CONTRIBUTORS AND DETRACTORS: RANKING COUNTRIES' IMPACT ON GLOBAL INNOVATION

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ABSTRACT

If the world is going to maximize global innovation, it will need to develop stronger mechanisms to encourage nations to do more contributing and less detracting to innovation.

Robust innovation is essential for economic growth and social progress around the world. Until now, most studies of innovation policy looked at how nations' policies affect innovation in their own country. This report assesses 56 countries—which comprise almost 90 percent of the global economy—on 27 factors reflecting the extent to which their economic and trade policies contribute to and detract from innovation globally.

The report finds that on a per-capita basis, the nations doing the most for global innovation (a combination of more effort on policies that support innovation and less on policies that harm it) are Finland, Sweden, and the United Kingdom. In contrast, India, Indonesia, and Argentina score the lowest overall. Singapore, Korea, and Finland rank highest on how much their policies contribute to global innovation. In contrast, India, China, and Thailand have put in place policies that have done the most to harm global innovation. The United States ranks 10th overall, with policies that do little to detract from global innovation yet fall short of those of other nations when it comes to contributing to global innovation. China ranks 44th overall, principally because it fields so many policies that actively detract from the global innovation system. The report also finds a strong correlation between countries' contributions to global innovation and their levels of innovation success, meaning that doing well domestically on innovation policy can also mean doing well for the world.

The report concludes that for the world to maximize global innovation capacity, it will need to develop stronger mechanisms to encourage nations to do more contributing and less detracting.

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EXECUTIVE SUMMARY

More innovation will be the determining factor in achieving greater progress. Countries' economic and trade policies can either help or hurt global innovation. For example, policies such as robust investment in and tax incentives for scientific research and education support global innovation. In contrast, policies such as export subsidies or forced localization harm global innovation. If nations increased their supportive policies and reduced their harmful policies, the rate of innovation worldwide would significantly accelerate. This report assesses countries on the extent to which their economic and trade policies either constructively contribute to or negatively detract from the global innovation system.

If the world is going to maximize global innovation, it will need to develop stronger mechanisms to encourage nations to do more contributing and less detracting to innovation.

Most studies comparing countries on innovation rank them on innovation capabilities and outcomes.[1] But no study has assessed the impact of countries' innovation policies on the broader global innovation system. This study assesses this by inquiring whether countries are attempting to bolster their innovation capacities through positive-sum policies such as investments in R&D, education, or tax incentives for innovation that contribute positively to the global body of knowledge and stock of innovation; or if they are trying to compete through negative-sum "innovation mercantilist" policies such as localization barriers to trade, export subsidization, or failing to adequately protect foreign intellectual property (IP) rights (e.g., through the issuance of compulsory licenses or even outright IP theft). Those types of policies are more concerned with expropriating existing knowledge, shifting innovative activity to suboptimal locations, or unfairly propping up inefficient companies. Because of the injurious effect of these policies on innovators (both those living in other nations, and even in-country) the result is less, not more, global innovation, and the world as a whole is hurt by such nations' innovation mercantilist policies.

This issue is of paramount importance, because as countries increasingly vie for leadership in the global innovation economy, they can implement policies that benefit only themselves at the cost of hurting global innovation, or policies that can bolster their own innovation capacity while also generating positive spillovers that benefit the entire global innovation system.

This report assesses the impacts of countries' economic and trade policies on the broader global innovation system. It examines 27 indicators, including 14 "contributors" that constructively spill over to contribute to global innovation, grouped into three categories—taxes, human capital, and R&D and technology—and 13 "detractors" that inhibit greater levels of global innovation, also grouped into three categories—balkanized production markets, IP protection, and balkanized consumer markets.

The report finds that the nations doing the most to support global innovation while doing the least to detract from it, on a per capita basis, are Finland, Sweden, the United Kingdom, Singapore, and the Netherlands, as Table ES-1 shows. The report identifies these countries as "Schumpeterians" for fielding policies—such as robust levels of government investment in scientific research and education and innovation-enabling tax policies—that produce significant spillovers to the global innovation system while generally eschewing use of policies that detract from it. In contrast, the countries making the least constructive impact on the global innovation system—Argentina, Indonesia, India, Thailand, and Ukraine—contribute less to global innovation and at the same time use more innovation mercantilist policies that detract from it. The United States ranks just 10th overall, largely because its innovation-supporting policies (such as funding for scientific research) are lower than those of the leaders (on a per capita basis). China ranks 44th, largely because it fields so many policies that harm global innovation.

Rank	Country	Type	Final Score	Contributions Score	Detractions Score
1	**Finland**	Schumpeterian	15.6	14.1	13.9
2	**Sweden**	Schumpeterian	14.2	13.9	11.1
3	**United Kingdom**	Schumpeterian	13.7	13.7	10.4
4	**Singapore**	Advanced Asian Tiger	12.3	15.0	5.9
5	**Netherlands**	Schumpeterian	12.1	9.6	12.4
6	**Denmark**	Schumpeterian	11.6	13.5	6.2
7	**Belgium**	EU Continentalist	11.4	9.4	11.3
8	**Ireland**	EU Continentalist	10.9	8.7	11.2
9	**Austria**	EU Continentalist	10.5	9.2	9.7
10	**United States**	Adam Smithian	10.5	8.5	10.4
11	**France**	EU Continentalist	10.2	10.2	7.8
12	**Germany**	EU Continentalist	9.4	7.0	10.3
13	**Norway**	EU Continentalist	9.4	7.8	9.2
14	**Japan**	Advanced Asian Tiger	9.2	11.3	4.3
15	**Taiwan**	Advanced Asian Tiger	9.2	12.3	3.1
16	**Slovenia**	EU Up and Comer	9.0	9.2	6.5
17	**Portugal**	EU Continentalist	8.8	7.5	8.4
18	**Estonia**	EU Up and Comer	7.3	4.3	9.5
19	**Iceland**	EU Continentalist	7.1	9.0	3.0
20	**Switzerland**	EU Continentalist	6.8	8.8	2.5
21	**Korea**	Advanced Asian Tiger	5.9	14.7	-6.9
22	**Australia**	Adam Smithian	5.9	4.7	6.0
23	**Israel**	Advanced Asian Tiger	5.1	8.2	-0.2
24	**Spain**	EU Continentalist	5.0	3.1	6.3
25	**Canada**	Adam Smithian	5.0	8.3	-0.5
26	**Czech Republic**	EU Up and Comer	4.5	2.1	6.5
27	**Hungary**	EU Up and Comer	4.4	2.9	5.3
28	**New Zealand**	Adam Smithian	2.9	-1.4	7.9
29	**Hong Kong**	Advanced Asian Tiger	1.4	-1.8	5.4

30	**South Africa**	Innovation Follower	0.1	-3.1	4.2
31	**Lithuania**	EU Up and Comer	-0.2	-3.9	4.7
32	**Slovak Republic**	EU Up and Comer	-0.8	-6.3	6.7
33	**Italy**	Innovation Follower	-1.2	-5.8	5.0
34	**Latvia**	EU Up and Comer	-1.4	-7.7	7.1
35	**Poland**	EU Up and Comer	-2.4	-6.1	3.0
36	**Bulgaria**	Innovation Follower	-5.0	-5.0	-3.9
37	**Turkey**	Innovation Mercantilist	-7.2	-4.8	-8.6
38	**Romania**	Innovation Follower	-7.7	-9.8	-3.0
39	**Malaysia**	Innovation Mercantilist	-7.9	-2.5	-13.1
40	**Chile**	Innovation Follower	-8.1	-10.9	-2.7
41	**Brazil**	Innovation Mercantilist	-8.3	-3.2	-12.9
42	**Russia**	Innovation Mercantilist	-8.9	-0.7	-17.4
43	**Greece**	Innovation Follower	-10.5	-15.4	-1.5
44	**China**	Innovation Mercantilist	-10.5	0.7	-22.6
45	**Colombia**	Innovation Follower	-11.0	-15.5	-2.5
46	**Costa Rica**	Innovation Follower	-11.3	-16.7	-1.5
47	**Philippines**	Innovation Follower	-12.1	-13.6	-7.3
48	**Peru**	Innovation Follower	-12.2	-13.6	-7.4
49	**Vietnam**	Innovation Mercantilist	-12.9	-8.1	-16.2
50	**Mexico**	Innovation Follower	-13.5	-16.7	-6.1
51	**Kenya**	Innovation Follower	-13.7	-14.9	-8.8
52	**Ukraine**	Traditional Mercantilist	-14.6	-14.3	-11.5
53	**Thailand**	Innovation Mercantilist	-14.8	-5.6	-23.3
54	**India**	Innovation Mercantilist	-15.5	-8.3	-21.2
55	**Indonesia**	Traditional Mercantilist	-17.5	-16.1	-15.2
56	**Argentina**	Traditional Mercantilist	-20.1	-15.8	-21.0

Table ES-1: Countries' Scores for Contributions, Detractions, and Total Impact on Global Innovation

Assessing countries' scores on just the contributions indicator, Singapore, Korea, Finland, Sweden, and the United Kingdom lead the world. Relative to the size of their economies, these nations invest more in science and human capital, and have stronger innovation-incentivizing tax policies. In contrast, Costa Rica, Mexico, Indonesia, Argentina, and Colombia field policies that contribute the least to the global innovation system. These countries tend to underinvest in research, produce fewer science researchers, and have relatively less-developed toolsets to support innovation policies.

In terms of detractions, Finland, the Netherlands, Belgium, Ireland, and Sweden field policies that do the least to detract from the global innovation system. In general, these countries play by the rules of the international system, implement few trade barriers, ensure strong protections for intellectual property, and do not overtly favor domestic enterprises at the expense of foreign competitors. In contrast, Thailand, China, India, Argentina, and Russia field policies that detract the most from the global innovation system. These countries make the most extensive use of trade barriers and other distortions while providing weaker environments for intellectual property protection. Figure ES-1 plots countries' contributions to the global innovation economy in terms of both their contributions and detractions, illustrating which nations are making greater or lesser contributions to the global innovation economy.

As the report subsequently elaborates, eight categories of countries emerge from this research: Adam Smithian, Advanced Asian Tiger, European Union (EU) Continentalist, EU Up and Comer, Innovation Follower, Innovation Mercantilist, Schumpeterian, and Traditional Mercantilist. Some of these groups—including the EU Up and Comers and Innovation Followers—contribute relatively little to the global innovation system, but do little to harm it. By contrast, most Advanced Asian Tigers, such as Korea, Japan, and Taiwan, make significant contributions to the global innovation systems (e.g., high levels of investment in scientific research and education) but also enact significant innovation mercantilist policies that detract from it. The Innovation Mercantilists—such as China and Russia—make modest contributions but implement severely detractive trade, competition, and IP policies.

Figure ES-1: Scatterplot of Countries' Contributions to and Detractions from Global Innovation

While on an absolute basis the United States' policies do more to drive global innovation than any other nation because of its sheer size, the United States ranks 10th overall. Along with other "Adam Smithians," such as Australia and Canada, the United States largely avoids the use of innovation mercantilist policies (ranking 6th for detractions), but in its often dogmatic faith in "free markets" does relatively little to proactively support innovation (and thus places just 17th for contributions). To become the number one-ranked nation, the United States could take five steps to significantly increase its score on contributions: 1) reduce its effective corporate tax rate to 18.2 percent; 2) increase its R&D tax credit to 24 percent; 3) implement an innovation box; 4) increase government funding of R&D by $68 billion annually; and 5) increase its number of college science, technology, engineering, and math (STEM) graduates by 20 percent.

Some policymakers may say that this it is all well and good to think about the global innovation system, but their job, after all, is to look out for the innovation welfare of their own country, not to be altruistic. However, this report finds a strong correlation between countries' contributor innovation policies and their levels of domestic innovation success, as evidenced by countries' contributor scores correlating with their innovation output scores on the World Intellectual Property Organization's *2015 Global Innovation Index*. In other words, doing well on innovation policy can also mean doing good for the world.

Perhaps the most important step needed is for global policymakers, economists, and pundits to begin to treat innovation as if it were as important as trade in optimizing global economic growth and welfare.

If the world is going to maximize global innovation, it will need to develop stronger mechanisms to encourage nations to do more contributing and less detracting. Perhaps the most important step needed to move in this direction is for global policymakers, economists, and pundits to begin to treat innovation as though it is as important as trade in optimizing global economic growth and welfare. Even if some policymakers do not believe it, most know they are supposed to repeat the mantra that free trade boosts global economic welfare. But that same intellectual consensus does not exist when it comes to supporting innovation policies, such as robust intellectual property protections, that are a key to maximizing global innovation (and thus global economic welfare). Importantly, this means pushing back against the false narrative advanced by organizations such as the United Nations Conference on Trade and Development (UNCTAD) that developed-nation innovation comes at the expense of developing-nation economies and that an innovation "redistribution" strategy helps, not hurts global innovation.

We also need to develop a better framework for distinguishing between countries' innovation policies that are good (i.e., that help the adopting nation and the world) as opposed to "ugly" (i.e., that purport to help the adopting nation but that hurt global innovation). For example, the World Trade Organization (WTO) should produce its own version of The Information Technology and Innovation Foundation's (ITIF's) *The Global Mercantilist Index*, which would comprehensively document countries' WTO-violating trade barriers as they relate to innovation, while unabashedly ranking the most egregious nations.[2]

There are also a host of specific actions that national and international development organizations—such as the World Bank—can take to support policies that maximize global innovation. One key step would be for them to stop promoting export-led growth as a solution to development and to tie their assistance to steps taken by developing nations to move away from negative-sum mercantilist policies. Countries that persist in fielding aggressive innovation mercantilist strategies should have their foreign aid privileges suspended.

Finally, we need to encourage more international cooperation in scientific research among nations whose policies on net contribute to global innovation. For example, these nations should establish and support a Global Science and Innovation Foundation (GSIF), whose mission would be to fund scientific research, particularly internationally collaborative research, on key global challenges. Countries should also work collaboratively to support more international cooperative scientific research initiatives and share the research results they produce. For example, in the Transatlantic Trade and Investment Partnership Agreement (T-TIP), the United States and Europe should establish a bilateral research and development (R&D) participation model in order to better coordinate cross-border pre-competitive research partnerships.[3]

Put simply, the world is not producing as much innovation as is possible—or as is needed. For as Joseph Schumpeter once stated: "technological possibilities are an uncharted sea." The problem today is that because of the policies of many nations, too many of the boats on this sea are underpowered, and the sea itself is too turbulent. It is time to understand that maximizing global innovation should be the key international trade goal of the 21st century and that, absent new approaches and stricter disciplines, the world will fail to deliver the promise of the future—new technologies, new products and services, new cures or treatments for diseases, and greater social and economic well-being—to the world's 7 billion inhabitants as quickly as possible.

Does "innovation altruism" pay? That is, do the nations that rank higher also have better innovation outcomes? The evidence suggests it does, and that doing good for a country usually means doing good for the world.

This report proceeds by articulating what innovation is, why it matters, and the conditions that must prevail in the global economy for the global production of innovation to be maximized before assessing how countries' innovation and economic growth policies affect the broader global innovation system. It concludes by offering a set of policy recommendations designed to increase the production of innovation globally.

WHAT IS INNOVATION AND WHY DOES IT MATTER?

Innovation concerns the improvement of existing or the creation of entirely new products, processes, services, and business or organizational models. Essentially, innovation is the creation of new value for the world, whether that "value" is created through new technologies, new business models, new products and services, or new forms of social entrepreneurship. Innovation drives both long-term economic growth for countries and supports global improvements in quality of life and standards of living. For instance, the U.S. Department of Commerce reported in 2010 that technological innovation can be linked to three-quarters of the United States' growth rate since the end of World War II.[4] The United Kingdom reports that two-thirds of U.K. private-sector productivity growth between 2000 and 2007 resulted from innovation.[5] And the economists Klenow and Rodriguez-Clare have found that 90 percent of the variation in the growth of income per worker across nations can be attributed to innovation.[6] Put simply, innovation has become the central driver of economic well-being, competitiveness, and even long-run employment and income growth for most economies.[7] As Organization for Economic Cooperation and Development (OECD) Secretary-General Angel Gurría commented upon the release of the *OECD Innovation Strategy* in March 2010, "Countries need to harness innovation and entrepreneurship to boost growth and employment, for innovation is the key to a sustainable rise in living standards."[8]

With innovation truly the most important "good" for the future of the global economy and society, policymakers cannot take it for granted. Innovation does not fall like "manna from heaven," as economist Robert Solow once suggested. Rather, innovation is a product of complex national innovation systems and strategies that seek to coordinate a range of disparate policies that impact the capacity and ability of both private and public actors to effectively innovate. These include policies related to scientific research, technology commercialization, investments in information and communications technologies (ICTs), education and skills development, tax, trade, intellectual property, government procurement, and competition and regulatory policies. But with countries increasingly recognizing that conscientious policy decisions impart a tremendous impact on the levels of innovation their economies and societies produce, a fierce race for global innovation leadership has emerged, as ITIF identifies in *Innovation Economics: The Race for Global Advantage*.[9] Indeed, countries are competing ever-more fiercely to incubate, scale, and grow—or attract from elsewhere—innovative enterprises and industries operating in the highest-value added sectors of economic activity, such as advanced manufacturing, the life sciences, ICTs, and renewable energy.

However, the policies that nations implement to maximize innovation in their own countries may not be the ones best suited to maximize global production of innovation, particularly when such policies are mercantilist in nature. For example, policies such as forced local production and forced IP or technology transfer as a condition of market access do nothing more than shift the location of where production occurs in the global economy from one nation to another or merely compel the transfer of proprietary IP without contributing to the global stock of knowledge produced. In contrast, when countries compete by strengthening the core building blocks of innovation in their societies—that is, by investing in scientific research, education, or digital infrastructure—this not only bolsters their competitive capacity, but produces new knowledge, skills, technologies, or novel products and services that spill over to benefit the entire world.

Accordingly, a typology of countries' innovation policies can be constructed, as depicted in Figure 1, as ITIF argued in *The Good, The Bad, and The Ugly (and The Self-Destructive) of Innovation Policy*.[10] The matrix shows that nations' innovation policies can be implemented from one of four distinct qualitative perspectives, in ways that either: 1) benefit the country and the world simultaneously ("good"), 2) benefit the country at the expense of other nations ("ugly"), 3) fail to benefit either the country or the world ("bad"), or 4) actually fail to benefit the country but benefit the rest of the world ("self-destructive").

"Good" innovation policies include increasing investments in basic scientific research and development; effective policies to transfer technologies out of universities and national laboratories for commercialization by the private sector; openness to high-skill immigration; effective science, technology, engineering, and math education initiatives; promotion of ICT deployment and adoption; and tax policies that spur the investment that leads to innovation. Countries' "good" innovation policies are positive for the world as well as for the country, as discoveries, inventions, and innovations made in one nation ultimately spill over to the benefit of citizens worldwide. In contrast, countries' "ugly" policies include those—such as currency or standards manipulation, forced IP transfer, or domestic sourcing of production as a condition of market access—designed to benefit themselves to the detriment of others. "Bad" policies are those, such as import substitution industrialization policies or restrictions on inbound foreign direct investment (FDI), that a country believes will help it, but that in fact do more harm than good to a country's economy. Finally, "self-destructive" innovation policies, such as a country turning away high-skilled immigrants or raising corporate taxes so high that multinational corporations relocate elsewhere, are those that hurt a country while actually benefiting others.

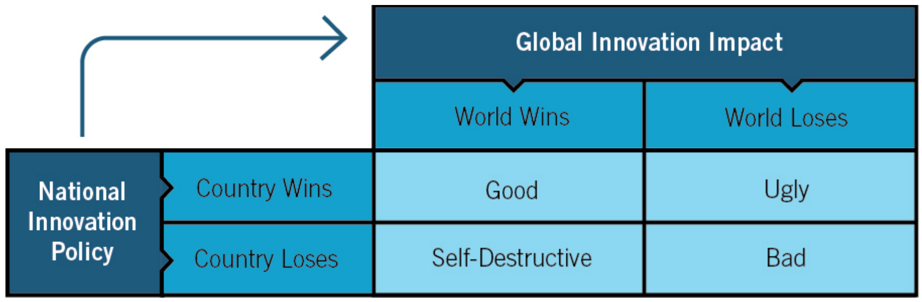

Figure 1: The Good, the Bad, the Ugly, and the Self-destructive of Innovation Policy

The policies that nations implement to maximize innovation in their own countries often are not the ones best suited to maximize the global production of innovation.

This matters particularly because the spillover effects from innovation activities at the global level are tremendous. Just as no one firm can capture all the gains from its innovation efforts, neither does one nation capture all the benefits of the innovation efforts of its enterprises, industries, organizations, or government agencies. That explains why Yale economist William Nordhaus estimates that inventors capture just 4 percent of the total social gains from their innovations, with the rest spilling over to other companies and to society as a whole.[11] Such spillovers are not confined to breakthrough products such as tablet computers or anti-cancer biologic drugs such as Avastin or Herceptin, but they also arise from organizations' investments in ICT and process R&D (that is, the R&D conducted to help organizations produce things more efficiently). For instance, Hitt and Tambe find that spillovers from firms' investments in information technology (IT) are "significant and almost as large in size as the effects of their own IT investment."[12] Likewise, Ornaghi finds "statistically significant knowledge spillover associations for process and product innovation," stating that these "knowledge spillovers play an important role in improving the quality of products, and to a lesser extent, in increasing the productivity of the firm."[13] Moreover, firms invest more in product R&D when they invest more in process R&D, meaning that spurring process R&D also spurs product R&D.[14] Cefis et al. observe relatively high technological spillovers and positive externalities resulting from process R&D.[15] Put simply, investments in innovation, ICTs, and R&D generate remarkable spillover effects for the world.

How nations decide, individually and collectively, to pursue innovation-based growth strategies holds important implications for the global innovation system, given that the world is essentially in the adolescent stages of a truly integrated global economy. As Potts notes, "National innovation policies strategically interact to form emergent de facto innovation policies. … The economics of the innovation problem—market failure in producing new knowledge and knowledge as a public goods problem—is inherently global because new ideas and their externalities are not easily contained by national borders."[16] Accordingly, countries cannot afford to be self-centered when thinking about growth.

Collectively, nations face a prisoner's dilemma: either embrace innovation mercantilism that might spur growth in the short run but damage global innovation in the long run, or eschew such policies in favor of legitimate innovation policies (e.g., funding for science, support for STEM education, introduction of R&D tax incentives, etc.) that maximize long-term global innovation. This issue presents perhaps the most serious global economic challenge. For if humanity is to maximize the global innovation needed to tackle an array of pressing challenges, including developing low-cost clean energy technologies, making breakthroughs in drugs and medical devices, dealing with climate change and resource scarcity, and developing new technologies that can boost productivity, the world will need a fundamentally new approach to supporting development of and trade in innovation-based industries. In short, nations will need to expand their "good" innovation policies while dramatically curtailing their use of innovation mercantilist policies.

MAXIMIZING GLOBAL INNOVATION

But while the previous discussion dealt with how countries' innovation policies have differential impacts on the global innovation system, it did not address the circumstances and conditions that must prevail in the global economy for innovation industries to flourish and the global stock of innovation to be maximized. This requires understanding both the nature of innovation industries and the needed characteristics of the global economy for them to produce the highest amount of innovation possible, as the following section elaborates.

The Nature of Innovation Industries

True innovation industries share four key characteristics in common. First, innovation—the regular development of new products and processes—is central to their competitive success. While all industries, even "traditional" ones, innovate to some extent, true innovation industries are ones where the rapid and regular development of new processes, products, or services—many of them disruptive in nature—is critical to their competitive advantage. For example, biotechnology and semiconductors are innovation industries, as their success depends not on making the current product marginally cheaper, but on inventing the next-generation drug or semiconductor.

A second key characteristic of innovation-based industries is that their average costs significantly exceed their marginal costs. The software industry provides the most extreme example of this. It can cost hundreds of millions of dollars to produce the first copy, but additional software can be produced at virtually no cost. Likewise, the cost to develop a new prescription medicine that gained marketing approval in 2013 reached $2.6 billion. Additional post-approval R&D costs of more than $300 million "boost the full product life cycle cost per approved drug" to close to $3 billion.[17] However, incremental copies of the initial medicine (one more pill off the production line) can be produced at cost. Similarly, it took Boeing almost eight years of development work and more than $15 billion before a single 787 Dreamliner was sold.[18] That $15 billion gets built into the cost of every 787. Economists describe such industries as experiencing increasing returns to scale, but not all industries share this characteristic. For example, a study of more than 1,000 European companies found increasing returns to scale for high-tech firms, but decreasing returns to scale for low-tech ones.[19]

Third, innovation industries depend more than other industries on intellectual property, both science- and technology-based IP but also the IP embodied in creative works. For example, software depends on source code; content creators depend on copyrights to protect their work from expropriation; life sciences firms depend on discoveries related to molecular compounds; and aerospace depends upon materials and device discoveries. The challenge, of course, is that intangible capital assets, such as IP, are more easily appropriable than tangible capital assets.

Finally, precisely because innovation industries are so knowledge intensive, they depend upon the unfettered movement of knowledge, information, and data across borders.[20] That is because creating value in the modern economy increasingly depends upon generating actionable insights from data. For example, 50 percent of global services trade depends on underlying data flows.[21] These four factors that characterize an industry as an innovation industry—constant innovation, high fixed costs relative to marginal costs, dependence on IP, and dependence on information—have significant implications for globalization and trade.

Four factors characterize an industry as an innovation industry: constant innovation, high fixed costs relative to marginal costs, a dependence on intellectual property, and access to global knowledge flows.

Market Conditions Needed to Maximize Innovation in Innovation Industries

Innovation industries play a vital role in contributing to global economic, environmental, and health progress, and thus the factors that drive the progress of innovation industries are extremely important. A wide range of studies has shown that domestic policies such as support for a robust science and engineering workforce, an entrepreneurial culture, public investment in research, and favorable tax treatment of R&D all foster innovation.[22] If implemented effectively, such domestic policies can spur greater levels of innovation from enterprises and organizations operating within a country, generating spillover effects that increase the global stock of innovation.

However, maximizing international innovation by innovation industries depends on three factors: 1) ensuring the largest possible markets, 2) limiting nonmarket-based competition, and 3) ensuring strong IP protections. All three factors get to the core challenge for innovation industries: Investment in innovation is uncertain, and therefore higher than normal profits on those innovations that succeed are necessary. Because innovation is about risk and uncertainty, failure is common; for every Apple succeeding with an iPad, there are many IT companies that fail. Moreover, innovation industries face not just loss of market share from competition, but loss of existence. This reality evokes Schumpeter's dictum that "every piece of business strategy must be understood against the perennial gale of creative destruction."[23] Innovation industries depend on so-called "Schumpeterian profits"—the profits that arise when firms are able to appropriate the returns from innovative activity. For if firms are assured at best only normal returns on successful innovation, none would undertake the enormous risk of investing in it. Moreover, because innovation is so expensive, higher returns endow companies with the capital to invest more in R&D and other innovation-based activities, perpetuating a virtuous cycle of innovation.

