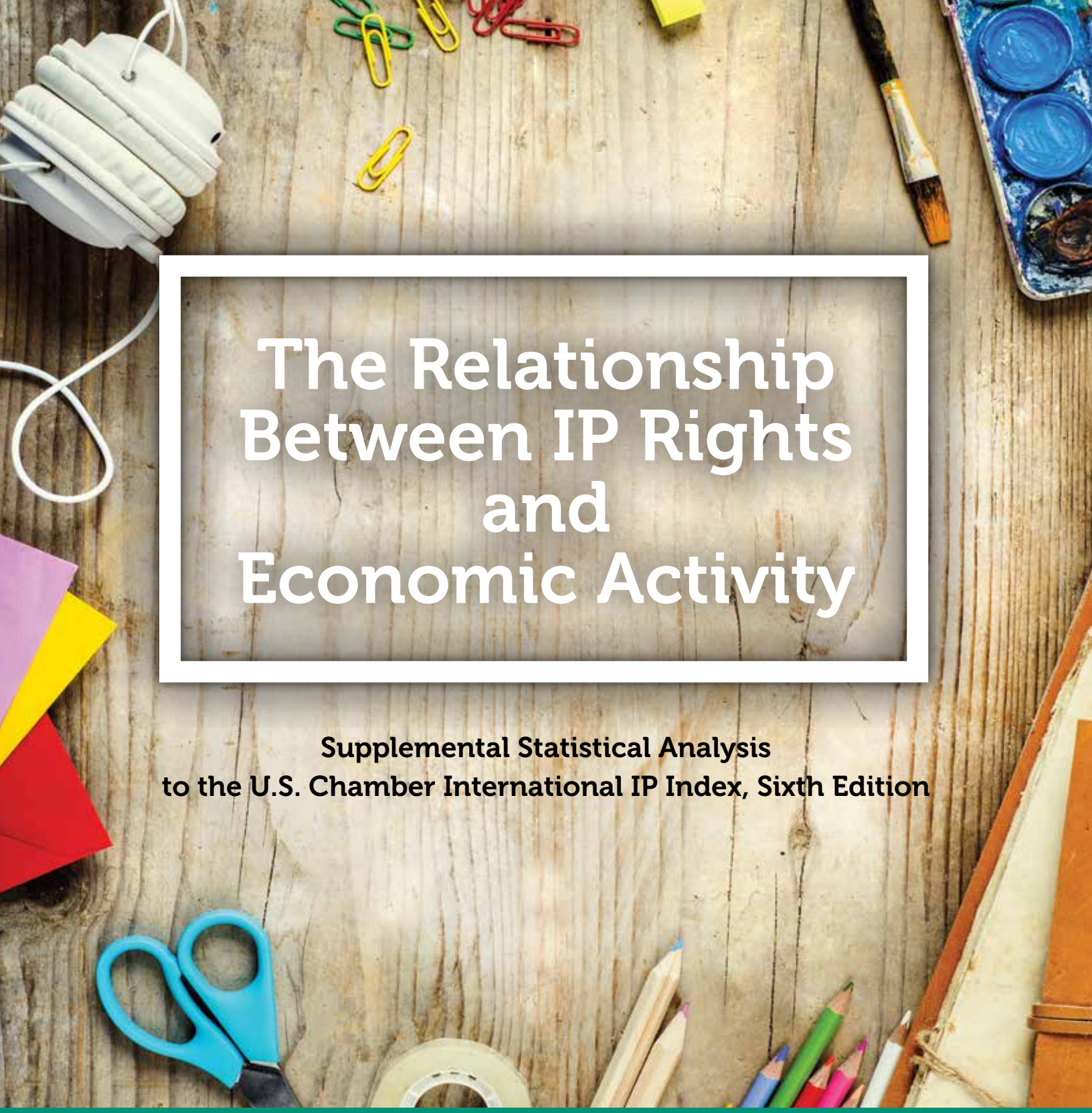

The Relationship Between IP Rights and Economic Activity

Supplemental Statistical Analysis
to the U.S. Chamber International IP Index, Sixth Edition

GIPC
GLOBAL INNOVATION POLICY CENTER

The U.S. Chamber of Commerce's Global Innovation Policy Center (www.theglobalipcenter.com) is working around the world to champion intellectual property rights as vital to creating jobs, saving lives, advancing global economic growth, and generating breakthrough solutions to global challenges.

The U.S. Chamber of Commerce is the world's largest business federation representing the interests of more than 3 million businesses of all sizes, sectors, and regions, as well as state and local chambers and industry associations.

This report was conducted by Pugatch Consilium (www.pugatch-consilium.com) a boutique consultancy that provides evidence-based research, analysis, and intelligence on the fastest growing sectors of the knowledge economy. Authors of this report are Meir Pugatch, Rachel Chu, and David Torstensson.

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Prof. Pugatch founded Pugatch Consilium in 2008. He specializes in intellectual property policy, management and exploitation of knowledge assets, technology transfer, market access, pharmacoeconomics and political economy of public health systems. He has extensive experience in economic and statistical modeling and indexing, valuation of assets and design of licensing agreements, and providing strategic advice to international institutions, multinational corporations, and SMEs from all sectors of the knowledge economy. In addition to his work at Pugatch Consilium, he is an IPKM Professor of Valorisation, Entrepreneurship and Management at the University of Maastricht in the Netherlands, as well as the Chair of the Health Systems Administration and Policy Division at the School of Public Health, University of Haifa in Israel. He is author and editor of an extensive number of publications and serves as a referee and editorial board member of numerous peer review journals.

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INTRODUCTION

The year 2017 has been unique in many respects. Brexit, "America First," and an increasingly influential China are examples of how the status quo is no more. Trade relations among nations are heading toward a new baseline. In the meantime, the global economy continues to improve, with manufacturing activity rebounding in the U.S., supportive monetary policies boosting economies in the European Union (EU) and Japan, and higher commodity prices helping the recovery of developing economies.[1]

To what extent have intellectual property (IP) rights contributed to this economic rebound? What is the role and impact of IP rights on furthering economic prosperity? Political rhetoric continues to target IP rights as one of the main reasons why developing economies have limited access to new technologies. Even in developed nations, questions arise about the merits of IP, such as the ongoing revision of the Supplemental Protection Certificates for innovations in under-researched medical indications. The sixth edition of the U.S. Chamber International IP Index (Index) discusses a series of other trends hostile to IP rights, such as blaming patents for the high cost of medicines, copyrights as an obstacle to the free exchange of ideas online, or IP rights as a hindrance to local economic activity.

Empirical evidence, however, tells a different story. Variables and indicators on both sides of the economic equation reveal how intellectual property plays a crucial role in optimizing macroeconomic inputs and outputs that are key to socioeconomic well-being. Bluntly stated, evidence shows that the stronger the IP environment is, the stronger an economy performs.

Like in previous editions, this Annex is intended to explore the correlation (statistical likelihood of two variables occurring together) between Index scores and several indicators of economic activity. Since the Index measures several types of intellectual property rights, an extra layer of granularity is possible to test the relationship between a given type of IP right and a specific sector of the economy.

The 6th edition of the Index benchmarks a total of 50 economies, an 11% increase in sample size from the 5th edition. Similarly, the current edition expands the correlation analysis between the Index and 23 economic variables—2 more than last year. Since the Index's inception in 2012 with 11 economies benchmarked, the sustained increase of the Index's sample size reveals in most cases a stronger positive association between Index scores and a number of indicators of economic activity. Even economies that implement moderate improvements to their IP environment see positive economic and societal outcomes ranging from access to financing and foreign direct investment to higher levels of economic value generation. In other words, IP has a catalytic effect in the socioeconomic prosperity of nations.

IP rights affect a wide array of aspects of a nation's economy, from stimulating inventiveness and creativity, to elevating the baseline in quality of life to spurring competitiveness and investment. As such, this Annex analyzes the impact IP rights have on variables on both ends of the economic equation: inputs and outputs. Inputs are divided into financial resources and enabling conditions. Outputs are grouped in the categories of competitiveness, value added, and creativity.

Economic Benefits of Improving IP Protection
Findings from 23 Correlations

Inputs	2016	2017	2018	Economies with robust IP protection (scoring above the median of the Index) on average tend to experience the following benefits compared with economies scoring below the median
Financial Resources				
Research and development (R&D) expenditure	.75	.70	.71	36% more likely to have in-house support by adequate investment for an idea or discovery
Access to venture capital and private equity funds	.81	.77	.79	42% more likely that an idea or discovery will be supported by venture capital and private equity
Foreign direct investment (FDI) attractiveness	.78	.78	.80	53% more attractive to FDI due to better macroeconomic indicators
Biomedical FDI	.68	.67	.72	15 times more clinical trial activity
Enabling Conditions				
Human capital	.80	.82	.82	Over 6 times more highly skilled researchers in a given labor force
Increase in high-value jobs	.80	.72	.67	Percentage of high-value workforce almost doubled
Access to advanced technologies	.83	.83	.81	26% more likely to benefit from access to latest technologies
Network readiness	.82	.82	.83	37% more likely to fully leverage information and communications technology (ICTs)
Access to licensed music outlets	n/a	.78	.79	Likely to provide up to 3 times wider access to new music through legitimate and secure platforms
Consumption of audiovisual content	.79	.73	.72	Likely to generate nearly 3 times more theatrical screenings of feature films
Access to video content	.64	.61	.66	Generates twice as many video-on-demand and streaming services

Outputs	Coefficient			Benefits from IP rights
	2016	2017	2018	
Competitiveness				
Economic competitiveness	n/a	n/a	.79	Economy 20% more competitive
Overall business environment	.77	.80	.78	Roughly 60% more receptive to entrepreneurship
Ability to incorporate new technologies and improve processes	n/a	n/a	.80	24% more agile at incorporating new technologies and improving processes
Value Added and Creativity				
Growth of high-tech sectors	.77	.80	.75	Production of up to 80% more knowledge and technology outputs
Added value of licensed software	.85	.85	.82	Twice the contribution to gross domestic product (GDP)
Online creativity	.81	.85	.84	Generates almost 3 times more online content
Innovation output	.85	.88	.86	75% more knowledge-based, technological, and creative outputs
Inventive activity	n/a	n/a	.68	Over 500 more high-value inventions
Biotech innovation	.83	.77	.78	Twice as likely to provide environments that are conducive for biotech innovation
Development of biotech therapies	n/a	.70	.75	Roughly 12 times more clinical research on biologic therapies
Cutting-edge clinical trial	n/a	.73	.76	21 times more early-phase clinical trials
Creative outputs	.80	.86	.85	62% more likely to have larger and more dynamic content and media sectors

METHODOLOGY

The Pearson Correlation Coefficient is the statistical analysis used to test the relationship between the Index's scores and other economic variables in this Annex. Simply put, the Pearson Correlation Coefficient is a widely used statistical method of establishing whether two variables are related to each other, or correlated. This statistical test provides a value between -1 and 1, which represents the strength of this correlation. Thus, the Pearson Correlation Coefficient tells us whether a linear relationship exists between two variables and if it is positive or negative.[2]

In this Annex, the strength of a given positive correlation follows this legend:

- .00 to .19: "very weak"
- .20 to .39: "weak"
- .40 to .59: "moderate"
- .60 to .79: "strong"
- .80 to 1.0: "very strong"

Each individual test of the correlation between two variables was performed under a confidence level of 0.95, which means that if this procedure was repeated on multiple samples, the calculated confidence interval (i.e., a range estimation that is calculated from the observation, and therefore would be different for each sample) would encompass the true parameter 95% of the time. In other words, the confidence interval represents values for the parameter, for which the difference between the parameter and the observed estimate is not statistically significant at the 5% level.

However, it is important to note that correlation—a statistical test of the existence of a linear relationship between two variables—does not imply causation (i.e., the fact that two variables are very strongly correlated does not mean that one has caused the other). That said, a strong to very strong correlation does imply that a linear relationship exists between the two variables, the nature of which depends on the variables.

ANALYSIS

In its 3rd edition, which surveyed 30 economies, the Index included for the first time a Statistical Annex that documented strong or very strong correlations between Index scores and 15 economic variables. The Index is now in its 6th edition, with 50 economies surveyed, and the correlation strength between Index scores and 23 economic variables has maintained and, in many cases, strengthened. The results of this research suggest a statistically significant relationship between Index scores and levels of economic activity, innovation, and growth.

This Annex examines the correlations from the perspective of economic "inputs" and "outputs."

INPUTS

Three key variables drive economic growth: capital, labor, and technology.[3] Unlimited accumulation of capital and labor eventually reaches a point of diminishing returns; this is not the case with technology. Economies with growth driven primarily by robust technological advancements have shown to be more likely to do well in the future, whereas the opposite holds true for economies driven primarily by capital or labor accumulation.[4] In other words, technology is key to sustainable long-term growth and economic resiliency.[5]

This section will explore the connection between Index scores and a series of indicators pertaining to economic activity and technological development. These variables are grouped into two main categories: financial resources and enabling conditions.

INPUT: ACCESS TO PROPER FINANCIAL RESOURCES

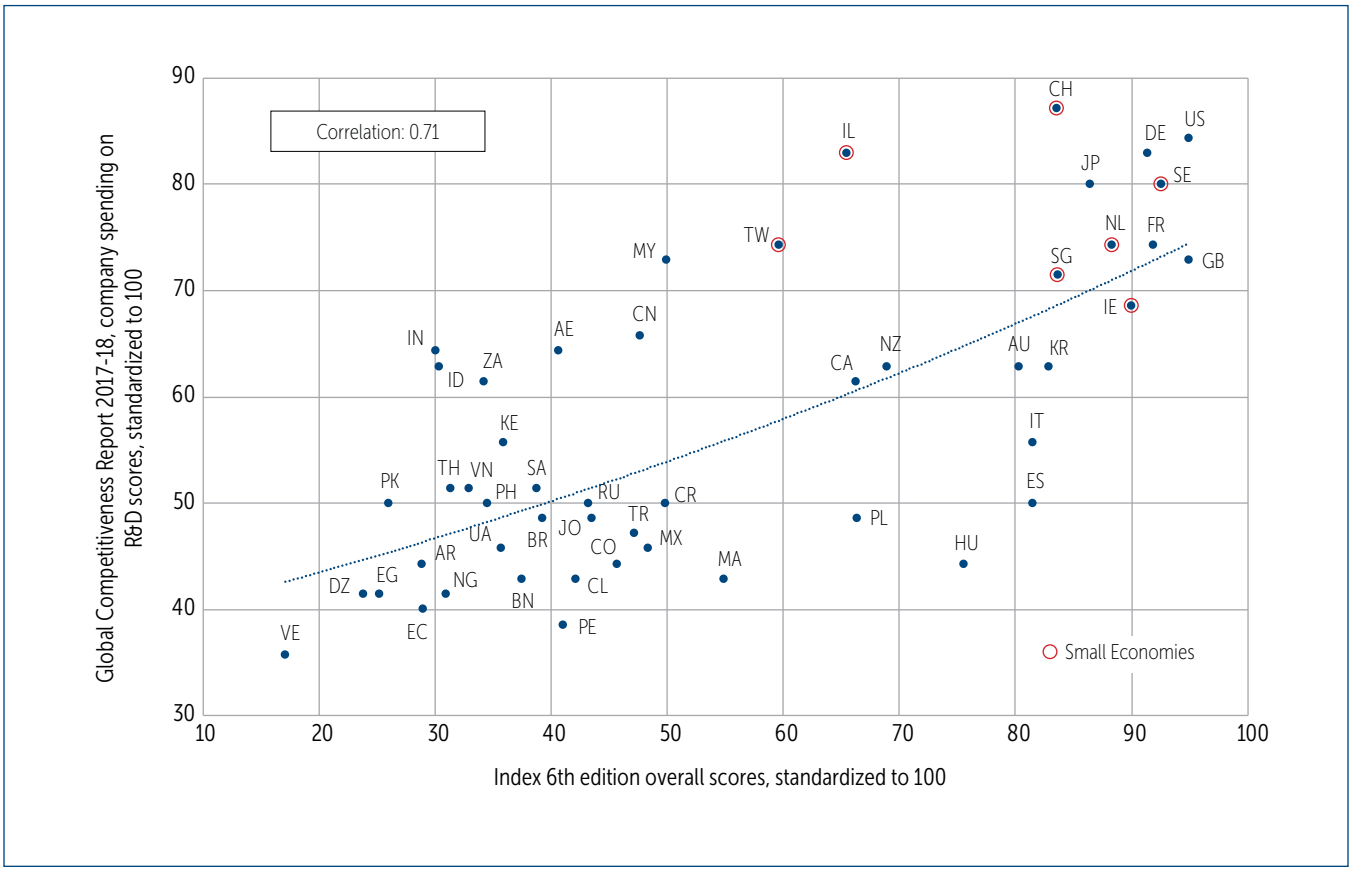
Technological advancement does not occur spontaneously in a vacuum. While some discoveries happen serendipitously, the vast majority are the result of arduous trial and error over long periods of time. The subsequent development of the idea or discovery into a useful and tangible product often involves even more time and resources than the preceding research phase. Financing such an endeavor involves a high degree of risk given the uncertain outcome of the project.

