POLICY MEMO

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Scale and Innovation in Today's Economy

BY MICHAEL MANDEL

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Conventional wisdom these days says that small is better when it comes to innovation and putting new ideas into practice.[1] Large enterprises are typically thought of as hidebound defenders of the status quo, dominating by market power and brute force rather than technological and innovative prowess.

Yet reality is far more complicated than this simple small versus big distinction. As we all know many common-sense beliefs turn out to be only partly true, or not to be true at all.[2]

In this policy memo we will reconsider the link between scale (size) and innovation. After 20 years where startups have rightly dominated the innovation headlines, we will show that the pendulum may be swinging back. As a result, there are reasons to believe that scale may be a plus for innovation in today's economy, not a minus. We will then relate scale to government policy, U.S. competitiveness and prosperity.

INTRODUCTION

The now-heretical idea that scale is an advantage for innovation actually dates back more than 60 years. Back then, Harvard economist Joseph Schumpeter, the inventor of the term 'creative destruction', suggested that large-scale firms were "the most powerful engine of progress." Following after his work, economists developed what came to be known as the "Schumpeterian Hypothesis." The first part of the Schumpeterian Hypothesis was the argument that bigger firms have more of an incentive to spend on innovation than a smaller one. For example, if we compare a company that manufactures 50 million t-shirts a year versus one that manufactures 10,000 t-shirts a year, the larger company is much more like to spend the big bucks needed to develop and test a new process for dyeing the t-shirts.

The second part of the Schumpeterian Hypothesis is the observation that companies with more market power might also be more willing to invest in innovation. The argument is that if a firm in an

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ultra-competitive market innovates, the new product or service is quickly copied by rivals, so that the gains from innovations are quickly competed away. Conversely, a firm with market power has the ability to hold onto some of its gains from innovation, so it may pay to invest in product or other improvements.

Together, these two conjectures are among the most controversial and most widely studied of economic theories. Economists and business experts have generated a long series of theoretical papers, econometric analyses, case studies, and anecdotal reports, examining the impact of scale on innovation.

> Big companies spend, on average, far more on research and development per worker

After all this research, we can summarize the economic evidence for and against the Schumpeterian hypothesis in two words: It depends. Part of the problem is that innovation influences scale, as well as vice versa. A successful and innovative small or medium-size company will often grow to be a successful and innovative large company, which perhaps dominates its market because of its very success.

At the same time, the link between scale and innovation, positive or negative, depends on the economic environment. In this policy memo, we will suggest that the current U.S. economy is dealing with a particular set of conditions that will make scale a positive influence on innovation. First, economic and job growth today are increasingly driven by large-scale innovation ecosystems, such as the ones surrounding the iPhone, Android, and the introduction of 4G mobile networks. These ecosystems require management by a core company or companies with the resources and scale to provide leadership and technological direction. This task typically cannot be handled by a small company or startup.

Second, globalization puts more of a premium on size than ever before. A company that looks large in the context of the domestic economy may be relatively small in the context of the global economy. In order to capture the fruits of innovation, U.S. companies have to have the resources to stand against foreign competition, much of which may be state supported.

Finally, the U.S. faces a set of enormous challenges in reforming large-scale integrated systems such as health, energy, and education. Conventional venture-backed startups don't have the resources to tackle these mammoth problems. Only large firms have the staying power and the scale to potentially implement systemic innovations in these industries.

We finish this policy brief with some observations about scale, innovation, and government policy. In particular, we raise questions about whether an aggressive policy of filing antitrust actions against America's key technological leaders is really the optimal course for improving U.S. competitiveness, raising living standards, and boosting job growth in the U.S.

This paper is part of the Progressive Policy Institute's series of policy briefs on innovation, job growth, and regulation. We believe that innovation is the best way to create good jobs and raise living standards for all Americans. Moreover, we believe that economic policy should focus on promoting investment in physical, human, and knowledge capital, and on moving the U.S. from a consumer economy to a production economy.

SCALE AND U.S. POST-WAR TECHNOLOGICAL DOMINANCE

The entrepreneurial or disruptive model of innovation, which relies heavily on small start-ups as the source of new ideas, has clearly been very beneficial for U.S. economic growth over the past twenty years.[3] Companies like Intel and Microsoft started as very small upstart firms, and grew into giants, contributing greatly to U.S. growth, especially in the 1990s.