Large Markets

Firms in many innovation-intensive industries are global because they require scale. For innovation industries with high fixed costs of design and development but relatively low marginal costs of production, larger markets better enable them to cover those fixed costs, so that unit costs can be lower, and revenues for reinvestment in innovation higher. If they can sell in 20 countries rather than 5, expanding their sales by a factor of 4, their costs increase by much less than a factor of 4. This is why numerous studies have found a positive effect from the ratio of cash flow to capital stock on the ratio of R&D investment to capital stock.[24] Higher sales allow more revenue to be invested back into generating more innovation. This also explains why one study of European firms found that high-tech firms' "capacity for increasing the level of technological knowledge over time is dependent on their size: the larger the R&D investor, the higher its rate of technical progress."[25]

No Excess Competition

Large markets enable firms to sell more. But if larger markets come with more competitors, total sales per firm can remain the same or even fall. But isn't this competition good for innovation? In fact, many studies have shown that innovation and competition can be modeled according to an inverted "U" relation, with both too much and too little competition producing less innovation. One study of U.K. manufacturing firms found this relationship.[26] Others, including Scherer and Mukoyama, have found similar patterns.[27] In a study of U.S. manufacturing firms, Hashmi found that too much competition led to reduced innovation in a slightly negative relationship.[28] Firms need to be able to obtain those "Schumpeterian" profits to reinvest in innovation that is both expensive and uncertain. As Carl Shapiro explains, "Innovation incentives are low if ex-post competition is so intense that even successful innovators cannot earn profits sufficient to allow a reasonable risk-adjusted rate of return on their R&D cost."[29]

This does not mean that market-generated competition is detrimental. Normally, markets will not produce an excess number of competitors. But governments often do—through financial bailouts, discriminatory government procurement, or other policies favoring weaker domestic firms. These policies let weak firms remain in the market, drawing sales from stronger firms and reducing their ability to reinvest in innovation. To be clear, some government innovation policies can be pro-innovation if they help innovative firms overcome particular challenges. For example, public-private research partnerships, such as the Fraunhofer Institutes in Germany, represent a case in point.[30] But these institutes, designed to help firms in an industry solve complex technical challenges, are different from mercantilist policies propping up particular firms that otherwise would exit the market.

Strong IP Protection

Firms in innovation-based industries depend on intangible capital, much of it intellectual property. Strong intellectual property rights spur innovative activity by increasing the appropriability of the returns to innovation, enabling innovators to capture more of the benefits of their own innovative activity. By raising the private rate of return closer to the social rate of return, intellectual property addresses the knowledge-asset incentive problem, allowing inventors to realize economic gain from their inventions, thereby catalyzing economic growth. In addition, as they capture a larger portion of the benefits of their innovative activity, innovating companies obtain the resources to pursue the next generation of innovative activities. However, if competitors are able to enter and/or remain in the market because they obtain an innovator's IP at less than the fair market price (either through theft or coerced transfer), they are able to siphon sales that would otherwise go to innovators. Why would a firm invest in IP if other firms can easily copy it to compete against them?

Barriers to Maximizing Innovation in Innovation Industries

These three market conditions—large markets, no excess competition, and strong intellectual property rights—are the key to maximizing global innovation. Accordingly, three corresponding factors that inhibit the prevalence of these conditions—market balkanization (i.e., fragmented consumer markets), excess competition (i.e., fragmented production markets), and weak intellectual property protections—form the basis for the "detractions" indicators assessed in this report, for they preclude innovation industries from reaching their true potential.

Market Balkanization (Balkanized Consumption Markets)

Trade barriers—such as high tariffs, localization barriers to trade, or restrictions on the ability of service enterprises to compete across international borders—limit scale economies at both the firm and establishment level (a firm being comprised of multiple establishments). Barriers that limit market access by foreign firms—in favor of domestic firms—raise global innovation costs by enabling more firms than necessary. These barriers stem from policies that favor domestic innovation firms over foreign ones. China's "indigenous innovation policies" provide a case in point.[31] Such policies seek to favor Chinese-owned innovation firms through discriminatory government procurement, land grants and other subsidies, preferential loans, tax incentives, benefits to state-owned enterprises (SOEs), generous export financing, government-sanctioned monopolies, and the use of domestic rather than international technology standards.

Internationally, maximizing innovation by innovation industries depends on three factors: 1) ensuring the largest possible markets, 2) limiting nonmarket-based competition, and 3) ensuring strong IP protections.

While indigenous innovation policies that seek to advantage a country's domestic enterprises at the expense of foreign competitors are spreading, some nations remain indifferent to the nationality of the innovation establishments in their markets; they just want them to produce locally. In other words, establishment-level barriers allow foreign firms to access markets, but compel them to locate production facilities in the country as a condition of entry to the market. To achieve this, some countries have turned to "forced localization policies," including local content requirements (LCRs), government procurement restrictions, or preferential domestic production benefits. For example, through its Preferential Market Access program, India's government aims for 80 percent of ICT products procured by government agencies to be domestically produced by 2020.[32] But such policies only inefficiently raise the number of establishments, which increases global production costs. For example, a biopharmaceutical enterprise may only need one plant to produce a drug for global sales, but if nations require the firm to manufacture locally in order to sell locally, then it will need multiple plants, increasing the firm's costs and reducing the resources available for investing in innovation (and thus likely lowering the rate of new drug discovery).

Excess Competition (Balkanized Production Markets)

Many nations seeking high-wage innovation industries (and jobs) unfairly subsidize new entrants or incumbents, leading to more competition than market forces might otherwise produce. Korea provides a good example. The Korean government targeted the dynamic random access memory (DRAM) chip industry as a key industrial target, with the Korean government propping up DRAM chip producer Hynix. The firm went bankrupt and was saved twice by its creditor banks, which were majority-owned by the government. While this helped the Korean memory chip industry, it hurt the global industry because it contributed to significant global overcapacity, reducing sales and margins for other competitors.

Another example is China's subsidization of a wide variety of industries, including steel, energy, glass, paper, and auto parts, which have contributed to significant global overcapacity in these industries and distorted markets for their trade.[33] As Usha and George Haley document in *Subsidies to Chinese Industry: State Capitalism, Business Strategy, and Trade Policy*, in the 2000s alone, China's total subsidies for those five industries exceeded $150 billion.[34]

China has pursued the same policy in aviation. Designing and building jet airplanes, especially larger, multi-aisle planes, is incredibly expensive and risky; given this, it is not surprising that there are just two major competitors (Boeing and Airbus). But this has not deterred the Chinese government from attempting to artificially create a third competitor, one that likely would not thrive (or even emerge) if market forces prevailed. COMAC, the state-owned Chinese commercial aircraft company, benefits from a wide array of mercantilist policies, including forced technology transfer in exchange for market access, massive subsidies, and discriminatory procurement.[35] If COMAC sells any planes, the result will be reduced revenues for Boeing and Airbus to invest in next-generation aviation innovation.

Many nations seeking high-wage innovation industries and jobs unfairly subsidize new entrants or incumbents, leading to more competition than market forces might otherwise produce.

Weak Intellectual Property Protection

Many nations believe that the way to accelerate the development of innovation industries is to appropriate intellectual property.[36] There are two main types of IP theft. The first is pure theft, through practices such as copying, bribing employees to obtain trade secrets, and cyber-espionage. The second is forced IP or technology transfer whereby a nation makes market access contingent upon transferring technology to domestic producers. Many countries use these practices despite the fact that they flagrantly breach a number of international trade agreements and laws.

For example, global IP theft of software remains rampant and persistent. In 2009, more than 4 out of 10 software programs installed on personal computers around the world were stolen, with a commercial value of more than $51 billion.[37] Nations also use market access as a cudgel to force technology transfer. It is commonplace for China to require that firms transfer technology in exchange for being granted the ability to compete in (or, in some cases, invest in) the country. As BASF Chairman and Chief Executive Jürgen Hambrech has stated, foreign companies doing business in China face "the forced disclosure of know-how."[38] Many other nations, such as Brazil and India, require forced technology transfer in exchange for market access.

ASSESSING COUNTRIES' CONTRIBUTIONS TO AND DETRACTIONS FROM GLOBAL INNOVATION

As noted, the types of policies countries implement in their attempts to bolster economic growth can have significant impact both on other nations' innovation industries and the broader global economy. This section assesses the extent to which countries' innovation policies broadly contribute to or detract from the global innovation system.

Indicators

To assess countries' contributions to the global innovation economy, this report considers 27 indicators, including 14 positive "contributors," grouped into three categories—taxes, human capital, and R&D and technology (as Table 1 shows)—and 13 "detractors," also grouped into three categories—balkanized production markets, IP protections, and balkanized consumer markets (as Table 2 shows). The contributing indicators account for 60 percent of a country's total score and the detracting indicators 40 percent. The rationale for the inclusion of each indicator as it affects global innovation is explained below.

Contributions Indicators (Weight=6)	Data Type	Category Weight	Indicator Weight
Taxes		2.5	
Effective Corporate Tax Rates	Raw Number		0.4
R&D Tax Credit Generosity	Raw Number		0.3
Collaborative R&D Tax Credits	Binary Variable		0.1
Innovation Boxes	Binary Variable		0.1
Taxes on ICT Products	Raw Number		0.1
Human Capital		2.5	
Expenditures on Education	Composite Score		0.3
Science Graduates	Raw Number		0.3
Top-Ranking Universities	Composite Score		0.25
Scientific Researchers	Raw Number		0.15
R&D and Technology		5	
Government R&D Expenditures	Raw Number		0.5
"Bayh-Dole-Like" Policy	Categorical Variable		0.1
National Innovation Foundation	Binary Variable		0.05
Research Citations	Composite Score		0.2
Government Funding of University R&D	Raw Number		0.15

Table 1: Contributions Indicators

How a country's tax environment supports innovation includes five indicators—effective corporate tax rates, R&D tax credit generosity, collaborative R&D tax credits, innovation boxes, and taxes on ICT products—accounting for 25 percent of the contributions' score. Four indicators of countries' success at cultivating human capital—expenditures on education, scientific graduates, top-ranking universities, and scientific researchers per capita—likewise account for 25 percent. Five measures of a country's R&D policies—

government R&D expenditures per person, existence of technology transfer policies, presence of a national innovation foundation, extent of research citations, and government funding of university R&D—account for half of the contributions' score.

Five indicators of balkanized production markets in countries—non-tariff trade barriers, localization barriers to trade (LBTs), foreign equity restrictions, currency manipulation, and export subsidies—account for 40 percent of a country's detractions' score. Weak IP protections, as evidenced by five indicators—a country's appearance on the U.S. Trade Representative's *Special 301 Report*, score on the Ginarte-Park Index of patent rights, score on other indices of intellectual property protection, levels of software piracy, and the environment supporting life sciences innovation (including the number of years of data exclusivity protection countries provide for biologic drugs and government policies to control pharmaceutical prices)—likewise account for 40 percent of the detractions' score. Finally, three indicators of balkanized consumption markets—restrictiveness toward services trade, mean tariff rates on all products, and tariffs on ICT products specifically—account for 20 percent of the detractions' score.

Detractions Indicators (Weight=4)	Data Type	Category Weight	Indicator Weight
Balkanized Production Markets		4	
Non-tariff Trade Barriers	Raw Number		0.2
Number of Types of LBTs	Categorical Variable		0.25
Foreign Equity Restrictions	Raw Number		0.15
Currency Manipulation	Categorical Variable		0.25
Export Subsidies	Raw Number		0.15
IP Protections		4	
Special 301 Report	Categorical Variable		0.35
Ginarte-Park Patent Rights Index	Raw Number		0.2
Intellectual Property Protection	Composite Score		0.2
IP and Reimbursement Environment Supporting Life Sciences Innovation	Composite Score		0.15
Software Piracy Rate	Raw Number		0.1
Balkanized Consumer Markets		2	
Services Trade Restrictiveness	Raw Number		0.4
Simple Mean Tariff Rate	Raw Number		0.4
Tariffs on ICT Products	Raw Number		0.2

Table 2: Detractions Indicators

Methodology

To combine these disparate indicators into comparable scores, variables were transformed into z-scores. Z-scores indicate the distance in standard deviations from a sample mean, and are calculated by subtracting the sample mean from a country's score on the indicator, then dividing by the standard deviation of a country's score on the indicator. This process is referred to as standardization. By definition, the set of z-scores for all countries in the sample have a mean of zero and a standard deviation of one, which allows disparate variables to be manipulated and combined in a meaningful way. For this report, z-scores were capped at 2.5 and -2.5 standard deviations from the mean, so that outliers would not carry too much weight.

For contributions, the 14 indicators were standardized, capped at 2.5 and -2.5, and then assigned weights according to the indicator's relative importance and uniqueness within each category. To produce the overall category scores, the standardized indicators scores are multiplied by their respective indicator weights and summed, and then standardized again to retain matching means and standard deviations among categories.

This process repeats itself as the six categories of indicators are used to form measures of countries' policies' contributions and detractions to global innovation, as Figure 2 shows. The contributions' metric standardizes aggregated scores for three categories—taxes, human capital, and R&D and technology—assigns weights to each category, sums the weighted z-scores, standardizes the results, and multiplies by 10. The same is done to create the detractions' score, standardizing, weighing, and combining scores for three categories—balkanized production markets, intellectual property protections, and balkanized consumer markets—standardizing the result, and multiplying by 10. For detractions' categories, positive scores indicate policies that detract less from global innovation, while negative scores indicate policies that detract more. Thus, the contributions' and detractions' final scores both have means of zero and standard deviations of 10, and the score for first place Finland can be understood as being 1.41 standard deviations above the mean in contributions and 1.39 standard deviations above the mean on detractions.

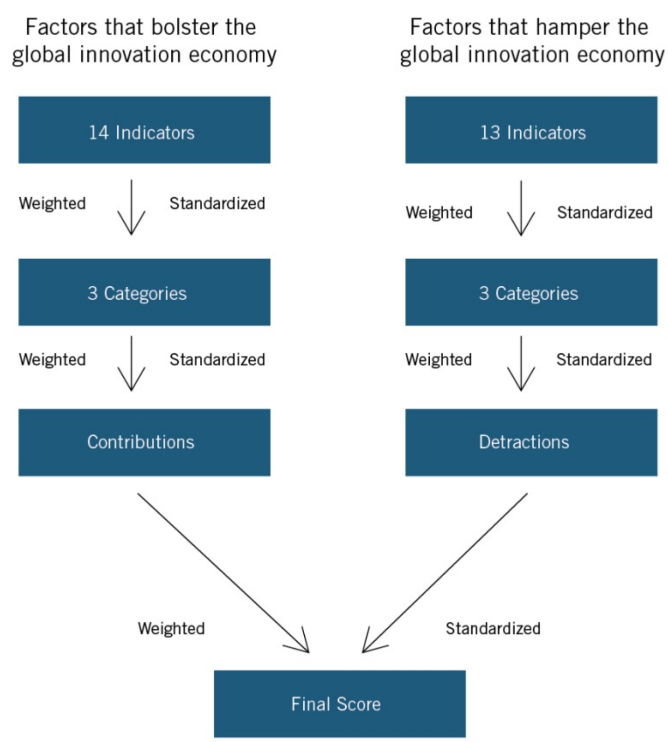

Figure 2: Depiction of Methodology Used to Generate Scores

For purposes of reporting, scores for contributions and detractions are weighted, combined, and again standardized to reach a final score. However, examining the two scores individually gives a much more interesting and more informative look at the global innovation system than just examining the final score.

In cases where data were not available, best estimates were made for the purpose of calculating the final score. In some instances, these estimates were simply the averages of other indicators in the categories, estimates based on predictors such as gross domestic product (GDP) per capita, or estimates based on alternative sources. Where this is done, methods for estimating data are noted in Appendix A under sources and methodologies for individual indicators. It is the goal of this report for results to be replicable using the sources provided and the descriptions of the methodology.

Results and Analysis

Table 3 gives results, finding Finland, Sweden, the United Kingdom, Singapore, and Holland have the most positive impact on global innovation, on a per-GDP basis. The United States places 10th. The bottom five countries are Argentina, Indonesia, India, Thailand, and the Ukraine, again on a per-GDP basis. This is not to say that a nation like Finland, with just 5.4 million people, has policies that do the most for global innovation on an absolute basis. It is to say that, controlling for the size of its economy, its policies do the most for global innovation. Likewise, Argentina's policies are the worst for global innovation, again on a per-GDP basis.

On net, China's policies do the most to harm overall global innovation, especially given its high negative detractions' score.

On an absolute basis, however, based on its score and the size of its economy, the United States' policies generate the most net benefit for global innovation, especially given the extent of federal funding for scientific research. In contrast, it appears that, on an absolute basis, China's policies do the most to harm overall global innovation, especially given its high negative detractions' score (-22.6), which is exceeded only by Thailand's.

In terms of contributions' scores, Singapore, Korea, Finland, Sweden, and the United Kingdom lead the world, on a per-GDP basis. Costa Rica, Mexico, Indonesia, Argentina, and Colombia score weakest for their contributions to the global innovation system. This is because these countries tend to underinvest in scientific research; produce fewer science graduates and scientific researchers; and have relatively less-developed toolsets to support innovation policies, such as less robust use of tax policies to support innovation (e.g., weaker R&D tax incentives, and less use of collaborative R&D tax credits or innovation boxes). In contrast, the leading nations invest more in science and education, and have stronger innovation-incentivizing tax policies.

In terms of detractions, Finland, the Netherlands, Belgium, Ireland, and Sweden field policies that detract the least from the global innovation system. This is because, in general, these countries play by the rules of the international system, implement few trade barriers, ensure strong protections for intellectual property, and do not overtly favor domestic enterprises at the expense of foreign competitors. In contrast, Thailand, China, India, Argentina, and Russia field policies that detract the most from the global innovation system. This is because these countries make greater use of innovation mercantilist policies such as imposing localization barriers to trade and high tariffs, restricting foreign investment and competition, subsidizing domestic producers, and providing weaker environments for intellectual property protection.

While the United States scores well in terms of refraining from using policies that detract from the global innovation system, its overall score is brought down by the fact that its contributions' scores do not match those of leading innovation nations. The United States ranks just 17th on contributions. Most notably, the United States has weaker scores on tax policies that incentivize innovation (e.g., relatively weak R&D incentives, no innovation box, and no collaborative R&D tax credit), its lack of a national innovation foundation, and, in recent years, relatively faltering federal investment in scientific research. It speaks to America's need to implement a more innovation-friendly corporate tax code, while at the same time increasing funding for science and technology.

America's middling rank speaks to the need to implement a more innovation-friendly corporate tax code, while at the same time increasing funding for science and technology.

Rank	Country	Type	Final Score	Contributions Score	Detractions Score
1	**Finland**	Schumpeterian	15.6	14.1	13.9
2	**Sweden**	Schumpeterian	14.2	13.9	11.1
3	**United Kingdom**	Schumpeterian	13.7	13.7	10.4
4	**Singapore**	Advanced Asian Tiger	12.3	15.0	5.9
5	**Netherlands**	Schumpeterian	12.1	9.6	12.4
6	**Denmark**	Schumpeterian	11.6	13.5	6.2
7	**Belgium**	EU Continentalist	11.4	9.4	11.3
8	**Ireland**	EU Continentalist	10.9	8.7	11.2
9	**Austria**	EU Continentalist	10.5	9.2	9.7
10	**United States**	Adam Smithian	10.5	8.5	10.4
11	**France**	EU Continentalist	10.2	10.2	7.8
12	**Germany**	EU Continentalist	9.4	7.0	10.3
13	**Norway**	EU Continentalist	9.4	7.8	9.2
14	**Japan**	Advanced Asian Tiger	9.2	11.3	4.3
15	**Taiwan**	Advanced Asian Tiger	9.2	12.3	3.1
16	**Slovenia**	EU Up and Comer	9.0	9.2	6.5
17	**Portugal**	EU Continentalist	8.8	7.5	8.4
18	**Estonia**	EU Up and Comer	7.3	4.3	9.5
19	**Iceland**	EU Continentalist	7.1	9.0	3.0
20	**Switzerland**	EU Continentalist	6.8	8.8	2.5
21	**Korea**	Advanced Asian Tiger	5.9	14.7	-6.9
22	**Australia**	Adam Smithian	5.9	4.7	6.0
23	**Israel**	Advanced Asian Tiger	5.1	8.2	-0.2
24	**Spain**	EU Continentalist	5.0	3.1	6.3
25	**Canada**	Adam Smithian	5.0	8.3	-0.5
26	**Czech Republic**	EU Up and Comer	4.5	2.1	6.5
27	**Hungary**	EU Up and Comer	4.4	2.9	5.3
28	**New Zealand**	Adam Smithian	2.9	-1.4	7.9
29	**Hong Kong**	Advanced Asian Tiger	1.4	-1.8	5.4
30	**South Africa**	Innovation Follower	0.1	-3.1	4.2
31	**Lithuania**	EU Up and Comer	-0.2	-3.9	4.7

32	**Slovak Republic**	EU Up and Comer	-0.8	-6.3	6.7
33	**Italy**	Innovation Follower	-1.2	-5.8	5.0
34	**Latvia**	EU Up and Comer	-1.4	-7.7	7.1
35	**Poland**	EU Up and Comer	-2.4	-6.1	3.0
36	**Bulgaria**	Innovation Follower	-5.0	-5.0	-3.9
37	**Turkey**	Innovation Mercantilist	-7.2	-4.8	-8.6
38	**Romania**	Innovation Follower	-7.7	-9.8	-3.0
39	**Malaysia**	Innovation Mercantilist	-7.9	-2.5	-13.1
40	**Chile**	Innovation Follower	-8.1	-10.9	-2.7
41	**Brazil**	Innovation Mercantilist	-8.3	-3.2	-12.9
42	**Russia**	Innovation Mercantilist	-8.9	-0.7	-17.4
43	**Greece**	Innovation Follower	-10.5	-15.4	-1.5
44	**China**	Innovation Mercantilist	-10.5	0.7	-22.6
45	**Colombia**	Innovation Follower	-11.0	-15.5	-2.5
46	**Costa Rica**	Innovation Follower	-11.3	-16.7	-1.5
47	**Philippines**	Innovation Follower	-12.1	-13.6	-7.3
48	**Peru**	Innovation Follower	-12.2	-13.6	-7.4
49	**Vietnam**	Innovation Mercantilist	-12.9	-8.1	-16.2
50	**Mexico**	Innovation Follower	-13.5	-16.7	-6.1
51	**Kenya**	Innovation Follower	-13.7	-14.9	-8.8
52	**Ukraine**	Traditional Mercantilist	-14.6	-14.3	-11.5
53	**Thailand**	Innovation Mercantilist	-14.8	-5.6	-23.3
54	**India**	Innovation Mercantilist	-15.5	-8.3	-21.2
55	**Indonesia**	Traditional Mercantilist	-17.5	-16.1	-15.2
56	**Argentina**	Traditional Mercantilist	-20.1	-15.8	-21.0

Table 3: Countries' Scores for Contributions, Detractions, and Total Impact on Global Innovation

Country Patterns

While overall country scores are interesting, perhaps more meaningful are patterns and country clusters that emerge, as Figure 3 shows.

We suggest that countries fall into one of eight categories that emerge from the data: Adam Smithian, Advanced Asian Tiger, European Union (EU) Continentalist, EU Up and Comer, Innovation Follower, Innovation Mercantilist, Schumpeterian, and Traditional Mercantilist.

Schumpeterians (named after the patron saint of innovation economics, Joseph Schumpeter) are countries that record both strong scores for contributions to the global innovation system while generally eschewing use of policies that detract from it. These countries—led by Finland, Sweden, the Netherlands, the United Kingdom, and Denmark—embrace what ITIF has called "The Helsinki Consensus," which affirms that governments have an active role to play in bolstering the innovation capabilities of their societies' enterprises, industries, and institutions, and hence commonly employ national innovation strategies.[39] However, these countries simultaneously believe in globalization and market-based trade, and so score well at protecting intellectual property, refraining from introducing barriers to trade, or balkanizing production or consumption markets.

Figure 3: Scatterplot of Countries' Contributions to and Detractions from Global Innovation

Nations' decisions, individually and collectively, on the innovation-based growth strategies they pursue affect the global innovation system; therefore, countries cannot think about growth only from their own narrow perspective.

The "EU Continentalists" group includes coun tries such as Austria, Belgium, France, Germany, Norway, Portugal, and Switzerland that generally share the same mentality but are a notch below the Schumpeterians in how intensively their policies contribute to the global innovation system and a notch below in the extent to which their policies do not detract from the global innovation system. In other words, these countries still contribute positively to the global innovation system, but perhaps their investments in R&D and education, as a share of GDP, are a bit below that of the Schumpeterians. Likewise, these generally continental European countries may make occasional use of localization barriers to trade policies (such as French content requirements for locally produced audiovisual media content) or impose significant pharmaceutical price controls that limit global life science innovation (as in France and Norway) that cause them to score slightly lower than the Schumpeterians on their detractions' scores.

A third category, the Adam Smithians, refers to the laissez-faire, neoclassical economic approach long adopted by Anglo-Saxon nations that endorses a less assertive role for government policy in shaping innovation capacities. For example, the United States has long been riven by internecine debates about the appropriate role of government in supporting America's innovation system, whether about the appropriate extent of government investment in basic versus applied scientific research or in its initiatives (such as the Manufacturing Extension Partnership) to support firm-level innovation. Adam Smithian countries, such as Australia, Canada, New Zealand, and the United States, generally have policies that do little to detract from global innovation, but because of their strong commit to neoclassical economics (with its disdain for innovation policy), they do not score as strongly as the Schumpeterians or EU Continentalists on contributions to the global innovation system. For example, the United States ranks just 17th, Canada 18th, and Australia 23rd for contributions' scores. Broadly, a lack of committed, long-term, proactive government policy aimed toward bolstering a nation's innovation system is a common feature of the Adam Smithian countries.

Australia has historically been a good exemplar of an Adam Smithian country, with a score of just 4.7 for contributions. As Australia's Chief Scientist, Ian Chubb, observed in May 2015, "almost every OECD country has a plan for the strategic growth of its scientific enterprise and to facilitate its translation into technology, innovation and economic development…Every country, that is, except Australia and Portugal."[40] However, in early December 2015, new Australian Prime Minister Malcolm Turnbull announced a new Australian national innovation and science strategy that featured 20 policy reforms and $1 billion in new investments.[41] It will be interesting to see if these measures can move Australia into the Schumpeterian category in the future. It is also interesting that the home of Adam Smith, the United Kingdom, appears to have overcome its prior neoclassical limitations, now ranking 5th in the world in contributions. This appears to reflect the pragmatic approach taken by the current conservative government and prior two liberal governments, grounded in a desire to overcome the country's prior deep de-industrialization and emerge as a major global innovation player. That explains why the Cameron administration has launched a "modern industrial strategy" for Britain.[42]

A fourth category of countries, the Advanced Asian Tigers, consists of countries that "just want to win" in the global innovation race no matter what, and while they make strong contributions by committing to high levels of R&D investment, robust education systems, and competitive tax environments, they also aggressively implement innovation mercantilist policies that detract from global innovation, and have relatively weaker IP protection environments. These Advanced Asian Tigers include Israel, Japan, Korea, Singapore, and Taiwan. (While not in East Asia, Israel fits this policy category.) Korea provides a strong example here. Korea actually scores second-best in the world for contributions—it leads the world with a national R&D intensity (R&D as a share of GDP) of 4.7 percent, for example—but it scores rather poorly, 42nd, for detractions. Singapore scores strongest in the world for contributions, but ranks just 22nd on detractions, which is near fellow Advanced Asian Tigers Hong Kong and Japan, which score 23rd and 27th, respectively, on detractions.