R&D EXPENDITURE

Mechanisms to protect others from copying an invention are key to financing technological developments. As such, robust IP protection works as a catalyst to invest in nascent, unproven technologies. Evidence shows there is a stronger likelihood (with a correlation strength of 0.71) that an idea or discovery will be supported by adequate investment in a robust IP environment—36% more likely. Notably, although market size is certainly an important factor when considering research and development (R&D) expenditure, evidence suggests it is not the deciding one. Instead, a key driver is the ability to protect the end result through local IP rights.

Companies Are More Likely to Spend on R&D in Favorable IP Environments

Association between Index scores and the Global Competitiveness Report, company spending on R&D scores[6]



Sources: World Economic Forum/Executive Opinion Survey (2017), company spending on R&D scores; GIPC (2018)

ACCESS TO VENTURE CAPITAL AND PRIVATE EQUITY FUNDS

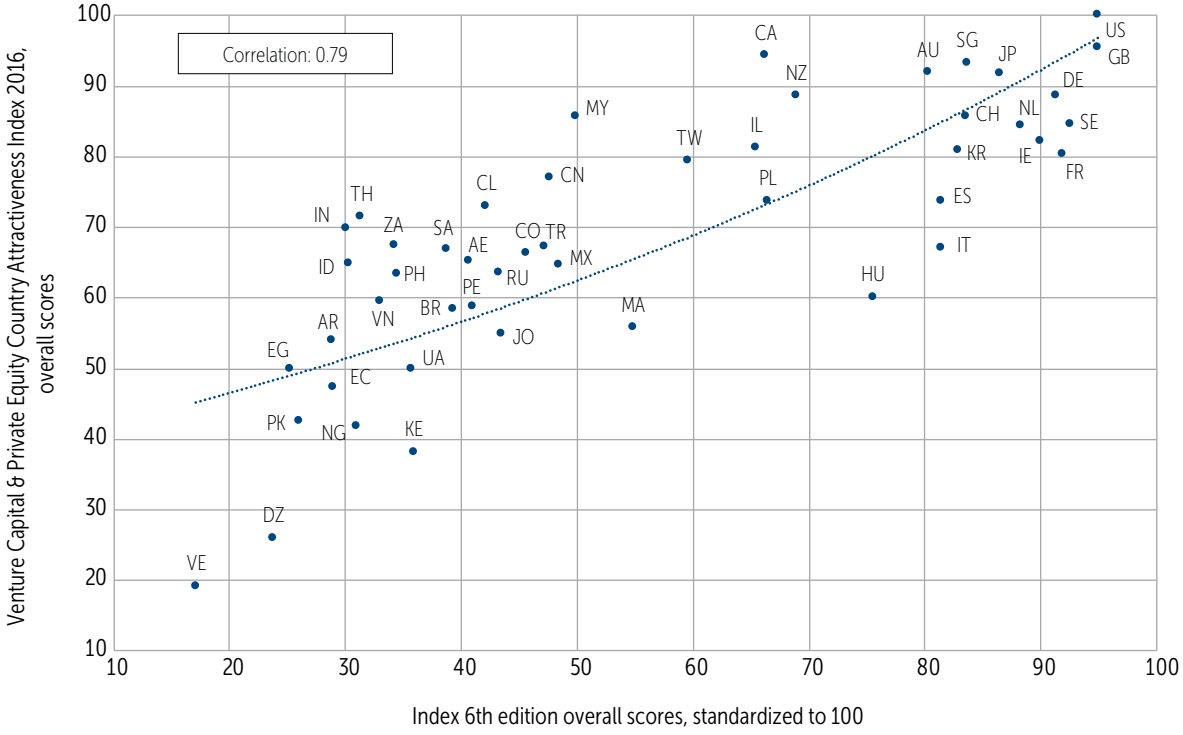
Venture capital and private equity funds are the main source of financing for nascent technologies not developed in-house; they are structured to bear the inherent high levels of risk and uncertain return on investment.

The correlation is strong between financing technological developments through venture capital or private equity and the local IP environment.

Evidence shows that economies with robust IP rights also have business-friendly environments with healthy financial markets searching for opportunities to invest in technology development. In fact, there is a strong correlation between the Venture Capital & Private Equity Country Attractiveness Index and the Index, at 0.79. In short, the stronger the IP environment, the more attractive the economy is for venture capital and private equity funds.

Favorable IP Environments Attract More Venture Capital and Private Equity

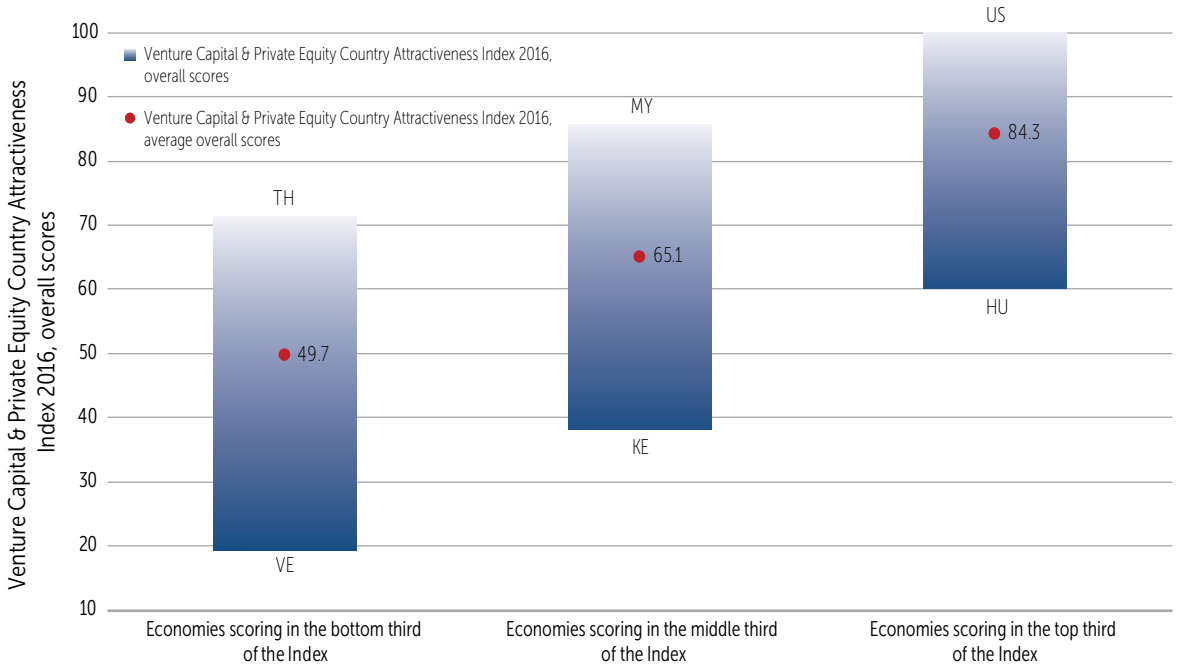
Association between Index scores and Venture Capital & Private Equity Country Attractiveness Index scores[7]



Sources: IESE Business School and EMLYON Business School (2016); GIPC (2018)
Note: Data are not available for Brunei and Costa Rica.

Dividing economies by the top, middle, and bottom third of their IP scores reveals that, on average, venture capital and private equity funds are roughly 42% more likely to be available in regions that have strong IP environments.

Association between Index scores and Venture Capital & Private Equity Country Attractiveness Index scores: Economies in the bottom, middle, and top of the Index



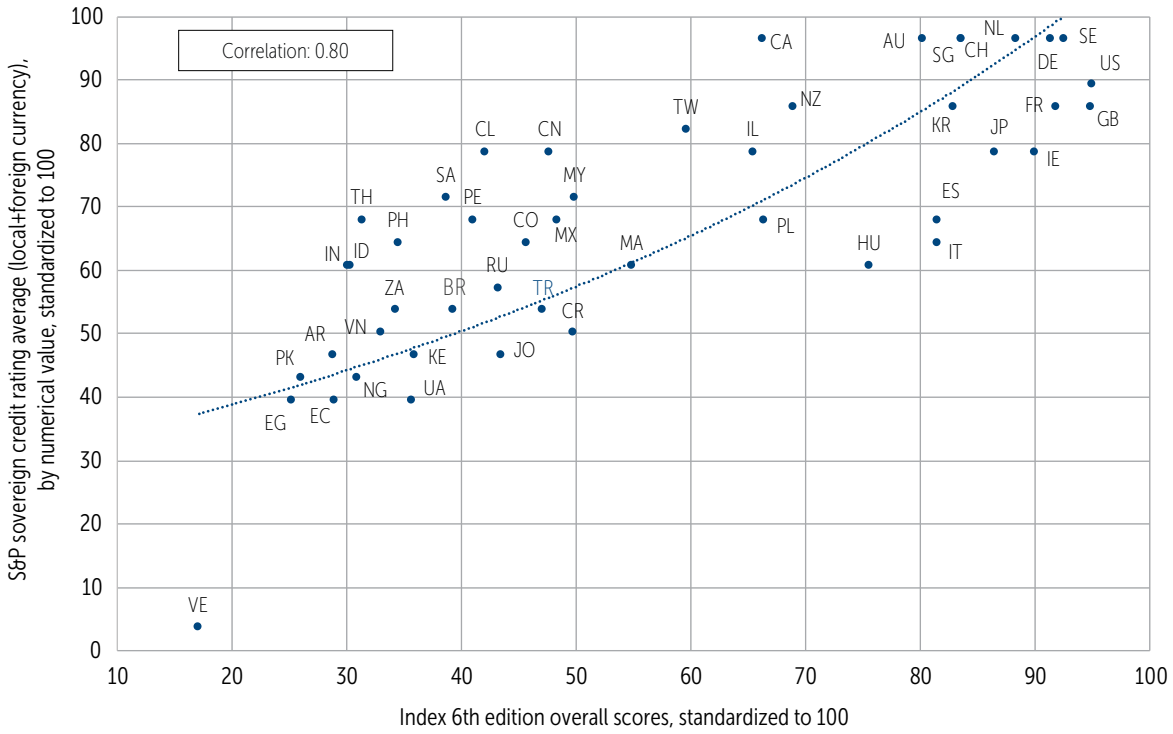
Sources: IESE Business School and EMLYON Business School (2016); GIPC (2018)
Note: Data are not available for Brunei and Costa Rica.
Legend: Top and bottom economies in each bar reflect top and bottom scores for the variable within each Index score group.

FDI ATTRACTIVENESS

More broadly, economies with high credit ratings also tend to have strong IP environments. Sovereign credit ratings reflect institutional and governance effectiveness, economic structure and growth prospects, external finances, and fiscal and monetary flexibilities.[8] Stated differently, a sovereign credit rating is a measure of an economy's health, a proxy of how attractive a market is to FDI. The relationship between the robustness of an economy's IP environment and its macroeconomic health has strengthened from 0.78 in 2016 to a correlation of 0.80 in 2018. On average, economies that score above the median score of the Index are 53% more attractive to FDI than economies below the median.

Attractiveness for FDI Is Higher in Robust IP Environments

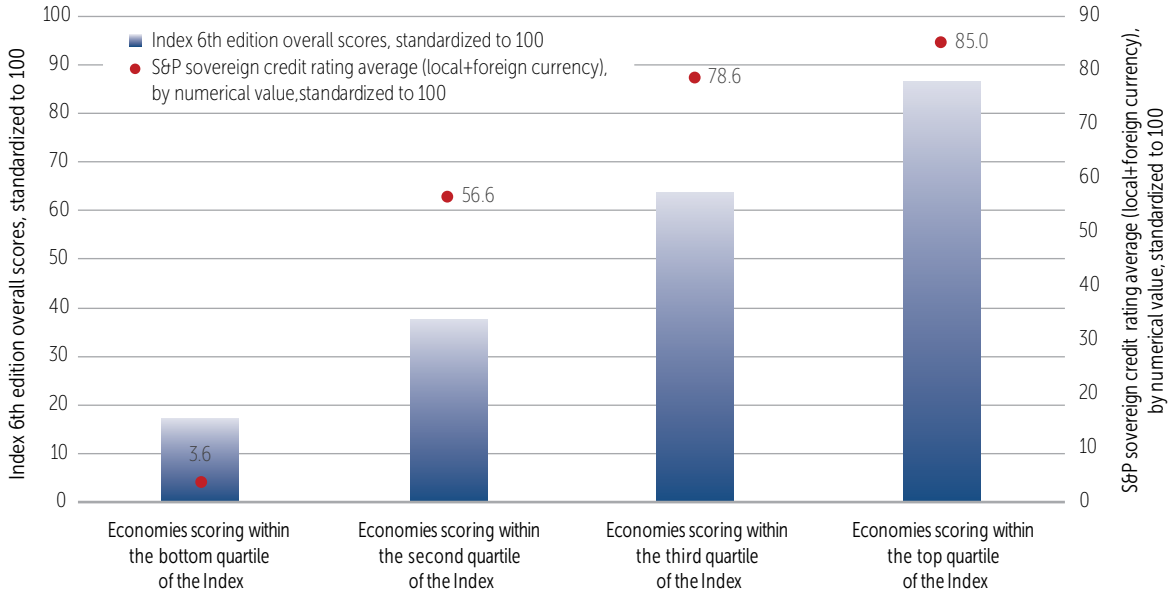
Association between Index scores and Standard & Poor's (S&P's) sovereign credit rating average[9]



Sources: Standard & Poor's sovereign credit rating, http://www.standardandpoors.com/en_US/web/guest/entity-browse; GIPC (2018)
Note: Ratings for Algeria, Brunei, and United Arab Emirates were not available.

When dividing economies by quartiles, those in the top quartile of the Index are nearly 40% more attractive to FDI than economies in the second quartile. Economies in the third quartile are up to 15 times more attractive to FDI compared to those in the bottom quartile.

Association between Index scores and S&P's sovereign credit rating average:
Sample grouping by quartiles of the Index



Sources: Standard & Poor's sovereign credit rating, http://www.standardandpoors.com/en_US/web/guest/entity-browse; GIPC (2018)
Note: Ratings for Algeria, Brunei, and United Arab Emirates were not available.

BIOMEDICAL FDI

Continuing the subject of the interplay between IP rights and FDI, it is worth analyzing the life sciences sector. The biopharmaceutical sector is one of the most R&D intensive. The industry invests on average 6 times more in R&D as a percentage of sales than all other manufacturing sectors, taking between 10 and 15 years and spending an average of USD2.6 billion to develop a new medicine.[10]

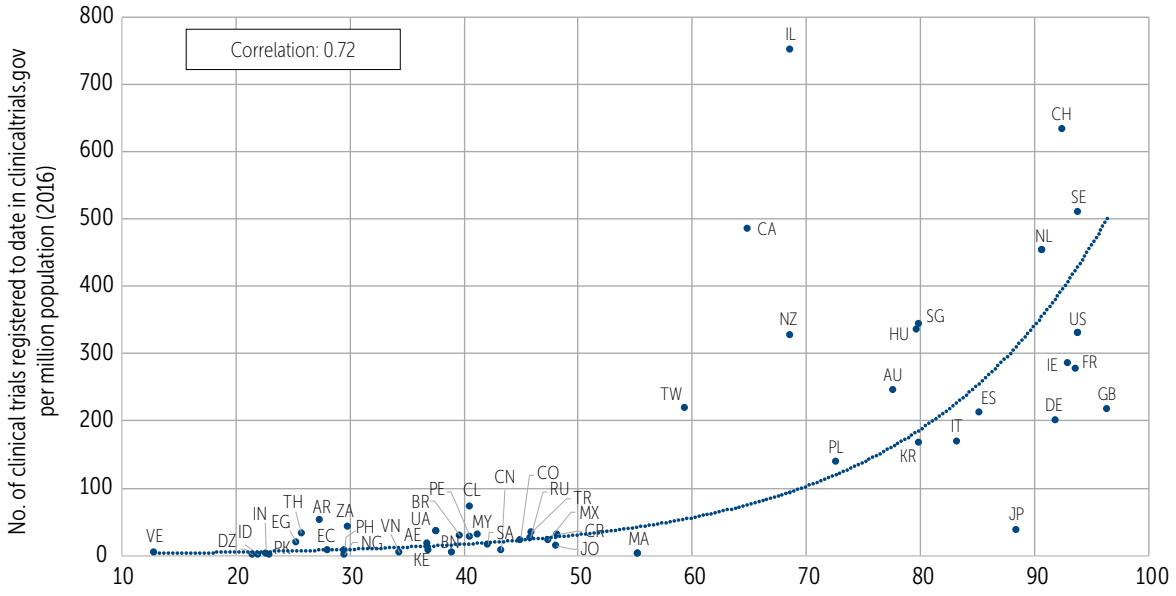
Once a compound shows enough promise in the laboratory, it is investigated in a clinical setting to determine its efficacy and safety. This is the largest and most expensive part of the development process, accounting for an estimated 60% of the R&D budget.[11]

This investment is significant, since clinical trial activity brings multiple benefits on the input side of the economic equation: It creates high-value jobs, such as in the instance of doctors conducting the trials together with a constellation of service providers supporting the research. Clinical trials also provide patients with ready access to cutting-edge therapies to treat unmet medical conditions.