But if we think back, the true height of post-war U.S. technological dominance came much

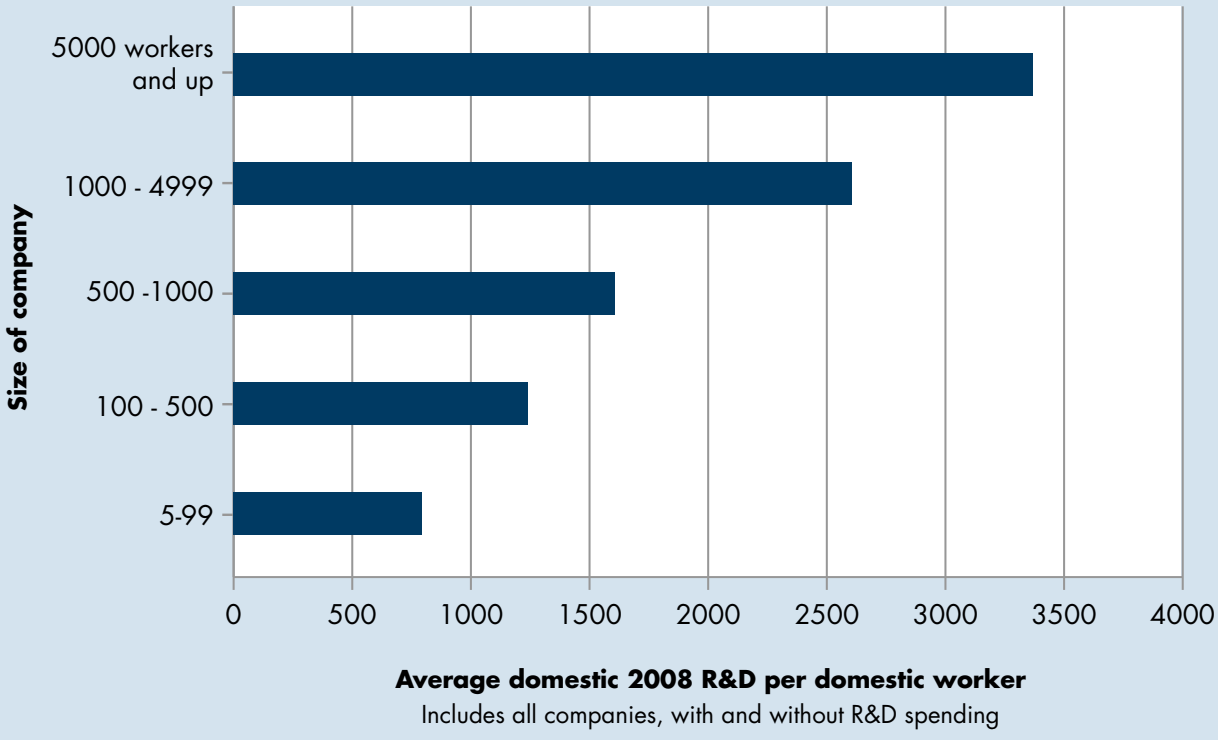
earlier, and was tied to innovation at the largest companies, not small startups. One useful indicator is the distribution of Nobel Prizes. Historically Nobel Prize winners have usually done their award-winning work either in academia or at the largest of companies—ones that can afford to support high-level research.

In the U.S., AT&T and IBM, two of the true giants, were responsible for all but one of the 'corporate' Nobel Prizes.[4] These enormous companies—which in 1980 had combined revenues equal to about 3 percent of GDP—had the resources and the motivation to fund large-scale cutting-edge research, to hire the best scientists and engineers and to encourage them to do great work.

Bell Labs, an offshoot of AT&T, produced seven Nobel Prizes, including the invention of the transistor in the late 1940s and early 1950s by William Shockley, John Bardeen, and Walter Houser Brattain. IBM produced another five Nobel Prizes, including the discovery of high temperature superconductivity in 1986.

Without research done at IBM and AT&T, it's very possible that the U.S. would not have been the leader in the information revolution. When Shockley left Bell Labs in 1953, he founded the first semiconductor company in Mountain View (CA), initiating a chain of events that led to the founding of Intel and the creation of Silicon Valley as we know it today. Bell Labs originated the laser, essential for fiber optic communications, and Unix, the operating system which forms the basis of Apple's Mac OS X. Similarly, IBM pioneered the mainframe, the personal computer, the relational database, and a wide range of

FIGURE 1: AVERAGE R&D PER WORKER INCREASES WITH COMPANY SIZE



Data: National Science Foundation, Census, PPI.

cutting edge technologies. Imagine what would have happened if IBM and AT&T did not have the great resources to devote to research. These fundamental discoveries might have been delayed, or perhaps made in another country, leading to a very different economic history.