A fifth group, EU Up and Comers, consists of countries primarily from Eastern Europe, such as the Czech Republic, Poland, Lithuania, Latvia, the Slovak Republic, and Slovenia, that score above average for detractions—in other words, they are generally playing by the international rules of the game and not fielding mercantilist policies—but, largely because they have lower per-capita incomes, they have not been able to invest as much as other nations in scientific research or education, and so score below the mean on these indicators. For example, Latvia, the Slovak Republic, the Czech Republic, and Slovenia rank a highly respectable 15th through 18th in terms of detractions' scores, but the Czech Republic scores 27th and Poland, the Slovak Republic, and Latvia just 40th through 42nd in contributions. So these countries score much better on detractions than contributions, but they are generally getting the right policy environments in support of innovation in place.

A sixth category consists of Innovation Followers, such as Chile, Colombia, Costa Rica, Greece, Italy, Mexico, Kenya, Peru, and South Africa. These countries score weakly for contributions; for example, Mexico and Costa Rica score last and second-to-last, respectively, while Kenya and Greece score 50th and 51st. However, these countries generally score just below the mean on detractions, with Greece, Costa Rica, Colombia, and Chile having detractions' scores ranging from just -1.5 to -2.7 below the mean. This means these countries are generally playing by the rules of the global system and not trying to blatantly free ride on the innovation efforts of others. However, these countries underinvest in scientific research and have undeveloped educational systems (particularly at the university level). Nevertheless, initiatives such as the Pacific Alliance—an alliance among Chile, Colombia, Mexico, and Peru (and perhaps soon Costa Rica) to establish a common free trade area and regional innovation ecosystem—demonstrate an intense commitment by countries in this grouping to bolster their innovation capacities and transform their countries into modern knowledge- and innovation-based economies.[43] Generally, these countries are pointed in the right direction. The appearance of Greece and Italy in this constellation, however, is characteristic of these countries' continually underperforming economies and unwillingness to embrace needed reforms that could bolster their innovation potential.

A seventh group of countries comprise the Innovation Mercantilists, including China, Brazil, India, Russia, Thailand, Turkey, and Vietnam. These countries score significantly below average—in fact, as much as 2 to 2.5 standard deviations below the mean—in terms of detractions, indicating that these countries significantly balkanize both global production and consumption markets through a wide range of trade barriers and have generally weaker environments for intellectual property protection than is the global norm, explaining why India, China, and Thailand account for the bottom three nations in terms of detractions. However, these countries generally outperform the Innovation Follower countries on contributions, with China and Russia both notably scoring near the mean. In China's case, this is largely a result of the country's intensifying investments in scientific research and commitment to improving its human capital through high numbers of graduates in STEM fields. Russia has long excelled at educational attainment and researchers per capita, but its innovation potential is held back by misguided economic development policies. In other words, while several of the countries in this group score decently on contributions, other policies tend to be significantly subtractive from the broader global innovation system.

A final grouping of countries, Traditional Mercantilists, consists of three countries—Argentina, Indonesia, and Ukraine—that score very weakly for both contributions and detractions. Ukraine, Argentina, and Indonesia score 49th, 53rd, and 54th for contributions and 47th, 52nd, and 53rd for detractions. In other words, these countries are not investing or enacting policies designed to advance their innovation economies in a strongly proactive way, but are active in using an array of trade-distorting policies to try to grow their overall economy. Each of these countries has ample opportunity to enhance its national innovation ecosystem and contribute more constructively to the global innovation system.

Relationships Between Scores and Other Factors

Countries' scores on contributions and detractions are positively correlated, at about 0.60.[44] In other words, countries that do more to support global innovation also tend to do less to harm it. In part this is a reflection of development level, as both scores are also positively correlated with GDP per capita, at 0.71 for contributions and 0.64 for detractions.

It is important to remember that this index measures only the qualitative impact of countries' innovation policies, not their raw contributions. The United States, which arguably produces the most innovation of any country, scores only moderately well on policy contributions, with high corporate tax rates and modest levels of support for scientific research limiting the country's ability to fuel global innovation at greater levels.

As a rule, richer, more-developed countries generally have a greater potential to contribute to and economically benefit from global innovation, and as such they reap more benefits from open, level playing fields and are less likely to enact policies that detract from global innovation. Still, the results exhibit plenty of variance. Some countries, such as Korea, contribute heavily to global innovation but maintain beggar-thy-neighbor policies that distort global markets and detract from global innovation. On the opposite end of the spectrum, some poorer countries, such as Costa Rica, Greece, and Latvia, contribute little to global innovation but exceed expectations by scoring moderately well on detractions.

Leading countries record both strong scores for contributions to the global innovation system and generally eschew the use of policies that detract from it.

Moreover, a country's total population has a significant negative impact on its detractions' score.[45] Population is correlated with the final detractions' score at -0.49, meaning that smaller countries tend to detract less, while larger countries tend to enact more harmful policies. This may be because large countries have more "market power" to enact policies that hurt global innovation because they have something that global companies want: access to their labor and consumer markets. These policies have negative impacts on global innovation that are magnified by the size of the offending economy. Contributions are weakly negatively correlated with population (at -0.11). This may be because small nations see more clearly that they are in intense global competition for innovation advantage, something policymakers in larger nations like the United States and Brazil sometimes seem to overlook.

It is all well and good to argue that nations should enact policies that support and do not detract from global innovation. But does "innovation altruism" pay? In other words, do the nations that rank higher also perform better internally on innovation outcomes? The evidence suggests they do. One measure of innovation outcomes, from the *2015 Global Innovation Index* (GII), includes two components: "Creative Outputs" and "Knowledge and Technology."[46] The contributions' score is more closely matched to the two GII outcome variables than is the detractions' score, but each has a strong statistical relationship, with correlations of 0.84 and 0.70 respectively.

One compelling aspect of ranking countries by the impact of their policies, as opposed to innovation outcomes, is that governments have the capability to quickly and effectively change how their policies contribute to or detract from innovation. To dramatically improve their scores on this index, many countries would require only a few targeted policy improvements that could have large, positive impacts on innovation outcomes, both for the country and for the world.

While on an absolute basis U.S. policies do more to drive global innovation than those of any other nation, the United States ranks just 17th on contributions, controlling for the size of its economy. Five changes, however, could make the United States the top performer on the contributions' ranking and the top-ranked overall nation. To become number one overall, the United States would need to:

- Reduce its effective corporate tax rate from 27.7 to 18.2 percent;
- Increase its R&D tax credit from 14 to 24 percent, making the effective rate on par with the sample average, at 12 percent, as opposed to the current rate of 6 percent;
- Implement an innovation box policy;
- Increase government funding of university R&D by $68 billion a year (to $212 per person); and
- Increase the number of tertiary graduates in STEM fields by 20 percent.

Five changes could make the United States the top performer on the contributions' ranking and the top-ranked overall nation.

In particular, the United States lags behind many other nations in how its tax policy supports global innovation. While it scores fourth in human capital and 12th in R&D and technology, the United States scores just 49th out of 56 countries on the impact of its tax policies on global innovation. In order to improve, the United States should lower corporate tax rates to 18.2 percent, or half a standard deviation below the sample mean, as opposed to the current effective tax rate of 27.7 percent, which stands at 1.2 standard deviations higher than the mean. In addition, a more generous R&D tax credit of 24 percent, one standard deviation above the mean of the sample and on par with nations such as Norway and the Netherlands, as opposed to the current tax credit of only 6 percent, is needed. Finally, the United States should implement an innovation box policy, joining the 12 other nations that have one. These changes would move the United States from 49th to 10th in its tax policy score. While this still leaves the country far from being the world's most competitive tax system for targeting and encouraging innovation, these three changes would dramatically improve America's ability to innovate and thus increase global innovation.

The United States should also make a concerted effort to raise the level of government funding for university R&D. The United States has the world's top-rated university system, yet invests only $130 per capita in university R&D, a mere 0.2 standard deviations above the sample mean in purchasing power parity terms. Increasing investment to one full standard deviation above the sample mean would put the United States 12th in the world in funding university research (and roughly on par with countries such as Switzerland and Sweden) but would substantially increase U.S. research benefits for the domestic and global economies. This change would increase the country's overall ranking on R&D and technology contributions from 12th to 10th.

Finally, the United States should enact policies and strategies enabling more students to graduate with degrees in STEM subjects. Every year, thousands of U.S. university students are dissuaded from majoring in STEM subjects by space constraints in these programs. Allowing students to attain invaluable human capital by majoring in science would dramatically improve the United States' ability to produce a large volume of innovation. An increase of just 20 percent, a challenging but attainable goal, would improve the country's score to a full standard deviation above the sample mean and would move the United States from fourth place to second place on human capital contributions.

As noted, China ranks 44th overall, ranking 28th for contributions and 55th for detractions. It may be surprising to some that China ranks so low in terms of constructive impact on the global innovation system, particularly when many contend that China acts as a major positive driver of global innovation. For example, McKinsey's report *The China Effect on Global Innovation* concludes that China has the potential "to emerge as a driving force in innovation globally."[47] But this is because most analysts, including those at McKinsey, look at China's large size, and don't adjust its impact for size. Moreover, they focus on China's good policies, such as funding R&D, but ignore its bad policies, such as forced technology transfer, or even imply that these policies actually support global innovation, as McKinsey does when it talks about China's "low-cost innovation model" without mentioning how it is supported by currency manipulation and massive industrial subsidies.

ASSESSMENT OF COUNTRIES BY SPECIFIC INDICATORS

The following sections explain why each chosen indicator matters significantly for the global innovation system and then assesses countries' performance on each contributions indicator.

Contributions

As noted, Singapore, Korea, Finland, the United Kingdom, and Sweden lead on overall contributions' scores, again on a per-GDP basis. Costa Rica, Mexico, Indonesia, Argentina, and Colombia make the fewest contributions. Table 4 summarizes countries' scores for contributions.

Rank	Country	Contributions	Taxes	Human Capital	R&D and Technology
1	**Singapore**	14.99	0.21	1.23	0.72
2	**Korea**	14.70	-0.34	0.27	1.24
3	**Finland**	14.10	-0.20	0.96	0.91
4	**Sweden**	13.94	-0.18	0.92	0.90
5	**United Kingdom**	13.69	0.82	1.67	0.20
6	**Denmark**	13.54	0.18	1.04	0.67
7	**Taiwan**	12.26	0.50	0.43	0.63
8	**Japan**	11.33	-0.55	0.14	1.11
9	**France**	10.20	0.94	0.49	0.25
10	**Netherlands**	9.64	0.87	0.65	0.18
11	**Belgium**	9.40	0.58	0.51	0.34
12	**Austria**	9.22	0.03	0.64	0.52
13	**Slovenia**	9.21	0.20	0.20	0.59
14	**Iceland**	9.00	-0.12	1.26	0.37
15	**Switzerland**	8.80	-0.07	1.08	0.39
16	**Ireland**	8.70	0.78	1.25	-0.04

17	United States	8.54	-0.79	1.25	0.63
18	Canada	8.28	0.68	0.70	0.15
19	Israel	8.17	-1.02	0.32	1.00
20	Norway	7.76	0.65	0.90	0.05
21	Portugal	7.53	1.31	0.12	0.00
22	Germany	7.01	-0.91	0.80	0.70
23	Australia	4.74	-0.47	0.87	0.30
24	Estonia	4.31	-0.12	0.07	0.38
25	Spain	3.11	1.05	-0.06	-0.19
26	Hungary	2.87	1.22	-0.63	-0.09
27	Czech Republic	2.09	0.18	0.09	0.06
28	China	0.67	0.20	-0.76	0.22
29	Russia	-0.75	-0.49	-0.07	0.18
30	New Zealand	-1.42	-0.65	1.02	-0.16
31	Hong Kong	-1.85	0.25	0.67	-0.47
32	Malaysia	-2.50	0.17	-0.54	-0.10
33	South Africa	-3.10	0.14	-0.68	-0.08
34	Brazil	-3.24	-0.09	-0.96	0.09
35	Lithuania	-3.88	0.35	-0.39	-0.34
36	Turkey	-4.84	0.32	-0.57	-0.34
37	Bulgaria	-4.97	0.79	-0.88	-0.45
38	Thailand	-5.57	0.55	0.04	-0.70
39	Italy	-5.81	-0.18	-0.11	-0.35
40	Poland	-6.13	-0.25	0.02	-0.39
41	Slovak Republic	-6.34	-0.25	-0.03	-0.39
42	Latvia	-7.67	0.25	-0.43	-0.58
43	Vietnam	-8.06	0.16	-0.61	-0.52
44	India	-8.32	0.25	-1.21	-0.38
45	Romania	-9.83	0.29	-0.75	-0.67
46	Chile	-10.86	0.10	-0.95	-0.60
47	Peru	-13.57	-0.21	-1.22	-0.60
48	Philippines	-13.62	-0.42	-1.21	-0.51
49	Ukraine	-14.32	-0.14	-0.71	-0.86
50	Kenya	-14.90	-0.97	-1.23	-0.37
51	Greece	-15.45	-1.35	-0.23	-0.58
52	Colombia	-15.53	-0.33	-1.18	-0.72
53	Argentina	-15.80	-1.05	-1.00	-0.49
54	Indonesia	-16.08	-0.90	-1.39	-0.44
55	Mexico	-16.68	-0.85	-1.13	-0.60
56	Costa Rica	-16.73	-0.78	-0.85	-0.73

Table 4: Aggregate Scores for Contributions

Taxes

The way taxes are structured has a substantial impact on innovation, in large part because some activities have a much greater impact on innovation, both within the firm and through "spillovers" to the rest of the economy. This is particularly true for investment in research and development and capital goods, especially ICT equipment. Many countries implement tax policies designed to reward innovators and recognize the benefits that R&D investments generate for society. Policies such as R&D tax credits, collaborative R&D tax credits, and innovation boxes provide incentives for firms to invest in R&D, thereby increasing the amount of innovation firms produce, to the benefit of the country and the world. Moreover, lower taxes on corporate profits enable companies to invest more in the capital goods and research that have positive long-term effects for innovation.

This report considers five tax indicators: effective corporate tax rates, R&D tax credit generosity, collaborative R&D tax credits, innovation boxes, and taxes on ICT products. Overall, Portugal, Hungary, Spain, France, and the Netherlands field the five strongest tax regimes, while Greece, Argentina, Israel, Kenya, and Germany field the five weakest.

Effective Corporate Tax Rates

In a world where capital is increasingly mobile, countries have increasingly realized that corporate tax levels need to be moderate in order to field globally competitive economies. This is the major reason why the average base corporate income tax rate of 33 non-U.S. OECD nations declined by 22 percent from 2000 to 2015, with the average OECD base corporate income tax rate declining from 32.6 percent to 25 percent over that time.[48] In contrast, the U.S. corporate income tax rate held constant at 39 percent over this period.

Policies such as R&D tax credits and innovation boxes provide incentives for firms to invest in R&D, thereby increasing the amount of innovation firms produce, to the benefit of the country and the world.

But reasonable and competitive corporate tax rates are not just good for national economic competitiveness; they also help drive global innovation. This is in part because high corporate taxes (from income, sales, property, and other taxes) reduce the amount of available funding for companies to invest in capital goods and R&D.[49] For example, Mukherjee, Singh, and Zaldokas find that "taxes affect not only patenting and R&D investment but also new product introductions."[50] Likewise, a 10 percent increase in the effective corporate tax rate reduces the aggregate investment-to-GDP ratio by 2.2 percent and reduces FDI inflows by 2.3 percent. Higher effective corporate income taxes have also been associated with lower investment in manufacturing and a larger unofficial economy (which unwittingly costs governments potential tax income from economic activity).[51]

Effective marginal corporate tax rates are based on what corporations actually pay in taxes, rather than the nominal rate.[52] (Data on countries' effective marginal tax rates comes from pre-tax and post-tax profits from public filings for companies worldwide to determine what they actually pay in taxes; thus, this measure incorporates everything a public company might pay taxes on, including property, sales, and income taxes.) Greece, Japan, Argentina, Israel, and Italy have the highest effective tax rates, while Bulgaria, Latvia, Lithuania, Ireland, and Hungary have the lowest, as Table 5 shows. With the highest statutory corporate tax rate and relatively modest deductions and incentives, the United States has the eighth highest effective corporate tax rate.

Government spending as a percentage of GDP has an impact on corporate tax rates, but does not dictate them. For example, Finland, the Netherlands, and Sweden, whose social justice models require some of the highest overall tax burdens in the world (on average, government spending is 34 percent of GDP in these nations), all have lower-than-average effective corporate tax rates.[53] This is because they rely on less distorting and innovation-reducing taxes, such as value-added taxes and taxes on individuals. On the other hand, Indonesia, India, Mexico, and Korea have some of the world's highest effective corporate tax rates but much lower overall government spending (on average 17 percent of GDP).[54]

Country	Effective Corporate Tax Rate	Country	Effective Corporate Tax Rate
Bulgaria	10.0%	Switzerland	20.3%
Latvia	13.2%	Spain	20.3%
Lithuania	13.2%	Czech Republic	20.4%
Ireland	13.4%	Canada	20.4%
Hungary	13.7%	Colombia	20.5%
Romania	14.1%	China	21.5%
Taiwan	14.4%	South Africa	21.6%
Hong Kong	14.5%	Malaysia	22.8%
Slovenia	15.0%	France	23.1%
Portugal	15.7%	Denmark	23.4%
Ukraine	15.8%	Philippines	24.0%
Singapore	16.3%	Brazil	24.1%
Thailand	16.4%	New Zealand	24.7%
Estonia	17.6%	Russia	26.0%
Iceland	17.6%	Kenya	26.4%
Chile	17.9%	Costa Rica	26.4%
United Kingdom	18.2%	Korea	26.7%
Sweden	18.4%	India	26.8%
Norway	18.4%	Australia	27.1%
Turkey	18.6%	Mexico	27.2%
Finland	18.6%	United States	27.7%
Netherlands	18.8%	Indonesia	28.1%
Peru	18.8%	Germany	28.2%
Slovak Republic	19.4%	Italy	29.1%
Vietnam	19.4%	Israel	29.7%
Poland	19.4%	Argentina	30.8%
Belgium	19.5%	Japan	31.5%
Austria	19.7%	Greece	32.8%

Table 5: Countries' Effective Corporate Tax Rates[55]

R&D Tax Incentive Generosity

Enterprises' investments in R&D constitute a fundamental driver of global innovation. However, global levels of private sector research activity remain suboptimal from a societal perspective, in part because firms cannot capture all the gains from their own R&D

investments. For example, Nicholas Bloom, Mark Schankerman, and John Van Reenen estimate that the gross social returns from business R&D are at least twice as high as the private returns, indicating that the normal level of underinvestment is quite high.[56] Likewise, Charles Jones and John Williams calculated the social rate of return from R&D and found that the optimal level was at least two to four times the current rate of investment.[57] Companies make strategic choices based on the R&D benefits they are able to capture, as opposed to the total benefits produced by their research, yet society would benefit from much higher R&D levels.

Accordingly, many nations offer their enterprises R&D tax incentives to bolster private sector research activity. Almost all scholarly studies conducted since the early 1990s find these R&D tax incentives to be both effective and efficient.[58] Evidence shows that every dollar of federal revenue invested in R&D tax credits in the United States leads to companies spending at least one additional dollar on R&D, with some studies finding a benefit-to-cost ratio as high as 2 or 2.96.[59]

Moreover, several studies have evaluated the effect of tax incentives for research across a number of nations. In examining R&D tax incentives in 17 OECD nations, Guellec and van Pottelsberghe find that incentives effectively stimulate business R&D.[60] Another cross-national study by Wolff and Reinthaler concludes that R&D tax credits stimulate at least one dollar of R&D for every dollar of tax expenditure.[61] Likewise, in a study of nine OECD nations, Bloom and Griffith find that every dollar of R&D tax expenditure stimulates approximately one dollar of business R&D. They also find that three countries (Australia, Canada, and Spain) that made significant changes in their incentives saw increases in private R&D, while decreases had the opposite effect.[62]

The United States introduced the world's first R&D tax incentive in 1981, and for years offered the world's most generous incentive, before being surpassed by dozens of other nations in R&D tax incentive generosity in recent years.[63] For example, a 2012 ITIF study found that the United States offered only the 27th most generous R&D tax incentive among OECD nations.[64] In this sample, the United States has the 32nd most generous R&D tax incentive out of 56 countries. Of the countries assessed in this study, India, Portugal, France, Spain, and Denmark offer the most generous R&D tax incentives, as Table 6 shows. In India, for every 100 rupees of private sector expenditure on R&D, a firm can receive a tax credit of 44 rupees. Eighteen countries offer no R&D tax incentive.

Country	R&D Tax Incentive Generosity	Country	R&D Tax Incentive Generosity
India	44.0%	**Russia**	10.0%
Portugal	41.0%	**Singapore**	9.0%
France	38.5%	**Philippines**	7.0%
Spain	35.0%	**United States**	6.0%
Denmark	29.0%	**Hong Kong**	5.7%
Malaysia	29.0%	**Lithuania**	5.7%
Brazil	26.0%	**Romania**	5.7%
Canada	25.5%	**Slovenia**	5.0%
Netherlands	23.5%	**Colombia**	2.4%
Norway	23.5%	**Latvia**	1.9%
Hungary	22.0%	**Greece**	1.0%
South Africa	22.0%	**Chile**	0.0%
Turkey	22.0%	**Costa Rica**	0.0%
Czech Republic	20.0%	**Estonia**	0.0%
United Kingdom	19.5%	**Finland**	0.0%
Korea	18.0%	**Germany**	0.0%
Vietnam	16.3%	**Iceland**	0.0%
Taiwan	15.0%	**Indonesia**	0.0%
Japan	14.5%	**Israel**	0.0%
Australia	14.0%	**Kenya**	0.0%
Belgium	14.0%	**Mexico**	0.0%
China	14.0%	**New Zealand**	0.0%
Argentina	13.4%	**Peru**	0.0%
Bulgaria	13.4%	**Poland**	0.0%
Thailand	13.4%	**Slovak Republic**	0.0%
Ireland	13.0%	**Sweden**	0.0%
Austria	12.0%	**Switzerland**	0.0%
Italy	12.0%	**Ukraine**	0.0%

Table 6: Countries' R&D Tax Incentive Generosity Levels[65]

Collaborative R&D Tax Credits

Collaborative R&D tax credits provide firms a more generous tax incentive for expenditures made to support research at universities, national labs, and research consortia. They represent a powerful innovation policy tool because, as noted, businesses seldom capture all of the benefits of their R&D activities, particularly with regard to risky, early-stage research conducted at universities, federal labs, or consortia. Collaborative R&D tax credits thus provide firms a stronger incentive for research collaboration.

Many sectors fund research performed at universities, federal labs, or industry consortia. For example, Motohashi found that 70 percent of Japanese firms engaging in R&D

participate in R&D collaborations, mainly among small- and large-sized firms.[66] Audretsch and Feldman found that between 1988 and 1996 the biotechnology sector formed 20,000 collaborative alliances globally among small startups, large firms, and universities, with annual growth in the number of collaborations reaching 25 percent.[67] Moreover, the innovation process itself is increasingly collaborative in nature. For example, University of California Berkeley professors Fred Block and Matthew Keller found that, whereas in the 1970s approximately 80 percent of award-winning U.S. innovations came from large firms acting on their own, today, approximately two-thirds of award-winning U.S. innovations involve some kind of inter-organizational collaboration.[68]

Country	Type of Incentive	Details
Belgium	75% payroll withholding tax credit	For companies collaborating with a university or research institute.
Chile	46% flat tax credit	For companies collaborating with a university or research institute and certified by the Chilean Economic Development Agency.
France	60% flat tax credit	For companies collaborating with research institutes or federal laboratories.
Hungary	Up to 400% taxable income deduction	Full deduction offered if company co-locates lab at a university or research institute. Half (200%) deduction is offered for all other collaborations.
Italy	40% flat tax credit	For industry-funded R&D collaborations with a university or research institution.
Japan	12% flat tax credit (large firms) or 30% flat tax credit (small firms)	For companies collaborating with a university or research institute.
Netherlands	14% (large companies) or 42% (small companies) flat tax credit	For wages paid to scientists and researchers in a collaborative agreement between business and another organization.
Norway	18% (small companies) or 20% (large companies) deduction of R&D expenses	For companies collaborating with a university or research institute. (Deduction capped at NOK 11 million.)
Spain	10% flat tax credit	For companies collaborating with a university or research institute.
Thailand	Up to 200% deduction for R&D activities[69]	Applies to both collaborative and non-collaborative industry-funded R&D.
Turkey	Up to 100% base deduction[70]	Applicable for firms with more than 500 researchers. Additional 50% deduction on R&D expenditure increases in following year.
United Kingdom	175% (small companies) or 130% (large companies) taxable income deduction	Contracted R&D with external organizations is eligible for the regular R&D credit.

Table 7: Countries With Collaborative R&D Tax Credits[71]

As Table 7 shows, 12 countries employ collaborative R&D tax credits. Among the most generous of these are Hungary's and France's. Hungary offers up to a 400 percent taxable income deduction, while France offers a 60 percent flat tax credit for all companies collaborating with French research institutes or federal laboratories. The United Kingdom offers a 175 percent taxable income deduction for small companies (and 130 percent for large companies) for investments in contracted R&D activity with organizations that are eligible for Britain's regular R&D tax credit. (Note: Canada receives half credit on this indicator because two of its provinces, Quebec and Ontario, offer collaborative R&D tax credits. For instance, firms in Ontario, Canada, can receive a 55 percent combined state-federal tax credit when they fund R&D projects undertaken in collaboration with a Canadian university or national laboratory.)

Innovation Boxes

Innovation boxes differ from R&D tax incentives in that they provide firms with an incentive for the commercialization of innovation, rather than just for the conduct of research.

The commercialization of innovation, going beyond the mere conduct of R&D, constitutes a vital driver of innovation and growth. Innovation boxes tax qualifying profits (profits derived from various kinds of intellectual property) at a lower rate in order to incentivize innovation. Innovation boxes differ from R&D tax credits in that they provide firms with an incentive for the commercialization of innovation, rather than just for the conduct of research. Research has found that innovation box policies do induce firms to patent more in the nations that have them.[72] ITIF has also found that industry R&D among European countries with innovation boxes increased by 4 percent from 2008 to 2009, versus 3.8 percent in non-innovation box nations.[73]

Country	Effective Corporate Tax Rate on Qualifying IP	Types of IP that Qualify	Year Enacted
Belgium	6.8%	Patents and supplementary protection certificates	2008
China	0-12.5%	Registered patents and know-how	2008
France	15%	Patents and supplementary protection certificates	2005
Hungary	9.5%	Patents, know-how, trademarks, business names, business secrets, and copyrights	2003
Ireland	<10%	Most IP	1973
Italy	15.7%	Patents and other intellectual property considered functionally equivalent	2014
Netherlands	10%	Patents or IP from qualifying and approved IP	2007
Portugal	N/A	Subjects only 50% of the gross income resulting from contracts exploiting patents, industrial designs, or models to the regular corporate rate	2014
Spain	15%	Most IP	2008
Switzerland	0-12%	Most IP	2011
United Kingdom	10%	Patents, supplementary protection certificates, regulatory data protection	2013

Table 8: Countries With Innovation Boxes[74]

Today, 11 countries in this sample use innovation boxes to foster innovation, most of which are clustered in Western Europe. (Table 8 provides a brief summary of these countries' innovation box policies, while Appendix B provides additional details.) Innovation box implementations differ among various nations along several dimensions. One is the types of profits that qualify for the lower rate. As expected, in all nations with innovation box regimes, patents are considered qualifying IP. However, Ireland, Spain, and Switzerland go further and also allow income from designs, copyrights, models, and trademarks to be taxed at the lower innovation box rate. Tax rates for eligible income in these countries vary from 6.8 percent in Belgium to 15.7 percent in France. Holland and the United Kingdom offer an effective corporate tax rate on qualifying IP of 10 percent.

