of advanced technology growth centers emerges—powered by luck (e.g. Bill Gates being from Seattle and moving home to start Microsoft), an existing industrial base that reinvents itself (Boston's instrumentation industries that enabled the rise of microelectronics and software firms), or other factors such as government investments (the U.S. government investing massively in R&D in Silicon Valley during the Cold War)—it can become self-perpetuating. Through the power of agglomeration economies and cumulative causation, the centers' early growth can then become "autonomous," meaning that they can continue to thrive based on their internal factors and dynamics.

However, this does not mean that once a region attains the position of an AAGC that it is on cruise control. Just as constant innovation is a requirement for firm success in innovation industries, constant innovation and adaptation is required for innovation regions. In 1994, AnnaLee Saxenian documented how Silicon Valley had overtaken Boston as the leading tech hub in the U.S., in part because many core Boston computing firms (e.g., DEC, Wang, Data General) made the wrong bet on mini-computers and not on PCs, and also because the region's innovation culture was not as adaptive and enabling of cross-firm learning.[88] However, in Boston's case, the remaining firms and the region overall took Saxenian's lessons to heart and adapted, and today again comprise a global tech hub.

But other regions have failed to make the transition. In the mid-19th century, Troy, N.Y. was one of the leading industrial tech hubs in America, as was Cleveland in the early 20th century, and Northern New Jersey after World War II. As new technology waves emerged, these places were left behind, in part because their firms did not adapt and hence lost market share, but also because the regional institutions did not adapt.

There are four kinds of advanced technology centers. The first are the successful, dynamic ones such as the Boston/Cambridge hub, Seattle, and Silicon Valley. The second are places that once thrived but now have been left behind, including Troy. The third are places that have some assets but lie so far behind the leaders—either because of size or industrial mix—that their capability and odds of becoming an AAGC is quite low. These would be places like Flint, Mich., Pierre, N.D., and Tallahassee, Fla., to name a few. Finally, there are the promising set of places: those that are large enough to become self-sustaining and have a reasonable array of innovation assets (research universities, existing innovation companies, skilled workers, etc.). These are the potential next set of U.S. autonomous "growth centers," and Section 8 identifies a selection of them. Here, we will term them simply as potential innovation economy "growth centers."

One useful metaphor for understanding these dynamics comes from cosmology. There are many places that are close to critical mass, whereby they can possess the factors to more or less automatically enable them to thrive and grow. But even with the right internal economic development policies, they can't achieve "escape velocity" absent some kind of external intervention. In fact, we would argue that virtually no promising technology centers in America today possess sufficient resources on their own to achieve escape velocity, regardless of how innovative and committed local leadership is. Think of it this way: For an "almost there" region to achieve escape velocity, it would need to attract the equivalent of not one, but multiple Amazon headquarters, while at the same time investing significantly more in its research universities and technical schools.

Which gets to a core problem with today's economic development environment. When dozens, if not hundreds, of places are trying to become AAGCs by investing in research universities, creating better built environments, reforming schools, and fostering entrepreneurial and tech transfer programs, there is so much competition that it is virtually impossible for any particular region on its own to gain escape velocity and transition to AAGC status. Transitioning from a promising innovation status to full-fledged AAGC-status requires both internal action as well as external coordination and investment. In short, for any tech center to become an AAGC like Boston, Seattle, or Silicon Valley, it needs a powerful external boost to get out of its lagging orbit. Unless it can achieve "escape velocity," it will remain stuck.

The next section will discuss how federal policy can enable five to 10 promising innovation centers to become full-fledged AAGCs, and in so doing spread the promise and opportunity of the innovation economy to more parts of America.

5. Why place-based intervention is essential—and how it can succeed

Given the dynamics of cumulative causation and agglomeration, then, the case for intervention becomes clearer.

The innovation economy is unleashing forces that benefit core regions, often to the detriment of the periphery. These dynamics are circular and cumulative and can lead to harmful path dependencies: skills sorting among metro areas as well as traps of underdevelopment. Together, these dynamics—which do not appear to be self-correcting—can threaten the nation's aggregate innovation potential. Intervention may be necessary.

The case for response is bolstered by the claims of social equity and of political stability discussed in Section 3. But on purely economic terms, the problems of skill sorting, underdevelopment, and competition from lower-cost foreign innovation growth centers constitute especially compelling rationales for action.

That all of these are nation-scaled problems, meanwhile, involving variegated conditions in divergent markets, underscores the need for *nation-scaled responses*.

At the same time, the uneven geographies involved in the divergence problem—and the reality of self-reinforcing local effects—demonstrate that the country needs not just nation-scaled solutions but *place-based* ones.

Fajgelbaum and Gaubert, as we have seen, proved that the U.S. economy features too much spatial sorting by skill and wages to reach optimally efficient outcomes given the local spillovers of highly skilled workers. They conclude that place-specific subsidies are needed to encourage more high-skill workers to stay in metro areas where they are growing scarce in order to increase the degree of productive mixing and learning among diverse workers.[89] They imply that such welfare-maximizing subsidies would need to be administered nationally to ensure greater mixing of high- and low-skill workers.

On the development side, Farole, Rodríguez-Pose, and Storper offer in the EU context a "provisional" case for interventions to attack underdevelopment in a growth-enhancing way, through regionally differentiated, national place-focused programs aimed, for example, at improving the R&D institutions and agglomeration potential of significant "non-core" metro areas.[90] The three argue for centralized efforts to increase aggregate growth by increasing the innovative capacities and public-goods provisions of less prosperous—but promising—regions.

Similarly, Gruber and Johnson would accept a "hypothetical" reduction in the efficiency of R&D spending in exchange for a national campaign to expand the pipeline of new ideas and concomitant regional economic gains.[91] They urge a "big push" to spread federal R&D dollars "wider than the existing superstar cities to which they flow today," albeit to places where they can nevertheless be employed productively.[92]

Edward Glaeser and his colleagues note that problems of underdevelopment such as joblessness may be more responsive to policy intervention in the hardest-hit places than elsewhere—and accepts action where the "elasticity" of response is great.[93] Along those lines, Glaeser and Hausman are leery of adjusting the expert process for awarding research grants but seem willing to accept spatially targeted R&D tax credits. They are also supportive of nudging universities in "high-joblessness" regions toward more local economic engagement, spurring entrepreneurship near those universities, and easing business regulation there.

And of course, there is the political-economy case for intervention. There is a long literature about the importance of federal support for innovation, especially federal support for research. But federal funding for scientific and engineering research as a share of GDP is at pre-Sputnik-era levels.[94] One reason may be that many members of Congress may see little benefit to their districts from supporting R&D funding and other innovation policies, especially when they come at the expense of other priorities such as agricultural subsidies. A more spatially balanced innovation economy could very well change the political dynamics of U.S. innovation policy, bringing more supporters to the table.

Apropos all of these dimensions, it bears noting that the federal government already does run an implicit spatial policy through its existing transfer programs. These transfer programs aren't well-designed to promote the kinds of intellectual property, technical talent, and institutional capacity necessary to achieve real agglomeration. But even so, they are a precedent for better targeted national efforts and are themselves much more generous to left-behind regions than successful ones.

In short, the current moment is calling forth a new willingness among even cautious neoclassical economists and policymakers to reconsider not just their skepticism of robust federal policy actions to counter the regional divergence, but their traditional disdain for "place-based" initiatives for delivering them. It is important to ease the way for place-based action to address the nation's spatial imbalances by acknowledging past criticisms of place-based policy and clarifying how new efforts focused

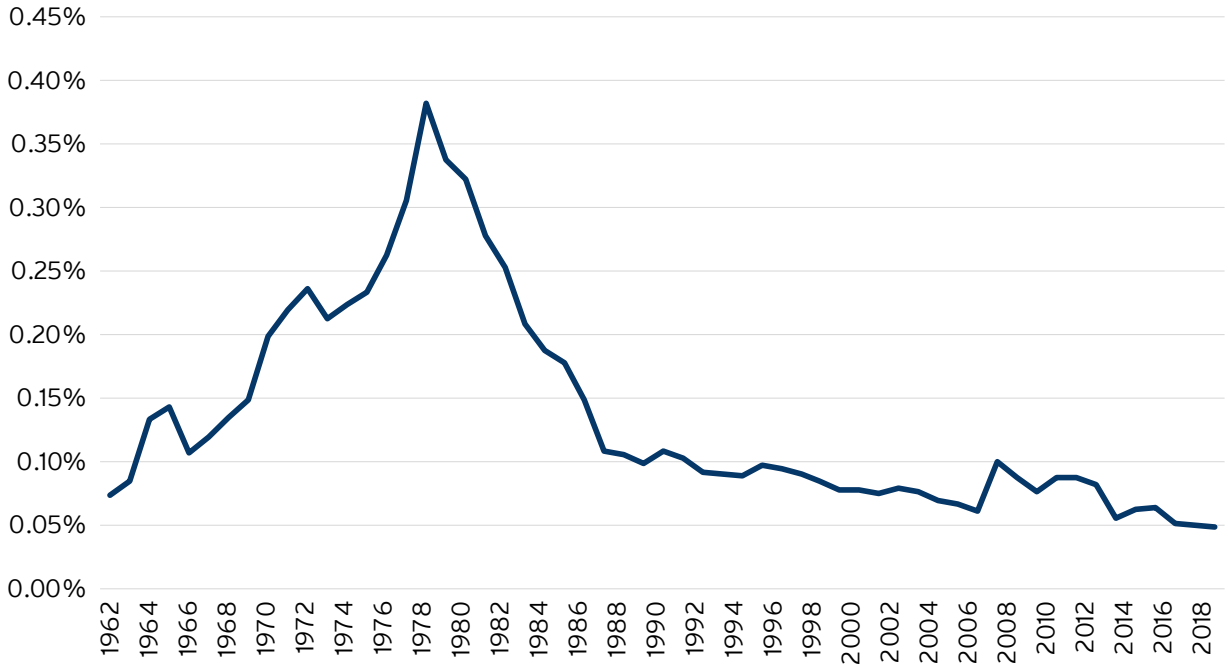
on skills and R&D investment to drive innovation would succeed.

It's certainly true that place-based policies—which target areas, rather than people or firms—have incurred a lot of skepticism from economists. Federal place-based initiatives, in this respect, have typically been at once too small and diffuse to deliver the goods, and at times poorly designed and implemented.

To the first point, consider that U.S. regional development efforts—a fair stand-in for place-based programs—are miniscule and getting smaller. Federal community and regional development include spending by a wide range of agencies and offices with important place-oriented missions, such as the Department of Commerce's Economic Development Administration (EDA) and federally chartered regional development commissions including the Appalachian Regional Commission and the Delta Regional Authority. This category of programming also includes funding provided to states and localities directly, such as the Community Development Block Grant (CDBG).[95] However, outlays of these programs (excluding disaster relief and insurance) peaked in 1978 at 0.38% of GDP, but fell to 0.05% by 2016, where they have remained since[96] (Figure 7). That's a 90% decline in effort, over a period that saw the breakdown of regional convergence and the rise of divergence as an urgent national issue. Furthermore, the highly place-oriented EDA—the only federal government agency focused exclusively on economic development—has seen an even larger decline. In 1978, the agency's funding level exceeded $3.5 billion (equivalent to about $14 billion in today's dollars); today the agency makes do with a $300-million authorization. It is not surprising that such tiny programs have not discernably rebalanced the nation's $20-trillion economy.

Figure 7. Outlays for community and regional development peaked in the late 1970s and have plummeted since

Community and Regional Development outlays as a share of GDP, 1962-2018



Note: Disaster relief is not included.
Source: Brookings and ITIF analysis of OMB Historical Tables and BEA data

As to the design and aggregate focus of these programs, those too have remained suboptimal. Multiple evaluations of place-based interventions point to a hodgepodge of miscellaneous programs that distribute modest resources all across the map. The Government Accountability Office (GAO), for example, assessed the $6.2 billion that Congress appropriated in fiscal year 2010 for community and economic development programs and found sizable overlap and inefficiency among the 80 programs (mostly place-based) that make funding available to communities to enhance local economic activity.[97] The next year, a second GAO report detected poor alignment of federal community and economic development grant support with local economic conditions.[98]

A major literature review by David Neumark and Helen Simpson concluded that the evidence on place-based policies to support growth in economically challenged areas is mixed.[99] Most notably, Neumark and Simpson found no clear indication that programs such as enterprise zones consistently create new jobs. Instead, their review found isolated successes offset by other cases in which the programs either had little effect or simply reallocated economic activity among similar areas.

Other critics conclude that the current array of federal place-based policies is far too narrowly focused on brick-and-mortar and narrow neighborhood redevelopment, when the modern economy revolves around innovation inputs, technology, and people.[100] In this vein, Amy Liu of the Brookings Institution argues that such narrowly conceived place-based policies have likely been ineffectual because they have been unaccompanied by concomitant investments in neighborhoods' fundamental human and innovative capacities.[101]

A final critique of place-based programs is that there is considerable reason to think that policy needs to do a better job of prioritizing. There are many areas that simply are not likely to rebound no matter what federal policy brings to bear. In contrast, there are places that have the potential to rebound and grow, especially if they can attain a critical mass of economic input factors. However, federal policy has made no distinction among the two kinds of areas. As a result, federal place-based support has tended to be so widely distributed (or "equitable") that it has often lost effectiveness. For example, one recent Urban Institute review of Community Development Block Grant funding showed that even as real CDBG funding per state declined, the number of places receiving grants increased, resulting in significant declines in funding per grant recipient.[102] Ultimately, the nation's "a little for everybody" approach has meant that while many places got too little support to create material change, too few received the help they would need to "break through" and become self-sustaining.

