There is strong bipartisan consensus in Washington about the urgent need to promote “innovation” to keep the U.S. economy prosperous. However, high levels of U.S. unemployment raise unsettling questions about whether our innovation system is still primed to create and maintain new jobs for Americans. In our view, innovation is indeed the key to sustaining America’s competitiveness, but the understanding of innovation has to be broadened.

Most discussions concerning innovation focus on novel breakthrough developments that give rise to game-changing American technology, thereby generating enormous wealth and value for the nation. Think of this as “novel-product” innovation, where the firm or lab producing it comes up with an entirely new technology or product. However, novel-product innovation is only half the story. Taking a novel idea or invention from concept to market requires an array of incremental product innovations, such as continual improvements in automobile transmissions, together with innovations in production processes. This concept is known as incremental and process innovation, or I&P for...
short. The globalization of design, production, sophisticated manufacturing, and distribution requires a new approach to this second, often forgotten form of innovation in order to avoid the risk of losing the jobs and production capabilities essential to American competitiveness.

The United States still holds a commanding advantage in novel-product innovation. It has successfully structured an innovation ecosystem to support this familiar type of innovation, and the success of leading American firms such as Apple, Google, Pfizer, and Qualcomm shows that our capabilities remain strong in this area. However, the intense emphasis on this single form of innovation has two fundamental problems. First, novel-product innovation by itself does not generate many jobs because the developmental work and production are increasingly off-shored from the beginning. As Nate Rosenberg has shown, incremental and process innovations are the true unsung heroes of economic growth.\(^1\) Second, the complete divorce of high-end novel-product innovation from incremental product improvement and production process innovation decreases the rate and quantity of novel-product innovation and erodes overall innovative capacity. As we consider policies and business procedures for reinvigorating growth, the United States must address both challenges. We should be greatly concerned that

• High-value-added innovations are no longer yielding the development, production, and job growth for America that we have assumed naturally follow novel innovation

• The supply base of small and midsize firms for middle-value-added products that could benefit from supply-chain factors is both dwindling and not truly innovative

• The changing mix of skills necessary for I&P innovation in the small and midsize enterprise (SME) supplier base falls outside the range of core skills in traditional American production shops

• Our system of financing innovation has become increasingly narrow, focusing on specific financial vehicles, which in turn specialize primarily in novel-product innovation and require high-yield financial exits within a relatively short timeframe

These flaws have contributed to the accelerated decline in the overall share of production in the U.S. economy and to a decline in the broad-based economic benefits from America’s novel-product innovations, putting the country’s long-term advantage in novel-product innovation in jeopardy.

We argue that a strategy bolstering I&P innovation in the United States must recognize the growing interdependence of services and manufacturing in the new global landscape, because sophisticated services and goods are being integrated into many markets. An I&P strategy should focus on the same four building blocks that have worked so well for novel-product innovation:
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- **Shared production assets**: Firms need to fund and use assets held in common by a variety of contractual and institutional mechanisms.
- **Effective innovation network structures**: Markets, contracts, and firms no longer provide adequate “glue” to effectively link pools of innovators.
- **Flexible business models**: Restructuring the traditional definitions of supply and demand functions in markets is often as important as an innovative product.
- **Specialized financial institutions**: Risk assessment capacity and lending/investment models appropriate to different types of innovation are necessary.

These building blocks address both market mechanisms and the building of social capital—a critical dimension of innovation systems. However, sustaining different types of innovation requires differing combinations of policies and institutions.

The rest of this article explains the role these building blocks play in fostering innovation and how to shore them up for I&P innovation. Section one analyzes the different forms and economic impact of innovation, explaining how today’s conventional model for innovation policy, with its emphasis on novel-product innovation, differs from the vertically integrated U.S. innovation model that dominated through the 1960s. Section two analyzes the weaknesses in the conventional model of innovation with regard to I&P innovation. Section three focuses on the four building blocks in terms of I&P innovation, and shows how policy changes could close those gaps and revitalize U.S. innovation. Section four concludes by suggesting specific solutions and avenues for reform.

To be clear, even if the United States does everything right for both forms of innovation, a substantial amount of future production, whether of goods or services, will never be located in this country, nor will jobs already off-shored be brought back, as off-shoring will continue to offer tremendous benefits to U.S. corporations and consumers. We live in a global economy in terms of both supply and demand. However, structural flaws in our innovation system mean that the United States has less sophisticated levels of production—and significantly fewer good jobs—than it could have. These structural failures have long-term negative consequences for our economic prosperity, our ability to create jobs, our trade deficit, and the ability of American corporations to secure competitive advantages based on innovations that they themselves pioneered.

**DEFINING INNOVATION AND THE CONVENTIONAL MODEL FOR INNOVATION**

Innovation has two forms. First, there is the best-known and rightly celebrated novel-product/technology innovation. Novel-product innovation is the act of
coming up with new products, such as the iPad or the first word processor, or new services, such as Facebook (for social utility) and Quicken (for tax preparation). American innovation policy is predominantly geared toward fostering this type of innovation. It has yielded such fruits as the first lasers, mobile phones, and protease inhibitors.

However, the emphasis on novel-product innovation confuses the act of invention with innovation. Innovation encompasses a whole array of activities that transform ideas for novel or better products and services that are actually commercialized. Thus there is a second category of innovation: incremental and process innovation. I&P innovation encompasses the improvements in how goods and services are designed, produced, distributed, and serviced. It is here, as Schumpeter observed, that the major impact on economic growth occurs. Inventing the internal combustion engine did not change modern society. It was the wave of ensuing innovations—improving the original innovation and applying it throughout the economy in new products, processes, and technologies—that changed the world. Some industries are defined less by rapid product innovation and more by continuous process improvements that alter cost and performance capabilities. These industries include those that produce cars, refrigerators, and even personal computers. The argument about German manufacturing success emphasizes its strength in precisely this kind of innovation. Continuity or slow turnover in fundamental end products does not mean that considerable innovation is missing; it often means just the opposite. A former head of R&D of a global consumer products company pointed out that major consumer brands may seem more or less the same over time, but all continually innovate in the process technology underlying them. Moreover, basic scientific research is also essential for both product and I&P innovation—the main difference is in the ways producers of science (such as universities and research institutes) and users of science (companies and entrepreneurs) interact to commercialize knowledge. The current U.S. system has hampered this relationship with regard to I&P innovation, which used to be one of the core strengths of American corporations.

Incremental and process innovation frequently implies more than small changes. It often requires major shifts in business models that upset expectations about how markets work and whom a set of products is aimed at. Henry Ford’s Model T melded process and business model innovation by perfecting the idea of mass production, and then joining it with the mold-breaking business model of pricing cars within reach of all working households and paying Ford’s employees enough so they could become leading users of their own products. Similarly, Apple made the iPod into a breakthrough success because of product and business model innovation: a slick hardware-software-service combination of the iPod and its music store. Apple’s business model inverted the conventional wisdom on pricing. Instead of pricing hardware as a cheap
commodity and charging a premium for content, iPods were expensive and songs cheap, thereby turning songs into a product that customers were once again willing to buy. With the current global fragmentation of production, we need to pay close attention to business model innovation along with necessary inter-firm and inter-organization collaborations as elements of successful product and process innovation.