The intensity of clinical trials acts as a reliable proxy for an economy's attractiveness for FDI in the biopharmaceutical sector—and IP rights play a crucial role in creating the conditions to attract FDI.[12] Evidence shows a strong correlation between Index scores and clinical trial activity per million population, at 0.72.

Clinical Trial Activity Gravitates toward Robust IP Environments

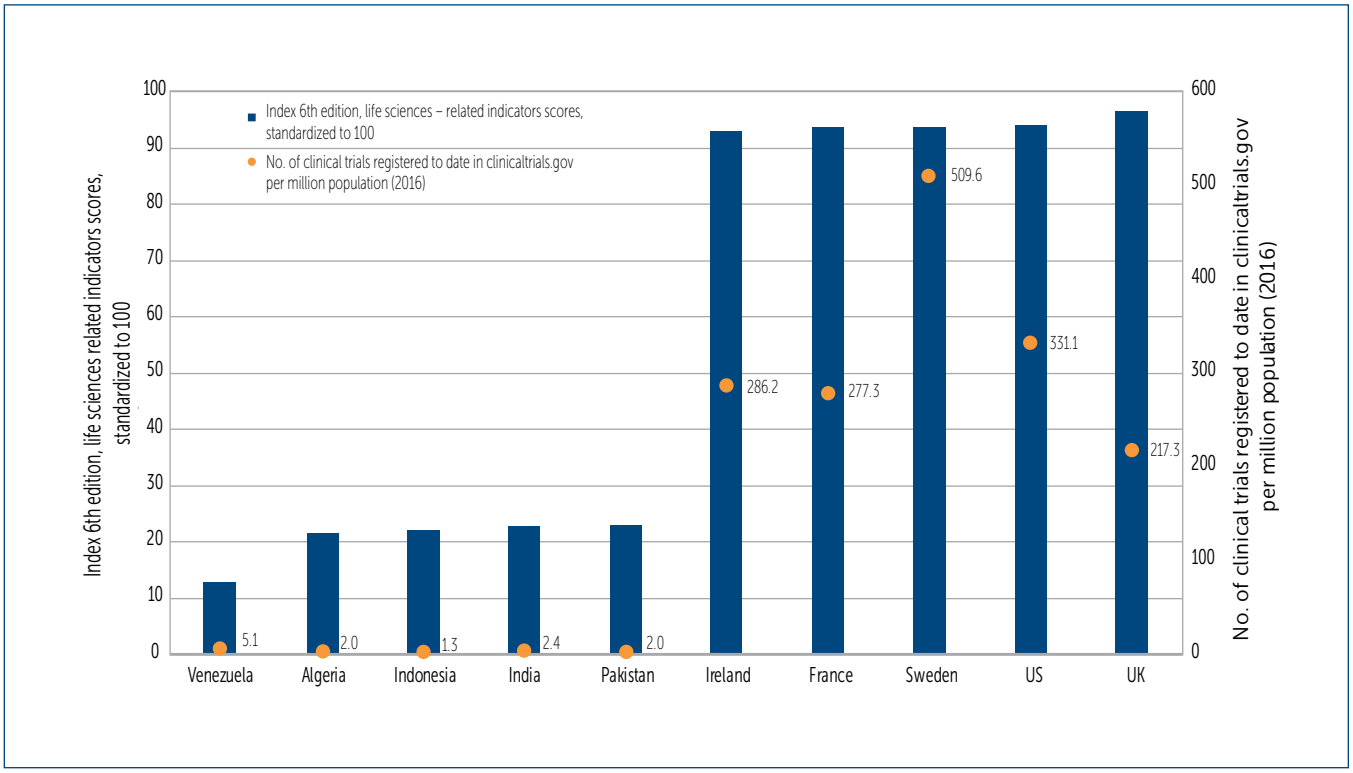
Association between Index life sciences–related indicators scores, and number of clinical trials per million population[13]



Sources: clinicaltrials.gov; World Bank; GIPC (2018)

On average, top-scoring economies on the Index's life sciences–related indicator host almost 15 times more clinical trials than low-scoring economies.

Association between Index scores and the number of clinical trials per million population: Top five vs. bottom five economies in the Index



Sources: clinicaltrials.gov; World Bank; GIPC (2018)

INPUT: ENABLING CONDITIONS

In addition to proper financial support, technology development also relies on trained researchers, skilled entrepreneurs, a modern communication infrastructure, state-of-the-art equipment, and several other enabling conditions that stimulate innovative and creative thinking.

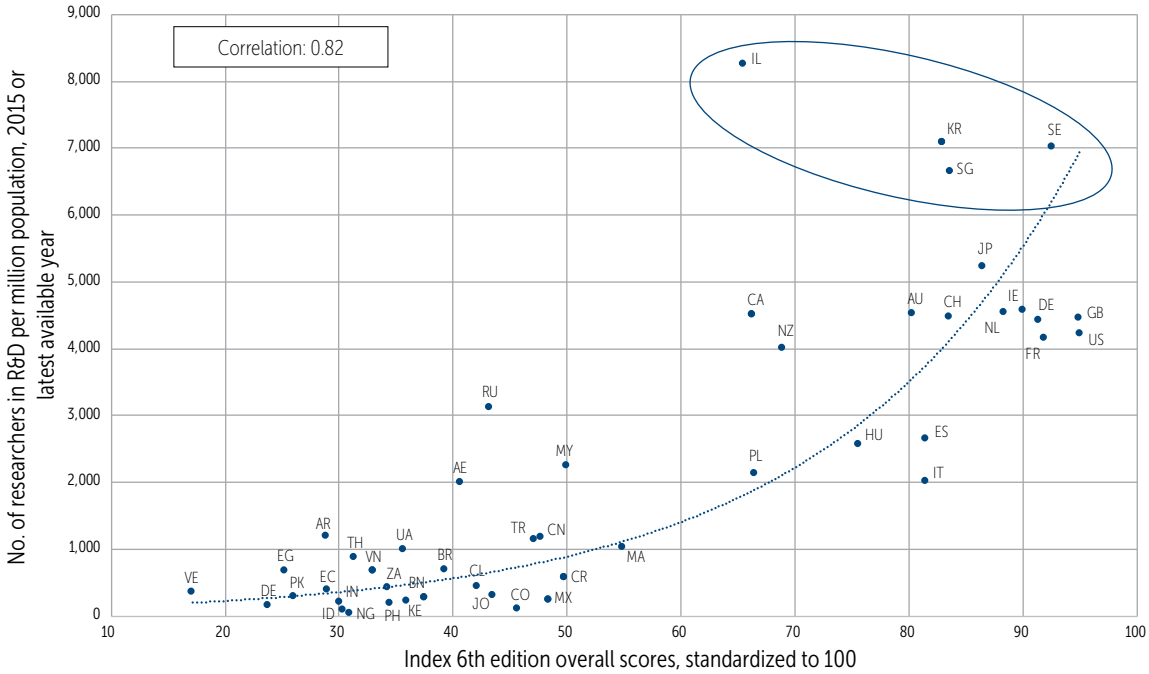
ACCESS TO SKILLED HUMAN CAPITAL

The more talent dedicated to creating technological advancements, the greater the chances of achieving sustained long-term growth. Studies have shown that highly educated and trained researchers and individuals who hold advanced degrees are essential for the technological advancement of any sector, and of the economy at large.[14]

The correlation between Index scores and the number of highly skilled researchers (adjusted per million population) is very strong, at 0.82. As the number of economies included in the Index has increased, this correlation has strengthened. Notably, the 4 economies with the highest number of researchers—Israel, Singapore, South Korea, and Sweden—have seen dynamic rates of economic growth for the past 20 years.[15]

The Stronger the IP Environment, the Higher the Number of Researchers

Association between Index scores and the number of researchers in R&D



Sources: The World Bank; GIPC (2018)
Note: Data are not available for Peru, Saudi Arabia, and Taiwan.

Economies with favorable IP regimes (scoring above the median score of the Index), on average, have over six times more R&D-focused personnel than economies whose IP environments require improvement (scoring below the median score of the Index).

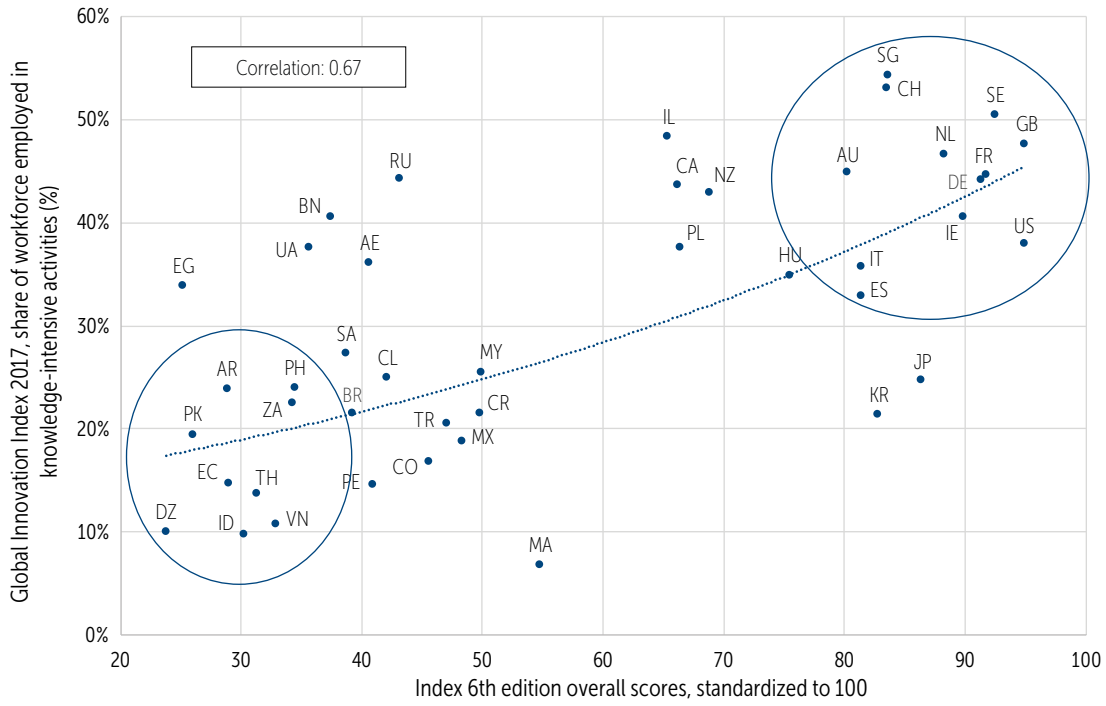
INCREASE IN HIGH-VALUE JOBS

Creating, developing, and diffusing new technologies requires strong scientific skills as well as many knowledge-intensive, non-research-related, "soft" communication and entrepreneurial skills; expert thinking; and learning agility. As such, highly skilled jobs are always in great demand by high-tech sectors. In turn, each highly skilled job supports approximately three jobs in other sectors of the economy—and five jobs in the ICT sector.[16]

There is a strong correlation (0.67) between Index scores and the share of the workforce employed in knowledge-intensive activities, as measured by the Global Innovation Index.

A Robust IP Regime Promotes High-Value Job Creation

Association between Index scores and Global Innovation Index share of workforce employed in knowledge-intensive activities[17]



Sources: Global Innovation Index, WIPO/INSEAD (2017), share of workforce employed in knowledge-intensive activities; GIPC (2018), standardized to 100

ACCESS TO ADVANCED TECHNOLOGY INFRASTRUCTURE

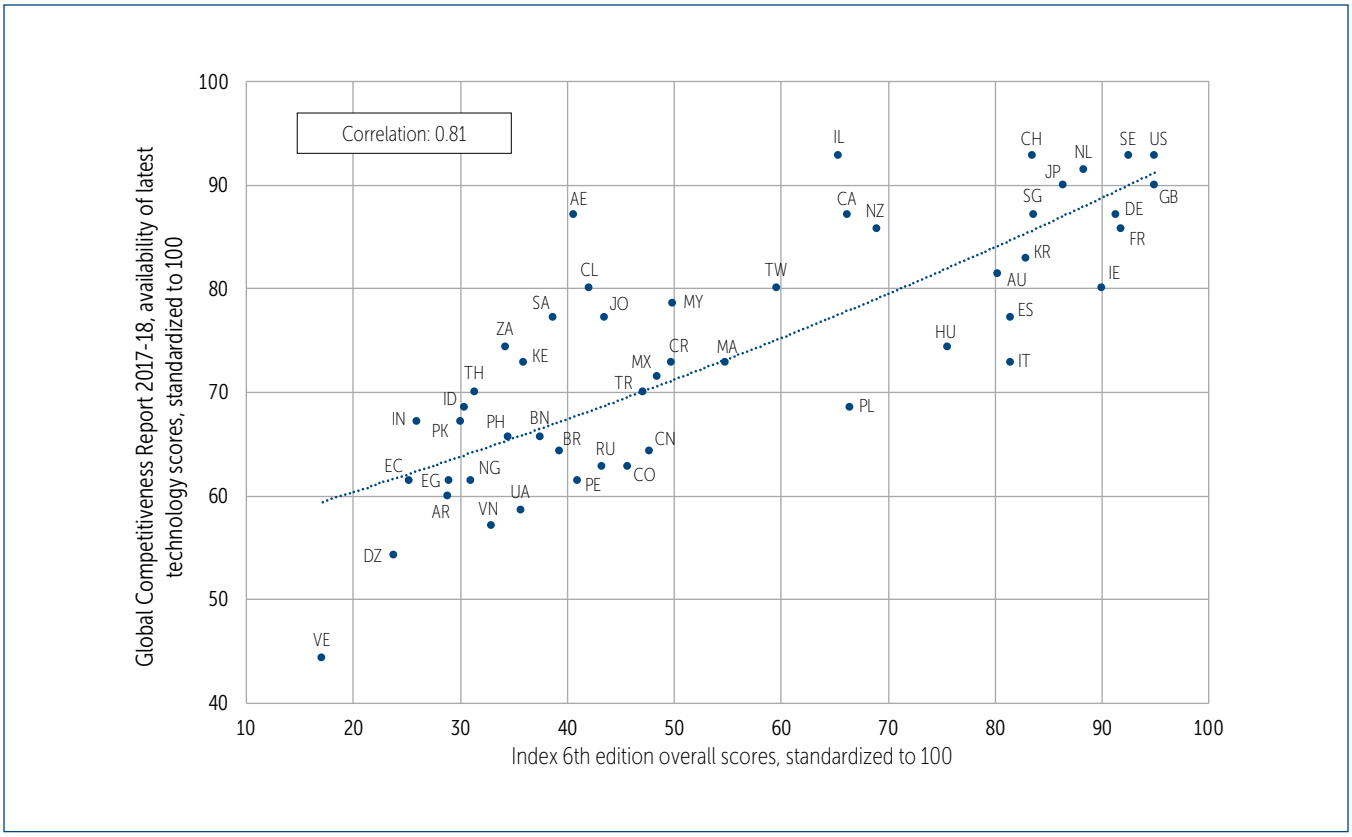
Economies that aspire to become global competitors in technological advancement must develop an enabling infrastructure that professional researchers can use to collaborate and exchange ideas. State-of-the-art equipment, the latest electronic devices, high-speed broadband Internet access, and a thriving technology transfer market are essential gears of innovation. For example, a recent study found that for every 10% increase in broadband penetration, the GDP of high-income economies grows by 1.3% and the GDP of low- to middle-income economies grows by 1.21%.[18] In short, widespread technological readiness positions an economy to excel in innovation and to prosper economically in the long run.