For all of that, place-based responses are getting another look today, as optimism about the status quo declines.[103] Most notably, a 2018 paper by the Harvard economists Benjamin Austin, Edward Glaeser, and Lawrence Summers entitled "Saving the heartland: Place-based policies in 21st Century America" marked a significant revision of recent policy skepticism.[104] The three economists observed that "in recent decades regional income convergence has slowed or even reversed." Then they argue for "reconsidering place-based policies" in light of these trends, in particular on problems where greater responsiveness to interventions can be obtained by focusing on particular "hot spots."

The voluminous literature assessing place-based policies is not entirely caustic. Among other things, it tends to suggest that the development and expansion of higher-education institutions generates sizable productivity spillovers that may be highly localized. Significant evidence also finds that university research facilities spawn high-tech, innovative firms in an area—or attract them, which can help form industry clusters that may deliver longer-term benefits from agglomeration.[105] Other research shows that initiatives such as seed and venture funding can be successful, but that their current limited availability ensures limited effects. While much of the benefit of universities and advanced industry development may be owed to the presence of

faculty "stars" in key fields, such findings are promising.[106] So are the continued positive impacts of several of the Obama administration's experiments with modestly sized place-based technology hubs, such as the Manufacturing USA network of regional innovation institutes.[107]

In sum, amid an emergency of regional divergence, both theory and practice warrant a new push for a well-designed, place-based intervention to expand the geography of the nation's innovation sector. Care will be needed to get the details right. But even so, such a push will need to rise above the small-bore work of fixing local market flaws to instead "think big" about leveraging the role of government to create markets and transform landscapes.[108]

6. Countering regional divergence through growth centers

What the nation needs now is a set of ambitious federal initiatives to counter today's spatial divergence. That can be accomplished with the creation of a set of dynamic new innovation-oriented growth centers aimed at adding to the nation's net innovation, building global technology competitiveness, and spreading economic success over more of the country.

Fortunately, while the proposal is ambitious, more is known about structuring place-based strategies to catalyze new growth than is usually acknowledged.

The federal government, for one thing, has a long history of undertaking place-oriented policies that have—amid mixed results—transformed the nation's geography, ranging from opening the frontier to establishing the land-grant colleges to investing in the defense knowledge base that led to the innovation superstardom of Silicon Valley and Boston's Route 128.[109]

Beyond that, the accumulated learnings of innovation economics, economic geography, policy analysis, labor market analysis, and placemaking now provide solid guidance for a framework of interventions that might begin to

readjust the nation's unbalanced growth patterns. As Gruber and Johnson note, "We have learned a great deal about what works and what does not in terms of public-private partnership around science and innovation."[110] Useful ideas from the past can now be improved upon by newer research insights as well as experience from more recent policy and implementation experiments.

This is the spirit in which we suggest, as one response to the divergence crisis, a 21st century comeback (with many adjustments) of the "growth pole" strategy—the 1960s and 1970s emphasis in regional economic planning that called for a "focusing of investment at a limited number of locations (usually as part of a deliberate effort to modify regional spatial structure), in an attempt to encourage economic activity and thereby raise levels of welfare within a region."[111]

Originally postulated by the French economist François Perroux in 1949, "growth pole" strategies note the "natural" occurrence of agglomeration-driven growth hubs across nations' economic space and seek to activate or induce the emergence of more such poles in order to revive depressed areas or otherwise modify the national urban system.[112] As such, something like growth pole theory—which fell out of favor in the 1980s due to the dominance of rigid neoclassical doctrines and because of a lack of political will to concentrate funding—now seems due for a revival. In fact, a focus on nurturing new growth poles as a way to improve the national urban system seems even more relevant today than when Perroux first discussed it, especially because agglomeration economies in the innovation era are significantly more important than in the industrial era.

Further relevance stems from the fact that growth pole theory points—albeit imperfectly—to practical policy possibilities. Growth pole theory holds, after all, that revitalizing lagging regions requires concentrating economic development resources in a few places that are large enough to become self-sustaining, including through the relocation, expansion, or emergence of key "propulsive firms" that generate induced growth through interindustry linkages as the industry expands.

To that older framing, one would today want to stress the centrality of innovation inputs such as R&D, highly skilled STEM workers, infrastructure improvements, and high-quality placemaking. And one would want to stress that the critical propulsive firms will mostly engage in advanced, innovation-oriented activities, employ and attract a larger share of highly skilled workers, and lead to entrepreneurial high-growth spinoffs. Still, the relevance persists. The theory and logic of growth poles provides a usable precedent for intervention to catalyze new growth hubs, revive left-behind places, and counter extreme and likely unproductive imbalances across the nation's regions.

With that said, growth pole policy remains one of those ideas that—to use a quip from Robert Reich—went from obscurity to meaninglessness without any intervening period. While many regional economists and policymakers embraced the idea in the 1950s and 1960s, its appealing intuitions lacked rigor and its implementation was quite limited.[113] Moreover, where it was followed, execution was poor.[114] To the extent policymakers embraced the idea, they largely focused on supporting growth poles in regions that were so depressed and isolated that little else could be done. These places lacked the size, structure, and capabilities to be self-sustaining centers, even after being designated as growth poles. In addition, the programs to implement them were poorly designed, only modestly funded, and often short-lived.

No programs focused enough adequate resources to enable targeted places to truly transform themselves and become self-sustaining poles, in part because of political pressures to spread resources far and wide. For example, the Appalachian Regional Commission (ARC) embraced the idea in the 1960s, but it emphasized highway investment, which did

little to enable growth. Moreover, rather than focus on promising metropolitan areas adjacent to the actual Appalachian region, the ARC focused on helping less-viable places within the region.[115] These are some reasons why, despite many economic geographers' and regional economists' enthusiasm for growth pole strategy, governments had largely turned away from it by the 1980s.[116]

Nonetheless, the theory and strategy of growth poles—or "growth centers," as we will call them in reorienting the concept for the modern context—has grown even more relevant than when Perroux first proposed them because, as we have noted, the innovation economy lends itself to concentration due to agglomeration factors. As a result, it is time to bring the strategy back, albeit with some modifications.

What would such an initiative look like? To start with, it is possible to identify at least five needed elements of a 21st century strategy by surveying and updating central the previous century's growth pole doctrines. Informed by the voluminous literature on the topic, these elements include:

Nation-level intervention. Today, "bottom-up" development strategies—those that prioritize local policy moves and discretion—garner the most attention. But growth pole theory from the outset assumed the importance of a "top-down" national strategy, albeit shaped and complemented by local action.[117] Such thinking presumed the need for strong government action to help places due to the need for scale and targeting. And it assumed that such action should be part of a broad effort to modify the urban system as *a whole* to improve the long-run performance of the national economy.[118]

Together, these original priorities look prescient. To reduce the nation's regional imbalances by helping a modest number of places make the transition from "almost there" to "there" requires strong policy efforts not just from below but from above. In addition, such help needs to be conceived as a systematic push to treat the national urban system as a system rather than a set of isolated points. In other words, not only do designated growth targets and their state governments need to embrace a set of bold local policies to catalyze greater innovation, but the federal government needs to provide focused, significant help to a select number of promising places—all with the intent of countering regional divergence and promoting "spillover" benefits across the hubs' hinterlands. Such an approach can help some places break out from the noise of so many places competing against each other and work toward getting to scale. Absent such robust federal action, few if any of these places will be able to transform themselves into true stars with self-sustaining innovation growth paths, nor will the stark dynamics of divergence likely change.

Innovation inputs—at scale. The original growth pole framework envisioned investments in factors such as infrastructure more oriented to mid-20th century production economies. However, Richardson and Richardson suggested in the 1970s that growth pole strategy offered an opportunity for integrating "industrial policy, physical planning, and interregional and intraregional economic planning."[119] As such, at least some growth pole discourse anticipated the use of the strategy to target and deliver 21st century inputs to catalyze growth in the innovation sector. This should be the focus for a new growth center strategy for the innovation economy. The prime purpose of any new growth center initiative should be to help midsized "up-and-coming" markets plug into the agglomeration tendencies of the current economy. In that vein, a modern growth pole push should focus especially on research funding and technical skills, as well as regulatory and other approaches to catalyzing entrepreneurship and placemaking. Also critical will be the physical amenities and high-quality "placemaking" that have increasingly been shown to improve accessibility, foster civic vitality, and support innovation.[120] These are the crucial inputs of the innovation economy, and they must be delivered at scale to make a difference.

Focus on particular locations. A key insight of growth pole strategy, even in the 1950s, was its focus on encouraging growth in particular locations that had a chance of success rather than more diffusely. That insight remains even more urgent today, when we know that the lion's share of innovation output emanates from a relatively few urban areas. This is not to imply that the poles' benefits won't diffuse outward to smaller towns and rural areas in the same region—in fact, that is the plan. Brookings's Amy Liu has stressed the interdependence of metro areas and their adjacent nonmetro counties.[121] But targeted poles should be seen as core foci for regional investment. If such investment succeeds, growth at the targeted pole will be transmitted to dozens of nearby towns and cities as well as the remainder of the region.

Focus on just a few places. Relatedly, a federal growth center push will need to target its efforts on a very short list of metropolitan areas. From the beginning, growth pole strategy astutely tended to limit the number of locations that were designated for investment. That limitation remains critical. Even though there are currently 382 U.S. metropolitan areas, only a small number are or could be true innovation centers, in part because innovation hubs—while substantial, growing, and disproportionately important—still encompass just a modest share of the nation's output, ensuring that there are not enough of them to "go around." Likewise, the requisite base of innovation inputs needed to assure "takeoff" remains significant. This suggests that if federal policy is going to effectively jump-start more self-sustaining advanced industry innovation centers in parts of the country that currently lack them, it will need to focus not on providing a small amount of support to a large number of places—as is currently the case—but rather a large amount of support to a small number of places. In this way, a rigorous growth center initiative might paradoxically have a shot at benefiting many more lagging communities than were directly supported.

To understand why it is a critical to focus on a few places, consider the recent decision by Amazon on where to locate its second headquarters. Amazon received proposals from 238 jurisdictions seeking to be the new home and selected a short list of 20. A look at those 20 and the ultimate two winners (Washington, D.C. and New York) tells one a lot about why innovation activity is concentrated and how to spread it more widely. With the exception of Columbus, Ohio, Indianapolis, Nashville, Tenn., and Pittsburgh, the 20 finalists were either existing self-sustaining hubs (e.g., Austin, Texas, Boston) or extremely large metro areas (e.g., Los Angeles and New York). Most tellingly, Amazon did not choose one of the exceptions—it made the safe choices of New York and Washington.

Choosing a city that was neither an existing self-sustaining hub nor an extremely large metro area would have been a risk for Amazon. Would it be the only major tech employer? Would it be able to attract enough tech workers willing to move to a place where the depth and breadth of tech jobs was limited? Would it be able to find enough regional suppliers and partners? Would the air transportation links be sufficient? While Washington and New York were more expensive choices, they were safer. When every company faces the same questions independently when it makes new investments, it is easy to see why we don't break out of existing spatial patterns.

One of the key functions of a new national growth center policy would be to make it safe for a company like Amazon to locate in a city or metro area such as Albuquerque, Columbus, Indianapolis, Nashville, or Pittsburgh. Imagine if Amazon had known that these five places had been designated national growth centers in a federal competition and were due to get significant support over the next decade: It would be likely that many innovation firms would be moving or expanding at least some jobs in these places and that the local infrastructure—including schools and airports—would be improved. Now

the calculus changes. Amazon could go to New York and DC and possibly face questions, at least in the media, on why it didn't support national policy. Or it could go to these designated centers, enjoy widespread support, lower costs, and suffer little risk to business operations. Now imagine this dynamic spread to scores, if not hundreds of leading technology firms seeking to make expansion decisions.

Selectivity. Focus, finally, implies selectivity. Perroux and other promoters of growth pole strategy felt success required careful selectivity among locations. They stressed focusing on centers that had the potential for sustaining a given range of new economic activity. This will also be critical for any new initiative. The nation badly needs more advanced industry hubs spread broadly throughout the nation. But the number of attainable additional hubs is not 100, or even 50, most likely. Rather, policymakers should recall the mediocre record of more diffuse place-based interventions and set their sights on jump-starting a smaller, more realistic number of, say, eight to 10 metro areas. What's more, they should learn from the failures of earlier growth pole initiatives (and more recent federal grant-making) to focus their attention on up-and-coming metro areas with genuine capabilities and potential, rather than the hardest cases. In doing that, policymakers should know that the original growth pole concept very much anticipated that each pole would generate broader regional benefits, such as the success Boston has spread to Worcester. A large success with radiating benefits across a struggling region will deliver more good for truly hard-hit places than diffuse distributions across many struggling places.

Along these lines, then, the growth pole vision—while blurry at times and never fully implemented—has a timely and powerfully intuitive appeal that points in useful directions. As to the outline of a modern federal growth center initiative, it would need to build on these vintage growth pole principles, but do so employing modern approaches. As presaged by growth pole strategy, an updated push would:

- Concentrate a substantial, unapologetic **federal push** aimed a widening the reach of U.S. prosperity by jump-starting new technology hubs in the American heartland (defined as territory at a healthy remove from current "superstar" hubs.

- Focus on **innovation inputs**—including quality of place—rather than mass-consumption real estate or broad tax policy. Central to a state-of-the-art technology push would be a comprehensive mix of research funding, targeted investment tax credits, highly skilled STEM workers (through STEM education/training and visa preferences), federal regulatory exemptions and business financing, and federal land and infrastructure supports for visionary, pro-innovation placemaking.

- Concentrate on a **short list of specific, promising cities** that already possess much of what's needed to emerge as a true technology hub, including a high-quality university, a sizable pool of skilled workers, a supportive entrepreneurial scene, and a high or high-potential quality of place. Catalyzing dynamic growth in these places would likely bring growth to adjacent cities and towns.