One final note: There is only one startup that produced a Nobel Prize. But we have to go all the way back to 1909, and the Nobel Prize in Physics that went to Guglielmo Marconi for his "contributions to the development of wireless telegraphy." At the age of 23, Marconi founded the Wireless Telegraph and Signal Company in 1897. Four years later, Marconi's startup company sent the first wireless signal across the Atlantic, an achievement won him the Nobel. However, no startup has won a Nobel since.

CURRENT DATA

What does the data say about the link between scale and innovation? The best we can currently do is look at research and development spending, as reported to the National Science Foundation (NSF) on a recent survey.[5] That certainly doesn't give the full picture of innovation, because it leaves out a lot of spending on product design, and related activities. Meanwhile, some industries, such as telecom and banking, may be underreporting their spending on R&D on the survey because of accounting conventions.

> Scale may be a plus for innovation in today's economy, not a minus

With those caveats, it's clear that big companies spend, on average, far more on research and development per worker. According to survey data collected by NSF in 2008, we see that big companies—those employing over 5000 workers in the U.S.—spent an average of $3368 per worker. Small companies—those employing from 5 to 99 workers in the U.S.—spent an average of $793 per worker on R&D, less than a quarter as much.[6]

FIGURE 2: R&D SPENDING AND INNOVATION

R&D spending, 2008	Share of companies that reported: **product innovation**	**process innovation**
$100 million and up	81%	69%
$50-$100 million	76%	56%
$10-$50 million	70%	51%
Less than $10 million	66%	51%
None	7%	8%

Data: National Science Foundation.

These figures are based only on domestic R&D and domestic employment, and include companies that do no R&D spending.

Of course, the mere fact that big companies spend more on R&D per employee doesn't mean that they are more innovative. In theory all that extra spending could be wasted. However, in the same survey, the NSF asked companies whether they had any product and process innovations in the three-year period 2006-2008. Not surprisingly, it turns out that companies with higher levels of R&D are more likely to report substantially higher levels of innovations. That suggests, though does not prove, that the extra spending is actually having an effect.[7]

ECONOMIC THEORY AND RESEARCH

Why would bigger companies devote more resources to innovation? The rationale behind the 'Schumpeterian hypothesis' is straightforward. Innovation is an expensive time-consuming process, whether it's to create a new smartphone, improve the quality of an existing wireless network, or develop a new search algorithm. But innovation has increasing returns to scale, so that a larger company can reap more benefits from the same R&D than a smaller company.

For example, a telecom provider will generally be quite concerned with improving the reliability, quality, and speed of its network. Yet developing and testing such upgrades before putting them

into practice is an expensive proposition. If we compare two telecom providers—one with a large network and one with a much smaller network—the telecom provider with a larger network will have more of an incentive to spend the money on developing and testing the improvements, because the benefits (and profits) will be larger.

For that reason, it's easy to write down simple theoretical models in which larger companies have more incentive to invest in "innovative activities" such as risky research and development and large-scale network improvements. Similarly, it turns out be equally easy for economists to create theoretical models in which increased market concentration boosts innovation.[8]

> Economic and job growth today are increasingly driven by large scale innovation ecosystems

However, the Schumpeterian hypothesis has been contested by a long line of economists and management thinkers, who have argued that smaller and more competitive is better when it comes to innovation. For example, some 50 years ago Nobel-Prize winner Kenneth Arrow wrote an influential theoretical paper demonstrating that "the incentive to invent is less under monopolistic than under competitive conditions."[9] Equally important was the very compelling 1997 book *The Innovator's Dilemma* by Clayton Christensen of Harvard Business School, which argued that large successful firms were at a disadvantage in implementing disruptive technologies.

Empirical research is mixed on the link between scale and innovation. For example, some economists have argued for a U-shaped relationship between scale and innovation, so that propensity to innovate increases as size increases, but only up to a point.[10] Other empirical studies have differentiated between closed and open innovation. One new study on Norwegian and Swedish firms suggested that:[11]

> Our findings suggest that there is a tight link between larger firm size, internal R&D and turnover from incremental innovation among incumbent older firms in the context of closed innovation. In the closed context, we find rather strong empirical support for a traditional interpretation of the Schumpeter hypothesis. In the open innovation context, we find much stronger links between start-up firms, external R&D and radical innovation.

