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Cover Page Footnote
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Richard S. Gruner*

Technological innovation outside the United States is increasing. The United States remains the largest single source of new inventions, but the rest of the world produces most technological advances. Yet, even as innovation capacity outside the United States grows, the production of advances remains under-incentivized in many developed and developing countries. Weak incentives apply to the outlier advances that are the province of patent laws. These outlier advances—typically reflecting material departures from prior technical knowledge and potentially establishing fundamentally new lines of technological development and consumer products—are particularly important components of technological development. By shortchanging incentives for outlier advances, society hinders the pace and scope of technological advancement.

Talented innovators located outside the United States too often look to home country patent laws for invention rewards and incentives. This results in weak incentives and undesirably low levels of technological innovation regarding the types of outlier advances addressed by patents. This article explains the inadequacy of many

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home country patent laws to incentivize innovation by inventors working outside the United States. It argues that inventors across the world should look to United States patent laws for their primary invention rewards. Such a strategy will not only spur additional funding and institutional backing for research worldwide, but will increase the likelihood that more outlier technologies will be created to the benefit of parties in the United States and throughout the world.

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INTRODUCTION

United States patent laws and associated rewards have the potential to incentivize innovation not just in this country but around the world. Innovators presently produce technological advances in diverse countries.1 Yet, the patent incentives in innovators’ home countries may only provide weak incentives to produce socially valuable innovations. Local laws may be poorly understood or fail to apply to important categories of advances (such as inventions turning on computer programming).2 Even patent laws that are superficially strong on their face (in that they are comprehensive and well-understood) may provide weak rewards due to poor enforcement.3 And, even where strongly enforced, patent laws applying only to relatively small economies may produce small economic rewards, since patent rights to control the manufacture, use, and sale of patented items in those small economies will be sources of only minimal payments and rewards.4

Fortunately, United States patent laws and the United States’ enormous economy can incentivize (and potentially subsidize) innovation across the world. Rewards from United States patent laws

1 International patterns of research are discussed infra Section II.
3 Differences in patent law enforcement across countries are discussed infra Section II.C.
4 The impacts of local economy size on patent-influenced incentives for innovation are discussed infra Section II.A.
can substitute for the weak incentives that would prevail if only home country laws applied. Under United States laws, inventors working in most foreign countries are treated equally to inventors in the United States, meaning that innovators in even the smallest countries can look to patent-influenced rewards in the United States for innovation incentives and compensation for successful innovation efforts.\footnote{The means by which to implement this patenting strategy and increase innovation incentives in both large and small countries are discussed \textit{infra} Section III.} The size of these patent-influenced rewards in the United States economy can, if properly pursued and managed, provide the primary inducements to innovation across the world and drive international innovation.

In effect, the United States invites and pays for useful innovations from worldwide sources. This “foreign aid” through the patent system does not require government intervention; rather, it occurs through private commercial processes, as mediated by United States patent rights.

This article describes why innovators throughout the world—and particularly in developing countries—should look to United States patents as their primary source of incentives and compensation. With an appropriate patenting strategy in the United States, innovators in the smallest countries can operate on the same plane as their counterparts in the United States. Fund raising and innovation planning that count on this source of rewards may promote innovation efforts in foreign settings far beyond the capabilities of local resources to justify and support technological research.

This article emphasizes the features of United States patent laws (relative to patent laws in many foreign countries) that should make United States patent laws and technological needs among the first considerations for foreign innovators in targeting innovation efforts and in allocating resources to those efforts. The article goes on to consider some of the strengths and weaknesses of such an innovation strategy. Overall, the use of United States patent laws and rewards to drive innovation in accordance with the methods described here can both generate more innovations worldwide and
support profitable innovation efforts in diverse international settings.º

I. INDICATORS OF ROBUST INNOVATION CAPACITY OUTSIDE THE UNITED STATES

A number of international indicators of innovation activities and related resources confirm that robust technological development processes are at work outside the United States. As described in this section, foreign innovation is benefitting from growing research and development (R&D) spending and increasing science and engineering expertise. This subsection reviews evidence of the strength and continuing growth in current technological innovation capacity outside the United States.

A. International R&D Expenditures

R&D spending is a global force supporting technological innovation.º Only a relatively small fraction of recent R&D spending worldwide occurred in the United States. While R&D spending in this country (approximately 26% of the global total of $1.918 trillion in 2015) leads the world, the remaining 74% of R&D spending supports innovation in diverse other countries.º According to the National Science Board, the top fifteen countries in R&D spending areº:

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º Profiles of research efforts in several countries that appear to already benefit from subsidies based on United States patents are contained infra Section IV(C).