- Employ modern **competitive selection** mechanisms to choose the most promising regions in which to catalyze growth, aimed at widening the geography of the nation's narrow set of superstar cities. Places would compete to demonstrate not only their potential but their willingness to do the hard work to transform themselves into 21st century global tech hubs. They would be chosen on the basic of objective criteria by insulated review panels.

Developed along these lines, a new effort to disrupt the trends of the agglomeration economy could draw on a deep set of concepts about the nature of modern growth in order to reinvent older ideas for new conditions.

7. Spreading tech hubs across America: A proposal

Moving now to specifics: Congress should establish—and the administration should implement—a national growth center initiative designed to expand the geography of the nation's innovation sector by catalyzing the high-tech takeoff of eight to 10 new advanced industry hubs in the heartland.

The goal of the new initiative would be straightforward: to better balance the U.S. innovation economy by aggressively accelerating the rise of a short list of "up-and-coming" locations outside the orbit of existing centers.

As such, the new initiative should channel substantial federal innovation inputs into the most promising new locations in America with the intention of catalyzing the innovation sector takeoff of those places and their adjacent regions. Needed in this respect will be:

- *Generous awards* of key federal innovation inputs, including regulatory benefits and supports for high-quality placemaking, sustained long enough to transform a modest number of strategically located technology ecosystems
- A *rigorous selection* process to identify the most promising locations for advanced sector growth that would counter the nation's regional divides

Along these lines, the federal government should:

1. Assemble a major package of federal innovation inputs and supports that would be awarded to organizations in select metropolitan areas not near existing tech hubs in order to support transformative innovation sector scale-up.

At its core, the growth centers strategy entails administering a big push of innovation resources to a short list of promising but still-emerging innovation industry ecosystems. To support that push, federal agencies will need to assemble for distribution a compelling menu of the kind of inputs and supports that are associated with innovation sector dynamism.

Both direct funding from a variety of agencies along with a variety of tax, regulatory, and other incentives will help move the needle. To be clear, all of these incentives would be time-limited to 10 years after the selection of winning tech hubs. Specific offerings should include:

1.1. Direct funding. Multiple kinds of federal investments should lie at the center of the growth center awards. These should include:

- *Research funding*. Research universities and federal labs often play a key anchor role in every advanced industry tech hub in the United States, and in most superstar locations the combined federal research funding far exceeds the funding in even "up-and-coming" cities.[122] Congress therefore should establish a new program whereby the nation—likely though the National Science Foundation (NSF)—elevates the potential of select metropolitan areas by providing additional grants to research universities in those cities for a period of 10 years.

  There is a precedent for this kind of spatially targeted research policy. The National Science Foundation Act of 1950 states that "[i]t shall be an objective of the Foundation to strengthen science and engineering research potential and education at all levels throughout the United States; and avoid undue concentration of such research and education, respectively."[123] For almost three decades, however, the NSF ignored that congressional intent. By the late 1970s, Congress decided to act and established the Experimental Program to Stimulate Competitive Research (EPSCoR), mandating that the NSF provide additional funding to states that received few NSF funds. Today, that program remains small and would not easily be reoriented to target a short list of promising metropolitan areas, as members of Congress from EPSCoR states would most likely fight to keep their funding. Given that, the best way forward will be to significantly boost the flow of NSF funding to promising metro areas by around $1.25 billion for each by the tenth year, for a total of $6 billion per metro area over the decade. (See nearby box on sizing this surge as well as Appendix B). This would be modeled in part on the NIH program for the Clinical and Translational Science Awards (CTSA), which go to advancing the clinical research programs at the nation's leading medical schools.[124] The grants would be to institutions, not to individual principal investigators.

  In order to ensure such funding actually spurs regional innovation development, it should be focused on universities or other research institutions that commit to expanding research capabilities aligned with the types of industries and technologies gaining traction in the region and relevant to key national challenges, whether it be artificial intelligence for the public good or clean energy or advanced data science. For example, if a region has strong capabilities in robotics, a significant share of the funding should go toward electrical and mechanical engineering and computer science programs. At a minimum, a modest share of funding should go to industry-university research partnership programs, again aligned toward key areas of importance to the region. In addition, winning regions should be those where universities agree to not only cooperate and align with

SIZING THE RESEARCH SURGE

In order to assess the optimal size of the projected R&D surge, it's worth examining the current funding flows of leading tech hubs. In 2017, North Carolina's Research Triangle Park received $2.7 billion in federal research funding, Boston institutions received $2.9 billion, and the San Francisco Bay Area received $3.3 billon. In contrast, the Pittsburgh region received $1.3 billion, St. Louis received $800 million, and Memphis, Tenn. received $740 million. This suggests that the goal for a designated growth center should be to have at least $2 billion in annual federal research funding for its region's universities by the tenth year. Assuming the average designated metro area receives a middling $750 million per year, that means that the federal government should inject an additional $1.25 billion by the tenth year. However, to assure regional universities' ability to absorb such increases, funding would need to be ramped up over a decade, with 10% of the gap provided in the first year, 20% in the second, and so on. This would mean that over a 10-year period, the federal government would be providing an average of $687 million to each region per year—with less early on and more in later years—for a total of $6.875 billion in additional funding for each metro area, or $68.7 billion total if 10 areas are selected.

each other, but with local industry and civic leadership as well.

Finally, to the question of institutional location: It's true that while funding could be distributed among various federal agencies, channeling it through one agency would make it easier for recipients to navigate the program. Given that, research funding should likely come from additional appropriations to the NSF, with the relevant state and local governments committing to provide all relevant capital expenditures (e.g., buildings for new laboratories, equipment) either on their own or in partnership with the private sector.

- *Graduate research fellowships*. Workers with Ph.D. degrees in STEM, especially U.S. residents, are highly valued by employers in the United States. And one key enabler of more STEM degrees is federal graduate research fellowships. However, today the NSF offers no more of such fellowships than it did the early 1960s, despite the fact that the number of college students graduating with degrees in science and engineering has tripled. Congress should therefore expand funding for the NSF Graduate Research Fellowship program (funded at $285 million in FY 2018), and reserve 35% of these new fellowships for students getting their degrees at universities located in targeted growth centers. This should be easy to do without reducing the quality of awards, given that in 2018, NSF received over 12,000 applications but offered just 2,000 awards.[125]

- *SBIR preferences*. In addition, Congress should require that all Small Business Innovation Research (SBIR) agencies provide preferences to SBIR applications coming from firms located in targeted growth centers, again for a period of 10 years. This could be done by adding location in a targeted growth center as one additional factor in proposal scoring.

- *Other research programs*. Similarly, if Congress expands funding for the Manufacturing USA network to establish new centers—which we believe it should—applications coming from the designated growth centers should receive preferences. Likewise, NSF should give priority to research universities in growth centers to support the creation of new NSF Industry-University Cooperative Research Centers and Engineering Research Centers. The National Institute of Standards and Technology (NIST)

and the Department of Defense should also give preference to the targeted metro areas in making further awards under the Manufacturing Universities Act of 2015. Finally, Congress should increase the funding for the Economic Development Administration's Regional Innovation Strategies award from around $20 million to $100 million per year, and allocate the increase to the winning growth center regions—again for 10 years—for activities such as the establishment of technology accelerators, maker spaces, and tech transfer organizations.[126]

- *Workforce development funding*. Finally, winning metro areas would be eligible for funding to boost workforce training programs, especially the creation, expansion or improvement of technical training programs, including around digital and statistical skills. The Department of Labor's Employment & Training Administration (ETA) would make awards of $5 million per year to each winning metropolitan region for a period of 10 years for this purpose, with an emphasis on regionalized industry-government-civic-philanthropic collaborations.

1.2. Tax and regulatory preferences. A number of tax and regulatory incentives would further improve the attractiveness of designated growth centers to advanced industry firms, spurring investment, innovation, and growth. Among these would be:

- *Capital gains reductions*. Whether or not Congress moves to tax capital gains as normal income, it should maintain an exemption for gains from firms less than 10 years old and located in growth centers. If Congress maintains the current rate, it should create a lower rate for growth center firms.

- *Capital equipment expensing*. The last major tax reform bill allowed all firms to expense first-year expenditures on capital equipment. However, this provision is slated to expire in 2022. To retain and target that benefit, advanced growth center legislation should exempt firms in the designated metro areas for as long as the 10-year program is in existence. Alternatively, Congress could establish an investment tax credit for new machinery, equipment, and software (including cloud computing subscriptions) for firms in selected growth centers. In order to create a stronger incentive for investment, the credit could be designed like the Alternative Simplified Credit (ASC) for R&D, where only expenditures over 50% of base period expenditures are eligible for the credit.

- *Sections 382 and 469*. Whether or not Sections 382 and 469 of the tax code are amended to support small companies nationally, they should in any event be adjusted to favor smaller firms in growth centers. Section 382 should be adjusted to make it easier for small companies in growth centers to carry net operating losses forward even as they continue to attract new investors. Small, research-intensive companies often go through several rounds of financing as they rack up expenses while getting nearer to their goal of profitability. However, Section 382 of the tax code prevents companies from carrying net operating losses forward if they undergo an ownership change. This rule eliminates an attraction to investors and also means small innovation firms begin paying taxes long before revenues exceed expenses. For that reason, qualifying R&D activities conducted by small businesses in designated growth centers should be exempted.[127] Likewise, Section 462 should be amended to allow passive investors to take advantage of the net operating losses and research tax credits of companies in which they invest. (The Tax Reform Act of 1986 severely limited this ability because it was seen as a way for high-income individuals to reduce their taxes by investing in operations that were never meant to be profitable.) Under this reform, investors could immediately use their share of net operating losses or any R&D credits.[128]

- *Collaborative R&D credits*. Congress should additionally establish a special collaborative R&D credit provision whereby firms that invest in R&D in universities, hospitals, federal government laboratories, and industry consortia in any of the selected growth centers would be eligible for a more generous credit than they get under either the regular or Alternative Simplified Credit (ASC). This could be done by providing firms with a flat 30% credit for all R&D expenditures at these kinds of organizations (as opposed to the incremental credit of 20% on the regular credit or 14% on the ASC). Economists have shown that there are much higher spillovers from research funded at universities and federal labs, and therefore firms underinvest in it from what is societally optimal.[129]

- *Human capital tax credits*. Any growing technology center will face the challenge of reshaping its workers' skills to reflect the needs of transforming industries. The provision of worker training tax credit modeled on the existing R&D tax credit would help small and large advanced industry firms invest in the requisite training while helping to ensure that low- and middle-income workers also participated in the expected "takeoff." Strong efforts here are essential to ensure that domestic workers benefit from the anticipated quality job creation.

- *Opportunity Zone eligibility*. To further support the growth center initiative, Congress could allow key additional neighborhoods of metropolitan areas designated as growth centers to quality as Opportunity Zones, the preferred-investment zones set up in the Tax Cuts and Jobs Act in 2017.[130] The program itself would also need to be amended and extended, since investment is expected to gradually decline over the next few years due to the structure of the incentives.
- *High-skill visa preferences*. STEM workers remain a crucial input to advanced industry dynamism, yet they also remain difficult to find. Expanding their availability in a growth center would greatly increase its dynamism and attractiveness. For that reason, Congress should lift the annual cap on the number of foreign nationals who can obtain H-1B status from 65,000 to 75,000, and set aside the additional 10,000 visas per year for jobs located in designated growth centers.

- *Regulatory sandboxes*. Regions should be able to apply to federal agencies for "regulatory sandbox" status, where lighter-touch rules for particular areas of innovation would apply as long as the impacts are local. Examples might be related to testing drones, flying cars, autonomous vehicles, and more. Technologies that would not be eligible would be ones where their immediate use is beyond the community, such as fintech and biotechnology.

- *University lab regulations*. Congress should establish a grace period that allows startups to access critical university/lab assets and equipment for a period of time (3-5 years) after licensing university and federal lab technologies. Federal grants often prohibit the use of assets purchased or supported by the grants from being used for commercial purposes. This prohibition adds unnecessary expenses for startups to purchase or procure assets, tools, and equipment that already exist and could be accessed inexpensively.

- *Antitrust exemption*. One reason firms in advanced industries don't invest more in "almost there" regions is that they want to be located in dynamic, dense clusters, and worry that if they take a chance on investing they will be the only major firm to do so, depriving them of agglomeration economies. This is a classic collective action market failure: No firm wants to invest if it thinks no other firm will. But if firms know that many other firms will also invest—making the place a much more vibrant tech hub—then individual firms will be more likely to congregate. One way to solve this collective action problem, then, is to provide firms a legal green light to cooperate on research location decisions. To do this, Congress would pass legislation modifying the 1984 National Cooperative Research Act.

This act allowed firms to get approval from the Department of Justice to form research and development consortia. Congress should let firms cooperate to establish "investment location partnerships" whereby they could coordinate with each other regarding the location of their investment expansions or relocations, as well as the investments of their corporate venture arms. One could envision a scenario where the top 50 U.S. advanced industry firms all agree to expand or locate jobs in the new growth centers. Firms would not be allowed to coordinate to avoid investing where their competitors are—although given the presence of significant "external economies" in advanced industries, as opposed to cost-based "commodity" industries, the odds of this are low.

1.3. Business financing. Business financing, especially equity financing, can play an important role in enabling high-growth advanced industry startups. Several sources of financing could be made available on a preferred basis to the growth centers:

- *SBICs and SBIC financing*. Licensed and regulated by the Small Business Administration (SBA), Small Business Investment Companies (SBICs) are important sources of venture capital financing to higher-risk small businesses. These privately owned and managed investment funds play an important role supporting advanced sector entrepreneurship and growth.[131] The challenge is that there is a significant geographical concentration of SBICs, with 70% located in just 10 states, all of them with advanced industry hubs. Therefore, Congress should pass legislation mandating SBA to give first priority in applications for new SBICs to the designated growth centers. This could be built on the recently passed Spurring Business in Communities Act, which was originally introduced by Sens. Rubio (R-Fla.), Baldwin (D-Wis.), and Kennedy (R-La.). That legislation prioritizes SBIC applicants in underlicensed and underfinanced states and expands a provision in the Small Business Investment Act of 1958 providing certain exemptions from full-private capital requirements to include applicants from underlicensed states. Now, specific preferences for advanced sector applicants in growth centers should be added to the SBIC law.