SCALE, INNOVATION AND JOBS

What is the link between scale, innovation, and jobs? In earlier policy memos, I've argued that innovation is the major source of new jobs.[12] At the same time, conventional wisdom says that small firms generate most of the jobs, which suggests that innovation at small firms is disproportionately important.

However, reality is a bit more complicated. A 2010 study from the Kauffman Foundation made the subtle and important distinction that job growth is driven by the small percentage of fast-growing innovative companies, rather than the broad class of small companies.[13] The Kauffman study showed that in any year, the top-performing 1 percent of firms generates roughly 40 percent of all new jobs.

Because job creation among small firms is so concentrated, these high-growth small innovative firms quickly grow into large innovative firms. Dane Stangler, author of the study, wrote (emphasis added):

> These super high-growth firms become **scale firms**, the next generation of iconic companies....Some of those young firms that grow rapidly in their early years and sustain this pace as they get older will eventually become acquirers—they will add lots of jobs by purchasing younger companies....But it highlights the fact that companies defined as "gazelles" in the data do not always embody clear-cut cases of organic employment growth. **There is little reason to favor "organic" or "acquired" growth either way: Employment and revenue growth through acquisition is no**

less important than organic growth because it facilitates the reallocation of resources to more productive uses.

In other words, small entrepreneurial firms are very important for job growth, but economic policy should not be totally focused on promoting the smallest companies. Nurturing innovation at larger high-growth companies can also play an important role.

SCALE AND INNOVATION ECOSYSTEMS

Let's summarize what we have seen so far. Economic theory and evidence does not support the principle that small is invariably better when it comes to innovation. However, there's also not compelling evidence for the proposition that large is always better when it comes to innovation.

Out of this welter of conflicting information, however, we can identify several key factors in today's economy that make scale more of a positive for innovation these days. The first factor is the rise of the **innovation ecosystem**, in which a large core firm invests in key technologies and intentionally creates a stable platform which improves the innovation environment for many smaller firms.

To understand the importance of innovation ecosystems, consider the case of Apple Inc. The latest published lists have not surprisingly deemed Apple as the most innovative company in the world.[14] Apple is also a big company, measured by market capitalization and revenue—in August 2011 it briefly passed Exxon as the company with the largest market cap in the world, and it showed up as number 35 on the Fortune 500 with revenues of $65 billion, just above Boeing.

How did Apple achieve this combination of size and innovativeness? Its lofty stature comes from great product design, of course, but Apple also benefits from its ability to create and sustain ecosystems around the iPod, the iPhone, and the iPad. These ecosystems notably include software companies that develop apps for the Apple platform, therefore making the ownership of an Apple device more useful.

From this perspective, an innovation ecosystem is a good way of encouraging people and companies to try new ideas at a relatively low cost, while enabling them to quickly scale up the winners by taking advantage of the services that the core firm provides. Such ecosystems thrive because of a "forward looking vision maintained by industry leaders."[15] In effect, the competition is between ecosystems, rather than between individual firms.

In addition to Apple, an innovation ecosystem has formed around Google's Android operating system. And a different sort of ecosystem has formed around major telecom providers such as AT&T, who have made multi-billion investments in building out high-speed mobile networks.

An innovative ecosystem has the advantages of being better able to handle both risk and scale. Startup companies can aim for a niche in the ecosystem, lowering their risk. Because of their size, the core partners can absorb more of the uncertainty, but in exchange get a higher return.

Core firms benefit from extending the reach and vitality of their affiliated ecosystem, not by stunting its growth. In particular, core companies have an incentive to acquire new technologies and scale them up quickly, because they benefit from an expansion of the ecosystem. Ask yourself whether AT&T would prefer to have more or fewer companies develop services that use its new 4G network.

Core firms need to be large enough to defend the ecosystem against unexpected threats.[16] For example, Google bought Motorola Mobility in part for its patents. Those patents, in turn, will make it safer for cell phone makers to install Android, which will be better protected against patent threats.

In sum, the scale of the core firm has the potential of making the entire ecosystem more innovative. That, at least, seems to be the way to success today.

SCALE AND GLOBALIZATION

These days large companies that are technology

leaders inherently compete on a global scale—in product markets, in technology markets, in talent markets. Sometimes the global competition is more subtle. For example, in recent years China has attempted to impose standards for data encryption that would favor Chinese companies.[17] Such standard-setting practices have become an important part of global negotiations.

In a 'first-best' world, the better product, service, or standard would win out, and neither the size of the company or the national origin would matter. Competition would be the answer. But in the real world that we live in, scale and national origin do matter.