In the United States, a unique conventional model for how to support innovation emerged through trial and error to dominate policy thinking beginning in the 1970s. Overall, U.S. innovation policy is viewed as market-conforming: policies and innovation institutions remove barriers and tweak the rewards to be gained in an effort to allow market mechanisms to complement actors, which are then willing and able to undertake the types of risks and reap the rewards necessary to generate change. This model reflects a worldview that sees individual firms as the main loci of all activities necessary to produce a product and transform novel innovation into specific products. Unfortunately, some of its basic assumptions no longer conform to the global reality of fragmented production, and thus the benefits of this model are eroding.

In the post–World War II era, most U.S. research spending and technology production involved large enterprises doing both novel-product and I&P innovation in-house. Many enterprises worked in both the defense and civilian markets (Boeing and GE, for example). These firms had enormous financial and human capital resources, including a substantial pool of “patient capital” that could be invested without expecting rapid returns. Significantly, they were highly vertically integrated, and they “internalized” the maintenance of networking among various specialist groups in different phases of design and production. For example, AT&T’s Bell Labs designed its facilities with long halls that forced researchers to walk past other labs, creating the chance for employees to converse with those in unrelated departments, which often led to unforeseen collaborations. Firms also internalized many of the financial risk-management functions for innovation.

The vertically integrated model of research is now all but extinct. Since the major corporate restructuring of the 1970s and 1980s, large firms have focused on core competencies, opening the way to a new innovation landscape where a great deal of innovation is driven by new entrants focused on specific stages of production. This significant change enabled the development of a new set of arrangements for financing and networking today’s fragmented ecosystem of innovation.

The conventional model for innovation policy in the United States has thus tilted sharply toward startup-driven, novel-product innovation. Although there are strong national policy components, the conventional model focuses on the interaction of the national and regional level in the form of technology clusters. In the conventional model, anchor universities are critical to both knowledge
creation and human resource capital. An essential part of this revised model is the set of new laws and regulations incentivizing the creation of financial vehicles (such as venture capital, or VC) and of new markets (such as NASDAQ) that allow the realization of financial gains within a short timeframe. Regional technology clusters also strive to develop an ecosystem of professional support services for these new technology-based firms—for example, law and accounting firms. The great success of this startup-based model, most famously in Silicon Valley, and the immense financial gains accruing to its founders and financiers have made it the focus of policy discussions. Fostering industrial clusters around emerging sets of technologies has become the policy mantra. The regional anchors, together with supporting federal measures, have made this conventional model politically viable in both blue and red states.

A successful technology cluster for novel-product innovation (the conventional model) addresses the challenges of both market failures and social-informational networking. Activities that address the costs associated with searching for finance when it is not a part of a vertically integrated and internal corporate innovation system include courting a base of venture and angel capitalists attuned to the region, and promoting incubators that lower costs and identify prospects for early investors. Significantly, common economic and research assets for new firms (such as mass spectrometers) are often created, frequently in anchor universities. Clusters provide networking institutions for high-end technology specialists so that people circulate freely and share knowledge via a countless variety of events.

As cluster leaders routinely acknowledge, people are arguably the most important asset for novel-product innovation industries. Clusters provide a social-institutional solution for the loss of networks formerly nested in vertically integrated firms. Research in economic sociology and geography shows that strong social networks, fostered by formal and informal institutions, are essential both to the circulation of knowledge and people, and to the building of trust—conditions that make for the most successful clusters. One classic study attributed the divergent paths of the California and Massachusetts information industries primarily to the difference in their social institutional networks. Underlying the regional clusters are vital national policies that fund basic and applied research and development; pay for the training of skilled researchers and engineers; protect the intellectual property rights so vital to ventures that push novel technologies; and enforce the rules of competition that keep markets open to newcomers.

This conventional model has served the United States well for novel-product innovation and will largely continue to do so, thanks to four strengths:

- The United States is home to excellent R&D and research universities. Not only does the U.S. remain the dominant science research power, it has a great
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regional spread of specialized strengths because of its highly competitive system of research universities.

• The United States is still the best place for the early commercialization of new ideas, with Israel a reasonable second. U.S. strengths include a strong rule of law, relatively easy market entry, and a deep market of entrepreneurs and experienced professional services.

• The United States possesses such hidden strengths as its sophisticated user base, which co-invents innovations and flexible value and business propositions. Where companies make their money and how they do so can be surprising and innovative.

• The United States has the world’s best system for mobilizing financial resources for ideas. Promising startups can, within their first few years of operation, attract $200 million to $400 million without it being considered an anomaly.

Still, even for novel-product innovation, there is a need to update the model, especially in light of rising international competition and the increasing global fragmentation of production and innovation. Financial incentives in particular, including the decline in U.S. government funding for basic and applied research, are undermining the U.S. advantage.

WEAKNESS IN THE CONVENTIONAL MODEL: THE FALTERING OF INCREMENTAL PRODUCT AND PROCESS INNOVATION

Even if the United States retains its leadership in novel-product innovation, its leadership in second-generation, incremental, and process innovation is in deep trouble. This area of innovation is doubly crucial for U.S. competitiveness, as it is increasingly influential in determining the ability of firms to retain their strength in novel-product innovation, and to provide a large share of the jobs accrued due to innovation. I&P innovation is both an input to novel-product innovation, especially incremental innovation, and a key to maintaining the highest feasible level of production activities—and hence, of employment opportunities. The failure to get incentives for I&P innovation right weakens the employment benefits made possible by novel-product innovation. Erica Fuchs’s research has shown that, in industries as diverse as automobiles and optoelectronics, these failures weaken the long-term ability to sustain novel-product innovation. We must address the task of fixing the incentives for I&P innovation to ensure prosperity. Stated directly, the conventional model does not produce the large number of jobs we need (compare the total employment of Apple or Facebook to that of a leading high-end, R&D-intensive contract manufacturing organization, such as the Taiwanese TSMC), and it may falter in sustaining novel-product innovation if it becomes too divorced from incremental changes, improvements, and production.
The weakness in our current I&P innovation system has two major causes. First, the way products and services are produced has significantly changed in the last two decades, yet the main assumptions underlying the conventional model have remained the same. We now live in a world of fragmented production. Activities along production networks are done by companies specializing in narrower sets of activities, from high-level R&D to design, manufacturing, and assembly techniques. If Apple once imagined, designed, coded, and assembled its computers in its own factories, today these activities are the work of a multitude of companies in the United States and (especially) Asia. Fragmentation allows companies to specialize in extremely narrow activities, whether high-end product definition or massive assembly processes.