º See generally NATIONAL SCIENCE BOARD, SCIENCE & ENGINEERING INDICATORS (2018), https://www.nsf.gov/statistics/2018/nsb20181/assets/nsb20181.pdf [https://perma.cc/UG8W-45XE]. All of the R&D spending amounts included here reflect estimates in current purchasing power parity (PPP) United States dollars. The gross domestic product (GDP) figures used to compute the R&D spending to GDP ratios were also measured in PPP United States dollars. See id. at ch. 4, at 35–37, tbl.4–5.

º Id. at ch. 4, at 34–41.

º Id. at ch. 4, at 37–40, tbl.4–5.
While R&D spending obviously varies greatly across the countries shown, at least three R&D spending patterns seem clear. First, a middle range of primary innovation producers spend remarkably similar amounts on R&D, taking into account differences in country economies. This similarity is apparent from the values above for R&D spending as a percent of country GDP. Focusing on the percentage values in Figure 1 and taking the United States as a “typical” benchmark for R&D spending at 2.74% of GDP, countries as dissimilar in location and background as Taiwan (3.05), Germany (2.93), France (2.22), Australia (2.11), and China (2.07) support roughly similar levels of R&D spending to the United
States. The differences in the absolute amounts of R&D spending across these countries may be artifacts reflecting the very large differences in their economy sizes.

However, two high and low variations from these countries’ spending patterns are also apparent. Taking into account their economy sizes, a few countries have markedly high R&D spending. Focusing once again on the percentage of GDP figures, South Korea (4.23) and Japan (3.29) spend more on R&D than the United States, adjusting for the sizes of their economies. The levels of research spending in these countries is higher than their GDP size would suggest, using the experience of the United States as a predictor. Businesses and other parties in these countries apparently emphasized R&D projects over other commercial enterprises to a greater degree than in the United States. Researchers in these countries may also be relying on significant sources of research support from outside of their own economies that are not constrained by their own economy sizes. These countries may be early pioneers in the type of international subsidization of home country innovation advocated in this article and explained in more detail in the last section of this text.10

Finally, several of the top fifteen R&D spenders seem to lag behind spending levels found in the United States and the comparable countries mentioned above. In particular, adjusting for differences in their respective economy sizes, the percentage of GDP figures shown in Figure 1 indicate that India (0.63), Russia (1.1), Brazil (1.17), Spain (1.22), Italy (1.33), the United Kingdom (1.7), and Canada (1.71) have markedly lower R&D spending levels than the United States. This means that businesses and innovation sources in these countries appear to be underemphasizing R&D, at least in comparison to their counterparts in the United States. Businesses and other innovation sources, such as major universities, in these countries may be the primary beneficiaries of changes to embrace the innovation subsidization strategies advocated here, using the additional subsidies from this strategy to bring their R&D spending to the level of the United States and beyond.

10 For a discussion of this strategy and the track records of a few countries that appear to be implementing it, see infra Section IV.
The patterns of R&D spending reflected in Figure 1 appear to be changing significantly in a few countries. China and South Korea are spending growing amounts on R&D, as spending in other countries stays relatively stable. This combination of selective growth and general stability is reflected in the following figure tracking changes in R&D spending over time:

**FIGURE 2**

**CHANGES IN R&D SPENDING: 1981 – 2015**

Note(s): Data are for the top eight R&D-performing countries and the EU. Data are not available for all countries for all years. Data for the United States in this figure reflect international standards for calculating gross expenditures on R&D, which vary slightly from the National Science Foundation’s report for tallying U.S. total R&D. Data for Japan for 1996 onward may not be consistent with earlier data because of changes in methodology. Data for Germany for 1981-85 are for West Germany.

Source(s): National Science Foundation, National Center for Science and Engineering Statistics, National Patterns of R&D Resources (annual series); Organisation for Economic Co-operation and Development, Main Science and Technology Indicators (2017 ed); United Nations Educational, Scientific and Cultural Organization Institute for Statistics Data Centre, data.unesco.org, accessed 13 October 2017. See Appendix Table 4-12.

Originally published in NATIONAL SCIENCE BOARD, supra note 7, ch. 4 at 42, fig.4–6.
Two features of the R&D spending changes in this figure stand out. First, in contrast to relatively similar levels of R&D spending from 1981 to 1995 (as measured from R&D spending as a percentage of GDP), after 1995 several countries diverged in their R&D spending. Japan moved to substantially higher R&D spending, while the United States and Germany increased spending modestly. R&D spending in France remained about the same, and similar spending in the United Kingdom decreased. The result is growing gaps between the spending levels of these countries.