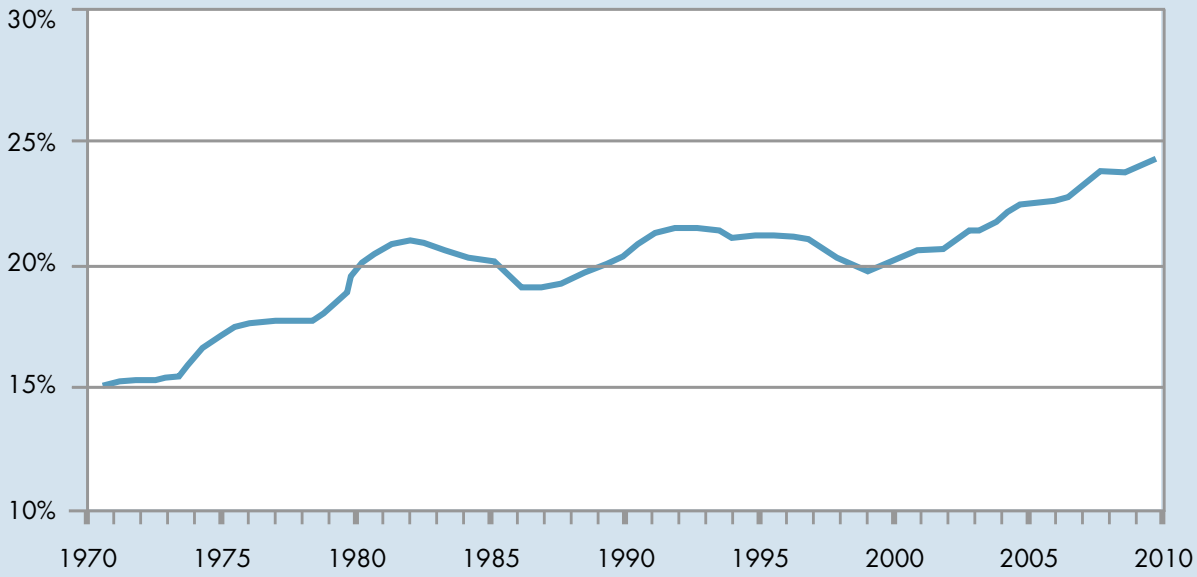
That's especially true as we shift to a global supply chain economy, where U.S.-based companies are dependent on their overseas suppliers for most of their production. In this situation, it's all too easy for suppliers to take advantage of smaller and weaker corporate buyers.
Conversely, U.S.-based core firms help anchor an ecosystem in this country, ensuring that a significant portion of investment and job growth happen domestically. To put it another way, these innovative ecosystems give the U.S. a sorely needed competitive edge.

What is the right size for competing globally? There's no clear-cut answer, but it's worth noting that even the largest of U.S.-based firms have been getting smaller relative to the global economy. IBM's revenues, for example, have grown considerably slower than the world economy over the past 30 years. That doesn't mean IBM, with $100 billion in revenues is small—but it does mean that size matters.

THE TOUGH PROBLEMS: FIXING LARGE-SCALE INTEGRATED SYSTEMS

Finally, let us consider the nature of the big problems that the U.S. economy faces. Our biggest societal issues—healthcare, education, energy—are delivered by large-scale integrated systems. If you want to innovate, then it's usually necessary to change multiple parts of the system simultaneously, perhaps in multiple locations.

FIGURE 3: THE TOUGH PROBLEMS: THE GROWING ROLE OF HEALTH, EDUCATION, AND ENERGY (SHARE OF CONSUMER SPENDING)



Data: Bureau of Economic Analysis

Such large-scale integrated systems are becoming a bigger part of the economy. Figure 3 tracks spending on energy, health care and education as a share of all consumer spending. These sectors—all of which need substantial reform—have grown from about 15 percent of consumer spending in 1970 to about 24 percent today.

> The true height of post-war U.S. technology dominance was tied to innovation at the largest companies, not small startups

Reforming such industries—with their deeply rooted constituencies and resistance to change—can be a daunting task. They need massive technological innovation to improve their productivity and quality, but small tech companies don't have the resources to innovate on the scale that is needed.

The healthcare system is an obvious example. The shift to electronic health records is essential, but it's been slow and painful. Smaller companies can provide innovative solutions, but in the end the solutions have to be implemented by large companies who have the appropriate scale and scope.