Taxes on ICT Products

Governments throughout the world impose costs on ICT products and services in a variety of ways and to a range of degrees. Many countries are pursuing a smart, hands-off approach to ICT goods and services. However, other countries impose discriminatory taxes on ICT goods and services, in part because they see them as luxury goods, akin to yachts or Rolex watches. By doing so, they deter ICT adoption, which represents a critical component of economic growth in domestic economies and also an important contributor to global innovation.

By imposing discriminatory taxes on ICT, nations deter its adoption, which represents a critical component of economic growth in domestic economies and also an important contributor to global innovation.

ICT drives global productivity growth because it represents what economists call a "general purpose technology" (GPT). GPTs—which have historically appeared at a rate of once every half century—represent fundamentally new technology systems that change virtually everything, including what economies produce, how they produce it, how production is organized and managed, the location of productive activity, the skills required for productive activity, the infrastructure needed to enable and support it, and the laws and regulations needed to maintain or even allow it.[75] GPTs share a variety of similar characteristics. They typically start in relatively crude form for a single purpose or very few purposes; they increase in sophistication as they diffuse throughout the economy; they engender extensive spillovers in the forms of externalities and technological complementarities; and their evolution and diffusion span decades.[76] Moreover, GPTs undergo rapid price declines and performance improvements; become pervasive and an integral part of most industries, products, and functions; and enable downstream innovations in products, processes, business models, and business organization. By any of these measures, ICT ranks well against the most transformative technological breakthroughs in human history, such as the wheel, the printing press, or electricity.[77]

Studies have shown that ICTs were responsible for as much as two-thirds of U.S. productivity growth between 1995 and 2002, and approximately one-third of growth since then.[78] And that goes not just for the United States. In a conclusive review of over 50 scholarly studies on ICT and productivity published between 1987 and 2002, Dedrick, Gurbaxani, and Kraemer found that "at both the firm and the country level, greater investment in ICT is associated with greater productivity growth."[79] In fact, nearly all scholarly studies from the mid-1990s to 2014 have found positive and significant effects of ICT on productivity.[80]

Scholarly economic evidence shows that higher prices resulting from taxes (and tariffs, as discussed subsequently) on ICT goods and services reduce adoption by both consumers and businesses, especially in lower-income countries. Estimates of elasticity of ICT demand by continent range between -0.2 (North America) and -1.4 (South Asia).[81] For example, Brazil imposes extra ICT taxes of 5 percent (in addition to ICT tariffs of 11.6 percent), meaning it adds an additional almost 17 percent to the price of ICT goods sold in the country. These higher prices for ICT goods lead to decreased demand for and consumption of ICT products. In fact, ITIF estimates that these significant additional taxes and tariffs conspire to decrease ICT adoption in Brazil by over 20 percent, which results in annual Brazilian GDP growth being at least 1.2 percent lower than it would be otherwise.[82]

Table 9 shows the 10 countries in this study imposing the highest additional taxes on ICT products, led by Turkey, Argentina, Kenya, Ukraine, and Brazil.

Country	Extra Taxes on ICT Products
Turkey	22.1%
Argentina	11.0%
Kenya	6.7%
Ukraine	5.2%
Brazil	5.0%
Greece	4.5%
United States	2.6%
Malaysia	2.0%
Colombia	1.7%
Mexico	0.7%

Table 9: The Ten Countries Imposing the Highest Extra Taxes on ICT Products[83]

In short, countries that impose additional taxes on ICT products not only harm themselves, but constrict the very consumption of innovation- and productivity-empowering ICT tools by companies and consumers alike, meaning the world gets fewer innovations than it otherwise would. Argentina, for example, has been held back in its mobile applications development activity in part because high taxes have deterred mobile phone consumption, depriving the world of useful mobile applications that might have been developed by Argentine entrepreneurs.[84] Moreover, the slower economic growth that high ICT taxes induce in countries spills over to the rest of the world, slowing broader global economic growth. As Harvard economist Benjamin Friedman has shown, growth, or its lack, produces positive or negative externalities, with higher innovation and growth providing not just narrow monetary benefits of the kind economists count, but also improving civil discourse and leading to more tolerant and humane societies.[85] At the same time, countries' high taxes on ICT products harm the global ICT industry by deterring sales of ICT products, meaning that companies are less able to spread the costs of development over a wider global consumer base.

Human Capital

While having the best and brightest minds has always been important, human capital is increasingly vital to innovation. In many cases, today's innovators and entrepreneurs can disrupt whole industries with nothing more than an education and a laptop. Countries with better education systems are, all else equal, able to produce more innovation, to the benefit of the entire world. This report considers four indicators of human capital attainment: countries' expenditures on education per student, graduates in scientific fields, number of top-ranking universities, and number of researchers per capita. The United Kingdom, Iceland, Ireland, the United States, and Singapore record the highest overall scores for human capital indicators, while Indonesia, Kenya, Peru, India, and the Philippines score the lowest.

Country	Expenditure on Education per Student	Country	Expenditure on Education per Student
Norway	$18,218	Malaysia	$6,878
Singapore	$17,153	Czech Republic	$6,199
Switzerland	$16,139	Estonia	$5,847
Denmark	$14,638	Israel	$5,792
Sweden	$13,935	Korea	$5,714
Austria	$13,185	Poland	$5,204
Belgium	$12,740	Hungary	$5,180
Finland	$12,245	Slovak Republic	$5,107
Netherlands	$11,640	Lithuania	$4,800
Ireland	$11,422	Latvia	$4,698
Germany	$11,416	Thailand	$4,434
Hong Kong	$10,813	Costa Rica	$3,792
United States	$10,467	Argentina	$3,606
United Kingdom	$10,437	Mexico	$3,593
France	$10,127	Chile	$3,510
Iceland	$9,200	South Africa	$3,270
Japan	$8,585	Bulgaria	$3,068
New Zealand	$8,561	Ukraine	$2,926
Slovenia	$8,297	Romania	$2,476
Italy	$8,170	Colombia	$2,246
Australia	$8,064	Vietnam	$1,625
Spain	$8,026	Indonesia	$1,409
Canada	$7,324	Peru	$1,268
Portugal	$7,108	India	$1,248

Table 10: Countries' Average Education Expenditures per Primary and Secondary Student (PPP Dollars)[86]

Education Expenditures per Student

The production of educated citizens and workers constitutes an important driver of global innovation. Especially for workers who do not go into advanced scientific fields, increasingly at least a basic computer literacy will be needed for them to become productive and contributing members of society. It is also worth noting that, globally, higher levels of education correspond to lower levels of unemployment and poverty, again empowering the world's citizens to make constructive contributions to innovation and growth.[87] Finally, imagine a thought experiment. If every nation relied only on high-skilled immigration to acquire educated workers and underinvested in education, the global pool of educated workers would be significantly less.

While certainly many factors inform the quality of nations' primary and secondary education systems, a very important (though by no means definitive) factor is how much nations invest in students' education. Of course, buying school supplies, paying teachers, and building schools cost vastly differing amounts in various countries, so spending is measured here in purchasing power parity (PPP) terms.

Table 10 provides data for countries' expenditures on education per student.[88] Here, Norway leads, followed by Singapore, Switzerland, Denmark, and Sweden in the top five. The United States ranks 13th. India, Peru, Indonesia, Vietnam, and Colombia spend the least on education per student.

Science Graduates

If the international community is to make progress toward solving commonly shared global challenges—including health challenges such as disease, pandemics, or the effects of aging; or environmental challenges such as climate change and resource scarcity—it is going to have to push forward the frontiers of science in numerous fields. Accordingly, a country's output of science graduates represents an important measure of the extent to which a country contributes to the global innovation system. That is because the highly educated science graduates of today become the scientists and engineers of tomorrow, making breakthroughs and new discoveries in a wide range of scientific fields from life sciences to physics. This has become increasingly important as the "burden of knowledge" grows ever higher, meaning that the greater the global body of knowledge becomes, the successively more difficult it is for innovators to master the existing knowledge base and acquire the specialized education required to make breakthroughs in their fields.[89]

At the same time, cultivating a high-quality scientific workforce is critical to individual countries' economic growth, as these workers enable more innovation in a region's economy, which leads to higher-wage jobs and greater economic output.[90] For example, Robinson has found "a statistically significant [positive] impact on the [U.S.] economy from science and engineering graduates."[91] Similar relationships between higher levels of science and engineering graduates and greater levels of economic growth have been found across a number of economies. For example, research suggests that Taiwanese science and engineering graduates may have an even larger impact on their country's economic growth than do U.S. science graduates.[92]

Table 11 provides data on countries' tertiary science graduation rates per thousand citizens, while Table 12 provides the percentage of those graduates who receive degrees in physical and life sciences fields. New Zealand, the United Kingdom, Ireland, Poland, and Australia have the most science graduates per 1,000 citizens, while Indonesia, Argentina, Mexico, Colombia, and Brazil have the fewest. Countries such as the United Kingdom, Germany, Greece, Ireland, and France have much higher percentages of students majoring in science, helping these countries surpass others with equally developed university systems and enrollment rates. Low-performing countries not only had lower overall tertiary enrollment rates; they also tended to have lower percentages of students enrolling in science education. Colombia, Chile, Romania, Bulgaria, and Brazil graduate the lowest percentage of students in science fields of the countries in this study.

Country	Science Graduates per 1,000 Citizens	Country	Science Graduates per 1,000 Citizens
New Zealand	1.67	Malaysia	0.65
United Kingdom	1.43	Ukraine	0.64
Ireland	1.37	Greece	0.64
Poland	1.08	Latvia	0.63
Australia	1.03	Norway	0.60
Slovak Republic	1.01	Spain	0.58
Iceland	1.00	Netherlands	0.56
Czech Republic	0.94	Turkey	0.56
France	0.92	Sweden	0.54
Germany	0.90	Japan	0.53
United States	0.85	Costa Rica	0.50
Denmark	0.81	Switzerland	0.50
Estonia	0.75	Italy	0.46
Korea	0.75	Bulgaria	0.45
Vietnam	0.75	Belgium	0.42
Russia	0.74	Hungary	0.41
Finland	0.74	Chile	0.31
Slovenia	0.70	Brazil	0.27
Portugal	0.68	Colombia	0.26
Lithuania	0.67	Mexico	0.23
Romania	0.66	Argentina	0.18
Austria	0.66	Indonesia	0.17

Table 11: Countries' Science Graduates per 1,000 Citizens[93]

Country	Percent of Graduates in Science Fields	Country	Percent of Graduates in Science Fields
United Kingdom	12.7%	Slovak Republic	7.5%
Germany	12.6%	Italy	7.4%
Greece	12.3%	Portugal	7.4%
New Zealand	12.2%	Korea	7.1%
Ireland	11.9%	Argentina	7.0%
France	10.3%	Poland	6.4%
Estonia	10.2%	Latvia	6.3%
Malaysia	9.5%	Hungary	6.2%
Czech Republic	9.4%	Netherlands	6.2%
Austria	8.9%	Russia	6.1%
United States	8.9%	Costa Rica	5.7%
Turkey	8.6%	Mexico	5.5%
Australia	8.3%	Indonesia	5.5%
Denmark	8.3%	Lithuania	5.4%
Slovenia	8.1%	Belgium	5.3%
Iceland	8.0%	Ukraine	5.3%
Sweden	7.9%	Brazil	5.3%
Spain	7.9%	Bulgaria	5.2%
Switzerland	7.7%	Romania	5.0%
Finland	7.5%	Chile	4.9%
Norway	7.5%	Colombia	4.4%

Table 12: Countries' Percentage of Graduates in Science Fields[94]

Top-Ranking Universities

Strong university systems can be instrumental in fostering innovation, endowing students with the capacity to innovate, funding faculties conducting diverse research (much of it basic research), and acting as a resource for collaboration with other innovators. Universities that can conduct research and then collaborate with others to allow these innovations to reach markets can play an important role in the development of innovative goods and services.

Coe, Helpman, and Hoffmaister note another reason why having top-ranking universities matters: "Countries where the quality of tertiary education is relatively high benefit more from their own R&D efforts, from international R&D spillovers, and from their own investment in human capital formation than do other countries."[95] The authors define "the quality of tertiary education" as "a composite measure of the extent to which tertiary institutions have: freedom to manage resources (including the selection of students); autonomy to decide on the sources and structure of funding and staff personnel policies; freedom in setting objectives, including deciding on course content; and are accountable, including various types of evaluations."[96]

The United States enjoys the highest raw number of universities on the Times Higher Education World University Ranking, with 108 of the top 400 (and 147 of the top 800) universities ranked, as Table 13 shows. The United States and the United Kingdom dominate the top 50 university rankings, accounting for about two-thirds of the world's top 50 universities. After the United States and the United Kingdom, Germany, Canada, and Australia have the most top 800 world-ranked universities. However, these countries are helped by their size. Therefore, the final country score (the last column in Table 13) is calculated by considering the number of universities a country has on the list controlled by population, the rankings of those universities, and the raw number of high-scoring universities on the list. Switzerland ranks third because it has a much higher concentration of universities, with eight universities in the top 400, or about one university per million citizens, including the Swiss Institute of Technology in Zurich, the highest-rated university outside the United States or the United Kingdom. Similarly, Singapore and Iceland have universities making the list despite much smaller populations. Bulgaria, Costa Rica, Peru, the Philippines and Vietnam each had no universities make the list.

Rank	Country	Number of Top 50 Universities	Number of Top 800 Universities	Composite Score
1	**United States**	26	147	2.56
2	**United Kingdom**	7	78	2.31
3	**Switzerland**	2	10	2.11
4	**Singapore**	1	2	2.05
5	**Netherlands**	1	13	1.82
6	**Iceland**		1	1.66
7	**Sweden**	1	11	1.46
8	**Australia**	1	31	1.33
9	**Germany**	3	37	1.23
10	**Hong Kong**	1	6	1.19
11	**Denmark**		6	0.98
12	**Canada**	3	25	0.87
13	**Ireland**		9	0.82
14	**Belgium**	1	7	0.77
15	**Finland**		9	0.70
16	**Norway**		4	0.45
17	**New Zealand**		7	0.35
18	**Austria**		7	0.22
19	**Italy**		34	0.21
20	**France**		27	0.14
21	**Estonia**		2	0.05
22	**Israel**		6	-0.02
23	**Korea**		24	-0.13
24	**Taiwan**		24	-0.23
25	**Spain**		25	-0.23
26	**Japan**	1	41	-0.29

27	**Portugal**		7	-0.31
28	**China**	2	37	-0.32
29	**South Africa**		6	-0.34
30	**Czech Republic**		9	-0.38
31	**Russia**		13	-0.46
32	**Greece**		7	-0.48
33	**Slovenia**		2	-0.55
34	**Turkey**		11	-0.61
35	**India**		17	-0.64
36	**Chile**		6	-0.64
37	**Argentina**		2	-0.67
38	**Mexico**		2	-0.68
39	**Hungary**		6	-0.70
40	**Brazil**		17	-0.71
41	**Malaysia**		5	-0.77
42	**Latvia**		1	-0.78
43	**Romania**		4	-0.79
44	**Poland**		7	-0.80
45	**Slovak Republic**		2	-0.81
46	**Colombia**		2	-0.81
47	**Lithuania**		1	-0.82
48	**Thailand**		7	-0.82
49	**Ukraine**		2	-0.88
50	**Kenya**		1	-0.89
51	**Indonesia**		1	-0.89

Table 13: Countries' Number of Top-Ranking Universities[97]

Scientific Researchers per Capita

Table 14 shows countries' scientific researchers per capita. The number of people conducting scientific research is a strong measure of a country's focus on R&D and the success of programs meant to encourage it. Finland, Iceland, Denmark, Singapore, and Israel have the highest numbers of researchers per capita, while the Philippines, Peru, Indonesia, Vietnam, and India have the least. It is no surprise that wealthier countries can support more researchers. The number of researchers per capita is correlated with GDP per capita at 0.77.[98] However, many countries outperform expectations. For example, compared with many of its European neighbors, top-scoring Finland has double the concentration of researchers. Surprisingly, Portugal is the highest European scorer outside Scandinavia, despite having a lower-than-average GDP per capita compared with the rest of the region. Many Asian nations—notably Singapore, Korea, and Japan—also score well on this measure.

Country	Researchers per 1,000 Population	Country	Researchers per 1,000 Population
Finland	7.41	**Hong Kong**	2.85
Iceland	6.89	**Slovak Republic**	2.83
Denmark	6.73	**Spain**	2.81
Singapore	6.24	**Hungary**	2.42
Israel	6.06	**Greece**	2.25
Korea	5.73	**Latvia**	1.98
Norway	5.43	**Italy**	1.81
Japan	5.17	**Poland**	1.76
Sweden	5.09	**Bulgaria**	1.65
Portugal	4.88	**Malaysia**	1.56
Austria	4.53	**Ukraine**	1.27
Switzerland	4.52	**Costa Rica**	1.24
Canada	4.43	**Argentina**	1.20
Slovenia	4.41	**China**	1.03
Germany	4.24	**Turkey**	0.95
Australia	3.94	**Romania**	0.90
United States	3.93	**Brazil**	0.69
Belgium	3.92	**Mexico**	0.37
United Kingdom	3.92	**South Africa**	0.35
Taiwan	3.80	**Thailand**	0.33
France	3.76	**Chile**	0.31
New Zealand	3.61	**Kenya**	0.20
Ireland	3.49	**Colombia**	0.18
Estonia	3.48	**India**	0.15
Netherlands	3.48	**Vietnam**	0.12
Czech Republic	3.16	**Indonesia**	0.08
Russia	3.11	**Peru**	0.08
Lithuania	2.86	**Philippines**	0.07

Table 14: Countries' Number of Researchers per 1,000 Population[99]

R&D and Technology

Nobel Prize-winning economist Robert Solow studied factors of production leading to growth and found that fewer than half could be explained using the common factors assumed at the time related to capital and labor supply. He found, instead, that technological and related innovations were the dominant factors—accounting for approximately 60 percent—leading to economic growth.[100] Elaborating on Solow's work, economists such as Paul Romer, Zvi Griliches, and Kenneth Arrow have confirmed that technological progress was the critical missing factor.[101] Succinctly put by William H.

Press, "As a factor of production, technology produces wealth and produces more technological progress, enabling a virtuous cycle of exponential growth."[102]

Given the private sector's tendency to underinvest in innovation, public R&D funding is needed to bring rates of economic growth, job creation, and improvement in living standards up to their potential.[103] Furthermore, governments tend to be less averse than the private sector to investments in high-risk, early-stage research that remains far from commercialization; thus, publicly funded R&D helps alleviate the private sector's underinvestment due to the "valley of death" problem experienced by young, innovative firms with unproven products or ideas. While much of this early-stage research does not lead to commercial results in the short term, it is more likely to produce the breakthrough innovations that generate large benefits for the domestic economy and the world in the long run while creating the underlying knowledge that subsequent innovation builds on. For example, nanotechnology may very well be to the 21st century what steel was to the early 20th century, but significant investment in basic research is still needed before commercialization of this new technology will be possible. As a result, governments currently fund the vast majority of nanotechnology research.

Despite funding higher-risk projects such as nanotechnology, public R&D has been shown to be efficient: Estimates of the return on investment from publicly funded R&D range from 20 percent to 67 percent.[104] And multiple studies have found that public R&D serves as a complement, rather than a substitute, for private R&D, with the information flow between public researchers and industry augmenting the value of industrial R&D.[105] For example, Levy and Terleckyj find that one additional dollar of government R&D has the effect of inducing an additional 27 cents of private R&D investment.[106] Accordingly, governments' support for scientific research amounts to a win-win for the country and the world.[107]

Unfortunately, some have questioned the value of public investment in R&D. For example, Matt Ridley, a member of the British House of Lords, recently authored a book, *The Evolution of Everything: How New Ideas Emerge*, which argues that government-funded public R&D does not benefit the economy nor speed innovation.[108] Ridley contends that private innovation has a life of its own that cannot be accelerated, stopped, or steered by the government.

But empirical research continuously demonstrates that publicly funded R&D constitutes a powerful engine of innovation and long-term economic growth. Ridley notably glosses over the long-term benefits of science. In doing so, he fundamentally misunderstands the role of government research: to expand the bounds of human knowledge. New scientific understanding enables subsequent applied research and the commercialization of technologies. Examples that have reshaped our world include hybrid corn, reverse auctions, the shale gas revolution, and supercomputing, as ITIF notes in *Federally Supported Innovations: Examples of Major Technology Advances That Stem From Federal Research Support.*[109]

Ridley further posits that public R&D crowds out industry and philanthropic R&D; however, as noted above, economic literature shows that public R&D accomplishes the opposite: Public R&D generates additional private R&D, as multiple studies have demonstrated.[110] This effect stretches to military R&D.[111] For example, military development of autonomous drone technology is now finding myriad applications for private commercialization, and the government-funded Human Genome Project, which sought to map the human genome, has sparked copious private investment in the promising field of genomics. Government R&D funds cultivation of basic scientific knowledge, which provides the foundation to allow companies to conduct subsequent applied R&D, which creates immense consumer benefits.

This section analyzes five indicators of countries' R&D and technology policies: government R&D expenditures per person, government funding of university R&D, whether countries have "Bayh-Dole-like" policies granting university researcher ownership of government-funded research, whether the country has instituted a national innovation foundation, and the extent of citations of research publications (e.g., in scientific journals). Korea, Japan, Israel, Finland, and Sweden score highest on the R&D and technology policy indicators alone, while Ukraine, Costa Rica, Colombia, Thailand, and Romania score weakest.

How much one country invests in R&D entails significant positive spillovers to other countries throughout the world, and particularly to trading partners.

Government R&D Expenditures per Capita

The knowledge that R&D generates has value for everyone, since the spillover effects of R&D tend to be profound for a domestic economy and substantial for a country's international trade partners. For example, Coe, Helpman, and Hoffmaister find in their paper *International R&D Spillovers and Institutions*: "There are spillovers from current R&D to future R&D activities. In an international context these spillovers cross national borders, implying that [the] R&D of one country impacts not only the future R&D costs of domestic firms, but also the future R&D costs of foreign firms."[112] But because the full value of R&D cannot be captured by the researchers themselves, private companies underinvest in R&D. As such, countries that invest more in R&D and create new knowledge and technologies provide a public good that benefits the entire global innovation ecosystem.

Estimates of the return on investment from publicly funded R&D range from 20 to 67 percent.[113] Likewise, Coe and Helpman find very high rates of return on R&D, both in terms of domestic output and international spillovers.[114] An economy's productivity level depends in part on its cumulative R&D base and on its effective stock of knowledge, with the two being interrelated. As Coe and Helpman maintain, "In a world with international trade in goods and services, foreign direct investment, and an international exchange of information and dissemination of knowledge, a country's productivity depends both on its own R&D as well as on the R&D efforts of its trade partners."[115] And, indeed, foreign R&D has beneficial effects on domestic productivity that are stronger the more open an economy is to foreign trade. For example, Coe and Helpman found that a 1 percent increase in the R&D capital stock of the United States increased domestic productivity by 0.23 percent and raised the average productivity of 22 developed countries studied by 0.12 percent.[116] Coe and Helpman observed a similar effect across the G7 countries (Canada, Germany, France, Japan, Italy, the United Kingdom, and the United States), finding that a $100 increase in the R&D capital stock in a G7 country raises its annual GDP by $123 on average. They also found large international R&D spillovers, concluding that, in 1990, the average worldwide rate of return from investment in R&D in the G7 countries was 155 percent. Thus, international spillovers from R&D are quite substantial. If the worldwide rate of return is as high as 155 percent, and countries' own rate of return is 123 percent, the externality is more than double. Finally, Coe and Helpman observed that about one-quarter of the total benefits of R&D investments in a G7 country accrue to its trade partners.[117]

Country	Government Expenditures on R&D (per capita)	Country	Government Expenditures on R&D (per capita)
Korea	$1,995	Brazil	$719
Israel	$1,991	New Zealand	$701
Finland	$1,893	Spain	$677
Sweden	$1,884	Italy	$656
Japan	$1,844	South Africa	$520
Slovenia	$1,537	Lithuania	$509
Germany	$1,525	Malaysia	$508
Denmark	$1,493	Turkey	$507
United States	$1,471	Kenya	$469
Austria	$1,463	India	$464
Singapore	$1,410	Poland	$455
Taiwan	$1,312	Slovak Republic	$454
Switzerland	$1,311	Greece	$404
Estonia	$1,303	Latvia	$394
Iceland	$1,291	Bulgaria	$380
Australia	$1,221	Hong Kong	$357
France	$1,165	Argentina	$342
China	$1,127	Romania	$301
Belgium	$1,123	Costa Rica	$237
Netherlands	$1,088	Mexico	$221
Canada	$1,045	Peru	$218
United Kingdom	$972	Chile	$213
Czech Republic	$954	Indonesia	$122
Norway	$937	Thailand	$109
Portugal	$882	Ukraine	$90
Ireland	$835	Colombia	$86
Russia	$813	Philippines	$43
Hungary	$783	Vietnam	$42

Table 15: Countries' Expenditures on R&D (per capita), in Current PPP Dollars[118]

Thus, put simply, how much one country invests in R&D entails significant spillovers to other countries throughout the world, and particularly to trading partners. As Table 15 shows, Korea, Israel, Finland, Sweden, and Japan invest the most per capita in public R&D, and thus are poised to produce the largest international spillovers, per capita. In contrast, Vietnam, the Philippines, Colombia, Ukraine, and Thailand invest the least. Again, while wealthier countries are expected to score better on this measure, some countries clearly have made public research a priority. Consider that the United Kingdom and Norway only outspend Brazil by 35 percent and 30 percent, respectively, on a PPP basis. Several eastern European nations, including Slovenia and Estonia, show high commitment to publicly funded research.