The innovation and financial needs of companies in different stages along this network are significantly varied. Hence, fragmentation requires new ways to collaborate among companies and across different modes of operation. We live in a world of networks between companies and organizations, not a world of working internally within one company. Therefore, innovation ecosystems should deploy policies to solve the supply problems of semipublic goods, such as shared production facilities, training, and the codevelopment of non-patentable innovation. Supply of these semipublic goods has become a critical issue in the most advanced high-tech industries, where, for example, optoelectronics, integrated circuit, and biopharmaceutical production facilities are usually not firm-specific, and thus no sole U.S. firm, especially young firms with limited resources, can (or should) independently invest in building the latest, most advanced production facilities. Accordingly, the need to fix network failures, and not solely market failures, is growing daily due to the changes in the global production system.

A second weakness in our current I&P innovation system stems from the fact that the conventional model and the U.S. financial system discourage large capital investment in production and production innovation in the United States. Disincentives include the growing focus of the conventional model on startups and novel-product innovation, the financial constraints under which U.S. public companies operate, and the character of financial vehicles open to private companies. Together, these factors make it hard to take risks on long-term capital investments. The conventional model—with its emphasis on startups and the venture capital investors’ demand for the ability to cash out with high returns in a relatively short period of time—is also not conducive to long-term investments in productive capacity. Similarly, publicly traded firms have difficulty reconciling the uncertain returns of long-term investments with the demands of constantly improving quarterly earnings. These constraints, coupled with the growth of foreign-based contract manufacturers, lead, even in the most advanced niches of the most advanced manufacturing in the high-tech-
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nology industry, to the creation of fewer and fewer U.S. jobs. Instead, production is simply done overseas from the beginning.

THE FAILURE OF I&P INNOVATION IN THE UNITED STATES

As a result of these constraints, the U.S. innovation system struggles increasingly to foster and sustain I&P innovation. The same four building blocks of innovation described above are as necessary for developing a strong I&P innovation system as they are for novel-product innovation. However, the United States has failed on all four counts, especially with regard to the small and midsize enterprises and suppliers that form the core of rich and sustainable I&P innovation systems:

- SMEs suffer from inadequate common assets to complement firm-specific assets. The changing mix of skills necessary for production and incremental product innovation, especially under conditions of fragmented production, falls outside of the traditional core.
- SMEs lack strong networking institutions to foster sharing of know-how and social capital. This system of innovation requires more than the circulation of smart people as fostered in Silicon Valley-like clusters. Context and craft-oriented innovations require more structured forms of networking within and, increasingly, among firms.
- The U.S. legal and regulatory systems do not block business model innovation, per se, but many SMEs depend on subcontracted work. Studies indicate that the rules and practices for subcontracting in the U.S. do not foster innovation.  
- The U.S. lacks financial institutions with the proper business models and risk assessment capabilities to analyze and invest in productive capacity by small, midsize, or even large firms.

The failures in all four building blocks suggest two major themes for reform and policymaking. First, they suggest that we need to move from regional networks (clusters) to regional platforms. In entrepreneurial startup-based regional networks, churn among employees and the constant start, failure, restart, and boom of companies enable human resource sharing and technology dissemination. For I&P innovation, however, churn is not enough. Innovation and production are now, more than ever, done via the provision of semipublic goods, such as through the use of shared production assets. These are the critical issue in more traditional industries, such as metallurgy or the automotive industry, where there is a constant need to spur and diffuse innovation across an array of SMEs. Thus, by definition, the ability of the process innovator to appropriate gains is limited. Shared assets may solve the problem of the necessary but economically disincentivized dissemination of knowledge. Shared assets can be truly shared facilities (owned jointly by a few companies under a variety of con-
tractual forms), or a private, for-profit organization focused on producing for other companies. Pooling productive capacity, however it is done, provides a focal point for the development of new tacit production knowledge and enables firms to share their know-how comfortably with a firm or entity that is not in direct competition. Better known as “contract manufacturing organizations” (CMOs), such specialized firms do not create their own products but instead emphasize process and production innovations as a production base for other firms. A successful example of the latter is Hospira, the world leader in the production of injectable pharmaceuticals, which began when Abbot Laboratories spun off its production division.

It is not enough simply to create a new CMO or spin off a division of a formerly vertically integrated company. Creating shared assets, including the training of workers, may mean introducing new business models. Historically, the creation of the “pure-play fab”—companies that specialize solely in the fabrication of integrated circuits (IC) designed by other organization—gave viability to business model of the “fabless” IC design company while creating a new logic and business pattern, with an emphasis on scale, quality, and security, for manufacturers. As a corollary, an increase will be needed in the range of financial options for different combinations of risk/reward situations involving innovations by CMOs. The VC model of financing does not fit these situations, nor do any of the predominant mix of American finance practices. Developing regional platforms, such as shared production capacity, requires a wholly new ecosystem. This is a big challenge, especially if we do not want the new entity to rely heavily on state subsidies. China’s SMIC, a pure-play IC fab based in Shanghai, has struggled to attract even local clients because of widespread skepticism about its responsiveness and a tax system that does not incentivize local fabless firms for producing at the local fab. Indeed, Chinese fabless IC companies tend to source their production in Taiwan or Singapore.

Second, the failure of all four building blocks suggests that we need to find solutions to network failures for incremental product and process innovation specialists. Having common production assets is not a panacea; some SMEs will and should continue to produce in-house. Sharing solutions within a supply network or introducing skills that are largely absent from a network will be critical. This requires bridging the knowledge silos of different industries and technologies, a very difficult task. For example, it is becoming apparent that in the United States, as in Israel (where a specific program has been launched by the chief scientist of the Ministry of Trade and Industry), many production companies, especially in traditional industries, lack the most crucial new skills in areas such as information and communications technologies, where the greatest promise for production innovation and improved productivity lies.

Beyond finding a means of disseminating technologies in existing producer firms, the United States has to find an appropriate model of the industrial
research systems that have worked so successfully in Germany, Taiwan, and Korea. Although these countries have very different industrial histories and political economic systems from the U.S., there are important lessons in their ability to disseminate technologies among otherwise less-advanced firms, as well as in their ability to create real innovative vitality in SME-based, often tradition- and engineering-intensive, industries.

Understanding these two themes, we now probe the four areas of failure in I&P innovation and production. In Section 4, these lessons will offer a concrete set of recommendations to solve the main issues.

To illustrate the challenges, consider the role of the United States in manufacturing. Contrary to popular belief, which holds that the U.S. has been in terminal manufacturing decline and long ago ceded its dominance to Asia, the United States was still the world’s largest manufacturing economy as recently as 2009, with about $1.6 trillion in output. As of that year, the U.S. produced 21 percent of global manufactured products; China was second at 15 percent, and Japan third at 12 percent. Moreover, even though the U.S. began a broad off-shoring trend in manufacturing in the 1970s and 1980s, allowing for the impact of recessions, the level of U.S. manufacturing output has continued to rise steadily year after year. Even with heavy off-shoring and real declines in employment since 2000, manufacturing still supported about one in six private-sector jobs (18.6 million, of which 12 million are directly in manufacturing).