When measured by the World Economic Forum's Global Competitiveness Report scores on availability of latest technology, the correlation strength with Index scores is very strong, at 0.81. The strength of this correlation has increased as more economies have been added to the Index. On average, economies with IP Index scores above the median are 26% more likely to benefit from access to the latest technologies than economies below the median.

Dividing economies into quartiles of their IP Index scores reveals that economies within the third quartile of the Index are 20% more likely to benefit

Advanced Technologies Are More Readily Available in Stronger IP Environments

Association between Index scores and Global Competitiveness Report availability of latest technology scores



Sources: World Economic Forum/Executive Opinion Survey (2017),availability of latest technology scores; GIPC (2018)

from access to the most recent technological developments compared with economies within the second quartile, which in turn are nearly 40% more likely to enjoy advanced technologies compared with economies that maintain inadequate IP environments.

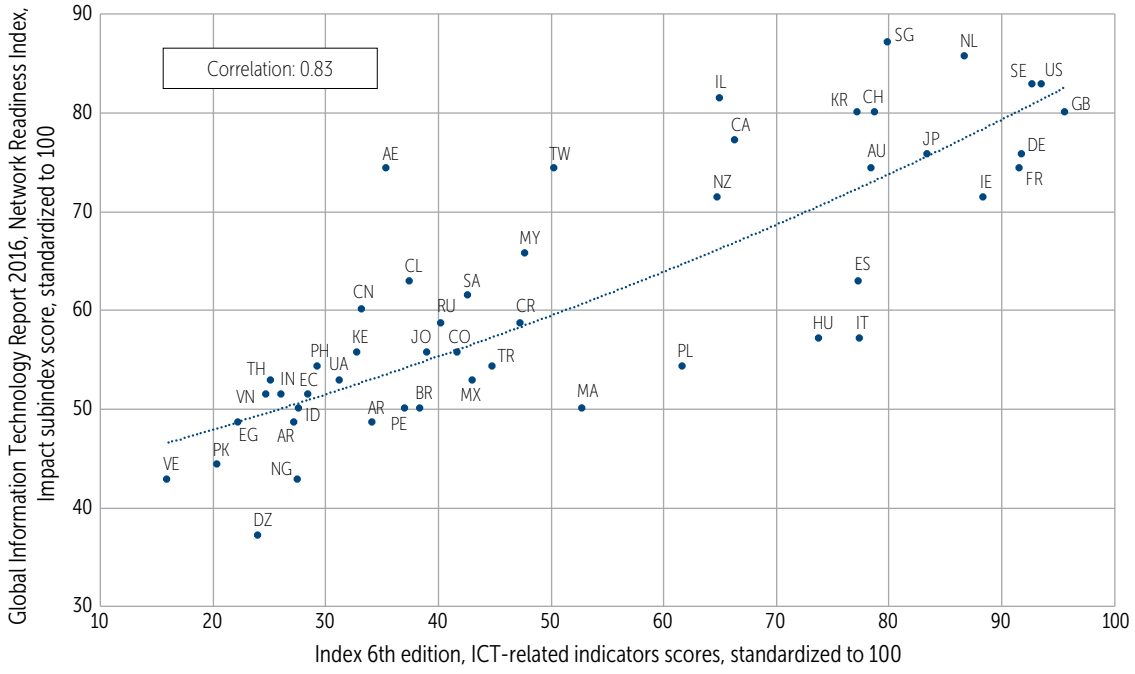
NETWORK READINESS

A key factor to enable technological innovation is information technology. Broadband has become an essential platform to accelerate economic development and stimulate social connections and civic engagement, particularly in areas such as health care, education, communications, and social networking. When combined with organizational changes, digital technology can generate powerful new efficiencies and economies of scale.[19]

The Global Information Technology Report is an analytical tool that ranks, among other aspects, how efficiently an economy can fully leverage and capitalize on the opportunities presented by ICTs. There is a very strong correlation between the Network Readiness Index scores and IP Index scores, at 0.83. The strength of this correlation has increased as more economies have been added to the IP Index. On average, economies with IP Index scores above the median are 37% more likely to fully leverage ICTs for increased productivity and technology development.

Optimal Network Readiness Takes Place in Robust IP Environments

Association between Index ICT-related indicators scores, and the Global Information Technology Report, Network Readiness Index Impact subindex scores[20]



Sources: World Economic Forum, Global Information Technology Report (2016, latest available), Network Readiness Index, Impact subindex; GIPC (2018), ICT-related indicators scores, standardized to 100
Note: Data are not available for Brunei.

ACCESS TO CREATIVE CONTENT

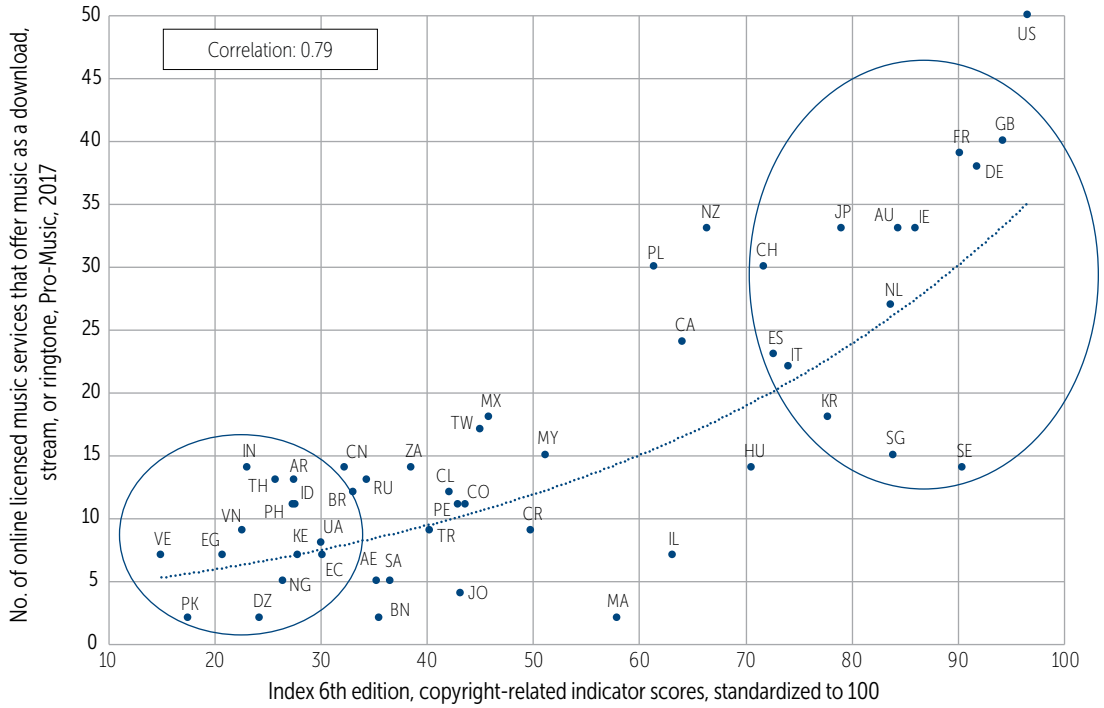
Access to film, movies, and music can often be underestimated merely as a leisurely activity without meaningful economic impact. This cannot be further from the truth.[21] Art generates an ecosystem rich in social, cultural, and economic benefits. According to the World Intellectual Property Organization (WIPO), artistic expressions are an important generator of economic value. They fuel job creation—especially highly skilled talents—and stimulate other sectors including tourism and hospitality. This in turn improves living standards, attracts business investment, and stimulates long-term economic growth.[22]

The impact of arts on the economy and prosperity has been extensively documented. For example, a recent economic impact report from the London School of Economics found that music schools are in fact a significant driver of economic growth in the UK.[23] Another economic study revealed that in 2013 the contribution of the audiovisual sector to Brazil's GDP was comparable to that of other important sectors such as tourism and sports.[24]

Evidence shows that access to music content and streaming services is greater where robust IP policies are in place, specifically strong copyright protection. There is a strong correlation of 0.79 between Index scores (copyright-related indicators) and the number of online licensed music services as measured by Pro-Music.org.[25] On average, economies with copyright-related Index scores above the median have close to 3 times greater access to licensed online music outlets than countries below the median.

Strong IP Rights Increase Access to Music

Association between Index copyright-related indicator scores, and the number of online licensed music services[26]

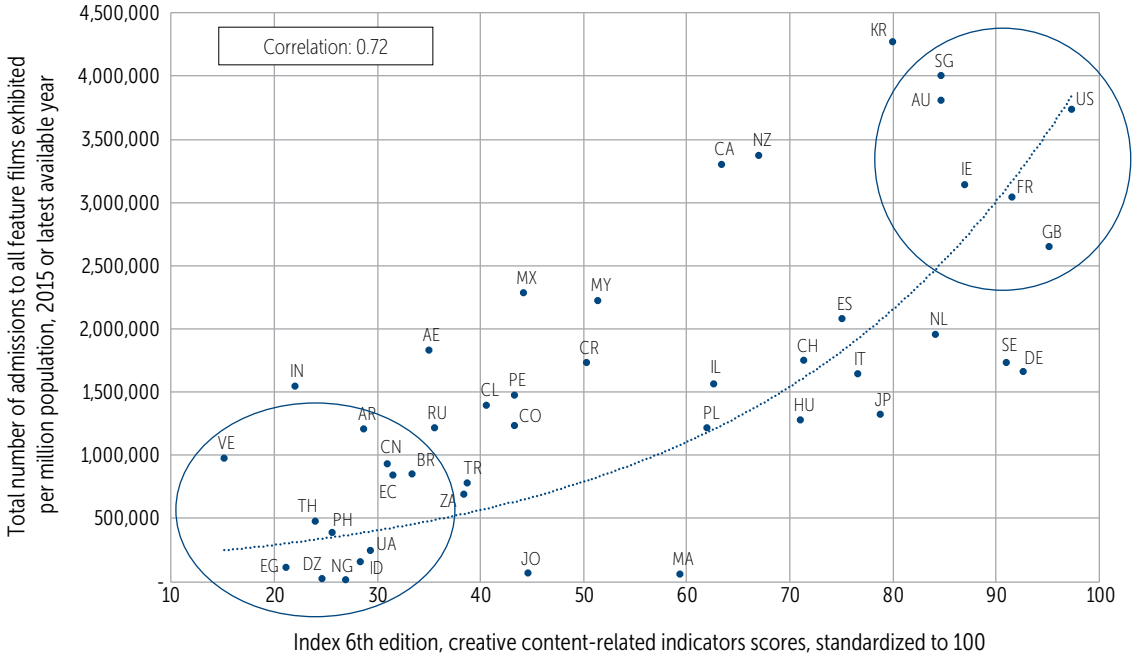


Sources: Pro-Music (2017); GIPC (2018), copyright-related indicator, standardized to 100

Further, consumers in economies that provide robust copyright protection are more likely to be able to access new content and to pay for it. For instance, there is a strong correlation of 0.72 between Index scores (creative content–related indicators) and theater screenings of feature films per million population. More specifically, people in economies in the top half of the Index are likely to go to the movie theater—and generate more tax revenue from ticket sales—nearly 3 times more than people in economies scoring below the median.

Strong IP Rights Increase Access to New Audiovisual Content

Association between Index creative content–related indicators scores, and the number of admissions to all feature films exhibited per million population[27]

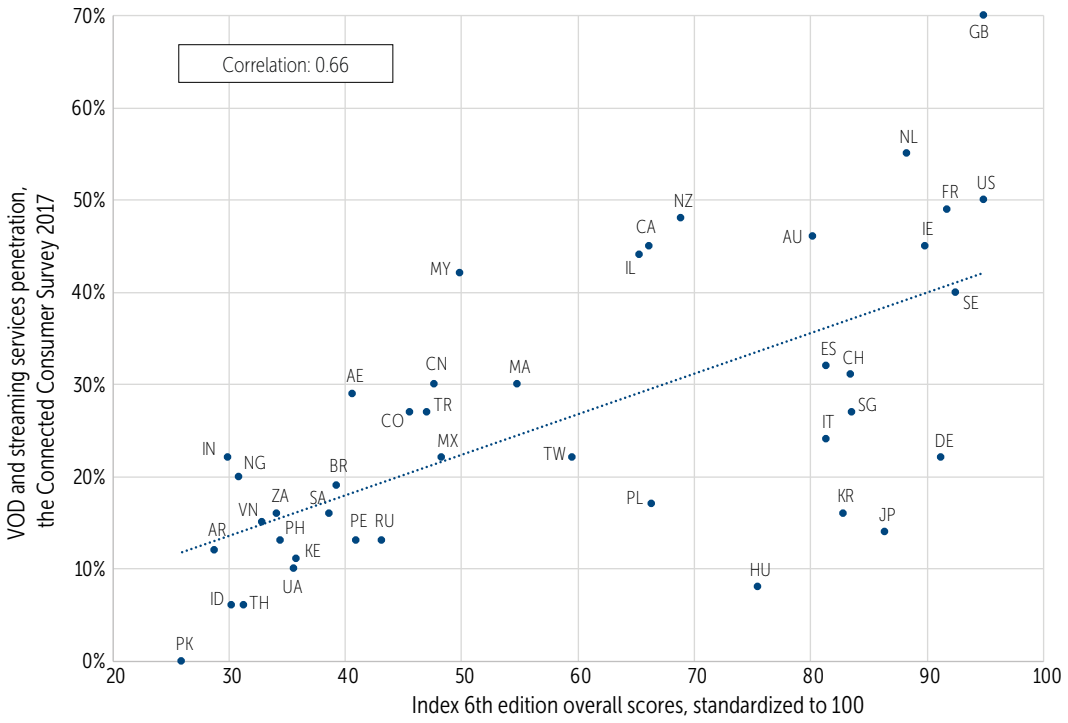


Sources: UIS Statistics (2017); GIPC (2018), creative content–related indicator, standardized to 100
Note: Data are not available for Brunei, Kenya, Pakistan, Saudi Arabia, Taiwan, and Vietnam.

A similar relationship exists between Index scores and rates of penetration of video-on-demand (VOD) and streaming services. The correlation between Index scores and the Connected Consumer Survey 2017 measurement of market penetration of VOD and streaming services, is 0.66. Economies that score in the top half of the Index, on average, have double the level of VOD and streaming services than economies in the bottom half of the Index.

Strong IP Rights Lead to Greater Access to VOD and Streaming Services

Association between Index scores and VOD and streaming services penetration[28]



Sources: The Connected Consumer Survey (2017); GIPC (2018), standardized to 100
Note: Data are not available for Algeria, Brunei, Chile, Costa Rica, Egypt, Ecuador, Jordan, and Venezuela.

In short, a robust IP environment creates a virtuous cycle: It stimulates creative content, enables its dissemination, and in turn fuels further innovation that opens new opportunities for long-term growth.

OUTPUTS

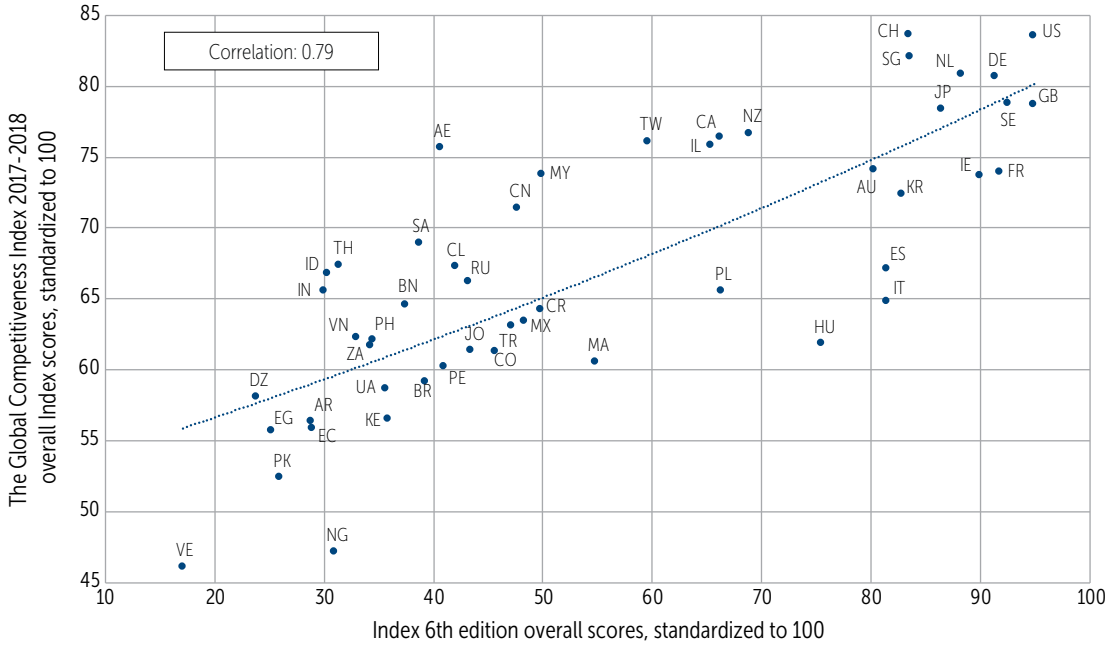
Having examined the association between Index scores and several economic inputs, this Annex shifts focus to economic outputs where IP plays a meaningful role. These indicators are grouped into two categories: (1) competitiveness, and (2) value added and creativity.