More strikingly, R&D spending in China and South Korea has increased substantially since about 1998. In 1998, South Korean R&D spending corresponded to 2.16% of GDP (roughly equal to the level of the United States for 1998 of 2.49), but shot up to 4.23% of GDP by 2015. This reflects nearly doubling of R&D spending by South Korea, as measured in relation to its GDP.

The changes in Chinese R&D spending are even more important given the enormous size of that country’s economy and GDP. From 1998, when R&D spending was only .65% of China’s GDP, to 2015, when spending amounted to 2.07% of its GDP, spending on R&D in China rose to match the average for the European Union as a whole (1.96). This reflects a more than threefold increase in Chinese R&D spending over 1998 levels. Assuming United States R&D spending stays at about 2015 levels over time (2.74)\textsuperscript{12} and Chinese spending continues to grow at the same rate as it increased between 1998 and 2015, Chinese R&D spending will exceed that of the United States in about 2019.\textsuperscript{13}

B. International PhD Recipients in Science and Engineering Fields

The worldwide distribution of scientific and engineering expertise provides another perspective for estimating international inno-

\textsuperscript{12} As shown in Figure 2 above, this spending level has not changed greatly since 2009 when it was 2.80.

\textsuperscript{13} The gap between United States and Chinese spending levels in 2015 on a percentage of GDP basis was 2.74 - 2.07 = .67. The per year change in Chinese spending levels over the 17 years between 1998 and 2015 was approximately .187 per year. At this same rate of change, it will take about 3.6 years for Chinese spending to catch up with that of the United States. \textit{See supra} Figure 2.
vation capacity. The home countries of recent doctoral degree recipients in science and engineering fields are settings where the latest technical expertise will be available. Distributions of doctoral degree recipients help us predict the locations of the next wave of technology pioneers. The following figure summarizes the global distribution of new PhD graduates in science and engineering fields in 2014 (the countries are listed in descending order of their R&D spending, as reflected in Figure 1):

### FIGURE 3

<table>
<thead>
<tr>
<th>Top Countries S&amp;E PhD Graduates 2014</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Country</strong></td>
</tr>
<tr>
<td>United States</td>
</tr>
<tr>
<td>China</td>
</tr>
<tr>
<td>Japan</td>
</tr>
<tr>
<td>Germany</td>
</tr>
<tr>
<td>South Korea</td>
</tr>
<tr>
<td>France</td>
</tr>
<tr>
<td>India</td>
</tr>
<tr>
<td>United Kingdom</td>
</tr>
<tr>
<td>Brazil</td>
</tr>
<tr>
<td>Russia (2013)</td>
</tr>
<tr>
<td>Taiwan</td>
</tr>
<tr>
<td>Italy</td>
</tr>
<tr>
<td>Canada</td>
</tr>
<tr>
<td>Australia</td>
</tr>
<tr>
<td>Spain</td>
</tr>
<tr>
<td><strong>Total Top 15</strong></td>
</tr>
<tr>
<td><strong>Total All Sources</strong></td>
</tr>
</tbody>
</table>

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15 The earned doctorate counts in this figure are extracted from NATIONAL SCIENCE BOARD, supra note 7, at app. tbl.2–38, 2–39 (last visited Aug. 31, 2018).
While these doctoral degree counts suggest that highly trained United States innovators will probably constitute the single largest national group pursuing future technological advances, much of the new expertise in science and engineering is likely to be located outside the United States. PhD recipients from the United States only constituted about 17% of the recent totals. While the home countries of doctoral degree recipients may not completely match the countries where the recipients will work (for example, a German degree recipient may relocate to and complete research in the United States), the home countries of these degree recipients provide a rough measure of the new expertise flowing into various countries.16

Using this measure, future technology development by foreign PhD recipients may produce about 83% of all advances (corresponding to the percentage of PhD recipients in science and engineering fields from countries other than the United States). As with R&D spending, the worldwide distribution of state-of-the-art science and engineering expertise (as reflected in the location of recent PhD recipients) suggests that much of the future of technology development lies outside the United States.

C. Science and Engineering Article Production

Scientific and engineering academic publications provide further evidence of probable foreign sources of technology innovation. Large numbers of published academic articles tend to correlate with intensive academic research activities and substantial innovation capabilities.17 Institutions where academic research concerning science and engineering is flourishing are settings where related technology innovation is likely.18 While not all academic findings described in published scientific and engineering articles will translate into new technology designs, such findings are often

16 See e.g., NATIONAL SCIENCE BOARD, supra note 14, at 10.
17 See e.g., NATIONAL SCIENCE BOARD, supra note 7, ch. 5, at 92 (last visited Aug. 29, 2018) (“The output volume of research, article counts, is one basic indicator of the degree to which different performers contribute to the world’s production of research-based [science and engineering] knowledge.”).
18 See id.
the jumping off point for new products and services. The academics who have made the findings may be the best positioned to pursue or at least aid related technology development. Furthermore, the presence of an actively publishing academic community in a given country implies that many highly trained parties emerging from the same academic community are probably available for technology development in that country.