Despite these rather sunny statistics, as Helper, Krueger, and Wial show, the larger picture for manufacturing is not healthy. Manufacturing employment is declining for reasons that are not reducible to rising productivity (automation) or uncompetitive wages and benefits. As Whitford notes, Germany has both high wages and benefits and high manufacturing productivity, yet manufacturing maintains a much larger role in its economy (20 percent of GDP versus about 11 percent in the U.S.). Hence, the decline in manufacturing employment and the trend of off-shoring before domestic production even begins must have other roots in the poor functioning of the American I&P innovation system. For our purposes, findings in three studies by Helper and Kuan, Reynolds, and Helper, Krueger, and Wial, are convenient starting points for a discussion of the weaknesses—and the consequences of weakness—of process and incremental product innovations in the United States, as summarized below.

High-wage, high-value-added production is central to the suggestions made both by Reynolds and by Helper, Krueger, and Wial for strengthening the manufacturing employment base; biotech and advanced electronics or ICT hardware production exemplify the possibilities for expanded domestic production.
In industries where various supply-chain issues (costs and time of shipping) may allow for somewhat increasing lower-value-added production, a main obstacle is that only a minority of U.S. suppliers engage in significant process or incremental product innovation. These U.S. suppliers do not have the institutional system to support these activities. Were I&P innovation in these traditional industries better supported, more production could take place in the U.S.

The composition of the value added in manufacturing is shifting. Most notably, the share of information value added (for example, software and computing services) in manufacturing is rising rapidly, thus making these inputs more central to process and product innovation. This means that the necessary skills for production success in manufacturing are shifting. Increasingly, effective manufacturing requires IT skills and savvy, areas where concerted training efforts and human resource development could bear real fruit.

Existing research highlights several policy omissions that hinder process and incremental product innovation in the United States. Since I&P innovation is essential to a healthy manufacturing sector, these hindrances harm U.S. employment prospects. Most alarmingly, these gaps may also adversely affect the ability to do novel-product innovation in some fields. In brief, high-value-added, high-product-innovation industries are no longer yielding the production and jobs base for America that we once assumed, and the lack of I&P innovation may be eroding capabilities in novel-product innovation.

First, the supply base of middle-value-added firms that could benefit from supply-chain factors has significant problems realizing its innovation potential. Many leading manufacturing companies, such as the American car companies, have delegated more and more of the critical manufacturing, design, and innovation responsibilities for their own final product to their supplier base. This change means that in order to thrive, leading U.S. manufacturers rely on the vibrancy and innovations of their supplier network. However, in order to flourish, networks need to overcome significant issues of collective action and to diminish free riding. Therefore, it is alarming that Helper and Kuan find, in the largest survey ever conducted on innovation in the automotive supply sector, that such shirking is commonplace, and worse, that American suppliers view American car companies as far less trustworthy partners than their European or Asian competitors. This discourages I&P innovation by the American supply base.

In the network structure of the U.S. auto supply base, there is a distinct minority of firms that really routinize innovation in their business. That so few firms routinize innovation is deeply problematic for the industry’s competitiveness. Among the many reasons for failing to routinize innovation in the U.S. auto industry, three in particular stand out. First, in order to excel in process and incremental innovation, firms must have workers with specific skills. Today, firms have too little stability to invest heavily in skills individually; due
to risks of free riding and shirking, they fail to overcome the collective action problems that keep them from sponsoring inter-firm skill training. Second, in market niches where intellectual property rights (IP) do not count heavily in the value propositions, firms cannot easily invest in innovation. Indeed, in these industries, some alternative forms of IP protection—such as the Michigan laws restricting labor from moving to firms in the same industry, which were designed to increase the incentive to innovate—can even hinder the dissemination of new techniques. Third, the supplier base for bigger, more innovative anchor firms frequently do not benefit significantly from innovation by the lead firm. Helper and Kuan find that American car makers provide comparatively little “feeding” of the innovation function in their supply base. Just as significantly, Whitford demonstrates that the current ways of pooling expertise among SMEs are largely ineffective, especially when compared to systems in other countries.

Second, the changing mix of skills necessary for production and incremental product innovation in the SME supplier base falls outside of the core skills of traditional production shops. ICT applications are changing production processes and opening the way to more tailored incremental product innovations because they lower costs and allow for broader functionalities, even in traditional product industries. Yet ICT specialists and the new generation of design specialists who can apply ICT products or processes are not part of the core skills of traditional producers. While some of the functions are available through outsourcing to specialist firms, the practical skills of even the designers depend heavily on the set of firms with whom they have worked previously.

Improved job training is the usual proposed remedy for the skills shortfall, but skill training does not replace the kind of learning necessary to embrace and successfully utilize major new sets of skills. Market forces can help, yet it can take considerable time to figure out how to seize the opportunities of new enabling technologies, such as information and communications services. In short, skills and knowledge emanating from new industries that can have a significant impact on innovation in traditional industries are insulated in silos that prevent these assets from being diffused and utilized effectively.

Reynolds illustrates the adverse impact of these problems on on-shore U.S. production in the biopharmaceuticals industry. As a technology matures, the industry can modularize production and reduce the high risk associated with biopharmaceuticals production. Coupled with the regulatory oversight slowly converging across national boundaries, companies have begun to shop for such incentives as favorable tax treatment. In addition, surplus production capacity has emerged in the industry, requiring consolidation of facilities. At the same time, the rise of foreign CMOs backed by strong local government support has created sophisticated off-shore suppliers that reduce the need for U.S. compa-
nies ever to produce. This has led to a sharp decrease in the number of new production facilities breaking ground in the United States. At the same time, other high-wage advanced economies, such as Ireland, Denmark, and even Switzerland, have become production hubs.

The parallels to the U.S. electronics industry loom large. The question facing policy analysts is whether these pharmaceutical CMOs are more like the “rote” CMOs in electronics, such as Hon Hai, or more like the “creative” CMOs that contribute significantly to design and process innovation, such as TSMC. The more rote-based CMOs’ activities will be very difficult to on-shore because they tend to be highly sensitive to labor costs. However, if pharmaceutical CMOs are the creative kind, how can we encourage this type of CMO to emerge in the U.S.? Higher end CMOs could reinforce U.S. leadership in the biotech industry and maximize the industry’s impact on local job creation.

Erica Fuchs’s research lays out a disturbing possibility: weakness in I&P innovation and the decline of domestic manufacturing are eroding the novel-product innovation capabilities of U.S. firms. Multiple problems hinder the process innovation crucial for domestic production of the most advanced optoelectronics, as well as critical new innovations in the automotive industry. Fuchs demonstrates how, under current conditions, it is more profitable to produce goods using older technologies in China. In optoelectronics, this led all publicly traded U.S. firms to off-shore their production to Chinese companies, leaving only privately held startups to advance new production technologies. Larger firms without productive capabilities do not attempt to innovate in these areas, thus ceding potential new areas for U.S. advantage and advancement. Fuchs found a significant reduction of innovation in all companies that off-shored their production. This suggests that, in advanced manufacturing, the loss of production activities can, within an extremely short timespan, lead to sharp reductions in the innovation capacities of firms.