OUTPUT: COMPETITIVENESS

In its annual Global Competitiveness Report, the World Economic Forum ranks the level of competitiveness of economies—the set of institutions, policies, and factors that determine an economy's level of productivity.[2] The strong correlation between Index scores and the Global Competitiveness Report scores (at 0.79) suggests that the IP environment plays a critical role in economic competitiveness. On average, economies with Index scores above the median are 21% more productive than countries below the median.

Robust IP Rights Increase Economies' Competitiveness

Association between Index scores and Global Competitiveness Report overall scores



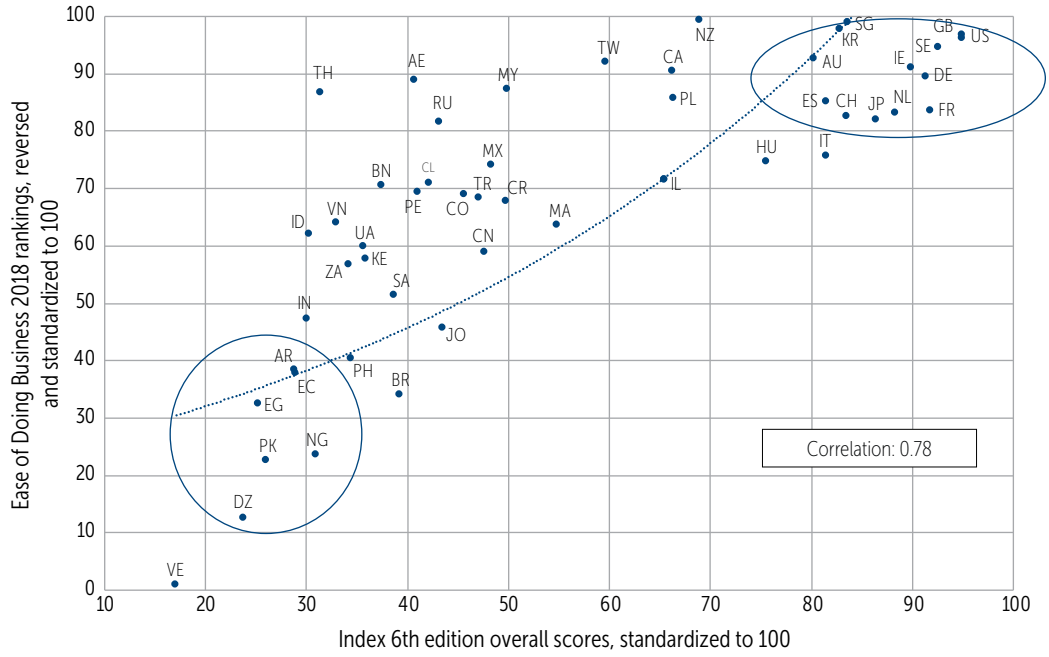
Sources: World Economic Forum, Global Competitiveness Report (2017); GIPC (2018), standardized to 100

OVERALL BUSINESS ENVIRONMENT

Productive economies rely on a functioning government and competent agencies that both effectively support and optimally regulate business activity. A dysfunctional government can overregulate or under-regulate to the point of stifling growth and dissuading entrepreneurship. The World Bank ranks economies on their ease of doing business, i.e., whether the regulatory environment is conducive to the start-up and operation of a local firm.[30] When comparing Index scores with the Ease of Doing Business rankings, a strong correlation of 0.78 is observed, suggesting that places that are hotbeds of entrepreneurship generally also have strong IP rights. The correlation between these 2 variables reveals that economies with robust IP environments are roughly 60% more likely to have a supportive business climate.

Clusters of Entrepreneurship Gravitate toward Environments with Strong IP Rights

Association between Index scores and Ease of Doing Business rankings[31]



Sources: World Bank, Ease of Doing Business ranking (Doing Business Report 2018); GIPC (2018), standardized to 100

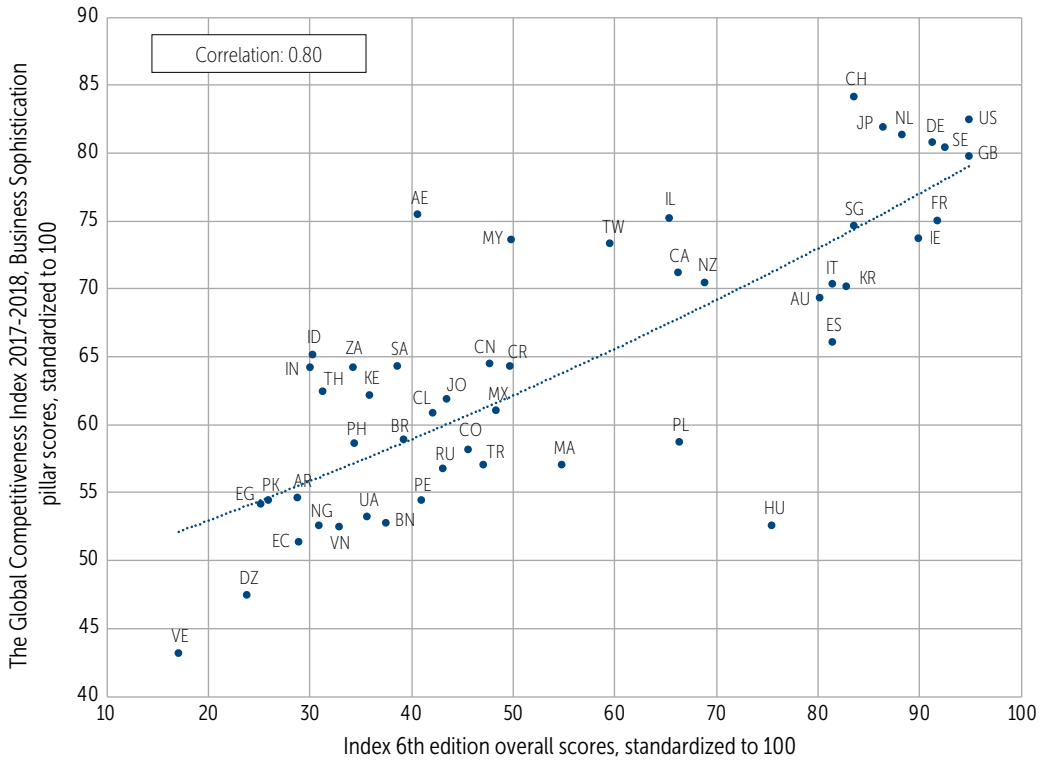
BUSINESS SOPHISTICATION

Evidence shows that economic potential and resiliency depends more on business sophistication—the ability to incorporate new technologies and to change the ways in which firms and units perform tasks—and less on investment in basic physical and human capital.[32] Economies in advanced stages have, for the most part, exhausted sources of productivity from basic infrastructure, and are now focused on productivity improvements from more strategic practices such as overall business networks and efficiency in operation—new, more efficient ways to produce things. As such, the key to fostering an entrepreneurial, vibrant, and creative environment is the level of economic sophistication.

A very strong correlation of 0.80 exists between Index scores and business sophistication pillar scores on the Global Competitiveness Report. This strong correlation reveals the pivotal role that the IP environment plays in accelerating technological change and creating incentives to engage in more innovative activities. Economies that score above the median of the Index are, on average, 24% more agile at incorporating new technologies and improving processes than economies that score below the median of the Index.

High Levels of Business Sophistication Tend to Exist in Strong IP Environments

Association between Index scores and
Global Competitiveness Report, Business Sophistication pillar scores[33]



Sources: World Economic Forum, Global Competitiveness Report (2017), Business Sophistication pillar; GIPC (2018), standardized to 100

OUTPUT: VALUE ADDED AND CREATIVITY

A common theme throughout this analysis is that technology generation is key to higher living standards and long-term growth. Technology generation is the result of creative thinking and high-value economic activity. It is the ability to challenge old ways and paradigms and find more productive and effective solutions. Creativity is also the ability to turn innovation "inputs," such as a skilled workforce, infrastructure, and IP framework, into innovation "outputs," i.e., direct and tangible economic outcomes.

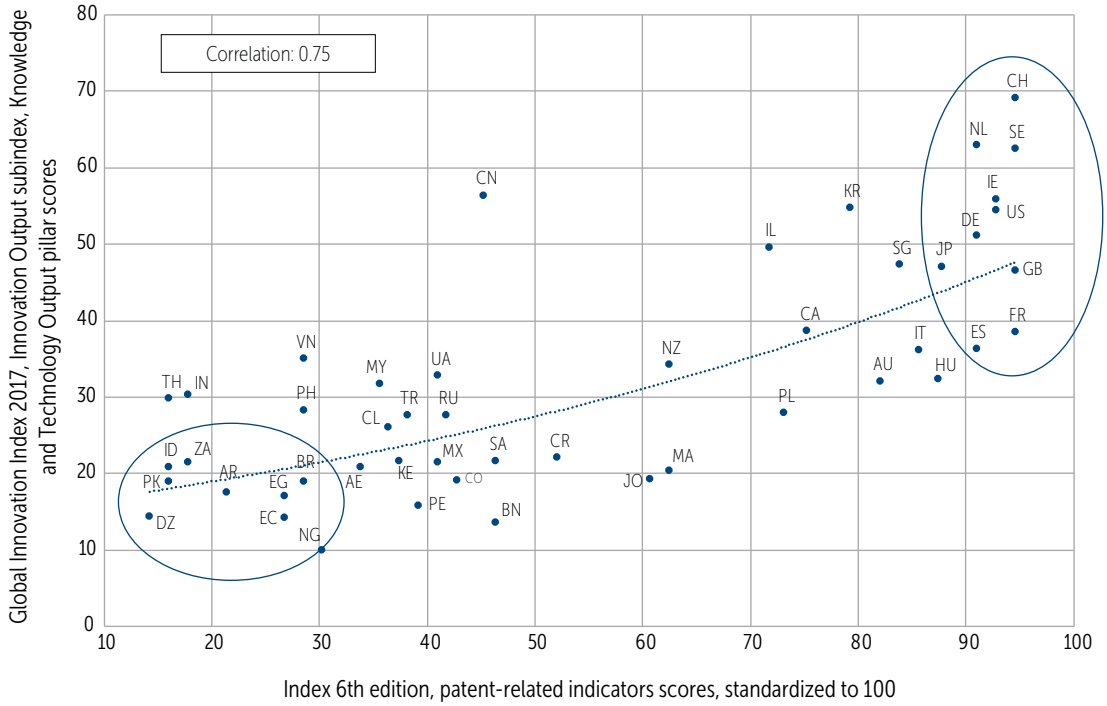
GROWTH IN HIGH-TECH SECTORS

Globalization is forcing economies to continuously become more competitive by moving up the value chain—mostly through productivity gains and technology development. Increases in productivity generally come from the effective application of advances in technology together with entrepreneurship and innovative approaches to the creation and delivery of goods and services.

Growth in high-tech sectors has been steadily on the rise. Since the mid-1990s, investments in knowledge and technological advancements have grown faster and yielded higher rates of return than investments in infrastructure, machinery, and equipment in most Organization for Economic Co-operation and Development (OECD) countries.[34] The relationship between knowledge and technology outputs—a strong indicator for robustness and growth in the high-tech sector in a given economy—and the protection of patents has strengthened from 0.71 in the 3rd edition of the Index to 0.75 in this edition. With the number of economies included in the Index increasing from 30 to 50, these results suggest a very robust, statistically significant relationship between the 2 variables. In fact, economies with robust IP systems tend to produce up to 80% more knowledge and technology outputs.

More Knowledge Is Generated in Strong IP Environments

Association between Index patent-related indicators scores, and the
Global Innovation Index, Innovation Output subindex Knowledge and Technology Output pillar scores[35]



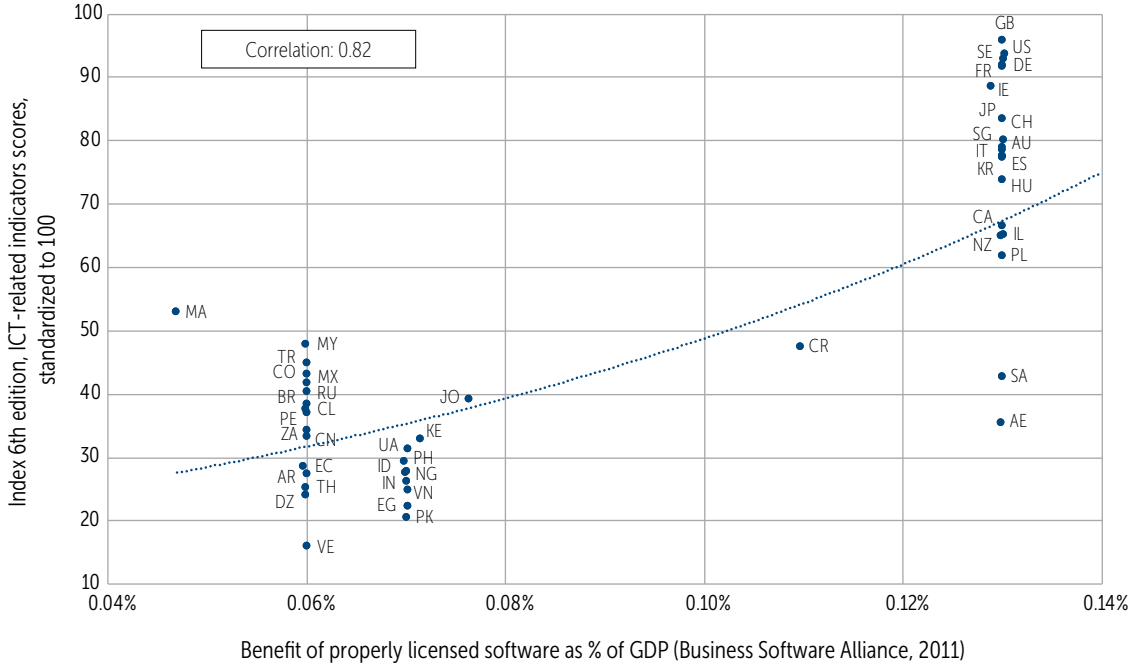
Sources: Global Innovation Index, WIPO/INSEAD (2017),
Innovation Output subindex, Knowledge and Technology Output pillar; GIPC (2018), standardized to 100
Note: Data are not available for Taiwan and Venezuela.

ADDED VALUE IN THE ICT SECTOR

Information and communication technologies, especially Internet-related economic activities, are becoming an essential component of an economy's productivity and competitiveness. New digital platforms spur better use of resources and innovation, and bring additional people, businesses, and services into the digital revolution. In fact, ICT is reshaping virtually every aspect of modern society. Artificial intelligence is developing exponentially and being applied everywhere. GPS mapping with real-time traffic information help save time and lower car emissions. New developments in health information technology, mobile health, and wearables help manage medical conditions more efficiently. Distance learning, social network civic engagement, virtual reality gaming, cloud computing, and the Internet of Things are rapidly elevating the standard of living. All this is happening while bandwidth and the speed of broadband and wireless expand by leaps and bounds.[36]

IP Rights Enable Economies to Experience Greater Economic Benefits of Properly Licensed Software

Association between Index ICT-related indicators scores,
and the benefit of properly licensed software as a percentage of GDP[37]

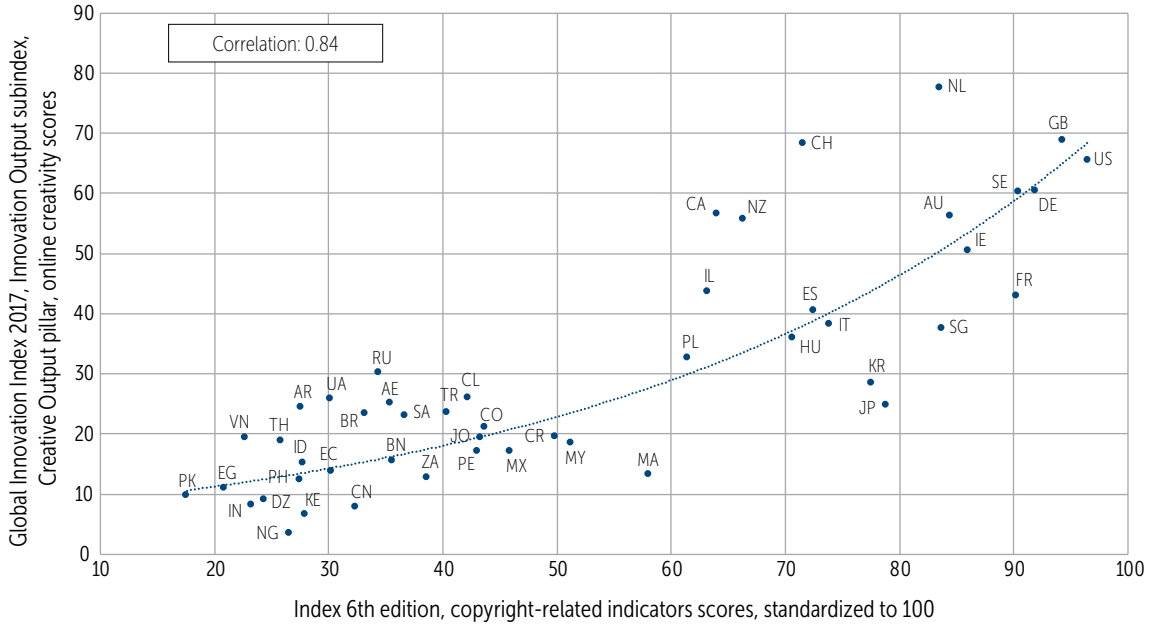


Sources: Business Software Alliance/INSEAD; GIPC (2018)
Note: Data are not available for Brunei and Taiwan.