- *SSBCI funding*. Likewise, Congress should direct the Treasury Department to channel State Small Business Credit Initiative (SSBCI) funding to growth centers. Created in 2010 by the Small Business Jobs Act of 2010, the SSBCI program consists of a $1.5 billion fund designed to strengthen state programs that support lending to small businesses and small manufacturers. The fund gives states significant flexibility to design programs to meet local market conditions, with SSBCI supporting 152 small-business programs from 2011 to 2015. Approximately 69% of the funding supported lending or credit support programs, and 31% supported venture capital programs. From 2011 to 2015, SSBCI programs supported nearly $8.4 billion worth of new capital in small-business loans and investments. Additional funding should go to capital in metro areas qualifying for this federal program.

1.4. Federal properties, infrastructure, and placemaking. The increasing preference of innovative companies for mixed-use, transit-oriented "innovation districts" where research institutions, advanced firms, and entrepreneurs can cluster and connect, means that federal contributions to concentrated development, modern transportation, and urban placemaking are also essential to spurring innovation in new growth centers.[132] One has only to recall the Amazon HQ2 headquarters solicitation of 2017 to remember the kind of priorities articulated by a leading 21st century tech company: "sustainability… connectivity… urban and suburban locations with the potential to attract and retain strong technical talent."[133] Amazon was not looking for a 1980s-era science park or suburban innovation corridor, but instead a truly urban innovation center. On this front, too, numerous existing federal programs could be

made specially available to the growth centers:

- *Land and buildings*. The federal government is, for one thing, the largest land and building owner in America, with significant holdings in many metropolitan areas. Gruber and Johnson note that there are 8.2 million square feet of federal property in metro-area Pittsburgh (with 665,000 feet un- or underused), as well as 1,300 acres of federal land.[134] Given inventory like that, Congress should direct the General Services Administration to assess all federal land and building assets in designated growth centers, and release surpluses to local governments where they could spur the local innovation economy.[135] Relatedly, Congress should establish a mechanism for relocating federal assets to support more dynamic uses in designated growth centers. Further federal supports will be needed to forge linkages with effective transit systems, adequate mixed-income housing, and mixed-use development.[136]

- *Infrastructure*. Innovative road, rail, transit, airport, and port solutions are also critical to shaping compelling innovation districts in competitive cities. Congress should consider prioritizing access to future iterations of go-to programs such as the BUILD and INFRA grant programs, as well as the credit assistance provided by the Transportation Infrastructure Finance and Innovation Act (TIFIA) for use in growth center development strategies. Federal help with airport modernizations and big projects such as highway teardowns and transit expansions would be especially important to helping to promote connectivity, reinvestment, and travel options.

- *Placemaking*. Equally important will be preferred access to programs that would aid and abet cities' efforts to craft the quality urban places that would help regions deliver the dense, vibrant use areas that attract and support workers and firms. Such preferred access might involve useful programs such as the New Markets Tax Credit, the Community Development Block Grant, the Public Works and Economic Adjustment Assistance programs, and others. Enhanced access to such programs could prove invaluable in helping designated growth centers deliver the kind of building renovations, redevelopments, and community design that have proven attractive to innovation activity. In a number of up-and-coming cities, the creation of intentional "innovation districts" has underscored the need for earlier creditworthiness and the lack of good credit enhancement alternatives for innovation district assets in their emergent phases.[137]

- *Federal employment*: The Trump administration has said it wants to move some government functions out of Washington, D.C., in part to get them closer to where their "customers" are. For example, the administration is moving parts of the Bureau of Land Management to Denver and some jobs in the Department of Agriculture to Kansas City. While controversial, it is true that with the rise of advanced information and communications technologies, such moves may make sense in some cases. Given that, further efforts to move some functions out of Washington should be targeted—where appropriate—to winning tech hubs where they would add to the local concentration of high-value economic activity.[138]

- *Community development*. Relatedly, "growth with inclusion" should preside as a key principle of regional responses. Growth center awards should support winning metro areas' desire to avoid the gentrification and inequality that has shadowed innovation success in today's superstar cities. And the competition should require and make available funding for programs focused on helping designated growth centers erase segregation, improve neighborhood connectivity, promote the inclusion of underrepresented residents, and ensure affordable housing options, including the option to purchase homes to allow lower-income or middle-class residents to accumulate wealth as property values and opportunities increase. Such investments will

help America's next generation of innovation hubs avoid the worst aspects of the last one by ensuring that new centers maintain affordability (before it becomes a problem) and that local innovation hot spots (such as innovation districts) don't become exclusive enclaves.

1.5. Workforce development. Finally, winning growth centers should receive funding to develop state-of-the-art workforce skills at all levels of education, simultaneously supporting innovation sector growth and ensuring that local workers of all types can participate in its benefits. As matters stand, many of the nation's potential new growth centers lack the requisite educational and workforce systems to supply enough of the technical workers that a tech sector scale-up will require. Making matters worse, innovation industries continue to struggle with major workforce diversity problems. Given that, the growth center competition should reward and support metro areas that propose ambitious initiatives for promoting regional upskilling and economic inclusion. Priority resources should therefore be made available to winning metro areas to support high-quality training programs for students and young adults, so they can benefit from opportunities as growth occurs. Crucial here will be multidimensional strategies and assistance for mid- to long-term programming to develop both college-level STEM knowledge and expertise in related technical fields that don't require a four-year degree. Special focus on the upskilling of underrepresented groups of all kinds will be essential as the nation heads toward a majority-minority workforce. Overall, the goal should be to grow the new innovation centers' workforces from within and benefit existing residents—not just attract talent from elsewhere (though that will need to happen too).

Overall, a rough estimate of the outlays involved for a federal program of the kind laid out here comes to **$100 billion over 10 years**. With that said, this estimate does not reflect dynamic scoring. Given the positive impact on GDP growth from these provisions, we believe the net cost to the federal treasury would be considerably lower than $100 billion. Additionally, it bears noting that the cost could be more than offset by canceling the $14.7 billion in federal fossil fuel industry subsidies, to pick just one example.[139] Terminating those subsidies would free up $150 billion of revenue over 10 years—more than enough to support the growth centers program and begin narrowing the nation's regional gaps.

2. Establish a rigorous and competitive process for selecting the most promising potential growth centers to receive the awards

To distribute its supports, the proposed growth center program would forthrightly pick eight to 10 winners—the eight to 10 metropolitan areas that had best demonstrated their readiness to become a new heartland growth center. However, the selection process would not be a casual or political affair. Instead, it would involve a competition employing rigid criteria and independent decisionmaking. Key elements of the process include:

- *RFP-driven challenge*. To begin the growth center initiative, Congress would need to establish the program—including its array of growth resources and other policy supports—and designate a federal agency to manage a national competition for the selection of awardees. Experience with previous advanced sector programs suggests that the National Institute of Standards and Technology (NIST) would be well-suited to manage the process. To initiate the process, NIST would launch a national competition by which metropolitan areas would compete for designation and support as new advanced sector growth centers in areas of the nation far from existing tech centers. A notice of funding opportunity and request for proposals would seek compelling plans for ambitious, technology-based economic transformation. Proposals would be required to articulate bold, data-driven strategies for promoting innovation-based advanced sector takeoff. That numerous metro areas and their states have the capacity to develop such plans is evidenced by the

quality of proposals developed by places such as Toronto, Boston, and Northern Virginia in response to the Amazon HQ2 challenge.[140] The same goes for numerous state-level "innovation economy" strategies.[141]

- *Goal-driven criteria*. The solicitation and selection processes will be structured by clear criteria aimed at clarifying the goals of the program. Eligibility for the growth center competition will be informed by the program's twin goals of boosting innovation in new regions while maximizing the odds of success. Along these lines, regions will need to have enough existing advantages (such as a reasonable share of tech jobs, a university base to build on, etc.) to suggest major promise but not so many that they are already a superstar city. Likewise, without being isolated, they need to be located far enough from coastal and other superstar cities (e.g., Austin, Denver) to promise a true reorientation of the nation's innovation geography. Again, the Amazon HQ2 headquarters solicitation, if nothing else, highlighted some of the siting factors prized by major innovation businesses: the size of the metro area, the presence of higher education, its strategic location, etc.[142] In any event, applicant metro areas would need to have many of the following attributes:

  - Population greater than 500,000 people within the metropolitan statistical area as of 2018. We believe that scale (urbanization economies) matters. Firms moving activity to places need reasonable airport service and a reasonably large and diverse talent pool.

  - Moderate to high levels of preexisting university R&D spending in STEM fields and significant patenting activity. It is difficult to build a tech hub without reasonably strong university research, in part because it generates spinoffs and industry partnerships but also because it is a source of skilled workers.

  - Above-average share of population with at least a BA and a sizable pool of STEM Ph.Ds. This is because local STEM talent is a key location factor for advanced technology firms.

  - Distance of at least 100 miles from a current "superstar" metro area. This is so there is at least some geographical spread from the current concentrated pattern.

In like fashion, the final selection of winning metro areas would be based on a set of criteria focusing on the critical dimensions of 21st century innovation readiness, ranging from research and technology development capacity, STEM worker availability, and entrepreneurial culture to business friendliness, a quality of place attractive to technical talent, and a collaborative and creative civic spirit. These criteria will be important both to identify excellent prospects and provide incentives for regions to make the sometimes tough political and institutional choices needed to become successful. In other words, in order to win, a region (and the state they are located in), must have skin in the game—not only financial resources, but political will to embrace innovative reforms such as a "smart city" vision and plan, PK-16 (pre-kindergarten to bachelor's degree) school reform, digital government, and strong placemaking agendas to establish a great quality of life and innovation environment. As such, selection criteria might call for:

- A strong technology development and takeoff strategy based on demonstrable technical advantage, focused on the local interplay of university and industry "core competencies" including in the current R&D program.

- A strong PK-16 STEM worker supply chain with adequate advanced technology specializations and plans for innovation and expansion.

- Strong entrepreneurship support and tech transfer programs.

- Cohesive new commitments to state and local economic development efforts.

- Commitments to address economic and innovation inclusion, including ensuring that technology skill development efforts focus on economically disadvantaged populations in the metro region.

- A current and planned "placemaking" strategy that fosters collaboration and innovation, while supporting affordability and congestion benefits. These criteria might call for urban land use that concentrates growth in compact, walkable urban centers while advocating for transit-oriented, walkable, bicycle-friendly land use and mixed-use development.

- Commitment to and a plan for achieving strong regional collaboration within the metropolitan area so that all jurisdictions work together, including the existence or planned creation of a metropolitan-wide economic development entity.

- Commitment to and plan for strong institutional reform, including in K-16 education, industry-relevant workforce development, government operations, and university tech-transfer and industry relevance.

- Creation or designation of an appropriate metro or regional development authority that would serve as the formal applicant for selection, as well as demonstrate broad local buy-in, provide decisive community leadership, identify prospective sourcing for matching funds, and offer appropriate accountability for results.

- Priority for plans detailing strong material and programmatic involvement of the metro area's state(s), whether for matching funding or provisions for state innovation, placemaking, education, training, or transportation investments.

- *Pre-application outreach*. To maximize the quality of regional submissions, NIST or whichever agency leads the program should hold workshops in heartland regions to help applicant consortia understand what the program is and what a successful application might look like. These would help applicant regions with appropriate traits optimally leverage their ability to advance a compelling strategy.

- *Independent selection*. Finally, objective, nonpolitical decisionmaking on selections will be guaranteed by the NIST's creation of an outside panel of expert reviewers. These reviewers would meet in open meetings and score and rank the applicants. They could not reside in the applicant metro areas or have financial or other interests. Such an approach would build on the successes of Congress' Base Realignment and Closure (BRAC) commission, which insulated numerous military base closures from both congressional and White House meddling.

In sum, the theory, the institutions, the mechanisms, and the know-how all exist to deliver a serious initiative for countering the nation's epidemic of divergence by fostering the rise of new innovation hubs in America. Congress should undertake such an initiative.

8. Candidates to be America's next top innovation hubs

Which metro areas could be America's next dynamic new innovation centers? As it happens, there are numerous candidates—many metro areas that concentrate sizable, well-educated populations and strong research enterprises sufficient to prompt serious optimism about their potential to, with a federal push, become self-sustaining.

Skeptics may doubt that new heartland innovation hubs can truly emerge—and may revert to the idea that today's geography of superstar cities is inevitable. However, even a cursory look at the nation's universe of cities suggests an array of plausible locations whose accelerated emergence could improve the nation's imbalanced geography.

To suggest the possibilities, we have here and in Table 2 and Appendix A collected basic information on several sorts of success factors implied by the growth center logic: issues of urban scale, innovation capacity, and workforce skills. With those data in hand, we have, for demonstration purposes only, benchmarked America's 382 metropolitan areas to assess the number and location of places that could be promising participants in a major program to create new growth centers.

- **Metro scale** is addressed in our assessment by applying a minimum population threshold of 500,000 residents, in order to ensure designated growth centers are sufficiently large to confer agglomeration economies on firms in the region.

- **Regional innovation capacity** is assessed using metro-level data on rates of STEM R&D spending by local universities and patent filings. We also require at least 0.5% of regional employment to already be in innovation industries.

- And the **skill base of the local labor** force is measured through data on the share of adults with a bachelor's degree or higher and the rate of STEM doctoral degrees granted by universities in the metro area.