These findings are even more disconcerting because they are replicated in the case of new material technologies for car production. Decisions to produce using a less innovative but more easily outsourced technology off-shore (thus requiring less financing) also leads to a technology trajectory that works against U.S. leadership, because the most advanced production technologies, where the U.S. still has a sustained edge, never reach the market.

However, this is not a completely hopeless story. Obstacles that encourage the out-sourcing and off-shoring trend can be clearly identified. If financing had been available to many of the firms studied by Fuchs, they would have pushed the innovative edge further and used the more-advanced production technologies in the United States. However, because a U.S. production strategy would be both more technically challenging and more capital consuming, all publicly traded companies shunned the option. (Startup financing does not easily cover the needs for such production.)
A shortage of financing and the inability of stock-price-sensitive firms to invest in the most modern production capabilities mean domestic CMOs are a highly valuable option. If shared production facilities in the United States had been built, all of the firms in Fuchs’s study would have used them and developed products using the latest technology. Having a CMO would make it possible to keep manufacturing within the U.S. and to push for more sophisticated production innovation.

Both Fuchs and Reynolds show how one of the issues facing production in the United States is the mismatch between two financial models—one driving the startup of research-intensive companies and publicly listed technology-based companies, the other driving long-term capital investment for production in the U.S. The venture capital system lacks the patience for production, and the stock market cannot as easily price, and hence punish, long-term investments. William Lazonick’s work further delineates the pressures against production-process decisions created by the “financialization” of the U.S. corporate model.

In theory, the financialization model focuses on disciplining management to emphasize return to shareholders and the core competence of companies. This should focus the firm on areas where it has sustainable advantages and can renovate cost and product structures constantly. Financial markets thus “monitor” publicly traded firms by emphasizing quarterly financial returns and investment in only the highest return alternatives. While certainly not impossible (as shown by Amazon), massive spending on difficult, capital-intensive investments with long-term paybacks have a much steeper threshold for approval under this approach. As the chairman of a privately held manufacturing company with 3,000 employees said to us, his company can handle quarterly disruptions in earnings from challenges of new production projects with far less difficulty than his counterparts that are publicly traded. Additionally, the new metrics for measuring financial performance and return to shareholders, together with new financial regulations about how to account for minority investments in other firms, have further tilted incentives toward the management of quarterly earnings performance through much expanded use of stock buybacks and other devices. Boards have reinforced this pattern by emphasizing incentives for top managers that are more and more tightly woven around stock price. However, by so strongly incentivizing top managers to pay attention, especially to the stock price, our financial system has often reinforced short-term financial engineering over long-term strategic investment in production.

Even as the financialization model of publicly traded firms has reshaped investment incentives for production in larger firms, the venture capital model has changed the investment and incentive calculus for smaller firms and start-ups. Here, too, the financial system discourages manufacturing and the develop
The VC model is not well suited for financing expansion into large-scale production and process and incremental innovation because it relies on a high-risk, high-return limited timeframe model. The goal is to invest in a company that can, within five years, offer financial returns on ownership stakes on the magnitude of a hundred or more per dollar invested. This is usually accomplished by going public or being acquired by larger firms.

In contrast to the VC model, most SMEs focused on production innovation aim to increase the profitability of an already established revenue stream in an average of low double digits and have no wish to sell ownership. While the VC industry has deep knowledge of novel-product innovations and new enterprise formation, it has little capability to judge the value of I&P investments. Judging I&P requires investors with deep knowledge of that industry and technology. Such knowledge was once the realm of industrial banks, but these are no longer part of the U.S. financial landscape. As a result, whether in a large firm seeking new productive capacity or an existing SME seeking to upgrade, the status quo financial system mitigates against increasing domestic production assets.

In the next section we suggest that, under the current conditions, innovation and education in manufacturing should be treated similarly to agriculture, where there is no assumption that the final agents—farmers—would either innovate or supply training and skills by themselves. The model of an agricultural extension service is highly applicable in the case of U.S. manufacturing. Such a view calls for a very different role for public research institutions and significant changes in university-industry relations. Indeed, when we look at the most successful international production innovators—Germany, Japan, Taiwan, the Nordic countries, South Korea, and, to a certain degree, China—we see that all of them have an extensive role for public research institutions that take on most of the actual R&D and diffuse the results throughout industry.

MOVING TOWARD SOLUTIONS: PROCESS AND INCREMENTAL PRODUCT INNOVATION

Our approach to revving up the innovation system in the United States assumes two constraints on the available policy choices. The first constraint is our divided system of power and the key role of federalism. Even if someone thought it wise—we certainly do not think so—having a centralized, top-down industrial policy as in Japan or South Korea is impossible for the United States. The strategies of East Asian states in various stages of their rise to power are frankly not available or applicable in the U.S. In contrast, the importance of competition policy in U.S. economic policy reflects this same fragmentation of power, as dominance by any market player surely upsets firms in other regions of the country.
The second constraint is that the fragmentation of the U.S. system of governance reinforces the natural tendency to have a wide variety of performance capabilities among agencies and administrative domains. The ability to execute policies to nurture innovation varies substantially from region to region.

In light of these constraints, we focus on changes in policy for enhancing process and incremental product innovation that are consistent with strong market competition among firms, that seek to expand the range of financial tools and organizational/business models available to firms, and that increase collective capabilities through the coordination of actors by a variety of mechanisms. We do not advocate a strong planning or directing role for the government at either the federal or state level. We also emphasize an I&P focus, rather than a manufacturing focus, built on particular manufacturing processes. Our approach avoids the tired fights over manufacturing versus services. Cloud computing centers may employ as many technicians with good wages as state-of-the-art manufacturing plants of comparable economic size. Furthermore, it is more effective for the U.S. government to respond to I&P priorities developed from regional discussions.

Although we do not dwell on issues of trade policy that influence competitive conditions for U.S. firms in world markets, we do note that that it is an important complement to getting domestic U.S. policies realigned. I&P innovation is essential for both large and small firms, but SMEs are at the heart of the supply base that I&P innovation can especially reinvigorate. The economic evidence shows that entering world markets is an accelerator of revenue growth, profits, and job growth for these firms. Therefore, the new emphasis in American trade policy on trade facilitation for smaller firms in such negotiations as the Trans Pacific Partnership is the smart way to have trade serve as an accelerator of the changes that we seek. We emphasize the role and lesson of regional clusters because they are best able to build on the results of a fruitful exercise in federalism, where local, state, and national authorities have cooperated in the past. Moreover, clusters are concentrations of knowledge, people, cooperation, and facilities that are critical to driving all forms of innovation. At the same time, a reformulated strategy built on regional anchors with federal support opens the way for winning necessary bipartisan political support. Finally, we embrace the lesson from the conventional model for novel-product innovation—that creating social capital is an essential complement to effective market institutions in I&P innovation.