Government Funding of University R&D

Research performed outside the private sector makes a critical contribution to most countries' innovation systems.[119] Even with robust corporate R&D investment, the private sector alone does not provide the level of innovative activity that society needs, because firms do not capture all of the benefits of innovation. Enterprises in many countries have expanded their investments in later-stage applied research, but investments in basic research have stagnated. For example, from 1991 to 2008, basic research as a share of corporate R&D conducted in the United States fell by 3.6 percent, while applied research fell by roughly the same amount, 3.5 percent. In contrast, development's share increased by 7.1 percent.[120] University research has become increasingly important in filling this basic, early-stage research gap. For example, as correctly noted in the Massachusetts Institute of Technology's report *The Future Postponed: Why Declining Investment in Basic Research Threatens a U.S. Innovation Deficit*, "As competitive pressures have increased, basic research has essentially disappeared from U.S. companies, leaving them dependent on federally funded, university-based basic research to fuel innovation."[121]

Moreover, university research spurs commercial innovation. For instance, in terms of its impact on product and process development in U.S. firms, Mansfield finds the social rate of return from investment in academic research is at least 40 percent.[122] A study by the Science Coalition found that "companies spun out of research universities have a far greater success rate than other companies."[123] In fact, in the United States, there were 651 spin-offs from university research in 2010 and 671 spin-offs in 2011.[124] Many of those start-ups were created as a direct result of federally funded research at universities. These start-ups are often incredibly innovative, but they are not themselves conducting the basic research. Government funding for research does not place governments in competition with industry; rather governments fund university research that is more basic in nature and that does not have an immediate economic impact, complementing the more applied research and development activity performed by industry.[125]

Country	Government Funding of University Research (per capita)	Country	Government Funding of University Research (per capita)
Singapore	$382	**Czech Republic**	$89
Switzerland	$369	**Spain**	$83
Denmark	$341	**Israel**	$82
Sweden	$304	**New Zealand**	$76
Norway	$279	**Greece**	$54
Austria	$257	**Slovenia**	$51
Australia	$249	**Slovak Republic**	$51
Finland	$227	**Brazil**	$47
Netherlands	$226	**Poland**	$44
Iceland	$216	**Argentina**	$35
Lithuania	$215	**Hungary**	$33
Germany	$179	**Thailand**	$26
Canada	$165	**Colombia**	$26
Latvia	$156	**Bulgaria**	$23
Estonia	$155	**Turkey**	$22
France	$151	**South Africa**	$21
Hong Kong	$140	**Costa Rica**	$20
Ireland	$131	**Peru**	$18
United States	$130	**Mexico**	$18
Kenya	$129	**Chile**	$17
Belgium	$128	**Russia**	$15
Taiwan	$117	**Indonesia**	$12
Portugal	$113	**India**	$12
Italy	$113	**Ukraine**	$11
Malaysia	$111	**China**	$11
United Kingdom	$99	**Romania**	$8
Korea	$99	**Philippines**	$8
Japan	$90	**Vietnam**	$7

Table 16: Government Funding of University Research (per capita)[126]

As Table 16 shows, Singapore, Switzerland, Denmark, Sweden, and Norway lead the world in government funding of university research per capita. Vietnam, the Philippines, Romania, China, and Ukraine invest the least. The United States lags noticeably on this indicator, with leader Singapore investing almost three times as much in government university research funding than does the United States. In fact, a recent ITIF study found that the United States ranks just 24th out of 39 leading (mainly OECD) nations in its level of federal funding for university research, with the United States ranking 18th in its rate of growth in federal funding for university research from 2000 to 2011.[127]

“Bayh-Dole-Like” Policy

It is one thing to conduct research at universities; it is another to effectively transfer that knowledge to the private sector for commercialization. One key way to incentivize this is for governments to give universities the rights to the intellectual property they produce. In 1980, the U.S. Congress passed the Bayh-Dole Act, which transferred ownership of an invention or discovery from the government agency that had helped to pay for it to the academic institution that had carried out the actual research, thus providing academic researchers with incentives to exploit their ideas.[128]

As enterprises increasingly invest in later-stage applied research and development, the role of universities throughout the world in conducting basic research has become more important.

Countries with a Bayh-Dole-Like Policy	Countries with Technology Transfer Legislation
Brazil	Belgium
Indonesia	Denmark
Japan	Germany
Malaysia	United Kingdom
Philippines	
Russia	
Singapore	
South Africa	
Korea	
Taiwan	
United States	
Vietnam	

Table 17: Countries With “Bayh-Dole-Like Policies” or Technology Transfer Legislation[129]

Since Bayh-Dole, technology transfer offices have more easily been able to facilitate the transfer of economically significant innovations to commercial markets. The results have been impressive. *The Economist* hailed the Bayh-Dole Act as:

> Possibly the most inspired piece of legislation to be enacted in America over the past half-century…It unlocked all the inventions and discoveries that had been made in American laboratories throughout the United States with the help of taxpayers’ money. More than anything, this single policy helped to reverse America’s precipitous slide into industrial irrelevance.[130]

A recent study by the Biotechnology Industry Organization (BIO) examined the economic benefits derived directly from technology transfer from universities to industry. Examining the period from 1996 to 2007, the study found that licensing agreements accounted for somewhere in the range of $47 to $187 billion of U.S. GDP. An additional $82 billion of GDP over the 12-year time period came from royalty rate yields at an estimated 5 percent. Additionally, the study estimated that, as a result of university licensing, 279,000 jobs have been created, and gross industry output increased from $108.5 billion to $457.1 billion.[131]

A follow-up study by BIO extended the period from 1996 to 2010 and included nonprofit research institutes with universities. The study found that technology transfer resulted in an impact of up to $836 billion in gross industry output, $388 billion in GDP, and 3 million jobs.[132]

Many countries have adopted policies similar to America's Bayh-Dole Act. The policy is particularly popular among Asian nations, with Indonesia, Malaysia, the Philippines, Singapore, Korea, and Taiwan all enacting policies, as Table 17 shows. While no EU country has an exactly analogous Bayh-Dole-like policy, several countries—including Belgium, Denmark, Germany, and the United Kingdom—have enacted related technology transfer legislation supporting university commercialization of publicly funded research.[133]

National Innovation Foundations

It is not enough for countries to fund science; they also need to do everything in their power to ensure that scientific research reaches society by being translated into new technologies, new processes, new products and services, and ultimately even entirely new industries (e.g., how America's federal government's investments in materials, physical, and information sciences helped unleash the global ICT revolution).

The more that countries support their domestic firms and other organizations in their innovative activities, the more they bolster the global production of innovation.

Innovation is the product of intentional human action and occurs within the context of national innovation systems, which is why scores of countries have in modern years created national innovation foundations that comprehensively consider the construct of their country's innovation ecosystems and how to optimize their performance. The more that countries support their domestic firms and other organizations in their innovative activities, the more they bolster the global production of innovation. At the same time, another important objective of many countries' innovation agencies has been funding research into the nature of innovation; firm-level innovation strategies; and the impact of innovation on regional, national, and global economies. In other words, countries with national innovation agencies create new knowledge about innovation that benefits not only themselves, but also the entire world.

As ITIF noted in *The Global Flourishing of National Innovation Foundations*, a central mission for national innovation foundations is to articulate a national innovation strategy—a coherent approach that seeks to coordinate disparate policies toward scientific research, technology commercialization, ICT investments, education and skills development, tax, trade, IP, government procurement, and regulation in a way that drives economic growth by fostering innovation.[134] Most national innovation agencies also seek specifically to support the innovation efforts of their small- and medium-sized enterprises (SMEs), to promote international linkages, and to support and manage regional innovation development networks.

While some of the oldest national innovation foundations date back to the 1960s, most have been founded within the past 15 years, as an increasing number of nations have become serious about developing their national innovation systems and turbocharging their economies' capacity to innovate. Today, national innovation foundations can be found in economies of all sizes and stages of development, from Colombia and Kenya to India, Indonesia, and Japan.

	Countries with a National Innovation Foundation		Countries without a National Innovation Foundation
Argentina	Hungary	Poland	Costa Rica
Australia	Iceland	Portugal	Greece
Austria	India	Russia	Italy
Belgium	Indonesia	Singapore	Latvia
Brazil	Ireland	Slovak Republic	Romania
Bulgaria	Israel	Slovenia	Ukraine
Canada	Japan	South Africa	United States
Chile	Kenya	Spain	
China	Korea	Sweden	
Colombia	Lithuania	Switzerland	
Czech Republic	Malaysia	Taiwan	
Denmark	Mexico	Thailand	
Estonia	Netherlands	Turkey	
Finland	New Zealand	United Kingdom	
France	Norway	Vietnam	
Germany	Peru		
Hong Kong	Philippines		

Table 18: Countries With or Without a National Innovation Foundation[135]

The organizational structure of countries' national innovation agencies varies immensely. In some cases, these are government agencies (such as the Danish Agency for Science, Technology, and Innovation), while others are autonomous or quasi-autonomous nongovernmental organizations (such as the Finnish Funding Agency for Technology, Tekes; or the United Kingdom's National Endowment for Science, Technology, and the Arts, NESTA). National innovation foundations exhibit a wide spectrum of budgets and organizational mandates, suggesting that the construction and direction of a national innovation foundation may still be as much art as science. Nevertheless, the best national innovation foundations and strategies are lean and nimble, able to shift their operations and priorities at the speed at which modern innovation and technological development unfold.[136]

As Table 19 shows, of the 56 countries in this study, 49 have created special agencies or foundations to maximize the innovation output of their countries' enterprises and organizations. Virtually all of these countries have also articulated national innovation strategies. Only seven counties in the study have not established a national innovation foundation. Most such countries are clustered in Eastern or Southern Europe, but the United States stands out as a leading developed nation lacking a national innovation foundation. In many of these seven countries, support for advanced industries and innovation occurs through discordant, piecemeal policies.

Country	Citable Documents	Total Citations	Country	Citable Documents	Total Citations
Switzerland	4.69	73.8	**Korea**	1.41	11.4
Iceland	3.97	75.3	**Slovak Republic**	1.12	6.9
Denmark	3.79	57.0	**Hungary**	0.95	8.1
Sweden	3.41	48.0	**Japan**	0.96	7.6
Netherlands	3.02	44.5	**Poland**	0.92	5.6
Norway	3.28	37.6	**Lithuania**	0.93	4.6
Australia	3.25	37.0	**Malaysia**	0.77	3.8
Singapore	3.12	36.6	**Latvia**	0.70	3.6
Finland	3.05	36.1	**Romania**	0.69	2.5
New Zealand	2.81	29.5	**Chile**	0.48	4.0
Belgium	2.51	33.6	**Bulgaria**	0.51	2.9
United Kingdom	2.52	30.6	**Turkey**	0.49	2.9
Canada	2.50	29.5	**South Africa**	0.28	2.4
Ireland	2.48	29.0	**Argentina**	0.27	2.3
Austria	2.43	27.2	**China**	0.31	1.6
Slovenia	2.60	21.4	**Brazil**	0.29	1.9
Israel	2.10	23.7	**Russia**	0.31	1.2
Hong Kong	2.05	21.6	**Thailand**	0.17	1.3
Portugal	1.93	19.3	**Ukraine**	0.20	0.7
United States	1.77	21.7	**Costa Rica**	0.13	1.7
Germany	1.83	20.6	**Mexico**	0.14	1.0
Estonia	1.85	18.7	**Colombia**	0.13	0.8
Spain	1.71	17.3	**India**	0.08	0.5
France	1.63	17.2	**Peru**	0.05	0.5
Taiwan	1.76	13.1	**Kenya**	0.04	0.5
Italy	1.51	16.4	**Vietnam**	0.04	0.3
Czech Republic	1.72	12.8	**Philippines**	0.02	0.2
Greece	1.55	14.3	**Indonesia**	0.02	0.1

Table 19: Countries' Citable Documents and Total Citations, per 1,000 Citizens[137]

Research Citations

Published research plays an instrumental role in the global sharing and circulation of knowledge. Countries contributing to the global innovation ecosystem tend to publish substantial numbers of research papers, the most valuable of which are frequently cited by other researchers in future literature. A citable document is an academic document such as a journal article, review, or conference paper that is able to be referenced by subsequent academic research. On a per capita basis, Switzerland produces both the most citable journal articles and total citations on those articles, followed by Iceland and Denmark, as Table 19 shows.

The relative value of each document can be assessed by observing the number of other documents that cite the research. More influential, innovative, and groundbreaking studies tend to garner more citations. The average number of citations for each document (after a five-year lag), along with the total number of citable documents per capita, is presented in Table 19.

Countries with high volumes of literature per capita tend to produce higher quality literature, based on the number of citations each receives. There is a correlation of 0.75 between the number of total citations and the number of citations per journal article. In fact, the top three scorers in citable journal articles, Switzerland, Iceland, and Denmark, are also the top three performers in citations per journal article. This effect is not simply caused by the raw volume of literature a country produces, as no correlation exists between total citable documents and citations per document.

Detractions

Countries can put policies in place that bolster both domestic and global innovation, but they can also put policies in place that harm the latter (and ironically sometimes the former). Some countries simply take advantage of the innovations of others without contributing themselves. But a growing number are adopting policies that actively harm innovation globally. For example, when nations' policy regimes enable or even promote intellectual property theft, they reduce the incentive for and ability of companies in other nations to innovate by lowering the financial returns from innovation (and content production). Likewise, when nations force innovative producers to localize production as a condition of market access, they raise global production costs (because the location is less efficient to produce in, by definition), thereby reducing resources available for innovation. If all countries subscribed to these kinds of deleterious policies, there would be significantly less global innovation. As things stand, countries adopting detracting policies slow the pace of global innovation, not only by contributing less themselves, but also by creating an environment where others' innovations are less likely.

Countries adopting detracting policies slow the pace of global innovation, not only by not contributing themselves, but by creating an environment where others' innovations are less likely.

This report considers three main categories of detractions as indicators: balkanized production markets (weighted at 40 percent), intellectual property (weighted at 40 percent), and balkanized consumer markets (weighted at 20 percent). Those relative category weights were chosen because fragmentation of production markets for innovative products and services and a failure to protect intellectual property rights exact the most damage on the global innovation system, one reason those two categories consider more sub-indicators than the balkanized consumer markets category does.

Table 20 shows that Finland, the Netherlands, Belgium, Ireland, and Sweden field policies that do the least harm to the global innovation system, while Thailand, China, India, Argentina, and Russia employ policies that detract the most from global innovation. (High scores indicate less detraction.) The United States ranks sixth in terms of least detractions.

Rank	Country	Detractors	Balkanized Production Markets	IP Protections	Balkanized Consumer Markets
1	Finland	13.9	0.86	0.92	0.42
2	Netherlands	12.4	0.68	0.81	0.64
3	Belgium	11.3	0.68	0.72	0.44
4	Ireland	11.2	0.70	0.71	0.38
5	Sweden	11.1	0.61	0.73	0.54
6	United States	10.4	0.25	0.98	0.75
7	United Kingdom	10.4	0.43	0.84	0.55
8	Germany	10.3	0.52	0.73	0.53
9	Austria	9.7	0.45	0.66	0.66
10	Estonia	9.5	0.73	0.34	0.57
11	Norway	9.2	0.41	0.57	0.80
12	Portugal	8.4	0.61	0.38	0.43
13	New Zealand	7.9	0.34	0.55	0.59
14	France	7.8	0.16	0.81	0.46
15	Latvia	7.1	0.61	-0.01	0.87
16	Slovak Republic	6.7	0.58	0.16	0.43
17	Czech Republic	6.5	0.49	0.25	0.42
18	Slovenia	6.5	0.56	0.08	0.58
19	Spain	6.3	0.41	0.24	0.54
20	Denmark	6.2	0.04	0.68	0.53
21	Australia	6.0	0.00	0.61	0.71
22	Singapore	5.9	0.20	0.65	0.11
23	Hong Kong	5.4	0.31	0.39	0.19
24	Hungary	5.3	0.19	0.31	0.66
25	Italy	5.0	0.29	0.29	0.36
26	Lithuania	4.7	0.31	0.00	0.80
27	Japan	4.3	-0.28	0.83	0.42
28	South Africa	4.2	0.33	0.35	-0.17
29	Taiwan	3.1	-0.01	0.29	0.48
30	Poland	3.0	0.21	0.09	0.34
31	Iceland	3.0	0.17	0.06	0.47
32	Switzerland	2.5	-0.55	0.75	0.69
33	Israel	-0.2	-0.28	0.36	-0.02
34	Canada	-0.5	-0.30	0.18	0.30
35	Greece	-1.5	0.08	-0.42	0.29
36	Costa Rica	-1.5	0.36	-0.69	0.14
37	Colombia	-2.5	0.32	-0.59	-0.28
38	Chile	-2.7	0.70	-0.87	-0.70
39	Romania	-3.0	0.08	-0.64	0.28
40	Bulgaria	-3.9	-0.11	-0.48	0.14
41	Mexico	-6.1	-0.12	-0.51	-0.47

42	Korea	-6.9	-0.79	0.27	-0.69
43	Philippines	-7.3	-0.50	-0.04	-0.92
44	Peru	-7.4	0.03	-1.01	-0.23
45	Turkey	-8.6	-0.68	-0.52	0.15
46	Kenya	-8.8	0.06	-0.49	-1.95
47	Ukraine	-11.5	-0.34	-1.36	0.17
48	Brazil	-12.9	-0.31	-0.67	-1.96
49	Malaysia	-13.1	-1.34	-0.06	-0.61
50	Indonesia	-15.2	-0.89	-0.68	-1.09
51	Vietnam	-16.2	-0.77	-1.14	-0.75
52	Russia	-17.4	-0.75	-1.19	-1.06
53	Argentina	-21.0	-1.14	-1.22	-1.15
54	India	-21.2	-0.94	-1.21	-1.78
55	China	-22.6	-1.79	-1.06	-1.26
56	Thailand	-23.3	-0.92	-1.68	-1.51

Table 20: Aggregate Scores for Detractions

Intending to benefit themselves, countries often detract from global innovation by enacting mercantilist policies that seek to unfairly corner production in advanced technology goods and services.

The following sections assess countries' performance on the three detractions' categories and sub-indicators.

Balkanized Production Markets

Intending to benefit themselves, countries often detract from global innovation by enacting mercantilist policies that seek to unfairly corner production in advanced technology goods and services. These policies include tariffs, restrictions on foreign equity, subsidized exports, currency manipulation, and various non-tariff barriers or local production requirements.

These policies harm global innovation in a variety of ways. First, they can lead to the production of a larger share of advanced technology goods in higher-cost locations, thereby reducing resources available for innovative companies. This is true even if the nation in question is a low-wage nation, for adding unfair and distorting measures on top of a low-wage advantage increases the share of production there. Second, they can make lower-tech production more economical than it would be otherwise, reducing the incentive for companies to innovate. For example, Fuchs and Kirchain find in their study *Design for Location: The Impact of Manufacturing Offshore on Technology Competitiveness in the Optoelectronics Industry* that if companies in a country can manufacture products below cost—because of artificially low wages or, more typically, government subsidies and unfair trade practices such as an undervalued currency—it can cause technology lock-in, limiting the development of next-generation technologies that cannot compete with the subsidized current technology.[138] This happens because the price difference between the old technology and the superior emerging technology is too great for the latter to gain market share, which in turn enables a company to bring prices for the inferior technology down even more by leveraging scale economies. Finally, if such policies protect or subsidize less efficient or innovative companies than market forces would otherwise support, this can lead to global overcapacity, making it more difficult for the more innovative enterprises to earn the profits needed to reinvest in innovation.

Country	Non-tariff Trade Barriers Rating (O=Best; 10=Worst)	Country	Non-tariff Trade Barriers Rating (O=Best; 10=Worst)
Hong Kong	1.92	Lithuania	4.26
New Zealand	2.17	Germany	4.28
Singapore	2.39	Mexico	4.28
Finland	2.61	Philippines	4.34
Portugal	2.93	India	4.37
Netherlands	3.16	Canada	4.41
Belgium	3.27	Czech Republic	4.44
Estonia	3.31	Italy	4.44
Ireland	3.43	Indonesia	4.49
Sweden	3.48	Peru	4.53
Greece	3.51	China	4.54
United Kingdom	3.51	Poland	4.68
Australia	3.65	Israel	4.69
Austria	3.66	Korea	4.88
Chile	3.67	Turkey	4.88
Malaysia	3.68	Iceland	4.94
Taiwan	3.75	Vietnam	4.98
Latvia	3.79	Japan	5.08
France	3.81	Switzerland	5.12
South Africa	3.84	Brazil	5.15
Spain	3.84	Ukraine	5.25
Denmark	3.87	Costa Rica	5.26
Slovak Republic	4.00	Bulgaria	5.37
Hungary	4.08	Russia	5.37
Slovenia	4.09	Kenya	5.39
Norway	4.10	Romania	5.41
Thailand	4.17	Colombia	5.46
United States	4.23	Argentina	7.55

Table 21: Countries' Non-tariff Trade Barriers Rating[139]

Finland, Estonia, Ireland, Chile, and Belgium score best on these policies, while China, Malaysia, Argentina, India, and Thailand field policies that most balkanize global production markets. The following section assesses the extent of countries' use of non-tariff trade barriers, localization barriers to trade, foreign equity restrictions, and export subsidies.

Non-Tariff Trade Barriers

While countries have made progress in reducing tariffs, the effect of those decreases has been tempered by a corresponding rise in non-tariff barriers (NTBs). Non-tariff barriers are measures other than tariffs that result in a distortion to trade, including quantitative restrictions, price controls, subsidies, non-tariff charges, unwarranted customs procedures, and the discriminatory application of technical standards. Other NTBs that seek to restrict trade include controls on foreign direct investment; discriminatory rules and regulations, including those pertaining to health and safety standards; weak intellectual property protection; or unfair import licensing requirements.

Though they are difficult to measure, it is likely that non-tariff barriers now have a greater detrimental impact on global innovation than tariffs do.[140] In fact, according to the World Trade Organization's *2012 World Trade Report*, such non-tariff measures are almost twice as trade restrictive as tariffs.[141]

This study employs the "Non-Tariff Trade Barriers" rating of the *Economic Freedom of the World Index* to assess countries' non-tariff trade barriers. The *Index* scores countries on the percentage of trade affected by non-tariff measures and the average number of notifications for products affected by NTBs (on an inverted scale, where a score of zero is best and a score of 10 is worst).

As Table 21 shows, Hong Kong, New Zealand, Singapore, Finland, and Portugal employ the fewest non-tariff trade barriers of countries assessed in this study, while Argentina, Colombia, Romania, Kenya, and Russia apply the most.

Non-tariff measures are almost twice as trade restrictive as traditional tariffs, and now likely have a greater detrimental impact on world trade than monetary tariffs.

Localization Barriers to Trade

Localization barriers to trade seek to pressure foreign enterprises to localize economic activity in order to compete in a country's markets. ITIF's 2013 report *Localization Barriers to Trade: Threat to the Global Innovation Economy* identified five specific types of LBTs: 1) local content requirements, 2) local production requirements, 3) forced offsets, 4) forced technology or intellectual property transfer as a condition of market access, and 5) compulsory licensing.[142]

- Local content requirements (LCRs) force producers to use a minimum percentage of locally produced output (e.g., components, IP, or audiovisual content). For example, countries may specify the percentage of "local content" a finished product must contain in order to be eligible for sale in a market or to be eligible to receive price preference in government procurement activities.

- Some LBTs mandate local production of a product or service as a fundamental condition of market access. In other words, if a company does not make the product (or produce the service) in-country, that product or service cannot be sold in-country. For example, an increasing number of countries have implemented localization barriers to digital trade, stating that a company must situate IT infrastructure locally to provide its digital service (e.g., social media or Web search engine) in a country.

- Forced offsets encompass a range of industrial compensation arrangements required by foreign governments as a condition of public procurement (and sometimes private procurement) contracts.[143]

- Requirements that firms transfer intellectual property or technology as a condition of market access—often as part of required joint ventures—have become an increasingly common forced localization tactic. These requirements constitute localization barriers to trade because they force companies to give up technology or intellectual property as a condition of operating or selling products and services in a country.

- Finally, compulsory licenses mandate the transfer of proprietary information (e.g., intellectual property, technology, etc.) to a country's own domestic manufacturers, so that those manufacturers can produce a good in-country. Compulsory licenses thus allow a third party to produce a patented product or process without having to incur the cost of developing the intellectual property.[144]

Scores of countries have introduced local content requirements, making LCRs the most common type of LBT. Some countries, such as Brazil, "have made local content requirements a centerpiece of their industrial policy," with LCRs touching sectors including ICT, energy, equipment and machinery, health, media, reinsurance, textiles, apparel, and footwear.[145] LCRs affected almost $928 billion of total global trade in goods and services in 2010, or about 5 percent of the $18.5 trillion of total global trade.[146] Hufbauer et al. estimate that the actual reduction of world trade due to new LCRs amounts to $93 billion annually and that almost 3.8 million jobs are affected by LCRs.[147]

Local production as a condition of market access has become a much more frequently used policy instrument in recent years, particularly for digital trade.

Forced technology or intellectual property transfer as a condition of market access is a technique used by countries throughout the world, though none more so than China. As Chief Market Strategist David Joy of Ameriprise Financial argues, "To me, that's [forced technology transfer] actually the biggest issue, more even than currency valuation. Being forced to give up technology for access to the market is essentially blackmail."[148] But despite the fact that China's WTO accession agreement contains rules forbidding the country from tying foreign direct investment or market access to technology transfer requirements, it remains commonplace in China to require that firms transfer technology in exchange for being granted the ability to invest in the country.[149] For example, in the *Catalogue for the Guidance of Foreign Investment Industries (2007)*, joint ventures with foreign firms have to be approved, and technology transfer agreements reached within joint venture contracts must also be submitted for approval. The guidelines encourage transfer of technology.[150]

Many nations have turned to compulsory licenses as a tactic to transfer know-how and technology to their economies.[151] For instance, on March 9, 2012, the Indian Patent Controller General granted a compulsory license to Natco, an Indian pharmaceutical company, enabling it to produce a patented cancer drug, Nexavar, made by Bayer.[152] Compulsory licenses are effectively indirect forms of forced localization. When a country issues a compulsory license, it mandates the transfer of proprietary information (e.g., intellectual property, technology, etc.) to its own domestic manufacturers, so that these manufacturers can produce a good in-country. Compulsory licenses thus allow a third party to produce a patented product or process without having to secure the consent of the patent owner.[153] Countries most often (though not exclusively) issue compulsory licenses in the case of pharmaceutical products, enabling countries not only to get drugs at a lower price without paying for the costs of drug development, but also to support their own domestic pharmaceutical and biotech industries.

Table 22 lists countries with one or more types of localization barrier to trade, finding that India, Indonesia, Malaysia, and Turkey field the most types of LBTs. Data was originally compiled from ITIF's *Localization Barriers to Trade* report from news analysis and a review of the literature and has been updated as of fall 2015.

Country	Total LBTs	LPRs	LCRs	Forced Offsets	Forced Tech/ IP Transfer	Compulsory Licenses
India	5	√	√	√	√	√
Indonesia	4	√	√		√	√
Malaysia	4	√	√		√	√
Turkey	4	√	√	√	√	
Argentina	3	√	√	√		
Brazil	3	√	√			√
China	3	√	√		√	
Greece	3	√		√	√	
Australia	2	√	√			
Canada	2	√	√			
France	2	√	√			
Korea	2	√	√			
Mexico	2		√		√	
Russia	2	√	√			
Taiwan	2	√				√
Venezuela	2	√			√	
Vietnam	2	√	√			
Austria	1			√		
Denmark	1	√				
Ecuador	1					√
Israel	1			√		
Italy	1		√			
Japan	1				√	
Kenya	1	√				
Lithuania	1			√		
New Zealand	1	√				
Norway	1	√				
Philippines	1			√		
Poland	1		√			
Portugal	1				√	

Romania	1			√	
South Africa	1		√		
Spain	1		√		
Switzerland	1	√			
Thailand	1				√
Ukraine	1		√		
United Kingdom	1			√	

Table 22: Countries' Localization Barriers to Trade[154]

Foreign Equity Restrictions

Foreign direct investment (FDI) builds international linkages and knowledge networks that augment innovation both domestically and globally, particularly by fostering the international diffusion of technology, know-how, and best practices. Indeed, research shows that FDI can contribute significantly to regional innovation capacity and economic growth, in part through the transfer of technology and managerial know-how.[155] For example, Dahlman suggests that higher rates of FDI can explain the relatively higher technological growth rates in East Asian countries.[156] And Coe, Helpman, and Hoffmaister find that a developing economy's productivity growth is larger the greater its foreign R&D investment.[157] Foreign R&D investment also has been shown to spur local companies in the receiving country to increase their own share of R&D, leading to regional clusters of innovation-based economic activity. Another channel through which a country's domestic firms benefit from inward foreign direct investment is competition.[158] Competition from foreign firms pressures indigenous rivals to update their technology and production processes and to use their existing resources more effectively.[159] In other words, greater levels of inbound FDI force domestic companies to ratchet up their competitiveness, potentially spurring them to greater levels of innovation output that can benefit both domestic and global constituencies. Therefore, it is essential that countries not only open their borders to incoming FDI, but that they allow their own domestic firms to invest overseas as well.