With these variables in hand, we then calculate a simple **Eligibility Index** for metro areas, with scores greater than zero reflecting above-average strengths in innovation and workforce development, and thus potential for growth center status.[143]

We have also set a number of **additional restrictions** to reflect our goal of seeding promising new stars in new places. To start with, the country's two mega-regions of more than 10 million people—New York and Los Angeles—have been barred from eligibility for growth center investments, along with the nation's capital, Washington, D.C. These coastal hubs stand out as de facto superstars and are factors in the nation's imbalanced innovation map. Looking next at the remaining top 20 metro areas with the most innovation sector jobs, only those that saw population or real GDP growth slower than the nation as a whole since 2010 are considered eligible to become designated growth centers.

By dint of that, cities such as Raleigh, N.C., Boston, San Francisco, Seattle, Austin are set aside because they are already self-sustaining superstars. They are safe bets for any new tech graduate looking for a job or any tech firm looking at add a few hundred jobs somewhere. Allowing these places to be eligible would simply reinforce existing spatial imbalances.

And finally, there is the matter of geography: As a last screen, any viable metro area that lies within 100 miles of the center of an existing innovation center is removed because their further emergence won't significantly improve the nation's current entrenched spatial alignment. For this reason, formidable and deserving metro areas such as Baltimore, Philadelphia, and Worcester, Mass. fall off the list.

What does that leave? Altogether, when we employ our rough criteria to U.S. cities we identify no less than 35 potentially transformative growth centers dispersed across the nation. Promising metro areas are situated in 19 states. They lie in multiple regions, especially in the Great Lakes, Upper South, and Intermountain West, and they exist often at far remove from the coastal superstars. Rather than being concentrated, they are quite widely distributed, suggesting the nation contains much more untapped potential in the innovation economy, in many more places, than is often presumed. And remember that this is a quite demanding set of criteria for identifying the most promising recipients of the federal innovation/placemaking surge. One can easily imagine less restrictive criteria—such as those suggested by Gruber and Johnson—that would identify many more potential growth centers.

The list of promising candidates identified here is compelling, in any event:

Table 2. Potential growth centers have many existing assets off which to build

Potential growth centers and their eligibility

Name	Population, 2018	University STEM R&D per capita, 2017	Patents per 100,000, 2015	BA share, 2017	STEM doctoral degrees per 100,000, 2017	Innovation sector job share, 2018	Eligibility Index
Madison, WI	660,422	$1,688.51	71.1	45.9%	80.8	5.9%	1.63
Minneapolis-St. Paul-Bloomington, MN-WI	3,629,190	$245.30	97.1	41.7%	11.3	3.2%	0.68
Albany-Schenectady-Troy, NY	883,169	$268.58	124.0	37.2%	19.5	4.3%	0.66
Lexington-Fayette, KY	516,697	$717.60	36.1	37.5%	29.3	1.8%	0.58
Rochester, NY	1,071,082	$370.93	113.0	34.1%	15.0	2.6%	0.53
Provo-Orem, UT	633,768	$59.56	67.9	41.3%	7.9	6.4%	0.47
Portland-Vancouver-Hillsboro, OR-WA	2,478,810	$14.90	90.8	40.3%	1.8	4.9%	0.47
Tucson, AZ	1,039,073	$593.64	63.5	33.6%	21.3	5.4%	0.45
Pittsburgh, PA	2,324,743	$539.74	38.1	35.1%	22.0	2.2%	0.40
Salt Lake City, UT	1,222,540	$264.64	55.2	35.5%	16.8	3.7%	0.34
Columbus, OH	2,106,541	$386.41	21.9	35.9%	20.1	1.7%	0.30
Chicago-Naperville-Elgin, IL-IN-WI	9,498,716	$166.67	40.9	37.7%	7.4	1.9%	0.29
Nashville-Davidson--Murfreesboro--Franklin, TN	1,930,961	$367.01	12.0	36.0%	11.2	1.0%	0.22
Akron, OH	704,845	$95.09	52.9	32.2%	24.0	1.7%	0.19
St. Louis, MO-IL	2,805,465	$286.57	27.7	34.6%	9.2	2.9%	0.19
Boise City, ID	730,426	$45.46	107.0	30.1%	2.0	3.8%	0.18
Milwaukee-Waukesha-West Allis, WI	1,576,113	$45.53	43.7	35.8%	6.2	2.1%	0.18
Cincinnati, OH-KY-IN	2,190,209	$195.99	48.6	33.2%	5.9	2.5%	0.16
Buffalo-Cheektowaga-Niagara Falls, NY	1,130,152	$342.04	22.4	32.5%	16.9	2.7%	0.15
Kansas City, MO-KS	2,143,651	$10.72	39.1	36.5%	0.0	1.9%	0.14
Des Moines-West Des Moines, IA	655,409	$0.00	35.0	36.6%	0.0	1.3%	0.13
Indianapolis-Carmel-Anderson, IN	2,048,703	$25.55	37.0	35.6%	3.7	2.8%	0.13
Detroit-Warren-Dearborn, MI	4,326,442	$53.90	76.7	31.1%	3.4	1.7%	0.12
Albuquerque, NM	915,927	$259.20	32.4	32.1%	11.6	5.0%	0.12
Palm Bay-Melbourne-Titusville, FL	596,849	$30.67	79.5	30.0%	7.3	8.6%	0.10
Syracuse, NY	650,502	$164.65	33.0	31.8%	15.8	3.0%	0.09
Cleveland-Elyria, OH	2,057,009	$234.98	44.7	30.8%	7.8	1.7%	0.09
Greenville-Anderson-Mauldin, SC	906,626	$161.63	54.9	28.6%	19.0	1.8%	0.07
Omaha-Council Bluffs, NE-IA	942,198	$11.41	19.5	36.3%	0.9	1.7%	0.07
Fayetteville-Springdale-Rogers, AR-MO	549,128	$252.46	15.5	31.8%	16.2	0.6%	0.06
Knoxville, TN	883,309	$307.77	25.3	28.8%	23.6	2.4%	0.05
Dayton, OH	806,548	$276.43	32.5	29.8%	13.3	3.4%	0.05
Charlotte-Concord-Gastonia, NC-SC	2,569,213	$9.58	18.6	35.5%	2.7	1.7%	0.05
Birmingham-Hoover, AL	1,151,801	$481.57	9.8	30.5%	8.0	0.6%	0.05
Columbia, SC	832,666	$218.31	11.6	31.9%	15.0	1.5%	0.04
All U.S. metros	281,128,123	$215.75	48.1	34.0%	10.6	2.8%	

Note: Eligibility Index calculated using a weighted average of normalized eligibility criteria variables for each metro.
Source: Brookings and ITIF analysis of Census PEP, NSF, USPTO, Emsi, and ACS data

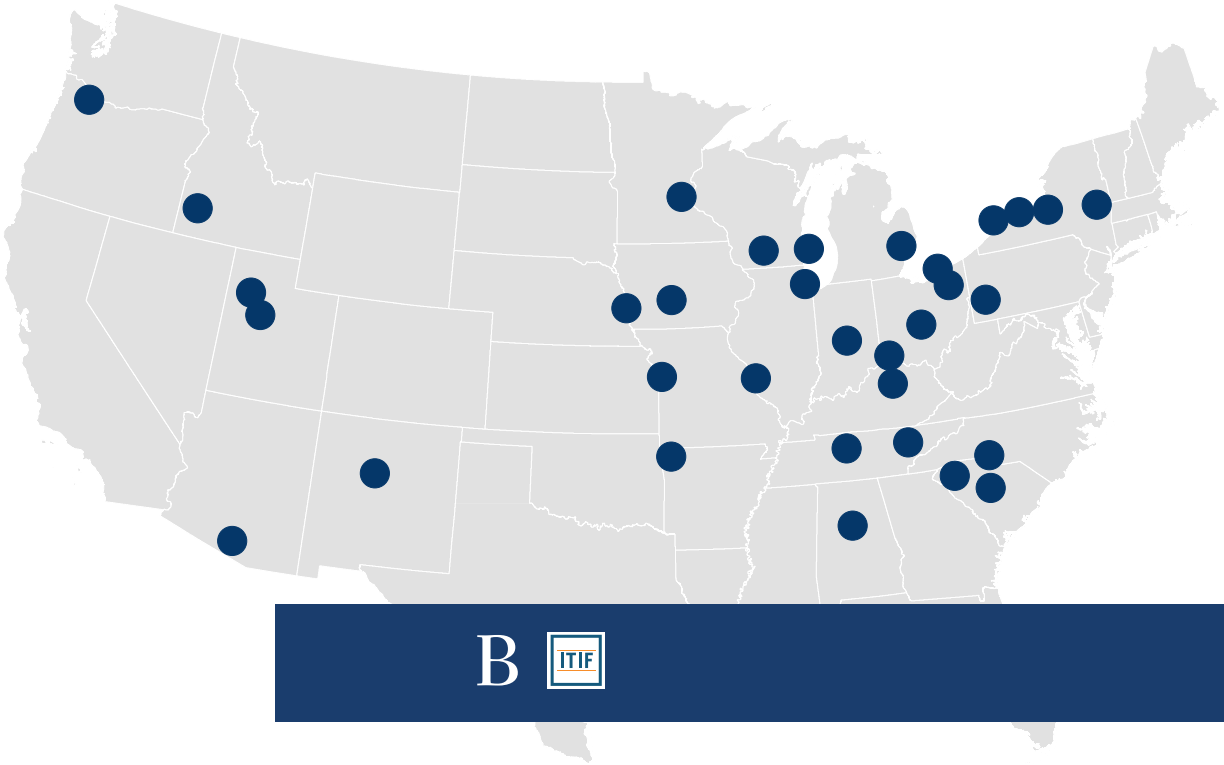
Right off, a scan of the potential growth centers surfaced by the Brookings-ITIF criteria suggests that the identified metro areas hold solid value and importance for the nation's innovation economy.

For one thing, they contain a substantial portion of the nation's most critical innovation infrastructure—its research universities. No fewer than 27 of the nation's Research 1 universities reside in the 35 potential growth centers. By contrast, that figure is 38 for the 15 most-established superstar metro areas, suggesting that the non-superstar heartland metro areas represent a high-value economic opportunity for the nation that cannot be ignored.

Likewise, research universities in the 30 metro areas graduate STEM Ph.D.s at a slightly higher rate than existing innovation centers—10.4 degrees per 100,000 people compared to 10.3 degrees per 100,000.

In addition, the quality of life among potential growth centers, as reflected in housing costs and traffic congestion, is on average far superior to that in the superstars (see Appendix A). The median home value in the 35 up-and-coming metro areas was just $194,000 in 2017, compared to $385,000 in the 15 top superstars. The comparisons are striking, with median home values equal to $165,500 and $172,200 in **Cincinnati** and **St. Louis** compared to $957,700 and $617,700 in coastal winner-take-most cities **San Jose, Calif.** and **Los Angeles**. And the story is similar in terms of congestion and commute times. On average, 6.3% of workers in the 35 metro areas commuted more than an hour to work, while that share is more than twice as high in existing innovation centers, reaching 22.5% in

Map 4. Strong potential candidates for growth center designation appear across the country



Source: Brookings and ITIF analysis

Appendix C. Growth centers program costs

While the following cost estimates are rough, we estimate that a program of the kind laid out in this paper would cost the federal government

total cost of $674 billion
was estimated by multip
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New York. By contrast, only 2.5% of workers do so in **Omaha, Neb.** and **Des Moines, Iowa**.[144]

On their face, then, the nation's up-and-coming midsized regional stars represent a sound opportunity for the nation given their aggregate potential.

And yet, a look at the geography of the potential growth centers spurs further interest: As identified here, the 35 most promising potential growth centers represent a set of possible tech hubs whose disparate locations suggest their takeoff might meaningfully help counter the nation's current regional imbalances. Troubled regions such as the Midwest and South might greatly profit from the such takeoff, as would the Mountain West.

The further expansion of such high-ranking innovation centers as **Madison, Wis.**, **Rochester, N.Y.**, **Lexington, Ky.**, **Pittsburgh**, and **Columbus, Ohio** would, for example, be an important counter to the economic drift of the eastern heartland. This is true also for investments in places such as **Cincinnati**, **St. Louis**, **Buffalo, N.Y.**, **Indianapolis**, **Cleveland**, and **Dayton, Ohio**. The same goes for Southern metropolitan areas such as **Nashville, Tenn.**, **Greenville, S.C.**, and **Birmingham, Ala**. In all of these cases, the presence of solid research universities and existing innovation sector momentum in otherwise left-behind regions suggests a viable way to begin reorienting the nation's economic geography, place by place.

With that said, the dearth of potential growth centers in the Plains states and the Deep South suggests both the limits of growth center strategies and the deeper challenges facing those states. Neither the Dakotas, Montana, Kansas, and Oklahoma, or Mississippi host a top-100 university for technology transfer, which all but precludes the viability of their cities for emergence as a growth center.[145] By contrast, Ohio contains four universities ranked in the top 100, which is surely a key reason five metro areas in that state are on the list of potential growth hubs. Similar shortcomings of city size, university research, and STEM education reinforce the ineligibility of Plains and Deep South cities. States and cities in those regions should consider if they are ready to begin the journey of systematically building up high-quality institutions as a base for growth—a journey that will require state action to start with. In any event, the map of America's future top growth hubs suggests much could be achieved with a concerted growth center strategy, but that not every region can be helped with this particular initiative.

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9. Addressing objections and concerns

To be sure, there will be objections. Some will say the present proposal goes too far, while others will say it doesn't go far enough.

To the first view, some traditionalist economists will continue to argue that any such push to promote regional equity will come at the expense of national growth and efficiency. However, as we have seen, it is a false choice to assume that every effort to boost second-level regions will harm the national good. There are certainly places where intervention can help underperforming metro areas turn the corner and add to the nation's total welfare, including global competitiveness. In this sense, the relationship between interregional inequality and national innovation and growth is likely shaped as an inverted "U," in which both too much inequality and too little are harmful to growth.