Similarly, if you want to deliver education online, you have to be concerned about the ability of **all** students to have access to the material, not just most. That means the capabilities of the online education system have to be reduced to the lowest common denominator, unless a concerted effort is made to improve bandwidth for everyone.

Or consider the transition from gasoline to electricity as the primary fuel source for motor vehicles. It's all good and well for a company to build and sell electric cars. But it's also necessary to make sure that potential buyers have access to 'filling' stations when they are away from home. It's not enough to simply provide one piece of the integrated system. That's why scale is essential.

GOVERNMENT POLICY AND SCALE

Let's return back to the connection between government policy, scale, and innovation. As we have seen, scale may be positively connected with innovation in the current economic environment. This is a Schumpeterian world: intense technological competition between innovative ecosystems, new global rivalries, and the need to reform large-scale integrated systems such as healthcare.

Such a world poses a big challenge for government regulators. Successful innovation ecosystems, anchored by large core firms such as Apple, Google and AT&T, don't look like conventional competitive (and fragmented) markets. In 2005, James Moore made this observation about ecosystems:[18]

> Antitrust cases that do not recognize this level of organization run the risk of ignoring and possibly damaging important collaborative, innovation-furthering public goods.... making the courts unwitting tools of narrow competitive interests and inadvertently impairing collective advances that might benefit the whole society.

Moreover, regulators are used to thinking in terms of U.S. markets. But most large companies today are global-facing, and concerned with their ability to compete in global markets, to negotiate with suppliers and to find customers. What matters is scale relative to the size of the global economy, not relative to U.S. markets.

Scale is not the enemy of American prosperity, when achieved through honest competition. Instead, the biggest drags on the economy are a lack of investment, weak innovation, and an emphasis on consumption rather than production. Companies that invest, innovate, and focus on production here in the U.S. should be treasured and encouraged—even if they are big.

ENDNOTES

1. "The Big Can, the Small Do," *The Economist* Free Exchange blog, June 10, 2011.
2. I'm thinking in particular of the view, widely-held until a few years ago, that U.S. national housing prices never fall.
3. Michael Mandel, *Rational Exuberance,* HarperCollins, 2004, for an extensive discussion of venture capital and the virtues of small startups.
4. The one exception is the Nobel that went to Jack Kilby for inventing the integrated circuit, work he did while at Texas Instruments in 1958. At the time Texas Instruments had been in existence under various names for 28 years, far from its startup days.
5. National Science Foundation, 2008 *Business R&D and Innovation Survey*.
6. To make these calculations, we used data from the Census Bureau to derive the total number of workers per size class, including companies with no spending on R&D.
7. As the NSF releases more data on R&D and innovation by industry in the coming months, we will be able to refine our analysis accordingly.
8. Richard Gilbert and David Newbery, "Preemptive Patenting and the Persistence of Monopoly," *American Economic Review*, 1982.
9. Kenneth Arrow, "Economic Welfare and the Allocation of Resources for Inventions" in *The Rate and Direction of Inventive Activity: Economic and Social Factors*, Princeton University Press, 1962.
10. Philippe Aghion and Rachel Griffith, *Competition and Growth*, MIT Press, 2005. Philippe Aghion, Richard Blundell, Rachel Griffith, Peter Howitt, and Susanne Prantl 'The Effects of Entry on Incumbent Innovation and Productivity', NBER Working Paper 12027, 2006
11. T.H. Clausen, "Examining the Schumpeter hypothesis in the context of closed and open innovation: survey evidence from Norway and Sweden," *International Journal of Entrepreneurship and Small Business*, 2011.
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13. Dane Stangler, "High-Growth Firms and the Future of the American Economy," Ewing Marion Kauffman Foundation, 2010.
14. http://www.fastcompany.com/most-innovative-companies/2011/ http://money.cnn.com/magazines/fortune/mostadmired/2011/best_worst/best1.html
15. James F. Moore, "Business ecosystems and the view from the firm." *Antitrust Bulletin*, Fall 2005
16. The best counterexample is the Linux ecosystem, which is not built around a large core firm.
17. Michael Wines, "Chinese Rules Said to Threaten Proprietary Information," *New York Times*, May 1, 2010.
18. James F. Moore, "Business ecosystems and the view from the firm." *Antitrust Bulletin*, Fall 2005

About the Progressive Policy Institute

The Progressive Policy Institute (PPI) is an independent research institution that seeks to define and promote a new progressive politics in the 21st century. Through research, policy analysis and dialogue, PPI challenges the status quo and advocates for radical policy solutions.

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