Greater levels of inbound FDI force domestic companies to ratchet up their competitiveness, potentially spurring them to greater levels of innovation output.

Accordingly, countries that introduce barriers to FDI harm the global innovation economy. The most direct form of FDI control is restrictions on foreign equity, which has been measured by the OECD.[160] With regard to foreign equity restrictions, countries are scored from zero (no restrictions) upward, with higher scores being worse. Several countries have no score on this indicator because they are neither OECD countries (e.g., Thailand) nor large enough to be included. Table 23 shows that China, New Zealand, Canada, the Philippines, and Vietnam impose the highest foreign equity restrictions among countries in the study.

Country	Foreign Equity Restrictions (0 = Best)	Country	Foreign Equity Restrictions (0 = Best)
Argentina	0.00	**Poland**	0.01
Austria	0.00	**Bulgaria**	0.01
Chile	0.00	**Singapore**	0.01
Costa Rica	0.00	**United States**	0.02
Colombia	0.00	**Belgium**	0.02
Czech Republic	0.00	**United Kingdom**	0.02
Denmark	0.00	**Brazil**	0.03
Estonia	0.00	**Sweden**	0.03
France	0.00	**Kenya**	0.03
Germany	0.00	**Taiwan**	0.04
Greece	0.00	**Malaysia**	0.04
Hungary	0.00	**Japan**	0.05
Ireland	0.00	**Peru**	0.05
Italy	0.00	**Korea**	0.05
Netherlands	0.00	**India**	0.07
Norway	0.00	**Israel**	0.08
Portugal	0.00	**Thailand**	0.09
Romania	0.00	**Russia**	0.10
Slovak Republic	0.00	**Ukraine**	0.10
Slovenia	0.00	**Mexico**	0.10
Spain	0.00	**Indonesia**	0.10
Switzerland	0.00	**Iceland**	0.11
Turkey	0.00	**Australia**	0.13
Lithuania	0.01	**Vietnam**	0.13
Hong Kong	0.01	**Philippines**	0.14
Finland	0.01	**Canada**	0.19
Latvia	0.01	**New Zealand**	0.23
South Africa	0.01	**China**	0.32

Table 23: Countries' Foreign Equity Restrictions[161]

Currency Manipulation

Currency manipulation occurs when a government buys or sells foreign currency to prevent the exchange rate from moving toward its equilibrium value.[162] Currency manipulation is now rampant, and perhaps the most important development of the past 15 years in international financial markets.[163] In their attempts to hold down the value of their currencies, governments distort capital flows by as much as $1.5 trillion.[164] And as Peterson Institute for International Economics scholar Joseph Gagnon writes, "In the past decade, currency manipulation has been overwhelmingly aimed at boosting [countries'] current account surpluses through an undervalued currency."[165]

Manipulating currency to keep it below what market forces would dictate is as pure a subsidy as if a government wrote checks to its exporters.[166] By imposing a blanket subsidy on its exporters, and a blanket cost on imports from other nations, currency manipulation has the effect of lowering competitiveness in other countries. This is because currency adjustment is the principal mechanism by which open markets adjust to changes in competitive advantage, particularly when low-wage nations increase their competitiveness. If a low-wage nation has an absolute cost advantage over a high-wage nation, a falling currency in the high-wage nation is the natural adjustment mechanism—it makes imports more expensive and exports cheaper, restoring comparative equilibrium.[167] By disabling the principal adjustment mechanism of international commerce, countries that manipulate their currencies accrue unsustainable trade surpluses and undermine confidence in trade's ability to bring globally shared prosperity. If the global output of innovation is to be maximized, the flow of goods, services, and capital should be determined on the basis of actual costs and prices, not on subsidies.

If the global output of innovation is to be maximized, the flow of goods, services, and capital should be determined on the basis of actual costs and prices, not on subsidies or currency manipulation.

Ending currency manipulation would go a considerable way toward easing opposition to globalization and maximizing its benefits, even for the nations currently propping up their currencies, by promoting a structural rebalancing of their economic growth away from exports toward domestic demand. This is not to say that nations should not be allowed to manage currency transitions so that they are not overly abrupt, but countries should endeavor to allow market forces to influence currency rates to the maximum extent possible. Put simply, the systematic manipulation of currencies to gain competitive advantage through beggar-thy-neighbor policies needs to cease.

Unfortunately, as Table 24 shows, a growing number of countries have recently intervened in currency markets to prevent their currency from appreciating. The Peterson Institute identified the world's 20 most egregious currency manipulators from 2001 to 2012.[168] The report identified currency manipulators based on excessive levels of foreign exchange reserve. In addition, ITIF examined whether a country's total currency reserves have increased by over 25 percent in the last 10 years. If both criteria were met, the country was labeled as an egregious currency manipulator. If the country met only one criterion, it was labeled a currency manipulator. As Table 24 shows, of the nations assessed in this report, six nations—China, Hong Kong, Malaysia, Singapore, Switzerland, and Thailand—met both criteria, while an additional 10 countries met at least one of the criteria. Three groups of countries stand out in this analysis: 1) long-standing advanced economies such as Denmark, Japan, and Switzerland; 2) newly industrialized economies such as Israel, Singapore, and Korea; and 3) developing economies such as China, Malaysia, the Philippines, and Thailand in Asia; and Argentina and Peru in South America.[169]

Egregious Currency Manipulators: Both Criteria	Currency Manipulators: One Criteria
China	Argentina
Hong Kong	Bulgaria
Malaysia	Denmark
Singapore	Hungary
Switzerland	Israel
Thailand	Japan
	Korea
	Peru
	Philippines
	Russia

Table 24: Countries Engaging in Currency Manipulation[170]

Export Subsidies

Export subsidies consist of all subsidies on goods and services that become payable to resident producers when the goods leave the economic territory of the nation or when services are delivered to nonresident consumers; they can include direct subsidies on exports and also losses of government trading enterprises with respect to trade with nonresidents.[171] Export subsidies harm global innovation by disadvantaging the most innovative, productive, and efficient firms in global marketplaces, who must now compete in international markets with foreign producers who are the beneficiaries of economically subsidized production and export activity. In effect, export subsidies distort international trade by fragmenting global production markets, inducing production activity to occur in locations to an extent it likely would not if market forces predominantly informed the production location decision. This harms the world's most genuinely innovative and efficient producers of those products and services, leading to less global innovation than would otherwise be the case.

Despite the fact that export subsidies are illegal under the WTO, a number of countries use them to give an unfair advantage to their domestic exporters. In particular, China's export subsidies have created severe distortions in international trade in many industries, chief among them steel, wind turbines, and solar cells. Subsides for China's steel, energy, glass, paper, and auto parts industries have been particularly intensive, contributing substantially to these firms' competitiveness in global markets and to global overcapacity in these industries.[172] As Usha and George Haley document in *Subsidies to Chinese Industry: State Capitalism, Business Strategy, and Trade Policy*, from 2000 to 2007, total energy subsidies to Chinese steel reached $27.1 billion. Meanwhile, China's glass and glass-products industry received $30.3 billion in subsidies from 2004 to 2008; the paper industry enjoyed $33.1 billion in government subsidies from 2002 to 2009; and the Chinese auto-parts industry received $27.5 billion in subsidies from 2001 to 2011.[173]

Country	Extent of Export Subsidies (Lower Score Worse)	Country	Extent of Export Subsidies (Lower Score Worse)
Australia	0.71	**Latvia**	0.39
Canada	0.71	**Lithuania**	0.39
Chile	0.71	**Poland**	0.39
Costa Rica	0.71	**Portugal**	0.39
Colombia	0.71	**Romania**	0.39
Hong Kong	0.71	**Slovak Republic**	0.39
Iceland	0.71	**Slovenia**	0.39
Israel	0.71	**Spain**	0.39
Japan	0.71	**Sweden**	0.39
Kenya	0.71	**United Kingdom**	0.39
New Zealand	0.71	**Mexico**	0.36
Norway	0.71	**United States**	0.12
Peru	0.71	**Russia**	0.08
Singapore	0.71	**France**	0.03
Switzerland	0.71	**South Africa**	0.01
Brazil	0.49	**Netherlands**	-0.15
Austria	0.39	**Philippines**	-0.39
Belgium	0.39	**Taiwan**	-0.59
Bulgaria	0.39	**Argentina**	-0.96
Czech Republic	0.39	**Ukraine**	-1.09
Denmark	0.39	**Turkey**	-1.37
Estonia	0.39	**Korea**	-1.51
Finland	0.39	**Thailand**	-1.69
Germany	0.39	**Indonesia**	-1.75
Greece	0.39	**Malaysia**	-1.86
Hungary	0.39	**India**	-2.45
Ireland	0.39	**Vietnam**	-2.71
Italy	0.39	**China**	-3.88

Table 25: Countries' Extent of Export Subsidies[174]

But while China is the most egregious export subsidizer, as Table 25 shows, it is by no means alone. Vietnam, India, Malaysia, Indonesia, and Thailand also provide extensive subsidies to their exporters. Brazil has long used export production subsidies. For example, Brazilian state governments competing to host new automotive plants have offered subsidies of more than $100,000 for each assembly job created. This led mainly to overcapacity and precarious financial positions for Brazilian state governments.[175] As the McKinsey Global Institute observes, such export promotion policies "have almost always led to low productivity and higher costs to consumers."[176] Export subsidies also remain endemic in countries' agricultural policies, particularly subsidies for cotton and sugar production for export. But as former WTO Director Pascal Lamy has noted, export subsidies for such commodities are perhaps "the most egregious form of trade support" and "eliminating subsidies on exports of commodities such as cotton would contribute to a fairer international trading system, boost economic growth and reduce poverty."[177]

Table 25 shows the relative extent of a country's export subsidies, with scores controlling for the size of the nation and then standardized, as estimated by examining WTO records on formal complaints levied against countries by their trading partners. China records 87 complaints, or 43 percent of all export subsidy-related complaints since 2005. India followed, having received 24 formal complaints at the WTO from trade partners about its export subsidies.

Intellectual Property Protection

Innovation depends on effective IP protections, for it is difficult to have innovation without the protection of ideas. Strong IP rights spur innovative activity by increasing innovators' ability to appropriate the returns from innovation, enabling them to capture more of the benefits of their own innovative activity. By raising the private rate of return closer to the social rate of return, IP addresses the knowledge-asset incentive problem, allowing inventors to realize economic gain from their inventions, thereby catalyzing innovation. In addition, as they capture a larger portion of the benefits of their innovative activity, innovators obtain the resources needed to pursue the next generation of innovative ideas (or content production in media industries).

Ensuring the continuation of beneficial and sustainable innovation for the world requires strong IP protections.

However, if competitors are able to enter and/or remain in a market because they obtain innovators' IP at less than the fair market price (either through outright theft or government-enabled coerced transfer), they are able to siphon off sales that would otherwise go to innovators. In other words, incentivizing innovations depends on ensuring a virtuous cycle of innovation that allows innovators to earn profits from one generation of innovation to finance investment in the next. As such, ensuring the continuation of beneficial and sustainable innovation for the world requires strong IP protections—in developed and developing nations alike. Whether it comes to better medicines, more advanced software and source code, or new manufacturing production processes, such benefits from innovation accrue to the world, not just the shareholders of any one company.

Unfortunately, many stakeholders in the global debate over IP have taken a "redistributionist" view of IP policy, arguing that weak IP spurs innovation and economic activity in developing nations and is a "fair" policy to help less-developed nations. But these stakeholders need to realize that this comes at a cost to the entire global economy: IP theft damages the production of innovation globally. A report by the Center for Strategic and International Studies and security firm McAfee estimates that data and IP theft from cybercrime costs firms globally as much as $1 trillion annually.[178] An earlier report by McAfee, *Unsecured Economies: Protecting Vital Information*, also noted that "developing countries spend more money on protecting intellectual property than companies in Western countries," showing that the greater rampancy of IP theft in developing nations exacts even greater relative costs on enterprises trying to compete in those countries, again lamentably consuming resources that could otherwise go to producing greater levels of genuine innovation that could benefit the entire global system.[179]

Moreover, strong IP policies are not altruistic. In fact, a large body of literature shows that strong IP rights help domestic economies, including by spurring more inbound FDI and increased levels of domestic R&D.[180] For instance, Cavazos-Cepeda et al. find that every 1 percent increase in the level of protection of IP rights in an economy is associated with a 0.7 percent increase in the domestic level of R&D. Likewise, a 1 percent increase in copyright protection is associated with a 3.3 percent increase in domestic R&D, while a 1 percent increase in trademark protection is associated with a 1.4 percent increase in domestic R&D.[181] Further, Liao and Wong conclude that developing countries should adopt policies that encourage R&D within their own borders as a complement to incoming technology as part of an overall development strategy.[182] Moreover, a number of studies have found that R&D/GDP ratios are positively related to the strength of patent rights.[183]

Watch List	Priority Watch List
Brazil	Argentina
Bulgaria	Chile
Canada	China
Costa Rica	India
Colombia	Russia
Greece	Thailand
Mexico	Ukraine
Peru	
Romania	
Turkey	
Vietnam	

Table 26: Countries Listed in USTR's *Special 301 Report*[184]

The Intellectual Property indicator in this report consists of five sub-indicators: the U.S. Trade Representative's (USTR's) *Special 301 Report*, the Ginarte-Park Index of patent rights, a composite indicator consisting of data from the U.S. Chamber of Commerce Global Intellectual Property Center's *Global International IP Index* and the World Economic Forum's IP protection index, software piracy rates, and protections for robust life science innovation ecosystems.[185] The United States, Finland, the United Kingdom, Japan, and France and the Netherlands (tied for fifth) have the strongest intellectual property regimes according to these indicators, while Thailand, Ukraine, Argentina, India, and Russia have the weakest.

Special 301 Report

The United States Trade Representative's *Special 301 Report* identifies countries that do not provide "adequate and effective" protection for U.S. intellectual property rights holders.[186] Countries not adopting adequate and effective protections are placed on either the Watch List (WL), Priority Watch List (PWL), or identified as a Priority Foreign Country (PFC), depending upon the severity of infractions. The *Special 301 Report* pays particular attention to situations where countries inadequately protect enterprises' advanced technology-based IP or when lax IP protection may lead to production of dangerous counterfeit products that can place consumers at risk.

As Table 26 shows, USTR includes 11 countries on its *2015 Special 301 Report* Watch List and seven on its Priority Watch List. (USTR listed no PFC countries in 2015.)

Ginarte-Park Patent Rights Index

Perhaps the most well-known index of countries' IP protections is the "Ginarte-Park Patent Rights Index," which provides a measure of the strength of patent protections in 110 countries. The Ginarte-Park Index presents the sum of five separate scores for: 1) coverage (inventions that are patentable), 2) membership in international treaties, 3) duration of protection, 4) enforcement mechanisms, and 5) restrictions (e.g., compulsory licensing in the event that a patented invention is not sufficiently exploited).[187] Countries are scored on an inverted scale from one to five, with five the best. The index endeavors to provide an indicator of the strength of patent protection in countries (though not the overall quality of countries' patent systems).[188] The United States posts the highest score, with nine nations tied after that. Costa Rica, Vietnam, Kenya, Peru, and Malaysia score weakest.[189]

Country	Ginarte-Park Index Score (5 = Best; 0 = Worst)	Country	Ginarte-Park Index Score (5 = Best; 0 = Worst)
United States	4.88	Philippines	4.18
Belgium	4.67	Australia	4.17
Canada	4.67	Norway	4.17
Denmark	4.67	Romania	4.17
Finland	4.67	Israel	4.13
France	4.67	China	4.08
Ireland	4.67	New Zealand	4.01
Italy	4.67	Turkey	4.01
Japan	4.67	Lithuania	4.00
Netherlands	4.67	Argentina	3.98
Bulgaria	4.54	Mexico	3.88
Sweden	4.54	Latvia	3.82
United Kingdom	4.54	Slovenia	3.82
Germany	4.50	Hong Kong	3.81
Hungary	4.50	India	3.76
Portugal	4.38	Taiwan	3.74

Austria	4.33	**Colombia**	3.72
Czech Republic	4.33	**Russia**	3.68
Korea	4.33	**Ukraine**	3.68
Spain	4.33	**Brazil**	3.59
Switzerland	4.33	**Iceland**	3.51
Greece	4.30	**Malaysia**	3.48
Chile	4.28	**Peru**	3.32
South Africa	4.25	**Kenya**	3.22
Estonia	4.22	**Vietnam**	3.03
Poland	4.21	**Costa Rica**	2.89
Singapore	4.21	**Indonesia**	2.77
Slovak Republic	4.21	**Thailand**	2.66

Table 27: Countries' Score on Ginarte-Park Patent Rights Index[190]

Intellectual Property Protection Indices

To provide one more indicator of the strength of countries' intellectual property protections, this report develops a composite measure of countries' IP environments based on data from the World Economic Forum's *2013-2014 Global Competitiveness Report* and the Global Intellectual Property Center's (GIPC's) *Global International IP Index.*[191]

Country	Score on *Global International IP Index* (0 = Worst; 30 = Best)	Country	Score on *Global International IP Index* (0 = Worst; 30 = Best)
United States	28.5	**Colombia**	13.7
United Kingdom	27.6	**Russia**	13.5
Germany	27.3	**Chile**	13.3
France	27.2	**Peru**	12.7
Singapore	25.4	**China**	12.4
Switzerland	24.8	**South Africa**	11.9
Australia	24.7	**Turkey**	11.9
Korea	23.3	**Ukraine**	11.7
Japan	23.3	**Brazil**	10.9
New Zealand	21.3	**Argentina**	9.2
Canada	17.9	**Indonesia**	8.6
Malaysia	14.6	**Vietnam**	7.8
Mexico	14.6	**India**	7.2
Taiwan	14.6	**Thailand**	7.1

Table 28: Countries' Scores on GIPC *Global International IP Index*[192]

The World Economic Forum's indicator "1.02 Intellectual Property Protections" surveys executives on how they rate countries on intellectual property protection, including anti-counterfeiting measures.[193] The GIPC's *Global International IP Index* maps the IP environment of 30 economies based on 30 indicators that are indicative of a robust IP system, including: the quality of countries' patent, copyright, trademark, and trade secret protections; IP enforcement policies and mechanisms; and membership in and ratification of international treaties protecting IP rights. As GIPC's *Index* covers only 28 countries included in this study, a composite indicator including data from the World Economic Forum's *Global Competitiveness Report* (which includes data for all 56 countries in this report) was created. Based on that combined indicator, Finland, the United Kingdom, Switzerland, France, and the United States score the highest, while Peru, Romania, Argentina, Bulgaria, and Vietnam score weakest. Table 28 presents scores for the countries assessed in the GIPC *Global International IP Index,* and Table 29 provides the scores countries receive on IP protection in the World Economic Forum's *Global Competitiveness Report*.

Country	WEF IP Protection Score (7 = Best; 0 = Worst)	Country	WEF IP Protection Score (7 = Best; 0 = Worst)
Finland	6.2	**Latvia**	4.0
Singapore	6.1	**Spain**	4.0
New Zealand	6.0	**China**	3.9
Switzerland	6.0	**Hungary**	3.9
United Kingdom	5.8	**Indonesia**	3.9
France	5.7	**Chile**	3.8
Hong Kong	5.7	**Costa Rica**	3.8
Japan	5.7	**Czech Republic**	3.8
Netherlands	5.7	**Greece**	3.7
Canada	5.6	**India**	3.7
Germany	5.6	**Italy**	3.7
Austria	5.5	**Lithuania**	3.7
Norway	5.5	**Poland**	3.7
South Africa	5.5	**Slovakia**	3.7
Sweden	5.5	**Mexico**	3.6
Ireland	5.4	**Philippines**	3.6
Australia	5.3	**Turkey**	3.6
Belgium	5.2	**Brazil**	3.5
Taiwan	5.2	**Kenya**	3.4
United States	5.2	**Colombia**	3.2
Denmark	5.0	**Thailand**	3.1
Estonia	4.8	**Bulgaria**	3.0
Iceland	4.8	**Romania**	2.9
Malaysia	4.8	**Russia**	2.9
Israel	4.6	**Vietnam**	2.9
Portugal	4.5	**Peru**	2.8
Slovenia	4.2	**Ukraine**	2.5
Korea	4.0	**Argentina**	2.3

Table 29: Countries' Scores on WEF Intellectual Property Protections Indicator[194]

Software Piracy Rate

Beginning in the late 1980s, value created in technology sectors became increasingly driven by software. Software production, like most digital content, has very high fixed costs and very low marginal costs. While the first copy of software can cost millions to develop, the second copy requires only a few cents (or nothing at all) to produce. This extreme dichotomy is common to the digital content industry (e.g., software, movies, music, books, and video games).

Software theft is rampant. In 2009, more than 4 out of 10 software programs installed on personal computers throughout the world were stolen, with a commercial value of more than $51 billion.[195] To be sure, not all of that piracy represents direct financial loss to the industry and therefore a reduction on its ability to invest in further innovation, but much of it does. Reducing the piracy rate on PC software could generate substantial global economic benefits. Reducing the piracy rate by 10 percentage points in four years would create $142 billion in new economic activity—more than 80 percent accruing to local industries—while adding nearly 500,000 new high-tech jobs and generating roughly $32 billion in new tax revenues.

Reducing the piracy rate on PC software could generate greater software innovation and substantial global economic benefits.

While software theft is prevalent everywhere, the United States and Japan, both large producers of software, have the lowest prevalence of theft. Much of Western Europe, with the exception of France and Italy, has rates lower than 30 percent. As rates grow higher, software theft moves from being mostly confined to consumers to representing content theft by companies. The worst offenders are Indonesia, Ukraine, and Vietnam, where less than 20 percent of software is purchased legally, as Table 30 shows.

Country	Software Piracy Rate (0 = Best; 100 = Worst)	Country	Software Piracy Rate (0 = Best; 100 = Worst)
United States	19%	Slovenia	46%
Japan	21%	Estonia	48%
New Zealand	22%	Iceland	48%
Australia	23%	Italy	48%
Austria	23%	Brazil	53%
Belgium	24%	Colombia	53%
Denmark	24%	Poland	53%
Sweden	24%	Latvia	54%
Finland	25%	Lithuania	54%
Switzerland	25%	Malaysia	55%
Germany	26%	Mexico	57%
United Kingdom	26%	Costa Rica	58%
Canada	27%	Chile	61%
Netherlands	27%	Greece	61%
Norway	27%	Turkey	62%
Israel	31%	India	63%

Singapore	33%	**Romania**	63%
Ireland	34%	**Russia**	63%
Czech Republic	35%	**Bulgaria**	64%
South Africa	35%	**Peru**	67%
France	37%	**Argentina**	69%
Taiwan	37%	**Philippines**	70%
Portugal	40%	**Thailand**	72%
Slovak Republic	40%	**China**	77%
Korea	40%	**Kenya**	78%
Hungary	41%	**Vietnam**	81%
Hong Kong	43%	**Ukraine**	84%
Spain	44%	**Indonesia**	86%

Table 30: Countries' Software Piracy Rates[196]

Because new-to-the-world innovation in the research-based bio-pharmaceutical sector is so risky and expensive, many nations seek a free ride on others' investments in biomedical R&D.

IP Protection and Reimbursement Policies for Life Sciences Innovation

Like the software industry, the life sciences industry, globally, is characterized by high fixed costs (e.g., upfront clinical research, development, and compliance costs), but considerably lower costs of incremental production. Moreover, the research-based global biopharmaceutical industry is perhaps the world's most R&D-intensive. In 2014, investment in R&D by the research-based global pharmaceutical industry reached 21 percent of sales in the United States, 17 percent in the European Union, and 11 percent in Japan.[197] The sector also accounts for the single largest share of all U.S. business R&D, representing nearly 20 percent of all domestic R&D funded by U.S. businesses, and employs the largest share of R&D workers of any U.S. industry.[198]

But because new-to-the-world innovation in the research-based biopharmaceutical sector is so risky and expensive, many nations seek a free ride on others' investments in medical research and development. They do so through policies such as price controls on pharmaceutical drug sales and weaker intellectual property protections for innovative life sciences discoveries, such as fewer years of data exclusivity protection for the clinical trial data that proves the safety and efficacy of novel pharmaceutical and biologic drugs. Because the process of innovating novel biopharmaceutical therapies is so expensive, innovators depend on robust profits from one generation of successful drugs to finance investment in the next. But if this chain is broken—either through price controls on the sale of drugs, which impede pharmaceutical manufacturers' ability to both recoup the original investment and earn sufficient returns to finance future investment, or through policies that significantly hasten generics competition, such as by reducing data exclusivity periods—there will be less money reinvested in risky R&D, and the world will be left with less biomedical innovation than would otherwise be the case. This section considers first the need for robust periods of data exclusivity for novel biologic drugs and then the effect of price controls that countries impose on the sale of biologic and pharmaceutical drugs.

Unlike traditional pharmaceutical drugs, which involve smaller molecules that operate largely on the basis of chemical reactions and that work by treating the consequences of a disease, biologics work by blocking diseases earlier in their development, in the immune system. And since they can be tailored to individuals taking the medicine, biologics constitute an important step toward realizing the vision of personalized medicine.[199] But as biologics are large, complex molecules that must be manufactured within living tissues, the resulting protein is unique to the cell lines and the specific process used to produce it, and even slight differences in the manufacturing of a biologic can alter its nature.[200] Indeed, the sensitivity of these complex proteins makes them more difficult to characterize and to produce such that even minor differences in manufacturing processes or cell lines may result in variations in the resulting protein.[201] Accordingly, the IP components of a biologic include both the structure of the molecule itself and the process for how to reliably, safely, and consistently manufacture the molecule at scale in living tissues.

Unfortunately, the process of developing a biologic drug is extremely risky, time-consuming, and expensive. In fact, the vast majority of biologic medicines never make it to the approval stage, with less than 15 percent moving from initial pre-clinical studies to clinical trials.[202] The cost to develop a new prescription medicine that gained marketing approval in 2013 was $2.6 billion (a 145 percent increase over 2003 costs), while an estimated post-approval R&D cost of $312 million "boosts the full product life cycle cost per approved drug" to close to $3 billion.[203] Moreover, for biologic drugs that are approved, development of manufacturing facilities represents an additional cost beyond R&D that can range from $90 million to $450 million or more. Given the time, risk, and expense involved in developing biologics, studies find that the break-even time to recover their development, manufacturing, promotion, and capital costs averages 14.6 years.[204] This long break-even timeframe means that biologics developers have a limited amount of time in which to recoup their investment before these drugs' intellectual property rights expire.