A supportive copyright environment is crucial for the creation and diffusion of content online. This is evident in the positive relationship of 0.84 between the Creative Output pillar scores on the Global Innovation Index and the copyright-related indicator scores on the Index.

Robust Copyright Protection Promotes Creative Activity

Association between Index copyright-related indicators scores, and the Global Innovation Index, Innovation Output subindex, Creative Output pillar, online creativity scores[38]



Sources: Global Innovation Index, WIPO/INSEAD (2017), Innovation Output subindex, Creative Output pillar, online creativity scores; GIPC (2018), standardized to 100
Note: Data are not available for China, India, Jordan, Kenya, Nigeria, Taiwan, and Venezuela.

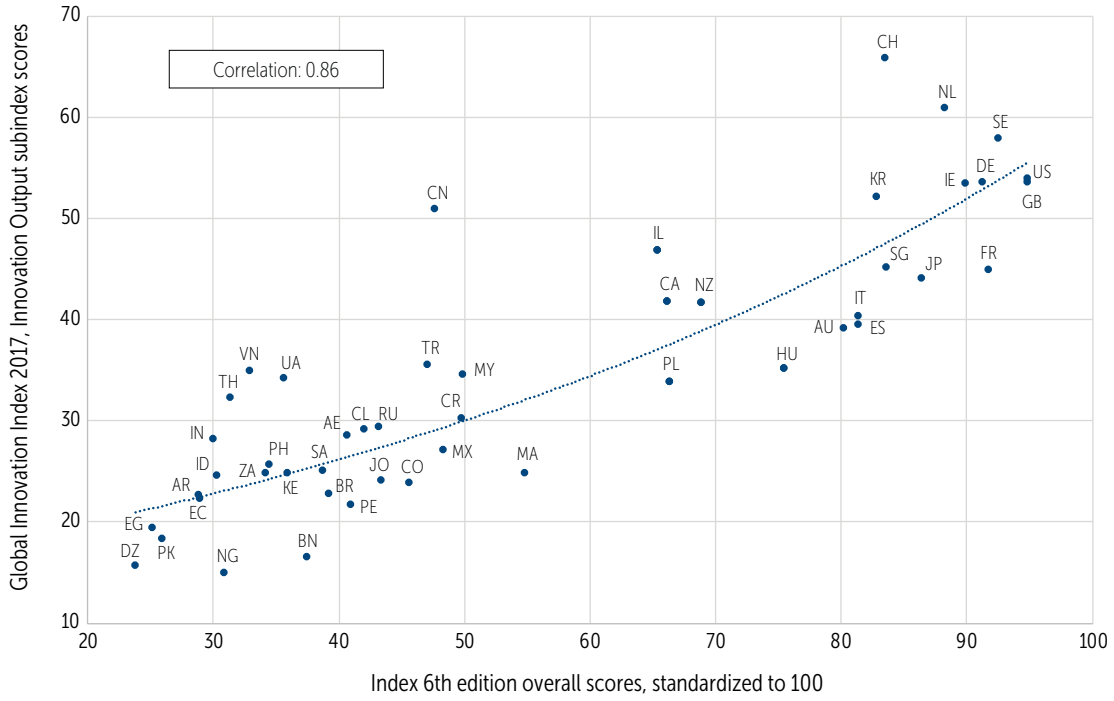
People in economies that provide strong copyright protection, including for digital and online works, tend to contribute more to the global diffusion of knowledge by generating nearly three times more online content compared with people in economies whose copyright-related IP environments are lacking.

INNOVATION OUTPUT

At a general level, IP protection strongly correlates with actual levels of innovation. Innovation may be defined in different manners and therefore measured in a number of ways, but one measure available today is the Global Innovation Index, Innovation Output subindex—an aggregate measure that looks at a wide variety of indicators reflecting knowledge creation and development, including intangible assets, research publications, and high-tech production. Innovation output and IP rights display a very strong correlation of 0.86.

Levels of Innovation Increase in Strong IP Environments

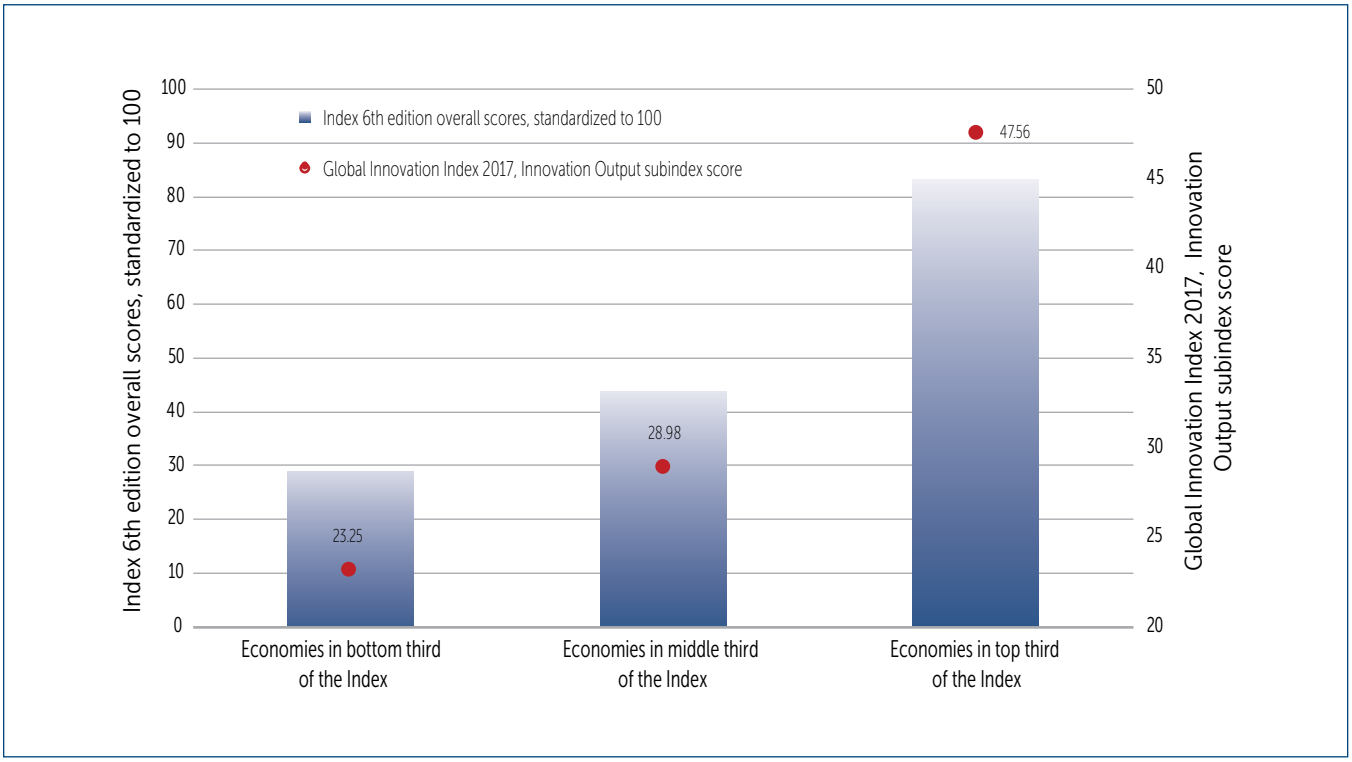
Association between Index scores and the Global Innovation Index, Innovation Output subindex scores[39]



Sources: Global Innovation Index, WIPO/INSEAD (2017), Innovation Output subindex; GIPC (2018), standardized to 100
Note: Data are not available for Taiwan and Venezuela.

Economies with robust IP regimes experience 75% more knowledge-based, technological, and creative outputs than economies whose IP regimes trail behind.

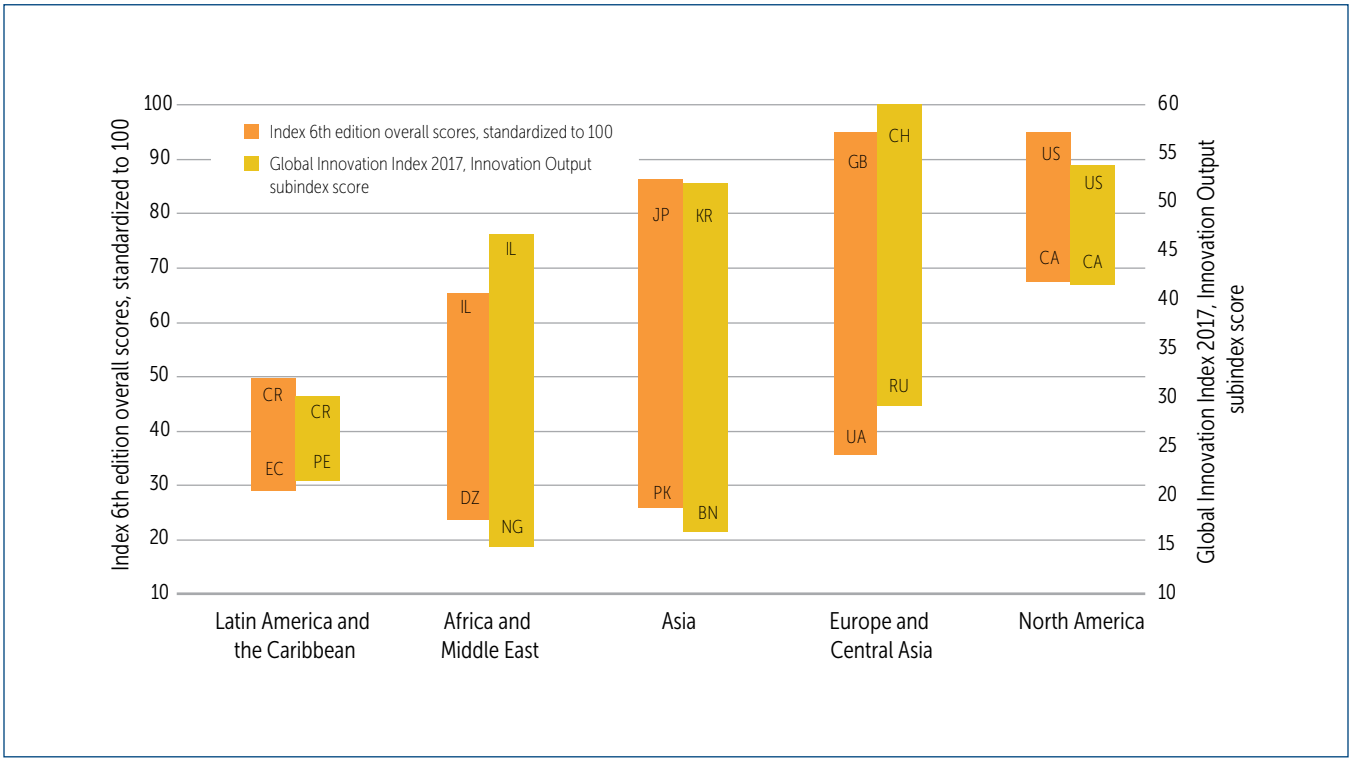
Association between Index scores and the Global Innovation Index, Innovation Output subindex scores: Economies in the bottom, middle, and top of the Index



Sources: Global Innovation Index, WIPO/INSEAD (2017), Innovation Output subindex; GIPC (2018), standardized to 100
Note: Data are not available for Taiwan and Venezuela.

A regional analysis also confirms the close correlation between scores on the two indices.

Association between Index scores and the Global Innovation Index, Innovation Output subindex scores: Regional analysis



Sources: Global Innovation Index, WIPO/INSEAD (2017), Innovation Output subindex; GIPC (2018), standardized to 100
Legend: Top and bottom economies in each bar reflect top and bottom scores within the Index and the variable, within each region.
Note: Data are not available for Taiwan and Venezuela.

INVENTIVE ACTIVITY

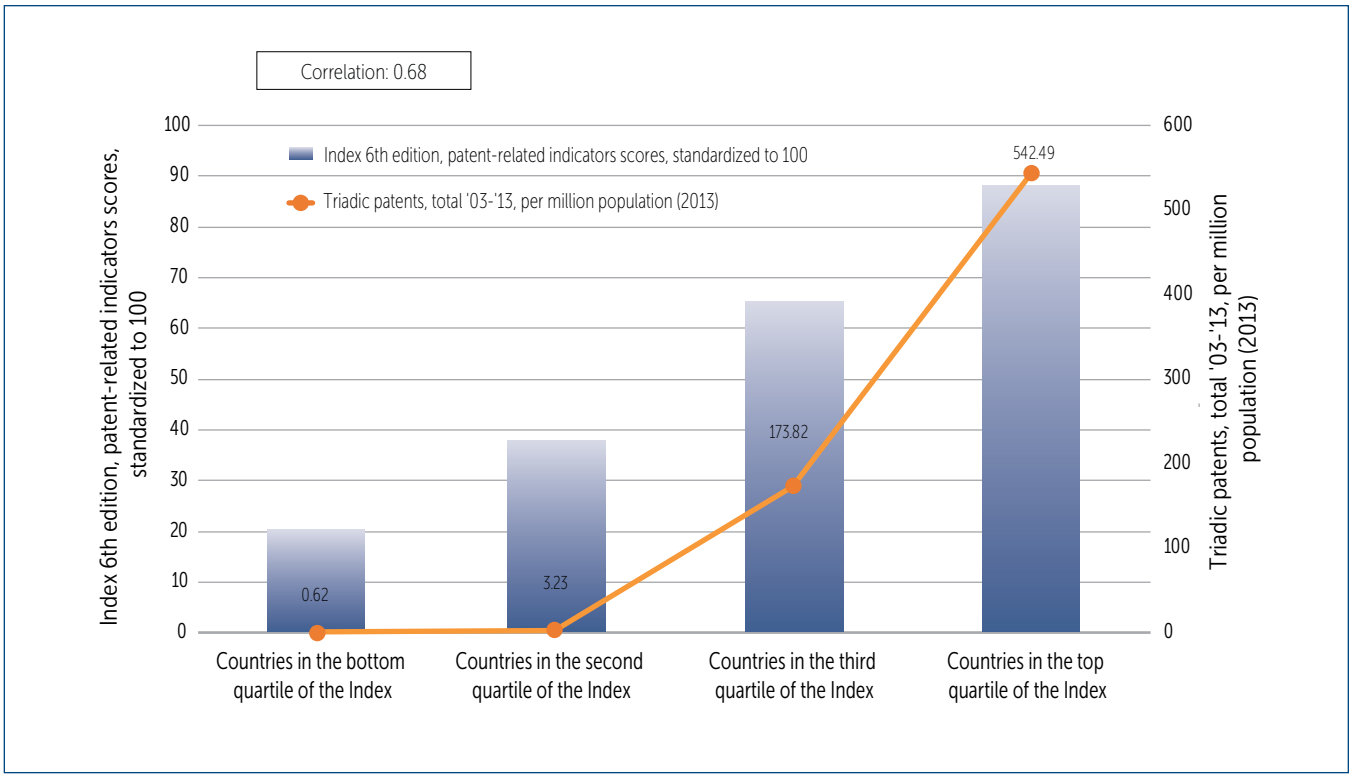
Moving on to more specific economic outputs, patenting rates are a reliable proxy for innovation activity generally, and technology development more specifically. IP rights, particularly for patents, provide the mechanism to incentivize innovative activity and protect the effort and investment spent in the research and development of valuable inventions. In turn, the IP rights become key assets for the growth of the enterprise.