The first necessary policy shift is to go beyond regional clusters to regional platforms. As noted earlier, clusters, where firms are locally embedded and networks are thriving, allow the industrial community engaged in novel-product innovation to excel continuously as a whole. Some of the success of clusters comes from addressing market challenges, as by increasing financial options for innovation or promoting shared use of critical and expensive scientific
infrastructure for smaller firms. Just as importantly, clusters build social network institutions that promote trust, fine-grained information transfer, and joint problem-solving.27 In short, clusters organize regions as networking and information systems to enhance the density of interconnection, the flow of human capital, and the transfer of knowledge, thus making it easier to match ideas to financiers (and other support services) and provide specific information. This model, established in areas such as San Diego, Palo Alto, and Boston, is highly effective in fostering the creation and financing of new innovation-based, novel-product enterprises. However, it falls short of fostering the skills necessary for success in I&P innovation. To build such capabilities, clusters must become regional platforms.

The aim of regional platforms, if constituted, would be to solve the various problems relating to the supply of semipublic goods and the failure of networks discussed above: specifically, the need for joint production assets, for the ability to routinize and disseminate innovation in SMEs, for the provision of necessary human talent, and for the ability to provide investment funds for production and expansion. Regional clusters do this by creating particular regional assets that are common and shared by all companies in an industry. Thus, platforms can alleviate the problems of free riding and collective action, supply the missing critical resources, change the risk and profitability calculation of firms before they opt to off-shore production, and enhance the conversion of ideas on production and further incremental product innovation within the U.S. Furthermore, successful platforms can serve as the seeds of new production-focused American companies that can successfully compete with the best (and sometimes state-supported) foreign CMOs.

Promoting these platforms would specifically acknowledge that process and incremental product innovation, both critical to production capabilities, may require something more than the circulation of people and the tapping of a common research base—the advanced benefits of most established clusters. Instead, as the biopharmaceutical case suggests, we should create common assets vital to production, whether through CMOs or some other means. (Key assets are not limited to production facilities but could include items such as testing and certification centers.) How best to do this is not a question that can be answered based on existing research. Moreover, it is not our place, nor that of the federal government, to dictate exactly how regional platforms should create these assets. We expect and welcome significant variations in the answer, depending on particular industrial structures. Regional experimentation will help to ensure that the best models emerge. Nonetheless, at this stage, we note three general options, which need not be exclusive and may be complementary in some cases.

A first option would be to look carefully at the record of CMOs in other countries. Low-end rote contractors that specialize in the lowest cost fulfill-
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ment of comprehensively blueprinted orders are not a relevant option. Nor would American workers relish these types of employment or the pay rates and hours necessary for them to be competitive. However, the example of TMSC and the CMO activities of Samsung, one of the world's most admired companies for its innovation-based growth strategy, deserve careful consideration. If labor costs are no longer the controlling factor, which they are not for more sophisticated CMO activities, what are the obstacles to the growth of such organizations in the U.S.? Similarly, are there examples of how to overcome obstacles to converting existing excess or unwanted production capacity into CMOs? For example, could current pharmaceutical and biopharmaceutical facilities be repurposed into CMOs instead of closing when their controlling companies, such as Pfizer, opt out of production? As one executive with whom we had many discussions has pointed out, the surplus capacity in biotech production need not be a deadweight loss. Instead, this capacity could be the basis for regional shared facilities that can grow into highly successful and profitable CMOs attuned to the specializations of a regional innovation platform. Once productive capacity is pooled as a CMO, the new organization must embrace its role as a producer and seek new and ever more productive means of manufacturing. Local government policies such as tax incentives may aid in this process.

A second option would be to increase the specialized regional industry training schemes. Lack of skilled manufacturing personnel is often cited as a hindrance to increased manufacturing in the U.S. Even where a CMO has been created, to ensure its I&P innovative capacity and effective operation, there is a need to rapidly develop and disseminate human capital. A good example is North Carolina's Research Triangle, where unique industry-university collaboration around the specialized training of workers for advanced biotech production is one of the keystones of the region's tremendous success. Funding for such endeavors comes from both public and private sources (again alleviating some of the collective action problems), and it is administrated by local government working together with industry and the local university system to identify the specific needs and unique strengths of their region. Such a model could be expanded to include representation from a local CMO to determine the types of human capital required and how best to train or attract it to the region.

A third option would be to address the need for new financial alternatives for firms, particularly SMEs, specializing in incremental and process innovations. One approach might be to create new public-private investment banks for specialized purposes. The goal would be to operate by converting relatively inefficient state subsidy (or other expenditure) streams into more leveraged banking schemes for production and product innovation. One of the new pioneers of this approach is the Connecticut Clean Energy Finance and Investment Authority, which has converted a subsidy fund collected by state utility cus-
customers to a public investment bank for clean energy projects. Such banks, assuming that they can overcome politicized targeting of their funding and risk-assessment practices, could easily be targeted toward regional cluster platforms. A strong benefit of this approach is that it might also be helpful for novel-product innovation and thus support both types of innovation simultaneously. One of the weaknesses of the Chinese I&P innovation model is the tendency to use local government (or indeed central government) pressure to encourage banks to make loans to favored firms or privileged sectors. While this enables rapid capital accumulation and expansion, it also has resulted in tremendous waste. Ensuring managerial independence for any such public-private bank would be essential for success.

A broader approach to finance would be to institute changes in deferral regulation and taxation to combat the current taxation and regulation incentives for public companies, both large and small, not to invest in production activities in the U.S. We strongly believe that the best job creation agents in the American economy are private companies. It is, therefore, of extreme concern and suggests a serious policy failure that, during this time of great recession, the best American corporations, such as Apple, sit atop the largest piles of cash in corporate American history. It behooves federal policymakers to think about ways that changes in taxation, and perhaps the availability of some matching funds, would tilt companies’ calculations about return on investment and risk just low enough for them to invest in the U.S. and not view this as an action against the best interests of their shareholders.

On the other side of the same coin, if privately held (that is, not publicly listed) companies are more positively disposed toward investment in production but their access to capital is limited, a set of new regulations and changes in taxation that would make such investment more profitable to financers, and maybe spur the re-creation of specialized investment companies, is also long overdue. The first, and simplest, step toward this reform would be for the White House to issue guidelines to all federal agencies for gathering evidence about regulatory and tax disincentives as a basis for a comprehensive overhaul. A second step would be to create new forms of regional networks specializing in “network solutions” to upgrade capabilities for I&P innovation. There are two significant issues with production innovation. First, much of this innovation is not protectable under the current intellectual property regimes (and certain existing alternative protection plans may only further retard knowledge dissemination). Second, a crucial issue is to ensure the most rapid diffusion and widest sharing of new innovation across the supplier base network. This combination of issues creates a perverse outcome. Lacking the ability to appropriate returns from their investment, many of the SMEs, which are the core of the supply base, underinvest in innovation. A solution to this, however, cannot solely be the strengthening of intellectual property rights (or some direct sub-
sidy to innovate), since this would lead to a slower and narrower diffusion of incremental and production innovation, which in turn would aggravate the second problem.