Others, meanwhile, will argue that a federal growth pole program cannot possibly succeed at reorienting the nation's innovation map. These critics will likely make two arguments: First, that government is incapable of effectively picking regional "winners," and, second, that the emergence of existing clusters had nothing to do with government efforts.

In attacking the government's competence to intervene, for example, tech policy gadfly

Vivek Wadhwa has called innovation clusters "modern-day snake oil."[146] But these critics are attacking strawmen by saying, as Wadhwa writes, that cluster theory holds that "regions could artificially ferment innovation. They just needed to build the right infrastructure and bring together chosen industries." But this is not what regional economists believe. Rather, they tend to argue the opposite, and suggest that creating vibrant innovation agglomeration economies can almost never be done from scratch—but that if policy builds on existing economic strengths, including localization economies, it can boost regional innovation clusters.

A similar argument against federal efforts comes from noted venture capital funder Marc Andreessen, who writes, "Previous efforts at such clusters failed for a variety of reasons, but one big reason is that government efforts alone simply don't draw people."[147] But again, this is an oversimplification, as few regional economists focused on innovation would disagree with Andreessen's point. Rather, they would say that government efforts need to be one part of the mix, and need to focus on places with existing strengths to succeed.

For their part, meanwhile, some neoclassical economists may acknowledge there is a potential role for government in spurring tech growth, but will insist that it should be much more limited than is proposed here. Harvard Business School professor Josh Lerner acknowledges a role for government, but one limited mostly to "setting the table." He writes (with limited empirical evidence) that government should "create laws that don't penalize failed entrepreneurs, reduce taxes, and spend heavily on R&D. Then get out of the way."[148] To be sure, all of that needs to be part of the mix. But to say that establishing seed capital programs, spurring tech transfer from universities and federal labs, developing specialized training programs, and helping small firms modernize and innovate should not be part of a regional push is to let ideology get in the way of pragmatic reality.

And then there is the frequent attack on the government's ability to address spatial imbalances. This objection discounts the possibility of any effort to alter the current uneven spatial distribution of advanced industry activities by noting that few places have graduated to become sustainable centers. But there is a key reason for this: To date, the federal government has made no explicit effort to do so. Significant, intentional effort to adjust the innovation map hasn't been attempted.

But those are just the arguments that denigrate federal effectiveness. More concerning are critics who simply see no possible role for government action—however limited—in mitigating the nation's severe spatial imbalances.

One of these arguments falls back on the canard that "Silicon Valley can't be copied."[149] And of course it can't. But to say that there is no potential to help some existing tech centers evolve to become full-fledged regional tech stars is simply wrong. New hubs won't look exactly like Silicon Valley any more than Seattle or Boston look like Silicon Valley. But they can and should be robust advanced industry hubs in their own fashion. Just look at other nations that have seen the emergence of globally ranked tech centers, including Canada, China, Germany, India, and Israel.[150] They didn't copy Silicon Valley, but they did help create globally competitive tech centers.

More broadly, though, many skeptics hold a naïve view that existing successful tech hubs such as Silicon Valley just organically emerged out of the apricot orchards, and that the federal government played little role. This, too, is badly mistaken.

In fact, when examining the history of many U.S. technology hubs, it is clear that the federal government played an important—if not decisive—role in helping them attain the critical mass of innovation resources to become full-blown innovation stars.

From the 1920s to the 1940s, many believed that Boston would go the way of the rest of New England, with the city's traditional manufacturing of textiles, shoes, and machines migrating to the low-cost South and stagnation setting in. But Boston took a different path toward becoming one the strongest innovation hubs in the world, in no small part due to federal support. World War II brought an influx of federal funding to the city, especially for the development of military electronics. As the Cold War began, that support was formalized and dramatically expanded. For example, the MIT Lincoln Laboratory, a Defense Department research and development center, was established in 1951, and became a hub for electronics research nationally.[151]

The federal government was even more instrumental in the development of Silicon Valley, with significant funding for Stanford and the University of California, Berkeley in the postwar era, the establishment of the Lawrence Berkeley National Laboratory in 1931 and what became NASA's Ames Research Center in 1939, and later, massive amounts of defense funding for R&D and prime contractors.[152] In fact, in 1992, Santa Clara County (the heart of Silicon Valley) received more defense prime contract funding per capita than any county in the nation.[153] As historian Leslie Berlin writes: "It's not a stretch at all to say that Silicon Valley exists because of the federal government."[154]

The federal government also had a major hand in the development of North Carolina's Research Triangle Park. While local leaders laid the groundwork for it in the 1950s, it was former Governor Luther H. Hodges who—as President Kennedy's secretary of commerce—played a key role in convincing Kennedy to establish the National Institute of Environmental Health Sciences in Research Triangle Park. This not only ensured an influx of hundreds of scientists to the region, but it sent a clear signal to technology companies that this was a viable location for innovation activities.[155] Similarly, while Austin, Texas was home to many technology companies, the decision by Sematech— a consortium of semiconductor firms funded in part by the Defense Advanced Research Projects Agency—to locate their headquarters there in 1998 helped cement the city's leadership status. And clearly, Washington, D.C.'s emergence as a tech superstar has had everything to do with federal R&D funding, especially defense and health. More recently, steady federal and state investments have supported the buildup of the semiconductor industry in Troy, N.Y.

None of this is to say that these federal investments created these places on their own or that they were designed to create these places (although in the case of Research Triangle Park, that was the case). Nor were the federal investments completely "greenfield" in nature; in each case, they supported existing federal and local effort. But they did help enable emerging growth centers to become self-sustaining. As such, there is no reason such federal interventions cannot be replicated today, albeit with new, better-informed, and more rigorous procedures.

Related to the objection to federal intervention, meanwhile, is its corollary: the notion that technology-based economic development is inherently the provenance of state and local governments, and not the federal government. Under this view, the only appropriate role for the federal government is to address broad macro factors such as tax and trade policy, research support, and the like. But this argument suffers from two flaws. First, the federal government has historically played a key role in economic development, from the establishment of land grant colleges in the 1860s, to the establishment of the Appalachian Regional Commission and Economic Development Administration in the 1960s, to creating enterprise and opportunity zones more recently. Moreover, ideologically rejecting a federal role to establish self-sustaining innovation hubs will mean that few—if any—places now struggling to become one will succeed. Despite the importance of state and local efforts, without federal help they simply cannot achieve the scale needed for takeoff. At the same time, the present proposal anticipates significant involvement of states in successful regional efforts.

In short, then, significant rationales exist for the sizable intervention proposed here, notwithstanding likely complaints that the proposal goes too far and attempts too much.

At the same time, though, others more sympathetic to the idea of intervening in the nation's spatial imbalances may say the present proposal does not go far enough. One objection is political or distributional. Stakeholders in places unlikely to receive support may argue that any growth center surge is inherently unfair. At one level, they are correct: The program would be uneven in its distributions. But the current "fair" process—in which many different places get minor help—is not working, resulting in negative effects ranging from lagging "dynamism" and global competitiveness to social unrest. Given that, a program that targets some places but not others is—in our view—clearly called for to boost American greatness and assure that takeoff begins in a key set of places. Such a program will also benefit many places that aren't themselves directly funded, through spillover regional gains, supply chain links, and similar effects.

Others will complain that a growth center push does not sufficiently "change capitalism" or address the full crises of America's smaller cities, towns, and rural areas. And there is a degree of truth to those concerns as well. The fundamental reality of agglomeration dynamics cannot be erased, for example, so there will always be strong centers and weaker ones. Nor are discussions of market structure, regulation, and industry concentration unrelated to the nation's geographical imbalances (even though they are set aside here).[156] Likewise, it is absolutely true that the "hollowing out" of hundreds of the nation's smaller cities and rural towns represents an additional claim on the nation—one not directly addressed here.

And yet in each case, the additional problem does not preclude the urgency of the action this paper proposes. A fuller discussion of gargantuan issues of "capitalism" and its structure should not delay the kind of emergency action suggested here to jump-start new dynamism in promising metro areas in the nation's interior. Likewise, the proposed innovation surge in the heartland's midsized cities would in fact bring new vitality to deeply struggling communities, allowing for smaller towns and counties to benefit from supply chain relationships, commuting, and other interdependencies with the growth centers.

In any event, the present initiative is best viewed as but one component of the full federal agenda needed to ameliorate the nation's unbalanced economic geography. The growth centers agenda is aimed at high-potential, midsized markets with a goal of expanding the future membership of the top echelon of innovation hubs. The agenda is not intended to jump-start the most distressed urban and rural communities in America, which would benefit from other critical interventions.

In sum, a concerted growth centers surge—while not a total solution for the nation's now-colossal set of regional imbalances—would represent a major break with past inaction and mount a much-needed first strike at altering dynamics that are hurting the entire nation.

10. Conclusion

In short, then, the time is right for a major push to counter regional divergence at a time of crisis.

While it does not represent the sum total of federal effort needed to revitalize the nation's left-behind places, a robust growth centers initiative represents a crucial element of such an overdue push.

The nation should begin the work. A feasible framework—and promising potential participants—now exist for spreading innovation-driven growth across much more of the nation's patchy and divided map.

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Endnotes

1. See, for example, Clara Hendrickson, Mark Muro, and William A. Galston, "Countering the geography of discontent: Strategies for left-behind places." (Washington: Brookings Institution, 2018); Ryan Nunn, Jana Parsons, and Jay Shambaugh, "The Geography of Prosperity" in Jay Shambaugh and Ryan Nunn, *Place-Based Policies for Shared Economic Growth*. (Washington: The Hamilton Project, 2018); and Robert J. Barro and Xavier Sala-i-Martin, "Convergence across States and Regions," *Brookings Papers on Economic Activity*, no. 1 (1991): 107-182.

2. Clara Hendrickson, Mark Muro, and William A. Galston, "Countering the Geography of Discontent: Strategies for left-behind places." (Washington: Brookings Institution, 2018); Ryan Nunn, Jana Parsons, and Jay Shambaugh, "The Geography of Prosperity" in Shambaugh and Nunn, *Place-Based Policies for Shared Economic Growth*.

3. Mark Muro and Jacob Whiton, "Geographic gaps are widening while U.S. economic growth increases." *The Avenue*. January 23, 2018.

4. For more on the importance of innovation-driven "advanced industries" see Mark Muro and others, "America's Advanced Industries: What They Are, Where They Are, and Why They Matter." (Washington: Brookings Institution, 2015). See also J. John Wu and Robert D. Atkinson. "How Technology-Based Start-ups Support U.S. Economic Growth," (Washington, DC: Information Technology & Innovation Foundation, 2017).

5. See Ginia Bellafante, "Are We Fighting a War on Homelessness? Or a War on the Homeless?" *New York Times*, May 31, 2019 and Bill Disbrow, "San Francisco peak hour commuters lost nearly 5 days to traffic congestions last year, study says," SFGATE, February 13, 2019.

6. Paul Krugman, "What's New About New Economic Geography?" *Oxford Review of Economic Policy*, vol. 14:2 (1998): 7-17.

7. See Enrique Garcilazo and Joaquim Oliveira Martins, "The Contribution of Regions to Aggregate Growth in the OECD." OECD Regional Development Working Papers 2013/28 and Joseph Parilla and Mark Muro, "Understanding US productivity trends from the bottom-up." (Washington, DC: Brookings Institution, 2018).

8. See Jason S. Spicer, "Electoral Systems, Regional Resentment and the Surprising Success of Anglo-American Populism," *Cambridge Journal of Regions, Economy and Society*, no. 11:1 (2018): 115-141; Ben White, "One GOP senator's plan to save rural America," *Politico*, November, 28, 2018; and Will Wilkinson, "The Density Divide: Urbanization, Polarization, and Populist Backlash." (Washington, DC: Niskanen Center, 2019).

9. Gareth Cook, "The Economist Who Would Fix the American Dream," *The Atlantic*, August, 2019.

10. See, for example, commentaries by Ronald Brownstein, who worries about sharpening tensions "between an economic order that increasingly favors the largest places—and a political dynamic that, for now, sublimates them to the smaller places that are economically falling behind." One statement of this appears in Ronald Brownstein, "The prosperity paradox is dividing the country in two." *CNN*. January 23, 2018. See also, Ronald Brownstein, "America, a year later." *CNN,* November 2017.

11. Edward Glaeser and Joshua D. Gottlieb, "The Economics of Place-Making Policies," *Brookings Papers on Economic Activity*, no. 1 (2008): 155-253.

12. An important exception is the Massachusetts Institute of Technology economists Jonathan Gruber and Simon Johnson, whose new book proposes a parallel intervention to the one discussed here. See Jonathan Gruber and Simon Johnson, *Jump-Starting America: How Breakthrough Science Can Revive Economic Growth and the American Dream*. (New York. Public Affairs, 2019).

13. See, for example, Benjamin Austin, Edward Glaeser, and Lawrence Summers, "Jobs for the Heartland: Place-Based Policies in 21st-Century

America," BPEA Final Draft, Spring 2018: https://www.brookings.edu/bpea-articles/saving-the-heartland-place-based-policies-in-21st-century-america/; Anna Hensel, "Where Steve Case's Rise of the Rest fund is investing 1 year in," *VentureBeat*, January 6, 2019; Adam Kelsey, "Democrats turn to rural issues to court Iowa, heartland voters," *ABC News*, March 31, 2019; and Eduardo Porter, "Why Midsize Cities Struggle to Catch Up to Superstar Cities," *New York Times,* June 16, 2019.

14. The sociologist Robert Manduca calls this the "local responsibility" view of regional economic development. In this vein, recommendations are typically aimed solely at local policymakers, suggesting actions that can be undertaken independently by individual regions.