Obtaining patent protection and enforcing it requires significant financial resources, more so if the invention is protected in multiple jurisdictions.[40] As such, only inventions that offer significant market potential, or that act as a springboard for further technology development, are worth protecting in multiple economies. Generally, such valuable inventions are patented in three major markets: the U.S., Europe, and Japan. Also known as triadic patenting, the practice is a reliable indicator of the development of high-value innovations with significant commercial potential.

The Index scores display a strong relationship (a correlation of 0.68) with triadic patenting rates standardized by population. Strong IP environments generate more triadic patenting, while the opposite makes it virtually nonexistent.

Levels of High-Value Innovative Activity Increase in Strong IP Environments

Association between Index patent-related indicators scores, and triadic patents per million population[41]



Sources: OECDStat, World Bank; GIPC (2018)

The chart reveals that economies with robust IP environments generate significantly more valuable innovations (almost 550 more per million population) than economies with weaker IP environments. Even economies in the third quartile of the Index, reflecting ongoing IP improvements, show a jump in triadic patenting of almost 200 per million population.

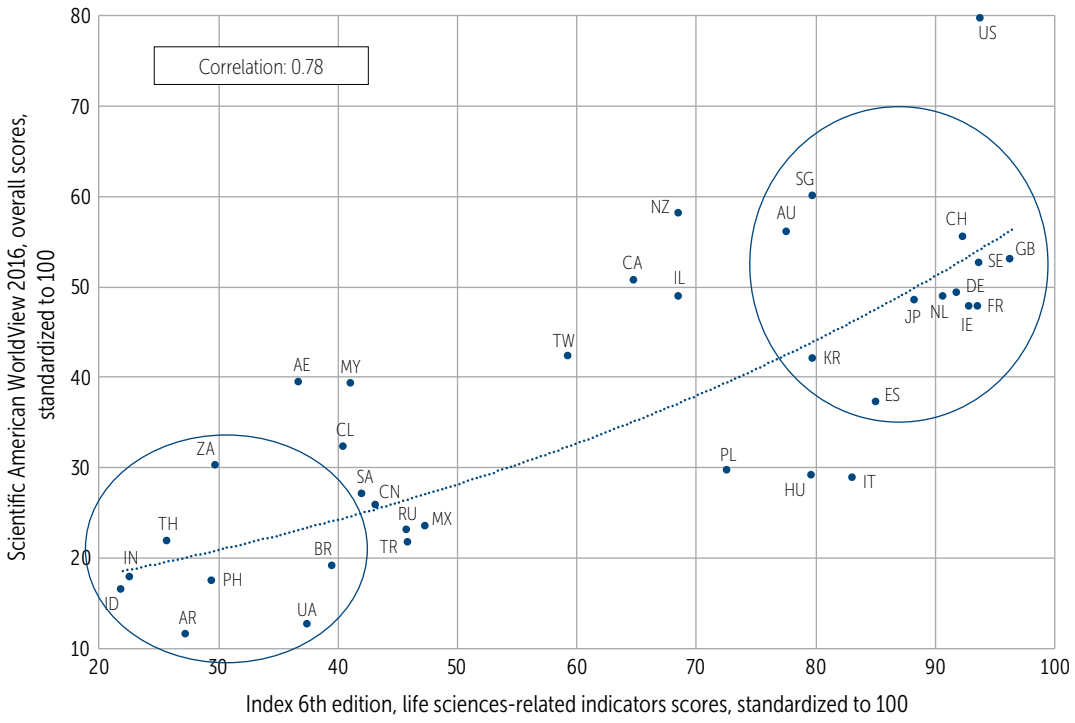
BIOTECH INNOVATION

The Scientific American WorldView Scorecard provides a useful indicator of an economy's innovation potential in biotechnology. The WorldView Scorecard analyzes sector-related outputs that cover 27 components in 7 categories.

There is a strong relationship between Index scores and the Worldview Scorecard scores, with a correlation of 0.78. In fact, economies that score in the top half of the Index are twice as likely to provide environments that are conducive to biotech innovation than economies that score in the bottom half of the Index.

Increased Levels of Biotech Innovation in Strong IP Environments

Association between Index life sciences–related indicators scores and Scientific American WorldView Scorecard overall scores[42]



Sources: Scientific American WorldView (2016); GIPC (2018), life sciences–related indicators
Note: Data are not available for Algeria, Brunei, Colombia, Costa Rica, Ecuador, Egypt, Jordan, Kenya, Nigeria, Pakistan, Peru, Venezuela, and Vietnam.

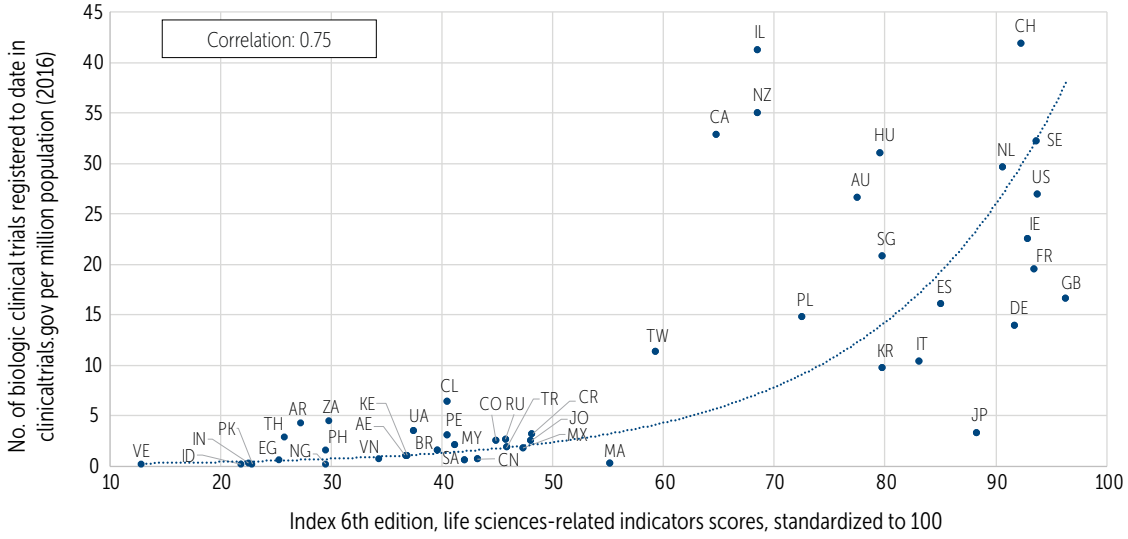
DEVELOPMENT OF BIOTECH THERAPIES

At the forefront of medical research is a new generation of therapies that involve gene-based and cellular biologics to treat a variety of unmet medical needs. These biological medical products interact cleverly with the patient's body (such as the immune system) and with the disease so that treatment is significantly more effective and carries fewer side effects. The trials involved in developing these biologics are highly complex and require exceptional levels of skill; this is the high end of the value chain in clinical research.

There is a strong correlation between the population-adjusted number of clinical trials on biologic drugs and the Index scores for life sciences–related indicators, a correlation of 0.75. Clinical trials for these complex novel therapies take place largely in environments with strong IP protection. Conversely, there is virtually no clinical trial activity on biologic therapies where IP laws are lagging.

More Biotech Therapies Are Developed in Strong IP Environments

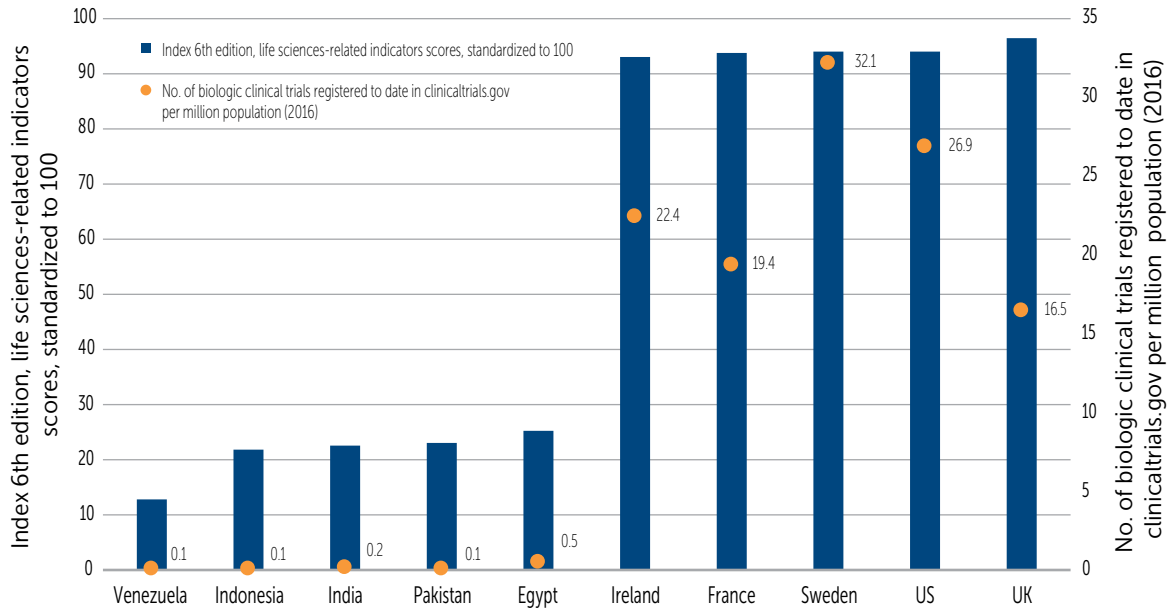
Association between Index life sciences–related indicators scores, and number of biologic clinical trials per million population



Sources: clinicaltrials.gov; GIPC (2018), life sciences–related indicators
Note: Data are not available for Algeria, Brunei, and Ecuador.

Economies with stronger IP environments host on average almost 12 times more clinical trials for biologics than economies with weaker IP environments.

Association between Index life sciences–related indicator scores, and number of biologic clinical trials per million population



Sources: clinicaltrials.gov; GIPC (2018), life sciences–related indicators
Note: Data are not available for Algeria, Brunei, and Ecuador.

CUTTING-EDGE CLINICAL TRIALS

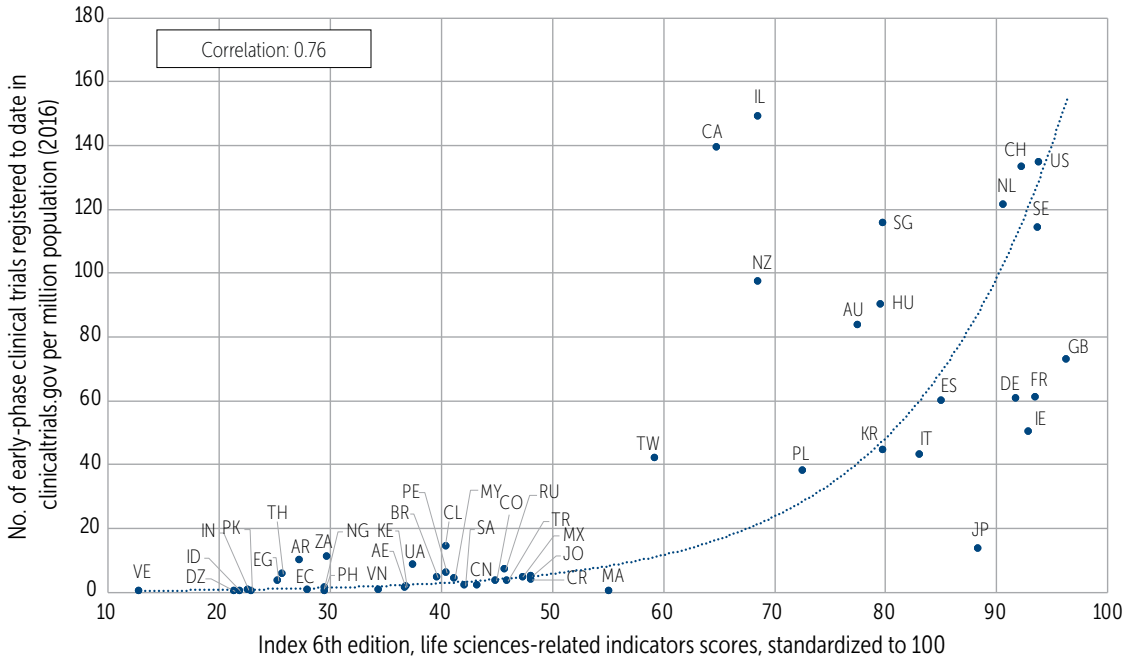
The effect of the IP environment is equally pronounced when looking at early-stage clinical trial activity. Once researchers complete the preclinical screening, new compounds are tested in a clinical setting with patients to determine safety and efficacy. Investigators in the early stages of Phases I and II are generally highly specialized doctors and researchers who rely on sophisticated clinical infrastructure.

Compared with Phase III, Phases I and II are much more complex and involve a higher degree of sophistication. Importantly, Phase I and II trials provide early access to novel therapies for patients with unmet medical needs.

The Index scores for life sciences–related indicators exhibit a strong correlation of 0.76 to rates of early-stage clinical trial activity.

More Early-Stage Clinical Trials Take Place in Strong IP Environments

Association between Index life sciences–related indicator scores, and number of early-phase clinical trials per million population

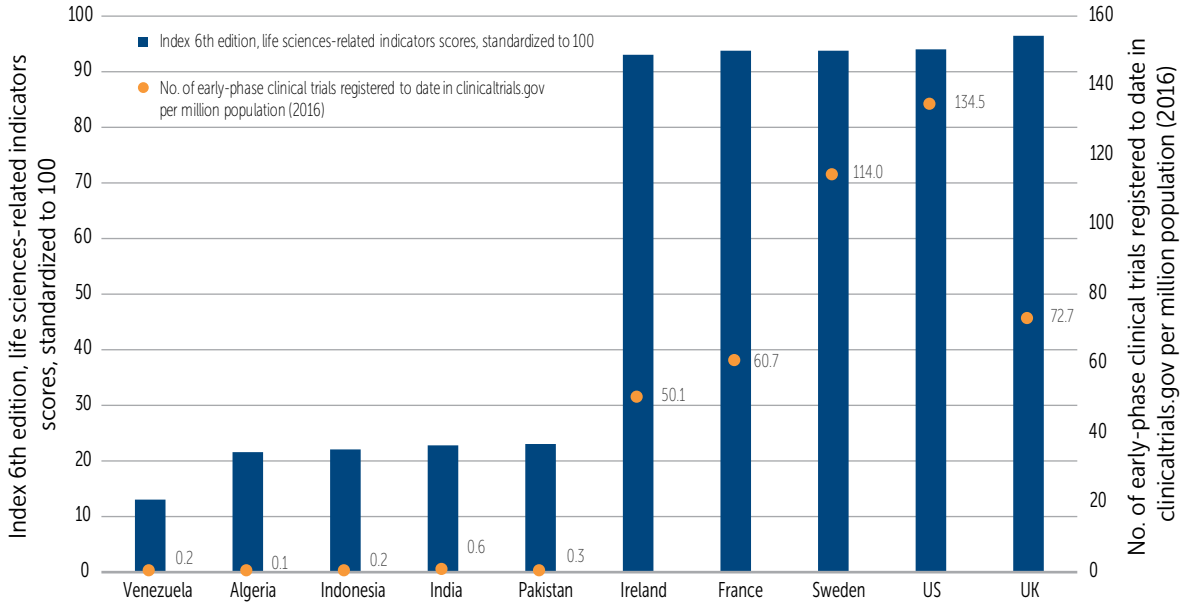


Sources: clinicaltrials.gov; GIPC (2018), life sciences–related indicators
Note: Data are not available for Brunei and Ecuador.

Economies that maintain robust IP environments tend to see roughly 21 times more early-phase clinical trials, on average, than economies whose life sciences–related IP environments trail behind.

In fact, nearly all early-phase clinical research takes place in environments where strong IP rights are available, i.e., in economies that score in the top half of the Index.