Some of the current solutions for information sharing can actually make the problem worse. Detailed studies of I&P innovation indicate that traditional systems of sharing information often do not effectively lead to detailed problem-solving and, worse yet, can lock firms into relatively narrow circles of expertise and transaction contacts. To upgrade the capacities of SMEs in, for example, low R&D intensive industries such as metal-bashing, it is critically important to build bridges across industry segments.

We propose a dual set of recommendations, one to maximize information sharing and collective action while negating network failures, and the other to deal with the need for production innovation, at least in some industries, by treating it as a semipublic good. The first way to implement “networked solution” systems is to create problem-solving teams that draw expertise from different segments of the supply chain. Other countries’ experiments with this approach have proven successful. These efforts have the following characteristics:

• They bridge traditional segments within an industry, thereby maximizing networking contacts.
• They bridge traditional industries and the new technologies and skills needed to operate them, thereby infusing these industries with new knowledge, ideas, and the skills to act on them.
• They are governed by multistakeholder boards, including government officials, so as to drive responsiveness to new group demands.
• They focus on solving problems and creating technical capabilities (such as lab testing for quality) for the network by engaging members of many organizations in the network. In the words of McDermott et al., such networks can “provide firms with a new scale and scope of diverse services and foster new learning relationships between firms from previously isolated producer communities.”

The regional base for such organizations plays an important role in their potential success, because they can develop informal transactional mechanisms that are more effective than standard contracts and rules when dealing with the kinds of uncertainty that characterize efforts at innovation. They can also provide important feedback to government institutions whose programs, especially in job training, are crucial to regional clusters. For example, these networks might reveal the merits (or demerits) of one proposal for expanding and renaming the Manufacturing Extension Partnership as the Innovation and Productivity Extension Partnership. The Manufacturing Extension Partnership is designed to, and has, enhanced process innovation in SME manufacturers. Rather than decide how to adjust, expand, and broaden this pro-
gram top-down from Washington, such ideas could emerge from regional networks. As Breznitz and Murphree argue concerning China, regional experimentation produced the ideas for reform and business practices that were later adopted nationwide. The same principle of allowing local platforms to take the lead and then cautiously applying the models more broadly should be considered in the United States.

A second prong of networked solution institutions will cross over with the creation of platform capabilities. Solving many production process problems through collaboration may lead to collective investments, perhaps through coop systems, in certain kinds of capabilities. For example, most SMEs have limited capacity for original applications of ICT customized to their needs or in design innovations. While many firms are offering to provide these inputs as outsourced activities, specialist suppliers often draw from a relatively small pool of relevant experiences. Providing a central node at the regional level for comparing ICT and design ideas, and even generating new ones relevant to the cluster, could be powerful. We strongly encourage both the federal and state governments to open and quickly expand programs such as the traditional industries program of the Israeli chief scientist. Of particular relevance is the part of the program that aims to match graduate students from various high-technology disciplines with production SMEs. Special attention should be given to how to incentivize both actors (that is, students and manager-owners of companies) so these internships in companies would lead both to innovative projects with innovative outcomes and, at least equally importantly, to routinizing such innovation activities in the SMEs.

Our third prong of networked solutions is to embrace public funding for an R&D system aimed at supporting the production (of goods and services) that emphasizes the networking benefits of R&D. There is agreement that an individual firm may not capture all of the returns from research and therefore underinvest in this knowledge creation. But there is disagreement about the size of this disincentive and the appropriate level of public funding to bolster applied research. This debate over the size of the market failure ignores the proven record of such research efforts, properly defined, in promoting the networking of knowledge and innovation among smaller firms.

The weaknesses of the American I&P innovation system have led some analysts to suggest that the U.S. would do well to look at how other countries have utilized various public research institutes to solve these same issues. The examples are many, from the Korean research institutions, to the currently idolized German Fraunhofer Institutes network, to the Taiwanese ITRI. These public research institutes have a similar design: their specialized departments (or sub-institutes) focus on particular industrial niches and sets of technologies, develop long-term relationships with industry, and establish a division of labor. By pooling private resources with an infusion of public funding, these institutes
can concentrate on the core and continuous production of R&D and diffuse the results widely to industry, which in turn focuses mostly on final development and implementation of these technologies. In Taiwan, the efforts of ITRI in particular are well known for successfully performing applied research within the institute and then disseminating the findings, either to various Taiwanese firms or through spinning off the technology and research group as an independent firm. Some propose ITRI analogues at the regional level in the United States.

However, it would be hard to duplicate institutions that owe much of their success to an institutional environment that is extremely different from conditions in the United States. A more productive precedent for the U.S. is our experience with agricultural research. In agriculture, the government assumption was uncannily similar to that regarding low- and mid-tech industries in other countries with industrial research institutions: farmers cannot be expected to fund or carry out necessary innovation or to implement technology on their own. While low- and mid-tech industries are essential to prosperity, we should not assume that the firms (like farmers) can conduct the necessary innovation, or even independently acquire the skills, to continuously excel in the market. Hence, a program for production innovation built around the organizational logic of agriculture research in the U.S., devised to reflect regional specialization and sponsored at both the state and federal levels, offers a better fit for the U.S.

The creation of regional innovation information systems could be an important tool for such “extension” systems. In their simplest forms, such systems can resemble the technological roadmaps that proved so useful to coordinating investment and spurring innovation in many domains, such as semiconductors. More expansively, industrial innovation extension programs are information mechanisms that involve the real costs of participation for those that engage in the exercise in order to improve the quality of the information. Unlike analogues in Taiwan and elsewhere, we do not expect the U.S. government to fund a comprehensive technology effort in many areas, because this level of extensive state intervention would go against America’s policy tradition. Still, we can learn from other countries that have used public-private dialogues at the national and regional levels to identify essential technology building blocks for significant innovations in particular industries. Such public-private dialogue-based charting exercises generate and share information by using indicative planning scenarios (asking, for example, what it would take to reach certain goals within resource constraints). They are costly in the sense that they involve a wide spectrum of stakeholders with expertise contributing to the building of the planning scenarios. To fit the agricultural extension model, they need to focus on specific regional I&P objectives, such as how to better match...
improvements in production processes to major biofuel innovations under way in a region.

The key challenge in these discussions and planning sessions is to turn an expert group’s exercise into a broader community discussion to validate and amend the maps to make them both widely acceptable to and desired by the broader industry. They can be powerful complements to public commitments for change, such as California’s requirement for diversification of energy resources by a certain date. In China, to take another example, part of the abundance of funding for photovoltaic systems is the result of a government bank, but an even larger part is the commercial banking system’s conviction that government roadmaps for reducing emissions cannot be met without photovoltaic systems. Hence, knowing the strong commitment to reducing emissions, banks are willing to invest in photovoltaics because they can be reasonably certain the market will emerge, even if the technology itself is not directly mandated by the state. To be sure, roadmaps can be flawed and investors can come to doubt them (witness the exit from some forms of green energy investments). But technology roadmaps also lead to a better sense of what capabilities need to be in place if an innovation (a successful movement from idea to commercialization) is to become more likely.