Accordingly, many countries afford biologics two forms of IP protection: 1) patent rights and 2) data exclusivity protection on the clinical trial data that validates the safety and efficacy of novel biologic drugs. Data exclusivity protects the actual investment needed to prove the safety and efficacy of a biopharmaceutical product. It represents the number of years that generics competitors (i.e., "biosimilars" manufacturers) must wait before they can use the original biologic innovator's clinical trial data to prove the safety and efficacy of their biosimilar products in their applications for drug approval.

As Table 31 shows, the United States, which is the world's leading developer of biologic medicines, not coincidentally offers the strongest data exclusivity protections for these drugs. U.S. legislators established a standard of 12 years of data protection to strike an appropriate balance between promoting competition and providing adequate incentives to support continued innovation of new treatments and cures. The 12-year term has succeeded in underpinning both the world's most robust innovative biologics market and also thriving generics competition, as evidenced by the fact that generics now account for nearly 85 percent of all prescriptions written in the United States.[205] For their part, European Union countries offer 10 years of data exclusivity protection, also supporting a robust environment for life sciences innovation.

Country	Data Exclusivity Period for Biologic Medicines (years)	Country	Data Exclusivity Period for Biologic Medicines (years)
United States	12	**Canada**	8
Austria	10	**Japan**	8
Belgium	10	**China**	6
Bulgaria	10	**Korea**	6
Czech Republic	10	**Turkey**	6
Denmark	10	**Australia**	5
Estonia	10	**Chile**	5
Finland	10	**Colombia**	5
France	10	**Costa Rica**	5
Germany	10	**Israel**	5
Greece	10	**Malaysia**	5
Hungary	10	**Mexico**	5
Iceland	10	**New Zealand**	5
Ireland	10	**Peru**	5
Italy	10	**Singapore**	5
Latvia	10	**Taiwan**	5
Lithuania	10	**Ukraine**	5
Netherlands	10	**Vietnam**	5
Norway	10	**Thailand**	4
Poland	10	**Argentina**	0
Portugal	10	**Brazil**	0
Romania	10	**Hong Kong**	0
Slovak Republic	10	**India**	0
Slovenia	10	**Indonesia**	0
Spain	10	**Kenya**	0
Sweden	10	**Philippines**	0
Switzerland	10	**Russia**	0
United Kingdom	10	**South Africa**	0

Table 31: Countries' Length of Data Exclusivity Periods for Novel Biologic Medicines[206]

Among countries outside Europe and the United States, Canada and Japan offer the strongest protections for biologic drugs, at eight years each, followed nominally by China, Korea, and Turkey, whose laws afford six years of data exclusivity protection. However, while China's laws formally offer six years of data protection for novel biologic drugs, that standard has often not been met in practice. This report uses five years as the term of data exclusivity for countries included in this study that have signed onto the recently concluded Trans-Pacific Partnership (TPP) agreement—notably Australia, Chile, Malaysia, Mexico, New Zealand, Peru, and Vietnam—although several countries (e.g.,Vietnam) will have long phase-in periods (of up to ten years) in which to meet the biologics data exclusivity commitments they are entering into in the TPP.. Argentina, Brazil, Hong Kong, India, Indonesia, Kenya, the Philippines, and Russia do not offer biologics data exclusivity periods, as Table 31 shows.

The appropriate length of the biologics data exclusivity period constituted perhaps the most contentious IP issue in negotiations toward concluding a TPP agreement, with those advocating for a shorter period often citing the need for greater "access to medicines" in developing countries. The positions of developed countries in the TPP, including Australia and New Zealand, were animated by a desire for cheaper medicines by hastening biosimilars competition. But while access to medicines is certainly important, it presumes in the first place the *existence* of medicines. Yet original, innovative biologic medicines will not exist without a system that allows innovators to capture an adequate portion of the benefits of their innovative activity. As noted, intellectual property rights endow innovators with the resources—and incentives—to pursue the next generation of innovative activities, engendering a virtuous cycle of innovation.[207] This virtuous cycle allows the profits earned from one generation of biomedical innovation to sow the seeds for investment in future generations of biomedical innovation. And while it is certainly important that life sciences firms implement novel pricing plans to help bring access to drugs to citizens of the world who genuinely cannot afford them, it is also vital to preserve an IP system that enables innovator biologic companies to invest in research on diseases for which there currently exist no treatments or cures. In other words, a balanced IP system must be concerned with addressing the needs of both current and future generations, lest the world be left only with the stock of medicines that exists today.

The United States, which is the world's leading developer of biologic medicines, not coincidentally offers the strongest data exclusivity protections for these drugs.

In summary, countries that offer no, or only minimal, periods of biologics data exclusivity fail to cultivate an environment in which life sciences innovation can flourish. In doing so, these countries undermine their own potential to become sources of biomedical innovation and thus also fail to contribute as much as possible to the global innovation system, both through their weak IP protections and through their underproduction of life sciences innovations.

Price controls for pharmaceutical drugs are another issue in the life sciences sector which bears a significant impact on the global life sciences innovation ecosystem. It is one thing when nations' formularies negotiate to buy in bulk to lower average costs for drugs (e.g., lower prices for painkillers), but it is quite another when countries use their monopsonistic buying power to compel life sciences enterprises to sell their products below market prices.

Some contend that there is no relationship between the profits life sciences companies generate and their ability to reinvest them in R&D activities. But, in reality, as the OECD report *Pharmaceuticals Pricing Policies in a Global Market* notes, "There is a high degree of correlation between sales revenues and R&D expenditures."[208] Indeed, recent data from the United Kingdom's Department of Innovation, Universities, and Skills R&D Scoreboard shows a very strong relationship between R&D expenditures and sales for the largest 151 pharmaceutical firms worldwide.[209] Henderson and Cockburn have identified scale effects for R&D in the pharmaceutical industry, finding that R&D expenditures are directly proportional to the amount of sales revenues available to undertake R&D investment.[210] Moreover, the pharmaceutical firms with the greatest sales are also the ones with the largest R&D investments, which may in part explain why most global R&D investments are undertaken by the largest multinational firms.[211] Symeonidis notes that this is in part because large firms are better able to spread the risks of R&D uncertainty, since they can undertake several projects simultaneously.[212]

Country	Extent of Pharmaceuticals Forced Price Reductions	Country	Extent of Pharmaceuticals Forced Price Reductions
Argentina	Low	**Latvia**	Moderate
Hong Kong	Low	**Lithuania**	Moderate
Indonesia	Low	**Malaysia**	Moderate
Israel	Low	**Netherlands**	Moderate
Mexico	Low	**New Zealand**	Moderate
Singapore	Low	**Peru**	Moderate
Switzerland	Low	**Philippines**	Moderate
Taiwan	Low	**Poland**	Moderate
United States	Low	**Portugal**	Moderate
Austria	Moderate	**Romania**	Moderate
Belgium	Moderate	**Russia**	Moderate
Brazil	Moderate	**Slovak Republic**	Moderate
Bulgaria	Moderate	**Slovenia**	Moderate
Canada	Moderate	**Sweden**	Moderate
Chile	Moderate	**Turkey**	Moderate
Colombia	Moderate	**Ukraine**	Moderate
Costa Rica	Moderate	**Vietnam**	Moderate
Czech Republic	Moderate	**Denmark**	High
Estonia	Moderate	**France**	High
Finland	Moderate	**Ireland**	High
Germany	Moderate	**Norway**	High
Greece	Moderate	**Spain**	High
Hungary	Moderate	**United Kingdom**	High
Iceland	Moderate	**China**	High
Italy	Moderate	**Australia**	High
Japan	Moderate	**Thailand**	High
Kenya	Moderate	**India**	High
Korea	Moderate	**South Africa**	High

Table 32: Countries' Extent of Pharmaceutical Price Controls[213]

Table 32 assesses the extent to which countries impose forced price reductions on the sale of pharmaceutical products. Nations enact price controls on pharmaceuticals directly or indirectly based on their national structure for healthcare provision. Ideally, countries develop price control policies to keep drug prices affordable for the general public, while at the same time not depressing prices to an extent that deters innovation. But therein lies the trade- off, because, be it for political or economic reasons, some countries enact price control policies that significantly reduce the sales price of drugs, limiting the incentive for pharmaceutical companies to invest in R&D.

Various factors inform the retail price of drugs, including wholesale markups, distribution costs, and various taxes. These additional factors vary at a country level and complicate comparable price levels, while government controls also target controlling cost increases due to these other factors—which are external to pharmaceutical companies' pricing decisions.

The OECD has compared price levels for pharmaceuticals against standardized economy-wide price levels. To compare across countries, prices are weighted by purchasing price parities converted to U.S. dollars. A basket of pharmaceuticals and general products was used in order to perform cross-country comparisons. For the basket of pharmaceuticals, the study used a mix of 75 percent original drugs and 25 percent generics to establish commonality. As a whole, the study attempted to assess whether consumers in OECD countries were overpaying or underpaying for their pharmaceuticals compared to the prices of day-to-day goods.[214]

Despite what some might contend, there is a very strong correlation between sales revenues and R&D expenditures in the global pharmaceuticals industry.

A "Global Framework" paper examining differential pricing of pharmaceuticals worldwide compares the net sales data of drug purchases against a theoretical equitable price weighted by gross national income levels and purchasing price parity. Through this framework and across all national incomes, certain countries pay more than an "equitable" price for drugs, while others pay less than a fair price for their drugs.[215]

Used together, these two papers provide a means to assess the tradeoffs countries make in designing pharmaceutical price control mechanisms and allow countries to be evaluated on whether their citizens pay high, normal, or low prices for pharmaceuticals. Table 32 ranks countries based on whether they impose low, moderate, or high levels of forced price reductions on pharmaceuticals sales.

Balkanized Consumer Markets

The term "balkanized consumer markets" refers to the fragmentation of global markets for the consumption of innovative products and services. This fragmentation can occur when countries raise the cost for consumption of these goods—such as through high tariffs on ICTs or other capital goods products—or when countries implement barriers to market entry, whether in the form of restrictions or limitations on trade in services or regulatory rules that make it more difficult for innovative ICT-based services companies—such as Airbnb and Uber—to compete in a country's markets. Balkanized consumer markets undermine global innovation both by deterring trade levels and by preventing innovative companies from accessing global markets at scale, so that they can recoup their risky investments in innovation activities.

This report considers three indicators of balkanized consumer markets: countries' restrictions on trade in services, their simple mean tariffs for all products, and their tariffs on ICT products specifically. In terms of the balkanized consumer markets indicators, Latvia, Norway, Lithuania, the United States, and Australia have the least balkanized consumer markets, while Brazil, Kenya, India, Thailand, and China have the most.

Services Trade Restrictiveness

Services account for approximately 70 percent of the modern global economy, and their importance increases daily, as companies increasingly generate value by extracting insights from data and delivering their services in digital form online. In fact, Tekes, Finland's National Agency for Technology and Innovation, estimates that half of all value generated in the global economy will be created digitally by 2025.[216] Moreover, the movement of data across borders has become increasingly vital for global trade, as 50 percent of global trade in services depends on the ability to move underlying data about the service being delivered across borders.[217] In other words, ICTs increasingly facilitate and drive global trade in services. That explains why the OECD recently found that, for countries that have statistics available, 47 percent of their exports and 43 percent of their imports were in ICT-enabled services in 2003, and 53 percent of their exports and 47 percent of their imports were in ICT-enabled services in 2008.[218] Yet services also matter greatly because they constitute a vital input toward finished manufactured products, accounting for at least 30 percent of the value-added in final manufactured goods. In fact, services value-added accounts for approximately one-third of gross exports for manufacturing industries in developed economies.[219]

By preventing innovative companies from selling services to large global markets, and by making it more difficult for domestic companies themselves to innovate, countries' services trade barriers undermine the entire global innovation economy.

But while services have grown in importance to the modern global economy, their share of global trade has not increased concomitantly, with services' share of global exports remaining relatively constant since 1990, at approximately 20 percent.[220] Unfortunately, information on actual measures applied to services remains scant. Common barriers include market entry restrictions for foreign firms and "behind the border" regulations, such as differential standards, licensing, and qualification recognition. These NTBs on average represent more than 50 percent of the cost of cross-border services delivery.[221] Barriers to trade in services affect virtually all service sectors, including financial, engineering, legal, medical, ICT services, and transportation. Scores of countries jealously guard many of their incumbent firms in non-traded sectors, such as European restrictions on cross-border licensing of legal or medical professionals and the constrained competition in financial services because of regulatory restrictions.[222]

Given these myriad restrictions, services trade liberalization represents the next frontier in global trade integration and liberalization. But because services trade barriers are often complex, opaque, and hard to measure, they have not been monitored as well as barriers to trade in goods. Nevertheless, in 2013, the OECD started building a database of measures affecting trade in 18 service sectors in 40 countries called the Services Trade Restrictiveness Index (STRI).[223] Because the STRI does not provide data for every country in this study, ITIF combined STRI data with data from the older General Agreement on Trade in Services (GATS) Commitments Restrictiveness Index (which measures the extent of GATS commitments for all 155 services subsectors as classified by the GATS) to create a composite index of countries' services trade restrictiveness.[224]

As Table 33 shows, Latvia, Lithuania, the United States, Australia, and Austria have the most open markets to trade in services, while Indonesia, Kenya, India, the Philippines, and China have the least open markets for trade in services.

Country	Services Trade Restrictiveness (Lower Score Worst)	Country	Services Trade Restrictiveness (Lower Score Worst)
Latvia	1.41	Iceland	0.27
Lithuania	1.26	Italy	0.27
United States	1.12	Switzerland	0.23
Australia	1.09	South Africa	0.22
Austria	0.95	Poland	0.22
Hungary	0.94	Korea	0.17
Netherlands	0.89	Argentina	0.16
New Zealand	0.77	Greece	0.12
Slovenia	0.77	Canada	0.12
Estonia	0.75	Romania	0.09
United Kingdom	0.70	Turkey	-0.21
Spain	0.67	Bulgaria	-0.22
Denmark	0.66	Mexico	-0.27
Germany	0.64	Vietnam	-0.60
Norway	0.59	Israel	-0.83
France	0.49	Chile	-0.83
Taiwan	0.48	Hong Kong	-0.89
Sweden	0.48	Malaysia	-0.89
Belgium	0.45	Peru	-0.95
Slovak Republic	0.43	Brazil	-1.03
Portugal	0.42	Singapore	-1.07
Finland	0.41	Russia	-1.15
Czech Republic	0.39	Thailand	-1.25
Ireland	0.33	China	-1.43
Colombia	0.31	Philippines	-1.60
Costa Rica	0.29	India	-2.02
Ukraine	0.28	Kenya	-2.29
Japan	0.27	Indonesia	-2.57

Table 33: Countries' Score for Services Trade Restrictiveness[225]

Countries that erect extensive barriers to trade in services tend to believe that by doing so they can shield domestic competitors from international competition, thereby boosting local employment and economic activity. But, as is so often the case with protectionist policies, countries only end up harming themselves. For instance, by precluding international best-of-breed competitors in the accounting, architecture, engineering, legal, or even medical sectors, services trade barriers can force domestic companies to either pay more for services or have to choose from inferior service providers, raising costs or lowering quality for the end consumers of their products and services. They thus impede the global diffusion of knowledge, skills, and best practices (e.g., restrictions on trade in the skilled services professions) that could bolster the innovation potential of a country's domestic enterprises and entrepreneurs. And because services account for an increasing share of the value-added of finished manufactured products, lowering barriers to trade in services decreases their import costs and thus raises the competitiveness of domestic manufacturing industries in developed and developing countries alike. In other words, countries with extensive barriers to trade in services only undermine the global competitiveness of their manufacturing sectors. Moreover, countries with high services barriers can deprive themselves of higher levels of foreign direct investment, technology transfer, or access to innovative business models and services that can transform sectors of their economy from education and government to transportation and health care. And again, by preventing innovative companies from selling products to large global markets, and by making it more difficult for domestic companies themselves to innovate (by hampering their ability to access global best-of-breed services), countries' services trade barriers undermine the entire global innovation economy.

Balkanized consumer markets undermine global innovation both by deterring trade levels and by preventing innovative companies from accessing global markets at scale, so that they can recoup their risky investments in innovation activities.

Simple Mean Tariff Rate, All Products

High tariffs are mercantilist in a number of ways. First, they often disadvantage more innovative, productive, and efficient foreign competitors, while protecting domestic enterprises that are often less innovative, productive, and efficient. Further, in the interest of trying to favor domestic sectors on which the tariffs are applied, high tariffs damage other industries in the economy that are consumers of those goods. For example, high tariffs applied on foreign ICT products in the interest of supporting domestic ICT producers can have the effect of both raising the cost of ICT goods for other industries in an economy and inhibiting the ability of those sectors to procure best-of-breed ICTs. Ultimately, then, high tariffs distort global markets for innovative products and services, and, by disadvantaging the economic interests of the most efficient and innovative enterprises, leave the world with less innovation than otherwise would be the case.

Table 34 shows the simple mean tariff rate on all products applied by the countries in this study. Hong Kong, Singapore, and Switzerland impose virtually no tariffs whatsoever (helping to explain why they account for some of the world's great trading nations), while simple mean tariffs in Norway are less than half a percent. European Union tariffs average just under 1.5 percent, while the United States' come in at 2.81 percent. Brazil, Kenya, India, Thailand, and Korea impose the highest simple mean tariffs, each over 10 percent.

Again, while the rationale countries often give for such high tariffs is protecting domestic enterprises and industries (and the jobs they provide) from foreign competition—in many cases as part of import substitution industrialization policies—such protectionist (or outright mercantilist) policies often breed adverse and unintended consequences. By shielding domestic industries from world-class competition, high tariffs can prevent domestic companies from raising their competitiveness to international standards, thereby unwittingly making it very difficult for them to compete in international markets. And raising the costs of all types of capital goods—from machinery to ICT products—diminishes the ability of enterprises in a wide range of industries from availing themselves of products and services that could bolster their own productivity, efficiency, and innovative capacity. Again, the costs of high tariffs significantly outweigh the benefits they provide countries, whether the intent is to fund national treasuries or attempt to assist domestic competitors.

Country	Simple Mean Tariff Rate (%)	Country	Simple Mean Tariff Rate (%)
Hong Kong	0.00	Israel	1.60
Singapore	0.00	Iceland	1.76
Switzerland	0.00	Taiwan	1.80
Norway	0.43	Japan	2.41
Austria	1.49	Turkey	2.46
Belgium	1.49	New Zealand	2.48
Bulgaria	1.49	Canada	2.79
Czech Republic	1.49	United States	2.81
Denmark	1.49	Australia	2.84
Estonia	1.49	Peru	3.17
Finland	1.49	Ukraine	4.21
France	1.49	Chile	4.85
Germany	1.49	Costa Rica	4.85
Greece	1.49	Indonesia	5.02
Hungary	1.49	Philippines	5.31
Ireland	1.49	Colombia	5.49
Italy	1.49	Malaysia	6.75
Latvia	1.49	Russia	7.07
Lithuania	1.49	Vietnam	7.13
Netherlands	1.49	South Africa	7.14
Poland	1.49	Mexico	7.42
Portugal	1.49	China	7.93
Romania	1.49	Argentina	9.73
Slovak Republic	1.49	Korea	10.33
Slovenia	1.49	Thailand	11.22
Spain	1.49	India	11.46
Sweden	1.49	Kenya	11.98
United Kingdom	1.49	Brazil	13.85

Table 34: Countries' Simple Mean Tariff Rates[226]

Tariffs on ICT Products

As noted previously, high taxes and tariffs on ICT products deter their consumption. This harms the global innovation system because it causes nations to produce less innovation and realize fewer productive efficiencies across all sectors of their economy than possible, and because it distorts global markets for sale of and trade in ICT products.

High tariffs on ICTs harm the global innovation system by causing nations to produce less innovation and realize fewer productive efficiencies, and by distorting global markets for trade in ICT products.

Country	Tariffs on ICT Products (%)	Country	Tariffs on ICT Products (%)
Hong Kong	0.00	Czech Republic	1.95
Japan	0.00	Denmark	1.95
Norway	0.00	Estonia	1.95
Singapore	0.00	Finland	1.95
Switzerland	0.00	France	1.95
Costa Rica	0.05	Germany	1.95
Malaysia	0.07	Greece	1.95
United States	0.12	Hungary	1.95
South Africa	0.16	Ireland	1.95
Canada	0.18	Italy	1.95
Peru	0.22	Latvia	1.95
Australia	0.29	Lithuania	1.95
Iceland	0.34	Netherlands	1.95
Ukraine	0.55	Poland	1.95
New Zealand	0.55	Portugal	1.95
Israel	0.55	Romania	1.95
Turkey	0.58	Slovak Republic	1.95
Mexico	0.67	Slovenia	1.95
Sweden	0.99	Spain	1.95
Indonesia	1.02	United Kingdom	1.95
Taiwan	1.20	Thailand	2.38
India	1.22	Vietnam	2.63
Kenya	1.41	China	3.14
Korea	1.51	Russia	3.37
Philippines	1.81	Chile	3.84
Austria	1.95	Colombia	4.08
Belgium	1.95	Brazil	12.24
Bulgaria	1.95	Argentina	12.49

Table 35: Countries' Tariff Rates on ICT Products[227]

Indeed, countries that have attempted to grow their domestic ICT production sectors through import substitution industrialization policies have only ended up harming both their own economies and the global innovation system. In reality, high tariffs on ICT products just increase the prices domestic users pay for ICTs, inhibiting ICT diffusion throughout domestic sectors such as financial services, manufacturing, retail, and transportation, thus lowering the rate of productivity growth. That is why the Indian economists Kaushik and Singh found that for every $1 of tariffs India imposed on imported ICT products (in the years before it joined the Information Technology Agreement, or ITA), it suffered an economic loss of $1.30, due to lower productivity. As Kaushik and Singh noted in their assessment of ICT adoption in India, "High tariffs did not create a competitive domestic [hardware] industry, and [they] limited adoption [of ICT by users in India] by keeping prices high."[228]

High tariffs on ICT products also make countries less attractive actors in global production chains for ICT products. That explains why the OECD has found that countries not participating in the Information Technology Agreement saw their participation in global ICT value chains decline by over 60 percent from 1995 (when the ITA was chartered) to 2009.[229] In other words, countries with high ICT tariffs are circumvented from participating in global ICT production networks. That helps to explains why countries not participating in the ITA record very low ICT goods exports as a share of total goods exports. In fact, ICT exports account for less than 1 percent of total goods exports in non-ITA-member countries Brazil, Chile, and Argentina, while they account for more than 20 percent in other developing country ITA members, including Costa Rica, Vietnam, China, Malaysia, and the Philippines.[230]

As Table 35 shows, at tariff rates exceeding 12 percent, Argentina and Brazil impose by an order of magnitude the highest tariffs on ICT products of the countries assessed. They are followed by Colombia, Chile, Russia, and China, which impose ICT tariffs in the 3 to 4 percent range. Hong Kong, Japan, Norway, Singapore, and Switzerland impose no tariffs on ICT products.

POLICY RECOMMENDATIONS

As this report has documented, countries' economic policies impact not just innovation within their borders, but outside as well. Indeed, innovation has the characteristics of a global public good, and is prone to both market failure and collective action problems at a global scale.[231] Some nations have adopted policies that drive innovation in their nations that at the same time add to the global pool of innovation. Some nations are content to benefit from the innovations created by other nations, but they do little that actually harms innovation outside their borders. Still others adopt policies that actually harm the innovation process in other nations. Countries' increasing use of such innovation mercantilist policies constitutes a major threat to global innovation.[232]

Unfortunately, innovation policy is still largely conceived of and discussed in the context of how it impacts national innovation and economic growth. For example, *The Global Innovation Index* assesses "Five input pillars [that] capture elements of the national economy that enable innovative activities."[233] Likewise, where the World Bank does support innovation and entrepreneurship efforts, it tends to focus only on country-level effects, ignoring global effects.[234]

This contrasts starkly with regard to how trade policy is discussed. For over half a century there has been a shared consensus, at least in rhetoric if not in practice, that trade policies should be considered in the context of how they affect the overall global economy, not just an individual nation's economy. But innovation policy is still largely viewed through national lenses. Until the discussion on innovation policy is moved to a global level, national innovation policies will continue to reflect the narrower (national) focus of the current discussion.

In fact, the global framing of innovation policy is actually significantly worse than the framing of trade. There is a consensus that trade benefits all nations; however, for innovation, there is a growing perspective—especially pronounced in international organizations—that innovation is zero-sum, with innovation success in advanced countries coming at the expense of developing nations. This stems from both an underappreciation of the importance of global innovation and also from a lack of understanding of exactly how innovation occurs and the policies and incentives needed to drive it.

Many developing nations and the organizations that represent them have adopted a false narrative that the former are being held back by the nature of the global innovation system.

As it has become clearer that innovation is a key driver of growth, many developing nations and the organizations that represent them have adopted a perspective that the former are being held back by the nature of the global innovation system, and that developed nations should do more to provide technology and intellectual capital to developing nations at a significant discount, treating this as a form of private foreign aid. This can take the form of pushing for weak intellectual property standards, forced technology transfer, or other measures. For example, the United Nations Commission on Trade and Development asserts in its 2014 annual report that the global trade framework as reflected in the WTO unfairly limits developing nations' innovation policies. For example, the commission notes that "reverse engineering and imitation through access to technology, curtailed under the Agreement on Trade-related Aspects of Intellectual Property Rights (TRIPS), had previously been used by many countries, including the now developed ones."[235] The report further contends, "Strong IP protection may have little or no impact on innovation, while reducing the diffusion of foreign inputs and technologies and increasing their costs." And it asserts that "in other developing countries, strong IPR protection most probably will not allow for more technology transfer or local innovation."[236]

But when it comes to free trade benefiting all nations and the world, UNCTAD is clear in its support, endorsing "The role of trade as a powerful enabler of growth and development."[237] The World Bank is even more unabashed in its support, stating, "A greater and more sustained effort to deepen the integration of developing countries into the global trading system through lower trade costs and fewer barriers between countries is essential to eliminating extreme poverty."[238] But when it comes to innovation policies, the World Bank presents quite a different, and fundamentally redistributionist, perspective. For example, it claims that a fully implemented TRIPS Agreement (a global agreement to protect intellectual property) would transfer more than $20 billion of "rents" from developing countries "to major technology-creating countries—particularly the United

States, Germany, and France—in the form of pharmaceutical patents, computer chip designs, and other intellectual property."[239] Yet assessments like this fail to recognize that "rents" are what pays for scientists in R&D labs to produce the next generation of innovation that individuals and companies in developing nations rely on for progress.

This intellectual inconsistency is not limited to global organizations. For example, Columbia University economist Jagdish Bhagwati, a full-throated advocate, if not downright zealot, for global free trade, has asserted that the TRIPS agreement "does not involve mutual gain; rather, it positions the WTO primarily as a collector of intellectual property-related rents on behalf of multinational corporations."[240] Likewise, Michael Finger, the former lead economist and chief of the World Bank's Trade Policy Research Group, once asserted that "the total rent transfer from developed to developing countries could be as high as $60 billion per year."[241] Never mind that developing countries benefit immensely from longer life expectancies from drugs created in developed countries, that they enjoy the benefits of innovative information technologies such as smartphones and tablets, or that their industries benefit tremendously from more efficient manufacturing processes and technologies.

Skeptical attitudes toward IP remain far too prevalent in the international development community; although, paradoxically, such perspectives only stunt not only global innovation, but also developing countries' innovation.