Association between Index life sciences–related indicators scores, and number of early-phase clinical trials per million population



Sources: clinicaltrials.gov; GIPC (2018), life sciences–related indicators

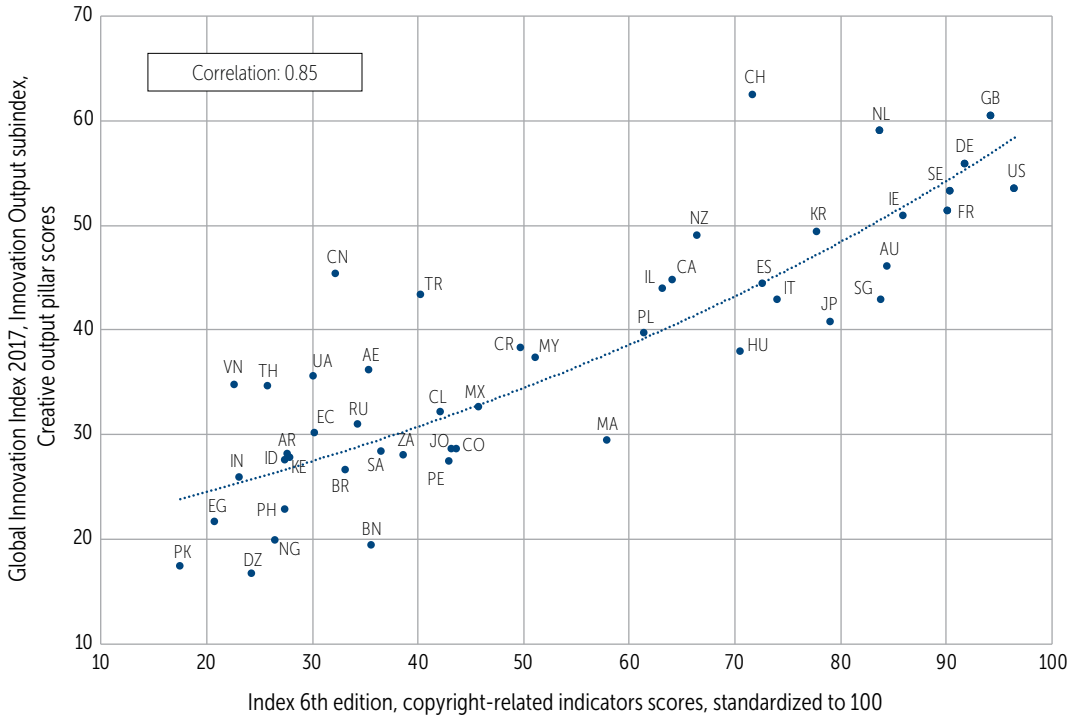
CREATIVE OUTPUTS

Creative activity, artistic expressions, audiovisual productions, and other forms of entertainment and cultural exchange tend to happen with more intensity in environments where copyright protection is available and enforced.

The association between scores on the copyright-related indicators in the Index and creative activity has remained very strong for the past 3 editions, currently standing at 0.85.

More Creative Content Is Produced in Strong IP Environments

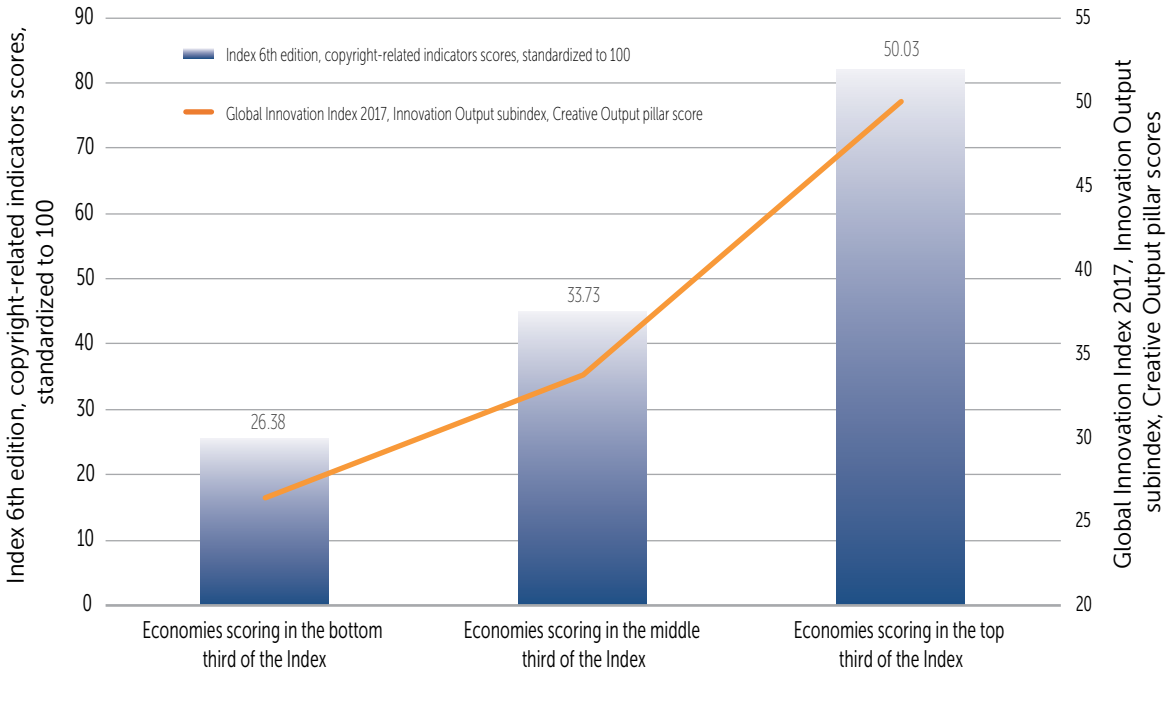
Association between Index copyright-related indicators scores, and the Global Innovation Index, Innovation Output subindex, Creative Output pillar scores[43]



Sources: Global Innovation Index, WIPO/INSEAD (2017), Innovation Output subindex, Creative Output pillar; GIPC (2018), standardized to 100
Note: Data are not available for Taiwan and Venezuela.

More specifically, economies that score in the top third of the Index's copyright-related indicators are 62% more likely to benefit from the growth in both volume and value of the dynamic content and media sectors than economies that score in the bottom half of the Index.

Association between Index copyright-related indicators scores, and the Global Innovation Index, Innovation Output subindex, Creative Output pillar scores: Top, middle, and bottom thirds of the Index



Sources: Global Innovation Index, WIPO/INSEAD (2017), Innovation Output subindex, Creative Output pillar; GIPC (2018), standardized to 100
Note: Data are not available for Taiwan and Venezuela.

ENDNOTES

1 World Bank, http://www.worldbank.org/en/news/opinion/2017/02/15/global-economy-in-2017-hope-and-uncertainty

2 The Pearson Correlation Coefficient is a statistical measurement of the linear relationship between 2 variables. Thus, a correlation value of 0 (r = 0) implies only that the 2 variables are not linearly correlated.

3 https://www.stlouisfed.org/on-the-economy/2015/june/what-drives-long-run-economic-growth

4 Id.

5 Reynolds, T. (2009), "The Role of Communication Infrastructure Investment in Economic Recovery" (Working Party on Communication Infrastructures and Services Policy, OECD, March), http://www.oecd-ilibrary.org/science-and-technology/the-role-of-communication-infrastructure-investment-in-economic-recovery_222432403368

6 The company R&D spending score is based on responses to the question, "In your country, to what extent do companies spend on research and development?" in the World Economic Forum's Executive Opinion Survey, 2016–17, where 1 = do not spend on R&D and 7 = spend heavily on R&D (standardized to 100).

7 The IESE and EMYLON Business Schools' Venture Capital and Private Equity Country Attractiveness Index measures economies' attractiveness to VC and PE funding by examining a range of factors including the capital market, taxation environment, investor protection, entrepreneurial culture, and deal opportunities. See: Groh, A., Liechtenstein, H., Lieser, K., & Biesinger, M. (2016), *The Venture Capital and Private Equity Country Attractiveness Index: 2015 Annual* (IESE Business School and EMYLON Business School).

8 https://www.spratings.com/en_US/topic/-/render/topic-detail/global-sovereigns

9 This correlation is based on an average of a sovereign's "local currency LT" and "foreign currency LT" [[unclear what "LT" stands for]] S&P credit ratings. A total of 28 possible ratings exist (ranging from the highest, AAA+, to the lowest, D). Each rating was assigned a numerical value and was then standardized to 100. In cases where the "local currency LT" and "foreign currency LT" ratings were adjacent (e.g., AA and AA+), the lower rating was used.

10 http://www.phrma.org/advocacy/research-development

11 IMS Health (2012), *Restoring Innovation as Global Pharma's Center of Growth: How to Optimize Clinical Trial Performance and Save $1 Billion Annually* (IMS White Paper), p. 1.

12 Clinical trial activity is also an indicator of high-value economic output. As such, this Annex tests the relationship between overall clinical trials and the Index on the input side of the economic equation, and evaluates the relationship between both clinical trials in the biotech sector and cutting-edge clinical trials against the Index on the output side of the economic equation.

13 Life sciences–related indicators consist of indicators that fall under the Patent category of the GIPC Index (excluding patentability of computer-implemented inventions), as well as indicators in Trademarks and Market Access, Commercialization of IP Assets, Enforcement, and International Treaties categories that are relevant to life sciences (specifically 1–2, 4–8, 16–25, 27, 29–33, and 38–40).

14 National Science Foundation (2014), *Science and Engineering Indicators 2014*, chapters 2–4.

15 World Bank

16 Bond, P. (2011), "Tech Provides Map for Nation's Future," Politico, September 18.

17 The share of the workforce employed in knowledge-intensive activities is measured by the sum of employees in categories 1 to 3 according to the International Standard Classification of Occupations as a percentage of the total employed. Categories 1 to 3 in this classification include managers, professionals and associate professionals, legislators and senior officials, administrative and managerial workers, and clerical and related workers. Source: WIPO/INSEAD/Cornell, Global Innovation Index 2017.

18 Zhen-Wei Qiang, C. "Telecommunications and Economic Growth" (Washington, D.C.: World Bank, unpublished paper), https://www.brookings.edu/research/technology-and-the-innovation-economy/

19 Brynjolfsson, E., & Saunders, A. (2009), *Wired for Innovation* (Cambridge, Massachusetts: MIT Press), https://www.brookings.edu/research/technology-and-the-innovation-economy/

20 The Impact subindex of the Network Readiness Index measures economic and social impacts of ICT, including value added, employment, and access to public and private services. Source: World Economic Forum, INSEAD, Global Information Technology Report and Network Readiness Index 2016. ICT-related indicators consist of indicators that fall under the Patent, Copyright, and Trade Secrets categories, as well as relevant indicators in Commercialization of IP Assets, Enforcement, and International Treaties (specifically 3, 8–15, 20–22, 24–25, 27–33, 37, and 39–40).

21 Netflix, for example, increased its earnings tenfold during the past decade to $8.8 billion in 2016, with half of its 100 million subscribers living outside the U.S.: https://www.statista.com/topics/842/netflix/

22 http://www.wipo.int/wipo_magazine/en/2015/05/article_0009.html

23 http://www.huffingtonpost.co.uk/tony-woodcock/why-music-is-important_b_1916731.html

24 https://www.mpaa.org/new-study-highlights-the-importance-of-film-and-television-to-brazils-economy/

25 The Pro-Music organization divides digital music services into three types: "download stores," which enable online purchase and direct download of individual tracks or full albums (e.g., iTunes); "subscription services," which provide access to online libraries of music using paid subscriptions (e.g., Spotify, Deezer); and "advertising-supported services," which enable free listening of music and viewing of videos while the performers and copyright holders receive royalties through advertisements; see: http://pro-music.org/digital-music-services.php

26 The availability of licensed online music services is measured by the number of online licensed music services per country that offer music as a download, stream, or ringtone, based on information from local industry groups that is compiled by the International Federation of the Phonographic Industry. Source: Pro-Music.org (2017).

27 Creative content–related indicators consist of indicators that fall under the Copyright category, as well as relevant indicators in Commercialization of IP Assets, Enforcement, and International Treaties (specifically 9–14, 22, 24–25, 27, 29–33, 37, and 40).

28 VOD and streaming services penetration is gauged by responses to the question, "Thinking about the last month have you watched TV programs using VOD and streaming services?" in the Connected Consumer Survey 2017. Source: Google Consumer Barometer (2017).

29 http://reports.weforum.org/global-competitiveness-index-2017-2018/?doing_wp_cron=1513383481.6478149890899658203125

30 http://www.doingbusiness.org/rankings

31 World Bank (2017), Doing Business 2017: Reforming to Create Jobs, 15th edition (International Bank for Reconstruction and Development/World Bank).

32 World Economic Forum (2016), The Global Competitiveness Report, p. 9.

33 Business sophistication is measured by the Global Competitiveness Report, Business Sophistication pillar scores, which measure the quality of the economy's business environment as well as the level of operation and interaction between local firms and suppliers that together enable a productive, creative, and innovation-driven economy.

34 OECD (2007), *Innovation and Growth, Rationale for an Innovation Strategy*, http://www.oecd.org/sti/inno/39374789.pdf

35 Knowledge creation, impact, and diffusion is measured by the Global Innovation Index, Innovation Output subindex, Knowledge and Technology Outputs pillar score. This score comprises variables such as patenting activity, growth of high-tech businesses, and knowledge-based exports. Source: Global Innovation Index 2017. Patent-related indicators consist of indicators that fall under the Patent category of the Index, as well as those indicators in Trade Secrets, Commercialization of IP Assets, Enforcement, and International Treaties categories that are relevant to patents (specifically 1–8, 23–25, 29, 31, and 39–40).

36 West, D. (2010), "An International Look at High-Speed Broadband" (Washington, D.C.: Brookings Institution, February).

37 BSA/INSEAD (2013), *Competitive Advantage: The Economic Impact of Properly Licensed Software.*

38 Online creativity is measured by the score of the Online Creativity subpillar of the Creative Outputs pillar under the Innovative Output subindex of the Global Innovation Index, which captures local creation of webpages and online audiovisual content. Source: WIPO/INSEAD/Cornell, Global Innovation Index 2017.

39 Innovative output is measured by the Global Innovation Index Innovation Output subindex score. The Innovative Output subindex accounts for knowledge and technology outputs, knowledge impact including labor productivity and high-tech outputs, and the diffusion of knowledge including high-tech and ICT exports as well as licensing fees and FDI outflows.

40 OECDStat, Patents by technology, Triadic patent families, Total patents, Inventor country of residence, Priority date, 2013 or closest available year; World Bank (Population).

41 Triadic patenting is generally considered to be the best indicator of the perceived overall value and quality of a patent. The patent application is filed in those three separate locations and filing costs are quite high. In this edition of the Statistical Annex, the triadic patent rates are calculated in a different manner than in past editions due to the lack of up-to-date patent data. Instead of looking at only 1 year, this correlation examines the sum of triadic patents over a 10-year period from 2003 to 2013 and adjusts these rates per million population to get a standardized rate of triadic patenting intensity. Source: OECDStat, Patents by technology, Triadic patent families, Total patents, Inventor country of residence, Priority date, 2003 to 2013 inclusive; World Bank (Population).

42 Overall scores of Scientific American WorldView are based on performance in seven categories: Productivity, Intellectual Property Protection, Enterprise Support, Intensity, Education/Workforce, Foundations, and Policy and Stability. Source: Scientific American WorldView (2016).

43 Creative output is measured by the score of the Creative Outputs pillar of the Global Innovation Index, Innovative Output subindex, which captures outputs such as exports of creative services, entertainment, media and ICT spending, and local creation of webpages and audiovisual content. Source: WIPO/INSEAD/Cornell, Global Innovation Index 2017. Copyright-related indicators consist of indicators that fall under the Copyright category of the GIPC Index, as well as those indicators in Commercialization of IP Assets, Enforcement, and International Treaties categories that are relevant to copyrights (specifically 9–15, 24–25, 27–33, 37, and 40).

LIST OF ABBREVIATIONS

Algeria	DZ	Morocco	MA
Argentina	AR	Netherlands	NL
Australia	AU	New Zealand	NZ
Brazil	BR	Nigeria	NG
Brunei	BN	Pakistan	PK
Canada	CA	Peru	PE
Chile	CL	Philippines	PH
China	CN	Poland	PL
Colombia	CO	Russia	RU
Costa Rica	CR	Saudi Arabia	SA
Ecuador	EC	Singapore	SG
Egypt	EG	South Africa	ZA
France	FR	South Korea	SK
Germany	DE	Spain	ES
Hungary	HU	Sweden	SE
India	IN	Switzerland	CH
Indonesia	ID	Taiwan	TW
Ireland	IE	Thailand	TH
Israel	IL	Turkey	TR
Italy	IT	Ukraine	UA
Japan	JP	United Arab Emirates	AE
Jordan	JO	United Kingdom	UK
Kenya	KE	United States	US
Malaysia	MY	Venezuela	VE
Mexico	MX	Vietnam	VN

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