Our fourth implementing action is to align the incentives of public officials using a new set of metrics to judge success in building networks. Public officials respond strongly to incentive structures that, for good or ill, shape their behavior and thus influence broader economic outcomes. In China, part of the reason local governments invest so heavily in new industrial parks and infrastructure construction is that these are ways to rapidly generate jobs, investment, and growth—three metrics on which promotions for Communist Party officials are based.

For initiatives such as an “industrial extension service” or public-private dialogues and roadmapping to work, we must find different ways to motivate and evaluate public officials. Despite popular distrust of government in America, government officials do valuable work on economic development at the regional level. Such officials also have a substantial level of bipartisan support. But we need to rethink many of the conventional measures of their success. Metrics such as simple calculations of the number of firms created, or the number of new jobs added within a defined period of time, or even a simplistic cost-benefit analysis would give exactly the wrong incentives to policymakers. They would also lead to the wrong evaluation of the effectiveness of these new policies by politicians and the public. As in China, such incentives would tend to encourage short-term and direct activities, rather than the long-term and more complicated process of building a sustainable I&P innovation ecosystem. We thus need to define metrics that actually measure the growth of networks, the effective diffusion of innovation within them, the percentage of new
production technologies that are implanted in the U.S., the growth rate of process and incremental innovation (which are not even properly counted currently), and maybe the growth of new high-end specialized producers in the U.S.⁴³

To conclude, the United States has all the necessary factors to continue to lead the world in novel-product innovation while also enjoying its job growth benefits. However, it is imperative to have leadership that aims to achieve these results within the next few years. The U.S. system has great advantages but is far from perfect. There are real lessons that can be learned both from experimentation and experience abroad and from projects at the state and local level within the U.S. All of these lessons need to be applied in order to encourage more production in the United States and to further enhance and preserve U.S. capabilities in critical but underappreciated incremental and process innovation.

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2. Product adaptation, the redefining of product characteristics to meet specific market needs (e.g., cheap reliable CT machines to be used in rural Asia), is a third type of innovation. While important, since most of this adaptation needs to be done in a specific regional context, we shall leave it outside our discussion.
4. We are skeptical that, as David Brooks has speculated, innovation has peaked and therefore job creation stagnates. We think that a particular form of innovation lags and this hurts employment. We agree with Brooks that the solution rests in reforms of both market and social institutions. David Brooks, “Where Are the Jobs?” New York Times, October 7, 2011, p. A23. On the need to revamp policy in this area, also see J. Stephen Ezell and D. Robert Atkinson, “The Case for a National Manufacturing Strategy,” Information Technology and Innovation Foundation, Washington, DC, 2011.
5. On the iPod, see Mark Huberty. “The Dissolution of Sectors: Do Politics and Sectors Still Go
Dan Breznitz and Peter Cowhey


13. Globalization means that significant amounts of production and employment will be created and remain outside the U.S., but higher rates of incremental product innovation and process innovation can greatly improve American production and employment.

14. These fragmented networks can misalign the interests of the state and the taxpayers, who pay for innovation policy with the expectation of higher returns to their locale, and the interests of companies, which are increasingly global. See Dan Breznitz and Amos Zehavi, “The Limits of Capital: Transcending the Public Financier- Private Producer Split in Industrial R&D,” Research Policy 39 (2010): 301-312.

15. The findings of Susan Helper and Jenny Kuan in the automotive production sector are especially worrying, as they suggest that leading American corporations face significant problems in adapting their mode of relationship with U.S. SMEs to the changing reality of global production. Susan Helper and Jenny Kuan, “Overcoming Collective Action Problems in the Automotive Supply Chain,” white paper, Connect Innovation Institute, Project on Production Innovation, 2012.


19. Free riding arises because other firms could benefit from the investment of another firm without contributing to the cost. Nonpatentable innovations or even worker training, when workers can switch firms, are examples of situations ripe for free riding.

20. While it is wise to make sure that broadband communications capacity at competitive prices is ubiquitous, a goal of many clusters, it is knowing how to deploy these resources to advantage...
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22. Lazonick, “Sustainable Prosperity in the New Economy?”


24. See Cowhey and Aronson, Transforming Global Information, chap. 1. These political factors can seduce competition policy into protecting competitors, not consumers. But they also lend potency to the competition commitment over time.


26. J. Sallet, E. Paisley, and J. Masterman, “The Geography of Innovation,” Progress of Science, September 2009. Paisley and Masterman argue that federal support for clusters has been too disjointed to be fully effective. However, we want to focus on specific gaps in the innovation effort.


33. R. Gilson, C. Sabel, and R Scott in “Uncertainty and Innovation,” Rules for Growth, Kauffman Foundation, 2011, argue that flexible problem-solving in uncertainty is easier in communities that can develop normative mechanisms to complement formal contracts.


35. This notion of networked solutions is starting to stir, but not in the full form. According to the Southern Growth Policies Board, regional clusters should look to examples such as the “Integrated Manufacturing Technology Initiative—a nonprofit member-based organization bringing together industry, academia, and government to support and strengthen the nation’s manufacturing community. Combining the knowledge and expertise of public and private organizations, IMTI includes five federal agencies and leading companies, such as Rockwell Collins and Procter & Gamble.” Southern Growth Policies Board, Innovation with a Southern Accent, 2006, p. 43.

36. There are proposals to resolve process innovation by creating pre-commercial production prototypes in the tradition of Sematech. Whatever their merits, our proposal advocates, rather, networked institutions for applied problem-solving.

37. This could also allow new ways of linking producer know-how with university expertise. Some propose enabling the NSF Engineering Research Centers program to support creation of
Design Research Centers, as well as to promote research and teaching of integrated design.


40. San Diego’s experience proves that even just developing an inventory list of all the firms and their activities in the industry is extremely worthwhile, but rarely done. The only such list in San Diego that is reasonably comprehensive is one for defense suppliers, which exists because DOD funded an information-gathering exercise called the “Connectory.” On the value of costly participation for establishing trust, see David Lake and Mathew McCubbins, “The Logic of Delegation to International Organizations,” in Hawkins, Nielsen and Tierney, eds., *Delegation and Agency in International Organizations*. Cambridge, England: Cambridge University Press, 2006.

41. Comprehensive roadmaps have value but do not fit this model. Two recent examples of such roadmaps have been generated by the California Council on Science and Technology, California Council on Science and Technology, Innovate2Innovation, 2011.

42. We owe this point to Professor Junjie Zhang.

43. These are possible to do with at least as much precision as metrics looking at standard economic data because of major methodological advances that allow us to chart the pattern and density of networks and their flows (such as innovations).