The following figure summarizes recent international trends in sources of academic publications19:

**FIGURE 4**

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19 Originally published in *id.* at ch. 5–110, Figure 5–22. The article percentages reflected in this figure are derived from article counts. *Id.* at ch. 5–127, app. tbl.5–27. For a more detailed breakdown of article counts by country, see *id.* at ch. 5–112, Table ch. 5–23.
As this figure illustrates, the United States was the largest single source of published academic articles, but was recently eclipsed in this respect by China in 2016. Authors in the United States accounted for only 17.8% of the published articles in 2016. Of the 82.2% produced outside the United States, the top sources were China (18.6%), India (4.8%), and Japan (4.2%). Countries in the European Union collectively accounted for a substantial share of all articles in 2016 (26.7%). However, large shares were also produced by other developed countries (11.4%) and developing countries (16.3%).

The large fraction of published science and engineering articles emerging from outside of the United States—and particularly the substantial fraction from developing countries—indicate that in the future, technological advances will probably come from diverse sources around the world. Some sources like India, which provide large numbers of published scientific and engineering works, but are relatively low in R&D spending, as measured by spending to GDP ratios, appear to have substantial scientific and engineering talent on hand. The same may be true for developing countries with substantial numbers of academic publications. Whether this talent can be translated into comparable high levels of technology

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21 See NATIONAL SCIENCE BOARD, supra note 7, ch. 5, at 110, Figure 5–22.

22 See id.

23 See id.

24 See id.

25 Using R&D spending to GDP ratios as measures of R&D spending treats different counties as if they had the same size economies (that is, the same GDPs) potentially supporting R&D spending. Differences in these ratios reflect differences in R&D spending that are not merely reflections of differences in economy sizes across countries. Thus, for example, the R&D spending ratios in Figure 1 indicate that France (R&D spending to GDP ratio of 2.22) and Australia (R&D spending to GDP ratio of 2.11) devote approximately the same fractions of their economy to R&D spending even though the French economy (with a GDP of about $61 billion) is almost three times the size of the Australian economy (with a GDP of about $23 billion). See NATIONAL SCIENCE BOARD, supra note 7.
innovation may depend more on increased R&D spending than on the cultivation of new scientific and engineering expertise. The publishing track record of these countries suggests that substantial expertise is present but needs to be matched by R&D spending support. The type of patent-influenced research funding and development described in this article may be a means for these countries to build on their high expertise and academic publishing levels through increased R&D spending.

D. Implications of Recent Dominance of Foreign Innovation

The evidence of the strength of foreign innovation presented to this point provides a remarkably consistent prediction of foreign domination in future technological development. Whether estimated from R&D spending (with a United States percentage of 26% of worldwide totals in 2015), PhD recipients (United States percentage of about 17% in 2014), or academic article production (United States percentage of about 18% in 2016), the United States seems likely to account for no more than about a quarter of future research efforts and supporting resources worldwide. The remaining three quarters or more of innovation will therefore be spread across the globe.

Given the magnitude of potential overseas innovation, what are the incentives promoting overseas innovation? As detailed in the

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26 The presence of raw scientific and engineering talent—as evidenced by large academic communities generating large numbers of academic articles—suggests the potential ability of talented individuals to solve technical problems and to formulate new technical designs. However, R&D funding is needed to support design projects undertaken by these talented individuals and to translate their expertise into workable technology designs. Furthermore, even if new technical designs produce some functional results, further R&D spending may be needed to transform basic designs into popular products used by numerous consumers. Thus, while extensive technical expertise is necessary to support technology development, the addition of substantial R&D spending to apply the expertise is also needed to produce successful new technologies with wide acceptance and importance to technology users and technology suppliers. See Tendayi Viki, Why R&D Spending Is Not a Measure Of Innovation, FORBES (Aug. 21, 2016, 1:46 AM), https://www.forbes.com/sites/tendayiviki/2016/08/21/why-rd-spending-is-not-a-measure-of-innovation/#7dc3407dc77d [https://perma.cc/2P48-LSFZ].