It is high time that the global development and trade community establish a framework that better distinguishes between policies that are good (e.g., help developed and developing nations) as opposed to ugly (e.g., help developing nations at the expense of global innovation). One of the most important steps policymakers, especially in developed nations, need to take is to more strongly push back against the perspective that developed nation innovation comes at the expense of developing nation economies and that an innovation redistribution strategy is needed.

One place to start: Organizations such as the World Trade Organization and the International Monetary Fund could beef up their staff expertise on the economics of innovation and innovation policy. For the economics of innovation is something that most conventional economists are not well versed in, and as such it is difficult for them to provide useful policy guidance about what contributes to or detracts from global innovation.

In particular, national and international development organizations—including the World Bank, the International Monetary Fund, the Overseas Private Investment Corporation (OPIC), the U.S. Agency for International Development (USAID), and the Millennium Challenge Corporation (MCC), among others—should both stop promoting export-led growth as a solution to development and tie their assistance to steps taken by developing nations to move away from negative-sum innovation mercantilist policies. For countries that continue to insist on fielding egregious mercantilist practices, these agencies should cut off or substantially reduce foreign aid funding.

In addition, we need better data on how nations' policies affect global innovation. Toward that end the WTO should produce its own version of a Global Mercantilist Index, as ITIF outlined in its report *The Global Mercantilist Index: A New Approach to Ranking Nations'*

Trade Policies, which would comprehensively document countries' WTO-violating trade barriers as they relate to innovation, while unabashedly calling out the nations with the most egregious policies.[242]

The world also needs new and more capable international institutions to support global science and innovation. Nations that set aside some of their current consumption to invest in science and research are helping not just themselves but the entire world, but there is less investment in science and research than is globally optimal because many countries enjoy free rides off of others' research investments. Leading nations should therefore establish a Global Science and Innovation Foundation (GSIF). Its mission would be to fund scientific research around the globe on key global challenges and in particular support internationally collaborative research. For any nation to be eligible to receive research funds, it would have to commit at least one-tenth of one percent of its GDP in funding to GSIF and be certified by the GSIF (with guidance from the IMF) as a nation not committed to innovation mercantilism.[243]

A principal mission of the international community should be to deliver the promise of the future to the world's 7 billion inhabitants as quickly as possible.

Countries that are not committed to innovation mercantilism should work to support more internationally collaborative research. To start, the United States and the European Union should collaborate to build a platform that jointly presents information on basic scientific research projects funded by Europe's Horizon 2020 program and by U.S. agencies such as the National Science Foundation and the National Institutes of Health. This could help connect "like-focused" researchers, expand visibility into the results of ultimately published research, and could well lead to more jointly funded projects, amplifying their potential.

The United States and the European Union in particular, but all nations more broadly, should set informal yet aspirational targets for the share of basic scientific research projects they fund that include international research partners. Only 4 percent of research projects funded by Europe's FP7 research program (the predecessor to the Horizon 2020 program) had U.S. partners, for example. Countries should aspire to raise such percentages closer to at least 10 percent.

Finally, in the Transatlantic Trade and Investment Partnership Agreement, the United States and the European Union should establish a bilateral R&D participation model in order to coordinate cross-border pre-competitive research partnerships. This would permit U.S. entities (commercial and academic) to participate on equal terms with EU entities in Horizon 2020 (by appropriate arrangements) and reciprocally allow EU entities to similarly participate in U.S. programs. This could bring greater levels of creativity, competency, synergy, and collaboration that would lead to increased economic value. Other nations should be invited to join similar structures.

CONCLUSION

The world is not producing as much innovation as is possible—or as is needed. But in contrast to some who marvel at the innovations appearing almost daily—smart phones, biologic drugs, electric cars, innovative ICT-based service sector businesses such as Airbnb and Uber, etc.—it remains fair to ask: Why do we not have more?[244] As George Bernard Shaw wrote, "Some men see things as they are and ask why. Others dream things that never were and ask why not." Indeed, the real questions are about the innovations that could be here, but are not. Why do educational systems in most nations look the same as they did 50 years ago? Why have we yet to cure cancer or Alzheimer's? Why aren't robots much more functional? Why does renewable energy still cost more than coal and oil? Why don't roads last 100 years without degrading? Why can't we desalinate water cheaply?

Grand challenges require grand solutions—and one grand solution is to move toward a more supportive environment that enables global innovation to flourish to the maximum extent possible.

The list of potential innovations could go on and on, for as Schumpeter once stated, "technological possibilities are an uncharted sea." To be sure, all of these innovations and more will eventually emerge for the simple reason that science and technology will enable them to do so, people will want them, and companies and governments will support the work to generate them. But why do we have to wait so long? Only anti-technology Luddites (of which, alas, there are a growing number) would not leap at the opportunity to wave a magic wand and reach into the future to transport every innovation that will exist in 2045 to the present day.[245] As such, a principal mission of the international community should be to do just that—to deliver the promise of the future to the world's 7 billion inhabitants as quickly as possible.

As this report has explained, to achieve such goals, the international community will have to work assiduously to architect a global innovation system supported by innovation-empowering trade rules and robust domestic policies to spur innovation, including public investment and innovation-supporting tax policies. Policymakers will need to better understand and more aggressively push back when countries employ policies that try to advance their own interests at the expense of global innovation. The world's leaders need to articulate a more robust vision of commonly shared global prosperity—predicated chiefly through substantial increases in global productivity levels and greater output of innovative products, services, processes, and technologies. And much greater global collaboration and coordination will be needed to tackle universally shared challenges, particularly health and environmental problems. Grand challenges require grand solutions—and one grand solution is to move toward a more supportive environment that enables global innovation to flourish to the maximum extent possible.

APPENDIX A: INDEX METHODOLOGY

The following provides the sources for and a description of the methodology used in developing each indicator for this report.

Contributions

Effective Corporate Tax Rates

Data Sources: PricewaterhouseCoopers and Business Roundtable, Global Effective Tax Rates, April 14, 2011, http://businessroundtable.org/sites/default/files/Effective_Tax_Rate_Study.pdf; KPMG, Tax Rates Online (corporate tax rates for 2006–2015; accessed July 10, 2015); http://www.kpmg.com/global/en/services/tax/tax-tools-and-resources/pages/corporate-tax-rates-table.aspx.

Methodology: For the 41 countries with effective tax rates for 2006 to 2009 reported by PricewaterhouseCoopers, rates were adjusted using the ratio of the country's average statutory rate from 2006 to 2009 over the country's statutory rate in 2015, thereby adjusting for recent changes. For the 15 countries without listed marginal effective tax rates, 2015 statutory rates were multiplied by the average discount rate of effective over statutory rates from the rest of the sample (0.88). Bulgaria uses a statutory tax rate of 10.0 percent. Ireland uses an ITIF estimate.

R&D Tax Credit Generosity

Data Source: Luke A. Stewart, Jacek Warda, and Robert D. Atkinson, "We're #27!: The United States Lags Far Behind in R&D Tax Incentive Generosity" (Information Technology and Innovation Foundation, July 2012), http://www2.itif.org/2012-were-27-b-index-tax.pdf; European Commission, "A Study on R&D Tax Incentives" (working paper no. 52, Brussels, Belgium, European Commission, November, 2014), http://ec.europa.eu/taxation_customs/resources/documents/taxation/gen_info/economic_analysis/tax_papers/taxation_paper_52.pdf.

Methodology: Data taken from Stewart, Warda, and Atkinson. Estimates for Bulgaria, Estonia, Latvia, Lithuania, and Romania come from qualitative data from the European Commission. Argentina, the Philippines, and Vietnam are ITIF estimates.

Collaborative R&D Tax Credits

Data source: Original: Matthew Stepp and Robert D. Atkinson, "Creating a Collaborative Tax Credit" (Information Technology and Innovation Foundation, June 2011), http://www.itif.org/publications/creating-collaborative-rd-tax-credit.

Methodology: Updated with original research into countries enacting R&D tax credits since 2011.

Innovation boxes

Data Sources: Robert D. Atkinson and Scott M. Andes, "Patent Boxes: Innovation in Tax Policy and Tax Policy for Innovation" (Information Technology and Innovation Foundation, October 2011), http://www.itif.org/publications/patent-boxes-innovation-tax-policy-and-tax-policy-innovation.

Methodology: Updated with original research into countries enacting patent boxes since 2011.

Taxes on ICT Products

Data Source: Ben Miller and Robert D. Atkinson, "Digital Drag: Ranking 125 Nations by Taxes and Tariffs on ICT Goods and Services" (Information Technology and Innovation Foundation, October 2014), http://www2.itif.org/2014-ict-taxes-tariffs.pdf.

Methodology: Romania, Taiwan, and Hong Kong are ITIF estimates based on Google search queries.

Education Expenditure per Student

Data Source: World Intellectual Property Organization, INSEAD, Cornell University, *Global Innovation Index 2014*, 2014 Country Rankings (2.2.1 expenditure on education; accessed January 20, 2015), https://www.globalinnovationindex.org/content.aspx?page=data-analysis.

Methodology: For most recent data year available (2011 to 2013), spending on each student in PPP dollars is standardized for both primary and secondary education, weighed equally and summed. For Canada and Vietnam, where one of the two indicators is missing, the other is used as an estimate. Missing data for Turkey, Russia, the Philippines, Brazil, China, Greece, and Kenya estimated using GDP per capita.

Science Graduates

Data Sources: UNESCO, education database (completion, tertiary graduates, graduates from ISCED 5 programmes in tertiary education, both sexes (number); graduates from ISCED 6 and 7 programmes in tertiary education, both sexes (number); graduates from ISCED 8 programmes in tertiary education, both sexes (number); accessed June 10, 2015); http://data.uis.unesco.org/Index.aspx?DataSetCode=EDULIT_DS; UNESCO, education database (completion, tertiary graduates, percentage of graduates from tertiary education graduating from science programmes, both sexes (%); accessed June 10, 2015); http://data.uis.unesco.org/Index.aspx?DataSetCode=EDULIT_DS; The World Bank, data (population, total, 2011-2015; accessed November 1, 2015); http://data.worldbank.org/indicator/SP.POP.TOTL?display=default.

Methodology: ISCED 5 grads weighted as 1, ISCED 6-8 grads weighted at 3, total weighted grads multiplied by percentage of students graduating from 'science' programs. Scores are standardized. Estimates for 10 countries with missing data (Canada, China, Hong Kong, India, Israel, Kenya, Peru, the Philippines, Singapore, and Taiwan) estimated with GDP per capita.

Top-Ranking Universities

Data Source: Times Higher Education, "The World University Rankings" (1 to 800, 2015–2016 supplement; accessed October 2, 2015), https://www.timeshighereducation.com/world-university-rankings/2016/world-ranking#!/page/0/length/25; The World Bank, data (population, total, 2011–2015;

accessed November 1, 2015);
http://data.worldbank.org/indicator/SP.POP.TOTL?display=default.

Methodology: Universities were assigned scores based on the Times Higher Education rankings. Where scores were available for universities ranking 1-200, a transformation was used to map university scores out of 100 to an exponential scale [(Score/10)^2/6]. Universities not given numerical ranks were assigned scores by rank category: universities 201-250 scored as 3.25; 251-300 scored as 3.0; 301-350 scored as 2.75; 351-400 scored as 2.5; 401-500 scored as 2; 501-600 scored as 1.5; and 601-800 scored as 1. University scores per country were then summed for each country to give a weighted rank score. Final score reflects an index consisting of: 1) the raw number of universities per country on the list of 800 weighed by rank score, 2) weighted rank score of universities divided by the country's population, and 3) the average weighted rank score of the country's universities (countries with no listed universities receive a score of 0). Country z-scores in each category are capped at 4.0 standard deviations from each respective mean (applies only to the United States' score on category 1). These three categories are weighed equally, summed, and standardized to acquire the final score.

Researchers per Capita

Data Sources: UNESCO Data Centre, UIS.Stat (science, technology and innovation, researchers by sex, per thousand labor force, per thousand total employment, 2002–2012; accessed February 2, 2015); http://data.uis.unesco.org/; The World Bank, data (population, total, 2011-2015; accessed November 1, 2015); http://data.worldbank.org/indicator/SP.POP.TOTL?display=default; Global Innovation Index 2014, 2014 Country Rankings (2.3.1 researchers, headcounts/million pop; accessed September 11, 2015); https://www.globalinnovationindex.org/content/page/data-analysis.

Methodology: Researchers are divided by population. Data from 2012 and 2011 is used, employing the most recent year. Australia, Indonesia, the Philippines, Switzerland, Thailand, and Vietnam use older data years as an estimate. Switzerland, Peru, and Thailand use GII data. Taiwan score is an ITIF estimate (one standard deviation above the mean).

Government R&D Expenditure per Person

Data Sources: OECD, OECD.Stat (science, technology and patents, research and development statistics, expenditure, government budget appropriations or outlays for RD, millions PPP dollars – current price, 2005–2014; accessed January 12, 2015); http://stats.oecd.org/; European Commission, press release database, updated February 2, 2015, (accessed February 23, 2015), http://europa.eu/rapid/press-release_IP-13-1232_en.htm; Martin Grueber and Tim Studt, "2014 Global R&D Funding Forecast" (Battelle and R&D Magazine, December 2013), http://www.battelle.org/docs/tpp/2014_global_rd_funding_forecast.pdf; The World Bank, data (population, total, 2011-2015; accessed November 1, 2015); http://data.worldbank.org/indicator/SP.POP.TOTL?display=default.

Methodology: Government R&D expenditures were divided by population. For EU countries, Horizon 2020 research funds (an estimated €9.3 billion in 2014) were distributed evenly over the EU's population and added to the total. Data from Battelle was complemented where missing with UNESCO data (0.98 correlation between Battelle and UNESCO results for countries with data on both). Data was then adjusted by a purchasing power parity index. ITIF estimates were used to provide data for Peru, the Philippines, and Vietnam. In all cases, the most recent data year available (ranging from 2009 to 2012) was used for R&D totals. Switzerland (2008) and Argentina (2006) had older data.

Bayh-Dole Like Policy

Data Sources: Thomas J. Siepmann, "The Global Exportation of the U.S. Bayh-Dole Act" *University of Dayton Law Review*, Vol. 30:2, pages 209-243, http://www.ipeg.eu/blog/wp-content/uploads/Thomas-Siepmann-THE-GLOBAL-EXPORTATION-OF-THE-U.S.-BAYHDOLE-Act.pdf; "University Inventions – Europe Needs a Bayh-Dole Act," Intellectual Property Expert Group, August 7, 2010, http://www.ipeg.com/university-inventions-europe-needs-a-bayh-dole-act/.

Methodology: Countries receive a score of 1 if they have a policy similar to the U.S. Bayh-Dole legislation in place. If not, Technology Transfer Legislation earns the country a score of 0.5. Google searches were used to verify data in the above reports.

National Innovation Foundation

Data Source: Organization for Economic Cooperation and Development, *OECD Science, Technology, and Industry Outlook* (OECD, 2014), 111-124, http://www.oecd.org/sti/oecd-science-technology-and-industry-outlook-19991428.htm.

Methodology: Countries receive a score of 1 if they have an acting national innovation foundation. Google searches were used to verify data in the above report.

Research Citations

Data Source: SCImago Journal & Country Rank (country rankings, 2009 and 2013; accessed April 12, 2015), http://www.scimagojr.com/countryrank.php.

Methodology: Citable documents per capita in 2013 and projected total citations after five years per capita (calculated using 2013 citable documents multiplied by 2009 citation rates) are standardized and weighed equally to calculate the final score.

Government Funding of University Research

Data Sources: OECD, OECD.Stat, gross domestic expenditure on R&D by sector of performance and source of funds (PPP dollars- current prices, higher education sector, sub-total government, 1981–2013; accessed March 9, 2015), http://stats.oecd.org/; UNESCO, "Science Technology and innovation, Expenditure on R&D, GERD by sector of performance, GERD performed by higher education (in '000 current PPP$)," accessed March 10, 2015), http://data.uis.unesco.org/.

Methodology: OECD statistics on subtotal government funding of research performed by universities divided by population. UNESCO data on total University R&D funding, using average ratio of OECD to UNESCO data for countries with both data sets (.77), was used to supply data for nine countries. These two data sets had a 0.97 correlation.

Vietnam, Brazil, Thailand, Indonesia, Peru, and the Philippines are ITIF estimates derived from weighted scores from university rank (0.25), total government R&D expenditure (0.25), and PPP GDP per capita (0.5).

Detractions

Foreign Equity Restrictions

Data Source: OECD, FDI Regulatory Restrictiveness Index (2013 FDI regulatory restrictiveness index by country; accessed January 18, 2015); http://www.oecd.org/investment/fdiindex.htm. The World Bank Group, Investing Across Borders: Indicators of Foreign Direct Investment Regulation (investing across sectors, light manufacturing and telecom; accessed October 12, 2015); http://iab.worldbank.org/data/exploretopics/investing-across-sectors.

Methodology: With ITIF estimates. Light manufacturing is weighted at 5 and telecom is weighted at 1. Where data is missing from OECD, estimates derive from the World Bank, which uses a similar weight and gives standard deviation scores based on countries with data available from both sources. Taiwan and Hong Kong are ITIF were estimates based on qualitative descriptions of policies.

Non-Tariff Trade Barriers

Data Source: James Gwartney, Joshua Hall, and Robert Lawson, "Economic Freedom of the World: 2014 Annual Report" (Fraser Institute, 2014), 237, http://www.freetheworld.com/2014/EFW2014-POST.pdf.

Methodology: Scores for each country are compiled from individual economy profiles throughout the *Economic Freedom of the World* report, using scores from category 4Bi: Non-tariff trade barriers.

Number of Types of LBTs

Data Source: Stephen J. Ezell, Robert D. Atkinson, and Michelle A. Wein, "Localization Barriers to Trade: Threat to the Global Innovation Economy" (Information Technology and Innovation Foundation, September 2013, http://www2.itif.org/2013-localization-barriers-to-trade.pdf; Office of the United States Trade Representative, *2015 National Trade Estimate Report on Foreign Trade Barriers* (USTR, 2015), https://ustr.gov/sites/default/files/2015%20NTE%20Combined.pdf.

Methodology: Information contained within ITIF's *Localization Barriers to Trade: Threat to the Global Innovation Economy* report was supplemented with information from USTR's *2015 National Trade Estimate Report on Foreign Trade Barriers* report and Google searches.

Currency Manipulation

Data Source: Joseph Gagnon, "Combating Widespread Currency Manipulation" (Peterson Institute for International Economics, July 2012), http://www.iie.com/publications/pb/pb12-19.pdf; World Bank, World Data Bank (total reserves (includes gold, current US$), 2000–2013; accessed April 1, 2015), http://data.worldbank.org/indicator/FI.RES.TOTL.CD.

Methodology: Countries are scored on a categorical variable with scores of 0, 1, or 2. Counties receive one point if they are listed as a currency manipulator on the Peterson Institute report and receive one point if the country's total currency reserves have increased by over 25 percent in the last 10 years.

Export Subsidies

Data Source: WTO, "Subsidies and Countervailing Measures," (by exporter, accessed May 10, 2015), https://www.wto.org/english/tratop_e/scm_e/scm_e.htm; GDP.

Methodology: The number of countervailing measures formally lodged against each country through the World Trade Organization. Number of complaints filed against a specific exporter between 2005 and 2014 are divided by the country's GDP in billion PPP dollars. To improve normalcy, the square root is taken before standardizing. Countries in the European Union are all penalized equally for trade complaints taken against the EU. Vietnam is an outlier, and its score is adjusted down to match the next highest score (in order to avoid overly biasing the sample mean).

Many countries receive complaints in retaliation for lodging complaints against others. To correct for this, we take the ratio of complaints filed against a country over complaints filed by a country. When that ratio is less than one, we multiply the number of complaints by that ratio before dividing by GDP in billion PPP dollars.

To correct for the tendency of large countries to receive more complaints than small countries, the above measure is controlled by GDP and standardized. This is then weighed equally with the original measure uncontrolled by GDP and summed to attain the final score.

Special 301 Report

Data Source: U.S. Trade Representative's Office (USTR), *2015 Special 301 Report* (USTR, April 2015), https://ustr.gov/sites/default/files/2015-Special-301-Report-FINAL.pdf.

Methodology: If a country appears on the *Special 301 Report* priority watch list, it receives a score of 2. If a country appears on the watch list, it receives a score of 1. Countries not on either watch list, including the United States, receive scores of 0. Ukraine is considered part of the priority watch list.

Ginarte-Park Patent Rights Index

Data Source: Walter G. Park, "International Patent Protection: 1960–2005," Research Policy 37, no. 4 (2008): 791–766; https://www.american.edu/cas/faculty/wgpark/upload/IPP-Research-Policy-May-2008-3.pdf.

Methodology: Scores for 2005 used. Data for Slovenia, Latvia, and Estonia are ITIF estimates.

Intellectual Property Protections

Data Source: Klaus Schwab, "The Global Competitiveness Report: 2013–2014," World Economic Forum (1.02 intellectual property protection; accessed January 30, 2015), http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2013-14.pdf; U.S.

Chamber of Commerce, Global Intellectual Property Center, "Unlimited Potential: Global International IP Index," http://www.theglobalipcenter.com/gipcindex/; Walter G. Park, "International Patent Protection: 1960–2005," *Research Policy* 37, no. 4 (2008): 791–766.

Methodology: A metric was created combining country scores on the Global Competitiveness Report's IP protection score, weighted at 0.4, and country scores on the Global International IP Index, weighted at 0.6. Where country data on the Global International IP Index is missing, the WEF's intellectual property score is used (the two scores have a correlation of 0.8).

Software Piracy Rate

Data Source: Business Software Alliance, "Shadow Market: 2011 BSA Global Software Piracy Study, Ninth Edition" (2011 Piracy Rates, May 2012; accessed March 12, 2015), http://globalstudy.bsa.org/2011/downloads/study_pdf/2011_BSA_Piracy_Study-Standard.pdf.

Period of Biologics Data Exclusivity Protection

Data Sources: Authors' research from multiple sources. See in particular International Federation of Pharmaceutical Manufacturers and Associations (IFPMA), *Data Exclusivity: Encouraging Development of New Medicines* (IFPMA, July 2011), http://www.ifpma.org/fileadmin/content/Publication/IFPMA_2011_Data_Exclusivity__En_Web.pdf; Lisa Mueller, "TPP and the Continuing Controversy Over the Exclusivity Period for Biologics," *BRIC Wall*, November 22, 2015, https://bricwallblog.wordpress.com/tag/data-exclusivity/.

Pharmaceutical Price Controls

Data Sources: OECD, OECD Health Policy Studies: Pharmaceutical Pricing Policies in a Global Market, OECD 2008, http://apps.who.int/medicinedocs/documents/s19834en/s19834en.pdf; Rutger Daems, Edith Maes, and Christoph Glaetzer, "Equity in Pharmaceutical Pricing and Reimbursement: Crossing the Income Divide in Asia Pacific," Value in Health Regional Issues 2 (2013) 160–166, http://www.ispor.org/ValueInHealth/ShowValueInHealth.aspx?issue=9D094770-F933-40CE-8859-BE54DA4395C1.

Methodology: ITIF research assigned countries a score from 1 to 3 based on prices and ability to pay for goods in each country. A score of 1 indicates that countries pay a significant premium for pharmaceuticals and biologics when compared to general price levels; 2 indicates that countries pay an equitable amount for their pharmaceuticals relatively in line with general prices; and 3 indicates that countries pay severely discounted prices for their pharmaceuticals in relation to general price levels. Additionally, ITIF research was used to determine data exclusivity periods on biologics, in years, for each country. These two measures were weighed equally and summed.

Services Trade Restrictiveness Index

Data Source: OECD (industry and services, services trade restrictions, indicator STRI, 2015; accessed November 16, 2015), http://stats.oecd.org/index.aspx?dataSetCode=STRI; World Bank, World Trade Indicators (GATS commitments restrictiveness index; accessed

March 12, 2014),
http://info.worldbank.org/etools/wti/3a.asp?pillarID=1&indList=66&indList=118&indList=152&indList=161&indList=100&regionID=i4&periodID=16#.

Methodology: For those countries missing a Services Trade Restrictions score, their market access score is determined by weighting General Agreement on Trade and Services (GATS) and Regional Trade Agreements (RTAs) at 70 percent and 30 percent, respectively.

Simple Mean Tariff Rate

Data Source: World Bank, World Development Indicators (tariff rate, applied, simple mean, all products; accessed February 26, 2015), http://data.worldbank.org/indicator/TM.TAX.MRCH.SM.AR.ZS.

Methodology: Simple mean applied tariffs reports the unweighted average of effectively applied rates for all products subject to tariffs calculated for all traded goods. Data are classified using the Harmonized System of trade at the six- or eight-digit level. Tariff line data were matched to Standard International Trade Classification (SITC) revision 3 codes to define commodity groups. Effectively applied tariff rates at the six- and eight-digit product level are averaged for products in each commodity group. When the effectively applied rate is unavailable, the most favored nation rate is used instead. To the extent possible, specific rates have been converted to their ad valorem equivalent rates and have been included in the calculation of simple mean tariffs. Taiwan data (a 3.25 effective tariff rate) is an estimate based on Google searches.

Tariffs on ICT Products

Data Source: Ben Miller and Robert D. Atkinson, "Digital Drag: Ranking 125 Nations by Taxes and Tariffs on ICT Goods and Services" (Information Technology and Innovation Foundation, October 2014), http://www2.itif.org/2014-ict-taxes-tariffs.pdf.

Methodology: All EU countries have a score of 1.49. Average of consumer product tariff and business use product tariff are used to calculate the final score. Hong Kong and Taiwan are ITIF estimates.

APPENDIX B: DETAILS OF COUNTRIES' INNOVATION BOX REGIMES

Country	Exemption Rate	Regular Corporate Tax Rate	Effective Corp. Tax Rate on Qualifying IP	Types of IP that Qualify	Acquired IP Qualifies?	Can R&D be performed abroad?	Expenses that Reduce Qualified Income	Year Enacted
Belgium	80% of patent income is exempt	20%	6.8%	Patents and supplementary protection certificates	Yes, under conditions	Yes	Expenses except license fees and amortization of acquired patents	2008
China	Exemption for revenue below RMB 5M and 50% above RMB 5M	25%	0-12.5%	Registered patents and know-how	Yes	No	Most expenses	2008
France	Flat rate	34%	15%	Patents and supplementary protection certificates	Yes, under conditions	Yes	Includes management expenses related to licensing IP	2005
Hungary	Up to 50% of pretax income	19%	9.5%	Most IP	Yes	Yes		2003
Ireland	Specific rules	10%	<10%	Most IP	Yes	Yes	For capital expenditures after May 7, 2009	1973
Luxembourg	80% of patent income is exempt	17%	5.9%	Software, copyrights, patents, trademarks, designs, or models	Yes	Yes	Most expenses	2008
Netherlands	Flat rate	25%	10%	Patents or IP from qualifying and approved R&D	No	Yes, but not for R&D certificate	Most expenses	2007
Spain	50% of patent	25%	15%	Most IP	No	Yes	None	2008

	income is exempt							
Switzerland	Specific rules	21%	0-12%	Most IP	Yes	Yes	Most expenses	N/A
Turkey	50% of patent income	20%	10%	Patents developed in Turkey, or Technology Development Zones	No, for patents from Technology Development Zones	No		2014
United Kingdom		20%	10%	Patents, supplementary protection, data protection, plant variety rights	Yes	Yes, must be self-developed by licensor		2013

Table 36: Detailed Information on Select Countries' Innovation Box Regimes

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