15. This is also the general vision of Gruber and Johnson, *Jump-Starting America*.

16. Gruber and Johnson, *Jump-Starting America*.

17. See Clara Hendrickson, Mark Muro, and William A. Galston, "Countering the geography of discontent: Strategies for left-behind places." (Washington: Brookings institution, 2018). For key writings on 20th century "convergence" in the U.S. see Robert J. Barro and Xavier Sala-i-Martin, "Convergence," *Journal of Political Economy* 100, no. 2 (1992): 223-251 and Robert J. Barro and Xavier Sala-i-Martin, "Convergence across States and Regions," *Brookings Papers on Economic Activity*, no. 1 (1991): 107-182. Olivier Jean Blanchard and Lawrence F. Katz, "Regional Evolutions," *Brookings Papers on Economic Activity*, no. 1 (1992): 1-75.

18. Peter Ganong and Daniel Shoag, "Why Has Regional Income Convergence in the U.S. Declined?" National Bureau of Economic Research, NBER Working Paper No. 23609, July 2017.

19. Elisa Giannone, "Skilled-Biased Technical Change and Regional Convergence," (January 2017): 1-86, http://home.uchicago.edu/~elisagiannone/files/JMP_ElisaG.pdf.

20. Adam Millsap, "Should Government Help People or Places?" *Forbes*, September 7, 2018.

21. See, for example, Ganong and Shoag, "Why Has Regional Income Convergence in the U.S. Declined?" and also Giannone, "Skilled-Biased Technical Change and Regional Convergence." See also Hendrickson, Muro, and Galston, "Countering the geography of discontent."

22. The "innovation sector" as discussed here is an especially R&D- and STEM-worker-intensive subsector of the "advanced industries" sector that the Brookings Metropolitan Policy Program has delineated and analyzed here: Mark Muro and others, "America's Advanced Industries: What They Are, Where They Are, and Why They Matter." (Washington: Brookings Institution, 2015). The earlier report identified 50 high-value advanced industries using two criteria: industry R&D spending per worker in the 80th percentile of industries or higher (so above $450 per worker); and above-average industry STEM worker shares, rating above 21% of all workers. Of these 50 industries, 13 were identified that represented a cohort whose R&D expenditures and STEM worker shares exceeded $20,000 and 45%. These "innovation" industries represent America's highest-tech and most advanced sector of all.

23. The "innovation sector" defined here resembles, with key differences, portions the "advanced industries sector" the Brookings Metropolitan Policy Program has delineated and analyzed here: Mark Muro and others, "America's Advanced Industries: What They Are, Where They Are, and Why They Matter." (Washington: Brookings Institution, 2015). Innovation industries do not include energy production nor a number of heavy manufacturing industries such as iron, steel, and ferroalloys; petroleum and coal products; and ship and boat building.

24. Muro and others, "America's Advanced Industries."

25. Edward Glaeser and Joshua D. Gottlieb, "The Wealth of Cities: Agglomeration Economies and Spatial Equilibrium in the United States," National Bureau of Economic Research, NBER Working Paper No. 14806, December 2011.

26. One example of the very slow dispersal of the U.S. innovation economy into new places is the "digital services" sector which—far from decentralizing—has actually been *concentrating* in

the current decade. See: Mark Muro and Sifan Liu, "Tech in metros: The strong are getting stronger." *The Avenue.,* March 8, 2017 and Mark Muro and Jacob Whiton, "Tech is (still) concentrating in the Bay Area: An update on America's winner-take-most economic phenomenon." *The Avenue.,* December 17, 2018. Another example is the life sciences sector. Nearly every governor, and many mayors, chased the "biotech economy" in the early 2000s in the aftermath of the sequencing of the human genome. Life sciences jobs of the future were sought by all and thought to be "the next big thing" for scores of metropolitan areas. Twenty years later, the number of true life sciences centers in the U.S. remains small (under 20) and stubbornly oriented to almost exactly the same places where the industry began. Author's correspondence with David Johnson, August 16, 2019.

27. This analysis was done for other industry groups as well: basic manufacturing, retail, health care, and finance. Employment shares for retail and health care track the distribution of total employment closely, which is to be expected, given that those sectors are primarily nontraded and depend on the size of the local market. Finance, as a traded service, demonstrates a greater degree of agglomeration, though not as great as the innovation sector. Lastly, employment in basic manufacturing is less concentrated than total employment, reflecting American manufacturing's multidecade search for lower land and labor costs by relocating to small metro areas and rural areas.

28. This type of thinking has been associated especially with the spatial economic theory known as the new economic geography (NEG). This school of thought emphasizes the economic-efficiency related benefits of the concentration of economic activity or "agglomeration" in particular regions and argues it may accelerate national growth. See Ron Martin, "National growth versus spatial equality? A cautionary note on the new 'trade-off' thinking in regional policy discourse," *Regional Science Policy & Practice*, vol. 1:1 (2008): 1-13. In the U.S. such ideas have informed work of numerous prominent scholars ranging from Paul Krugman to Ed Glaeser and Enrico Moretti. See, for example, Masahisa Fujita, Paul Krugman, and Anthony Venables, *The Spatial Economy: Cities, Regions, and International Trade*. (Cambridge: MIT PRESS, 1999); Masahisa Fujita and Thisse, J.F., "Does Geographical Agglomeration Foster Economic Growth and Who Gains and Loses from It?" *The Japanese Economic Review* 54: 121–145; Edward Glaeser and Joshua Gottlieb, "The Wealth of Cities: Agglomeration Economies and Spatial Equilibrium in the United States." Working Paper 14806, National Bureau of Economic Research; and Enrico Moretti, *The New Geography of Jobs*. (New York: Mariner, 2012).

29. Alfred Marshall's 1890 textbook, *Principles of Economics* (London, UK: Macmillan and Co., Ltd.), identified three reasons for agglomeration economies: industry-specific labor market matching, supply of specialized inputs, and knowledge spillovers. Since then, economists have formalized and modeled these Marshallian agglomeration economies and argued for their centrality in driving the clustering of economic activity across space. See Paul Krugman, "Increasing returns and economic geography," *Journal of Political Economy*, vol. 99:3 (1991): 483-499; Paul Krugman, "What's New About New Economic Geography?" *Oxford Review of Economic Policy*, vol. 14:2 (1998): 7-17; and Glaeser and Gottlieb, "The Wealth of Cities."

30. See Edward Glaeser, "The Economics Approach to Cities." Research Working Paper 08-003, Harvard University Kennedy School of Government. For more critical reviews see Michael Storper, "Separate Worlds? Explaining the current wave of regional economic polarization," *Journal of Economic* Geography, no. 18 (2018): 24-270 and Andrés Rodríguez-Pose, "The revenge of the places that don't matter (and what to do about it)," *Cambridge Journal of Regions, Economy and Society*, vol. 11:1 (2018): 189-209.

31. This sort of caution reflected the thinking of the Yale economist Arthur M. Okun, who in 1975 published the influential book *Equality and Efficiency: The Big Tradeoff.* (Washington, DC: Brookings Institution).

32. Data on commute times and median rents by metropolitan area are drawn from the US Census's American Community Survey 1-year

2017 estimates retrievable at https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml.

33. Housing price indices from the U.S. Federal Housing Finance Agency and retrievable at https://fred.stlouisfed.org/graph/?g=owao.

34. Shirin Ghaffary, "Even tech workers can't afford to buy homes in San Francisco." *Recode*, March 19, 2019. See also https://www.businessinsider.com/living-in-san-francisco-on-tech-salary-disappointing-photos-2018-9#so-they-teamed-up-with-a-family-already-settled-in-the-bay-who-allowed-them-to-post-up-in-their-rv-pad-for-a-fee-22.

35. See Hendrickson, Muro, and Galston, "Countering the geography of discontent: Strategies for left-behind places."

36. See Elisa Giannone, "Skilled-Biased Technical Change and Regional Convergence;" David H. Autor, "Work of the Past, Work of the Future," National Bureau of Economic Research, NBER working paper no. 25588, February 2019; Ganong and Shoag, "Why Has Regional Income Convergence in the U.S. Declined?" and also Andrés Rodríguez-Pose and Michael Storper, "Housing, urban growth and inequalities: The limits to deregulation and upzoning in reducing economic and spatial inequality," Centre for Economic Policy Research, Discussion Paper No. 13713, May 2019 and Pablo Fajgelbaum and Cecile Gaubert, "Optimal Spatial Policies, Geography and Sorting," Working Paper 24632, National Bureau of Economic Research.

37. Benjamin Austin, Edward Glaeser, and Lawrence Summers, "Jobs for the Heartland: Place-Based Policies in 21st-Century America," BPEA Final Draft, Spring 2018: https://www.brookings.edu/bpea-articles/saving-the-heartland-place-based-policies-in-21st-century-america/.

38. Joseph Parilla and Mark Muro, "Understanding US productivity trends from the bottom-up." (Washington, DC: Brookings Institution, 2018).

39. See Martin, "National growth versus spatial equality?".

40. Conversation with Robert Atkinson; May 2019.

41. See timely comparisons of living expenses here: https://www.expatistan.com/cost-of-living/comparison/kansas-city/san-francisco?.

42. Cost-of-living comparisons calculated at https://www.expatistan.com/cost-of-living/comparison/austin/indianapolis?.

43. See, again, Martin, "National growth versus spatial equality?".

44. Enrico Moretti calculates that each additional tech job in a local economy is associated with the creation of a long-run additional 4.9 nontradeable jobs in that economy. See Enrico Moretti, "Local Multipliers," *American Economic Review: Papers and Proceedings,* vol. 100:2 (2010): 1-5 and Enrico Moretti and Per Thulin, "Local Multipliers and Human Capital in the United States and Sweden," *Industrial and Corporate Change,* vol. 22:1 (2013): 339-362.

45. See, for example, Neil Lee and Andrés Rodríguez-Pose, "Is There Trickle-Down from Tech? Poverty, Employment, and the High-Technology Multiplier in U.S. Cities," *Annals of the American Association of Geographers,* vol. 6:5 (2016): 1114-1134.

46. A nation's income inequality can be decomposed into between-region inequality (how average income distributions across regions) and within-region income inequality (how income is distributed among households in each region). In advanced OECD countries, including the U.S., the within-region inequality accounts for most of nationwide inequality but between-region inequality has been increasing. See William Gbohoui, W. Raphael Lam, and Victor Duarte Lledo, "The Great Divide: Regional Inequality and Fiscal Policy." Working Paper 19/88, International Monetary Fund. For another perspective, see also Jonathan Rothwell, who minimizes the importance of between-region divides as a major driver of national inequality. See Jonathan Rothwell, "The Biggest Economic Divides Aren't Regional. They're Local. (Just Ask Parents)." *The New York Times,* February 12, 2019.

47. See, for example, John Sides, Michael Tesler, and Lynn Vavreck, *Identity Crisis: The 2016 Presidential Campaign and the Battle for the Meaning of America*. (Princeton: Princeton University Press, 2019).

48. See, most notably, Benjamin M. Friedman, *The Moral Consequences of Economic Growth*. (New York: Vintage, 2006).

49. Andrés Rodríguez-Pose, "The Revenge of the Places That Don't Matter (and What to Do About It)." *Cambridge Journal of Regions, Economy and Society* 11 (1): 189-209.

50. Ibid.

51. James P. Pinkerton, "The Worldwide Trumpian Majority: Lessons From Brexit, Britain, and the United States." *Breitbart*, August 7, 2016.

52. See, again, commentaries by Ronald Brownstein, as here: Ronald Brownstein, "The prosperity paradox is dividing the country in two" and Ronald Brownstein, "America, a year later."

53. Robert D. Atkinson and David Audretsch, "Economic Doctrines and Policy Differences: Has the Washington Policy Debate Been Asking the Wrong Questions?" (Washington, DC: ITIF, 2008).

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alternative model for a growth centers program. Focused on larger-scale translational research in the health area, repeat five-year awards of $30 million to $100 million go to advance clinical research programs at leading medical schools and insist upon demonstrable outcomes, documented tech transfer successes, industry buy-in, and demonstrable community benefit. In that sense, the CTSA program is an important precedent for the level of funding and intentionality that will be required to ensure the growth centers have the kind of impact they need to have.

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143. To calculate a metro area's Eligibility Index, all four criteria variables were first normalized. BA attainment and university STEM R&D spending were then given a weight of 0.3, while the rate of patenting activity and STEM Ph.D. graduates were

weighted 0.2. Finally, these weighted values were added together to produce the Index.

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Appendix A. Innovation industries employment change, largest 100 metropolitan areas

Name	Innovation industries	
	Employment change, 2005-17	National employment share change, 2005-17
San Francisco-Oakland-Hayward, CA	77,192	2.0%
Seattle-Tacoma-Bellevue, WA	56,394	1.3%
San Jose-Sunnyvale-Santa Clara, CA	52,288	1.1%
Boston-Cambridge-Newton, MA-NH	26,066	0.4%
San Diego-Carlsbad, CA	19,949	0.4%
Madison, WI	12,190	0.3%
Raleigh, NC	12,238	0.3%
Denver-Aurora-Lakewood, CO	10,255	0.2%
Charleston-North Charleston, SC	7,193	0.2%
Provo-Orem, UT	7,050	0.2%
Salt Lake City, UT	7,671	0.2%
Albany-Schenectady-Troy, NY	4,227	0.1%
Grand Rapids-Wyoming, MI	3,475	0.1%
Atlanta-Sandy Springs-Roswell, GA	5,736	0.1%
Pittsburgh, PA	3,763	0.1%
Jacksonville, FL	2,530	0.1%
Columbus, OH	2,864	0.0%
Oklahoma City, OK	1,941	0.0%
Cincinnati, OH-KY-IN	3,221	0.0%
Winston-Salem, NC	1,239	0.0%
Greenville-Anderson-Mauldin, SC	1,305	0.0%
Akron, OH	1,097	0.0%
Knoxville, TN	1,223	0.0%
Portland-Vancouver-Hillsboro, OR-WA	4,472	0.0%
Miami-Fort Lauderdale-West Palm Beach, FL	2,830	0.0%
Nashville-Davidson--Murfreesboro--Franklin, TN	1,097	0.0%
Baton Rouge, LA	1,108	0.0%
Las Vegas-Henderson-Paradise, NV	905	0.0%
Kansas City, MO-KS	1,674	0.0%
Greensboro-High Point, NC	626	0.0%
Chattanooga, TN-GA	322	0.0%
Deltona-Daytona Beach-Ormond Beach, FL	341	0.0%
Jackson, MS	241	0.0%
Orlando-Kissimmee-Sanford, FL	1,724	0.0%

San Antonio-New Braunfels, TX	1,472	0.0%
Toledo, OH	313	0.0%
Tampa-St. Petersburg-Clearwater, FL	1,789	0.0%
Bakersfield, CA	179	0.0%
McAllen-Edinburg-Mission, TX	94	0.0%
Indianapolis-Carmel-Anderson, IN	2,245	0.0%
North Port-Sarasota-Bradenton, FL	156	0.0%
Cape Coral-Fort Myers, FL	45	0.0%
Des Moines-West Des Moines, IA	247	0.0%
Columbia, SC	163	0.0%
Stockton-Lodi, CA	-123	0.0%
Spokane-Spokane Valley, WA	-43	0.0%
Augusta-Richmond County, GA-SC	-266	0.0%
Memphis, TN-MS-AR	-79	0.0%
Louisville/Jefferson County, KY-IN	-51	0.0%
Ogden-Clearfield, UT	56	0.0%
Worcester, MA-CT	348	0.0%
Tulsa, OK	-83	0.0%
Virginia Beach-Norfolk-Newport News, VA-NC	-33	0.0%
Springfield, MA	-437	0.0%
Harrisburg-Carlisle, PA	-483	0.0%
Palm Bay-Melbourne-Titusville, FL	506	0.0%
Dayton, OH	142	0.0%
Little Rock-North Little Rock-Conway, AR	-490	0.0%
Birmingham-Hoover, AL	-634	0.0%
Rochester, NY	106	0.0%
El Paso, TX	-701	0.0%
Fresno, CA	-784	0.0%
Charlotte-Concord-Gastonia, NC-SC	420	0.0%
Cleveland-Elyria, OH	260	0.0%
Urban Honolulu, HI	-844	0.0%
Scranton--Wilkes-Barre--Hazleton, PA	-1,014	0.0%
Buffalo-Cheektowaga-Niagara Falls, NY	-175	0.0%
Hartford-West Hartford-East Hartford, CT	599	0.0%
Lakeland-Winter Haven, FL	-1,361	0.0%
Syracuse, NY	-1,305	-0.1%
Austin-Round Rock, TX	1,200	-0.1%
Bridgeport-Stamford-Norwalk, CT	-821	-0.1%
Baltimore-Columbia-Towson, MD	68	-0.1%
Omaha-Council Bluffs, NE-IA	-1,872	-0.1%
Tucson, AZ	-1,271	-0.1%
New Orleans-Metairie, LA	-2,513	-0.1%
St. Louis, MO-IL	-448	-0.1%
Richmond, VA	-2,808	-0.1%
Allentown-Bethlehem-Easton, PA-NJ	-2,911	-0.1%

Minneapolis-St. Paul-Bloomington, MN-WI	874	-0.1%
Boise City, ID	-3,059	-0.1%
Milwaukee-Waukesha-West Allis, WI	-2,773	-0.1%
Detroit-Warren-Dearborn, MI	-1,904	-0.1%
Phoenix-Mesa-Scottsdale, AZ	109	-0.1%
Riverside-San Bernardino-Ontario, CA	-4,234	-0.1%
New Haven-Milford, CT	-4,526	-0.2%
Providence-Warwick, RI-MA	-4,672	-0.2%
Sacramento--Roseville--Arden-Arcade, CA	-4,389	-0.2%
Oxnard-Thousand Oaks-Ventura, CA	-4,998	-0.2%
Colorado Springs, CO	-5,496	-0.2%
Albuquerque, NM	-5,014	-0.2%
Houston-The Woodlands-Sugar Land, TX	-3,281	-0.2%
New York-Newark-Jersey City, NY-NJ-PA	7,162	-0.2%
Durham-Chapel Hill, NC	-5,741	-0.2%
Wichita, KS	-7,729	-0.3%
Washington-Arlington-Alexandria, DC-VA-MD-WV	-6,569	-0.4%
Philadelphia-Camden-Wilmington, PA-NJ-DE-MD	-9,178	-0.4%
Dallas-Fort Worth-Arlington, TX	-8,969	-0.5%
Chicago-Naperville-Elgin, IL-IN-WI	-12,582	-0.6%
Los Angeles-Long Beach-Anaheim, CA	-8,322	-0.7%

Source: Brookings analysis of Emsi data

Appendix B. Potential growth centers

Name	Population, 2018	Median home value, 2017	Share of workers with commutes over 1 hour, 2017	*Eligibility criteria*					Eligibility Index
				University STEM R&D per capita, 2017	Patents per 100,000, 2015	BA share, 2017	STEM doctoral degrees per 100,000, 2017	Innovation sector job share, 2018	
Madison, WI	660,422	$247,000	3.6%	$1,688.51	71.1	45.9%	80.8	5.9%	1.63
Minneapolis-St. Paul-Bloomington, MN-WI	3,629,190	$254,800	5.7%	$245.30	97.1	41.7%	11.3	3.2%	0.68
Albany-Schenectady-Troy, NY	883,169	$216,400	3.6%	$268.58	124.0	37.2%	19.5	4.3%	0.66
Lexington-Fayette, KY	516,697	$184,700	3.4%	$717.60	36.1	37.5%	29.3	1.8%	0.58
Rochester, NY	1,071,082	$144,500	3.7%	$370.93	113.0	34.1%	15.0	2.6%	0.53
Provo-Orem, UT	633,768	$296,600	5.8%	$59.56	67.9	41.3%	7.9	6.4%	0.47
Portland-Vancouver-Hillsboro, OR-WA	2,478,810	$376,000	8.5%	$14.90	90.8	40.3%	1.8	4.9%	0.47
Tucson, AZ	1,039,073	$182,300	4.2%	$593.64	63.5	33.6%	21.3	5.4%	0.45
Pittsburgh, PA	2,324,743	$153,300	8.4%	$539.74	38.1	35.1%	22.0	2.2%	0.40
Salt Lake City, UT	1,222,540	$294,800	3.5%	$264.64	55.2	35.5%	16.8	3.7%	0.34
Columbus, OH	2,106,541	$182,300	4.1%	$386.41	21.9	35.9%	20.1	1.7%	0.30
Chicago-Naperville-Elgin, IL-IN-WI	9,498,716	$240,300	14.1%	$166.67	40.9	37.7%	7.4	1.9%	0.29
Nashville-Davidson–Murfreesboro–Franklin, TN	1,930,961	$242,900	8.9%	$367.01	12.0	36.0%	11.2	1.0%	0.22
Akron, OH	704,845	$146,800	3.9%	$95.09	52.9	32.2%	24.0	1.7%	0.19
St. Louis, MO-IL	2,805,465	$172,200	5.7%	$286.57	27.7	34.6%	9.2	2.9%	0.19
Boise City, ID	730,426	$228,800	4.3%	$45.46	107.0	30.1%	2.0	3.8%	0.18

Milwaukee-Waukesha-West Allis, WI	1,576,113	$213,800	4.2%	$45.53	43.7	35.8%	6.2	2.1%	0.18
Cincinnati, OH-KY-IN	2,190,209	$165,500	5.0%	$195.99	48.6	33.2%	5.9	2.5%	0.16
Buffalo-Cheektowaga-Niagara Falls, NY	1,130,152	$148,900	3.4%	$342.04	22.4	32.5%	16.9	2.7%	0.15
Kansas City, MO-KS			3.5%	$10.72	39.1	36.5%	0.0	1.9%	0.14
Des Moines-West Des Moines, IA	655,409	$187,500	2.5%	$0.00	35.0	36.6%	0.0	1.3%	0.13
Indianapolis-Carmel-Anderson, IN	2,048,703	$162,200	5.0%	$25.55	37.0	35.6%	3.7	2.8%	0.13
Detroit-Warren-Dearborn, MI	4,326,442	$171,600	7.1%	$53.90	76.7	31.1%	3.4	1.7%	0.12
Albuquerque, NM	915,927	$191,700	4.8%	$259.20	32.4	32.1%	11.6	5.0%	0.12
Palm Bay-Melbourne-Titusville, FL	596,849	$195,400	5.2%	$30.67	79.5	30.0%	7.3	8.6%	0.10
Syracuse, NY	650,502	$139,400	3.2%	$164.65	33.0	31.8%	15.8	3.0%	0.09
Cleveland-Elyria, OH	2,057,009	$150,400	4.4%	$234.98	44.7	30.8%	7.8	1.7%	0.09
Greenville-Anderson-Mauldin, SC	906,626	$162,100	4.4%	$161.63	54.9	28.6%	19.0	1.8%	0.07
Omaha-Council Bluffs, NE-IA	942,198	$170,200	2.5%	$11.41	19.5	36.3%	0.9	1.7%	0.07
Fayetteville-Springdale-Rogers, AR-MO	549,128	$173,100	3.2%	$252.46	15.5	31.8%	16.2	0.6%	0.06
Knoxville, TN	883,309	$169,200	5.3%	$307.77	25.3	28.8%	23.6	2.4%	0.05
Dayton, OH	806,548	$133,400	4.2%	$276.43	32.5	29.8%	13.3	3.4%	0.05
Charlotte-Concord-Gastonia, NC-SC	2,569,213	$197,100	7.3%	$9.58	18.6	35.5%	2.7	1.7%	0.05
Birmingham-Hoover, AL	1,151,801	$161,400	7.1%	$481.57	9.8	30.5%	8.0	0.6%	0.05
Columbia, SC	832,666	$156,600	4.4%	$218.31	11.6	31.9%	15.0	1.5%	0.04
All U.S. metros	**281,128,123**	**$229,000**	**8.7%**	**$215.75**	**48.1**	**34.0%**	**10.6**	**2.8%**	

Note: Eligibility Index calculated using a weighted average of normalized eligibility criteria for each metro.
Source: Brookings and ITIF analysis of Census-PEP, NSF, USPTO, Emsi, and ACS data

Appendix C. Growth centers program costs

While the following cost estimates are rough, we estimate that a program of the kind laid out in this paper would cost the federal government approximately $100 billion over 10 years. However, this figure does not reflect dynamic scoring, and given the likely positive impact on GDP growth from these provisions, we believe the net cost to the federal treasury would be considerably lower. Only the items that we estimated costs for are included in the list below.

Direct funding. Elements included in our total cost estimate:

- *Research funding*. The federal government would provide an average of $687 million to each region per year, totaling $68.7 billion over 10 years if 10 growth centers are selected.
- *Graduate research fellowships*. FY2018 program funding was $285 million. While we call for additional appropriations, for calculation purposes, we assume that only our geographic preference recommendation is adopted for new fellowships. Over 10 years, the total cost would be $2.85 billion.
- *Other research*. The estimated combined cost of our other proposals with budgetary implications—expansion of Manufacturing USA network and the EDA's Regional Innovation Strategies awards program—equals $2.63 billion over 10 years.
- *Workforce development funding*. We call for the Department of Labor to make $5 million grants every year for 10 years to each growth center, totaling $500 million over 10 years.

Tax and regulatory preferences. Elements included in our total cost estimate:

- *Capital gains reductions*. Our recommendation of preferential capital gains treatment for young firms in growth centers presents a total cost of $674 billion over 10 years. This was estimated by multiplying the total cost of eliminating the capital gains tax on small businesses[157] over 10 years—$14 billion—by the GDP share of the 10 highest-scoring metro areas on our Eligibility Index—4.7% in 2017.
- *Capital equipment expensing*. In 2022, 100% expensing of first-year capital equipment expenditures will expire. Assuming that our proposal takes effect in 2020, companies in designated growth centers will be eligible for eight years of full expensing. This tax expenditure was estimated to cost $65.4 billion[158] in FY2020, meaning that if we continue to use 4.7% to proxy winning growth centers' share of the capital investment, this provision would cost $24.1 billion over eight years.
- *Sections 382 and 469*. The estimated cost of reforming Section 382 is $600 million annually by 2022. If growth centers account for 4.7% of claims, that equals $282 million dollars over 10 years.[159] For Section 469, our proposed reform is estimated to cost $390 million annually, or $183 million over 10 years for firms in winning cities. The combined cost of these changes is therefore $465 million.
- *Collaborative R&D credits*. If each university receives approximately $40 million on average per year in industry R&D funding,[160] and each growth center has an average of 1.5 research universities, the total support growth centers would receive over 10 years is $6 billion. Raising the credit rate from 7% to 30%, as we propose, creates a tax expenditure of roughly $1.4 billion.
- *Human capital tax credits*. In 2018, $88 billion was spent on worker training.[161] If firms in growth centers are assumed to account for 4.7% of this, the proposed credit would be applied to $4.1 billion in spending. With a credit

of 14% on over half of base-year expenditures, this would amount to roughly $288 million annually, or $2.8 billion over 10 years.

Federal land, infrastructure, jobs, and placemaking. Elements included in our total cost estimate:

- *Infrastructure*. The FAA spends roughly $840 million every year on airport improvement grants. If each growth center received at least one grant in a 10-year period with each grant worth $50 million, the total cost of these investments in air transport infrastructure would be $500 million.[162] Each state receives on average $1.28 billion annually for highway construction. If an additional $50 million is spent on each growth center, this would amount to $500 million of additional spending per year, or $5 billion over ten.

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