27 See id.

28 See infra Sections II.A–II.C.

29 See infra Sections II.A–II.C.
next two sections of this article, there are reasons to believe that patent-influenced incentives for overseas innovation are surprisingly weak.30

Weak patent incentives for overseas innovation are particularly important since they hinder production of fundamentally new outlier innovations.31 Outlier advances reflecting marked departures from past technology understanding play key roles in technology development. These advances have the potential to produce fundamentally new products and services based on the latest scientific knowledge. Furthermore, outlier advances have the potential to divert subsequent technology developments in new directions that innovators might not otherwise have pursued, enriching the technology base or “prior art” from which further innovations can spring. Outlier advances—roughly the same as the nonobvious advances promoted by the United States patent system32—are the focus of patent systems in most countries.33 These outlier advances are referred to here for convenience as “patentable advances” or “patentable technologies.”

30 Patent laws in many foreign countries offer limited incentives due to both the small size of many foreign economies and the at times weak enforcement of patent laws. See infra Section III. While patent rights and incentives under United States laws are available to foreign inventors, the force of United States markets and patent-influenced rewards under United States laws are not being fully applied to promote advances from outside the United States. See infra Section IV.

31 Weak patent incentives undercut the normal impacts of patent systems in promoting the creation of outlier advances. Patent-influenced rewards encourage highly talented innovators to take risks on innovation projects that prevailing technical knowledge suggests are likely to fail. The promotion of more high-risk projects by talented innovators tends to increase the number of outlier advances produced. Absent patent incentives, highly talented innovators will tend to apply more of their efforts to lower risk endeavors with greater likelihood of success and returns. See Richard S. Gruner, *Imagination, Invention, and Patent Incentives: The Psychology of Patent Law*, U. ILL. J. L. TECH. & POL’Y., 375 (2017).

32 Patents and associated innovation incentives are limited under United States patent laws to advances that would not be obvious to a well-informed person of average skill in the field of the advance. See 35 U.S.C. § 103 (2012); *Graham v. John Deere Co. of Kansas City*, 383 U.S. 1, 3 (1966).

Weak incentives apply to patentable technology innovation undertaken outside the United States for two reasons: 1) the weakness of the patent rewards and incentives in many of the foreign countries where inventors work, making reliance on home country patent laws a source of only small innovation incentives (for reasons described more fully in the section III of this article) and 2) the failure of many foreign inventors to look to patent rewards in the United States and in other countries with large economies as sources of major research rewards and incentives for outlier innovations (discussed in section IV of this article).

II. POTENTIAL WEAKNESSES IN HOME COUNTRY PATENT INCENTIVES

There are several reasons why many innovators may find that patent laws in their home countries are sources of poor incentives and potential distractions for innovation projects aimed at patentable advances. This follows from several features of the patent laws and economies of specific countries, as described in this subsection.

Unfortunately, some observers have suggested that strong home country intellectual property laws are essential for promoting local innovation and that important support for technology development can be produced through relatively simple legal changes in home country laws.34 The view that improved patent laws and enforcement in developing countries will incentivize innovation in those countries is often expressed, but largely inaccurate. Commentators have claimed that, if only patent laws were strengthened and regularly enforced in developing country “X,” technological research and development in that country would be encouraged and likely to increase materially.35

35 See id. This view was captured in the following comments by Joseph Howard, a senior attorney adviser in the Intellectual Property Rights Branch of the U.S. Customs and Border Protection Service:
This view is misleading in at least five respects: 1) even with strong patent laws, small home country economies will only yield small innovation rewards; 2) substantive uncertainties about patent laws and related rights can undercut the value of such rights; 3) weak enforcement of home country patent rights may further reduce projected patent rewards; 4) local commercial interests in some developing countries may ensure weak patent enforcement; and 5) consumer interests may support weak patent enforcement in some countries. These sources of weak patent rewards in specific countries are detailed in this subsection.

A. Small Markets Produce Small Rewards at Best

Even where a country has strongly drafted and comprehensively enforced patent laws, if the economy in that country is small, the scope of patent-influenced revenues and rewards from local patent enforcement will also tend to be small. The amount of the rewards is constrained by the size of the local economy. The patent incentives to an innovator in that country from home country patent enforcement will be similarly constrained.

Most patent-mediated rewards for patented advances result from elevated prices that patent holder, or their licensees, can charge for goods or services incorporating the patented features.36

Perhaps the most critical obstacle to effective enforcement is the absence of a full understanding of the value of intellectual property rights to every nation that engages in international trade. I’ve spoken in several countries overseas, and in each I was asked, ‘Why should we do this? Why are we protecting the wealthy nations or manufacturers who own these intellectual property rights?’ My response is that, first, if your country is governed by the rule of law and has signed certain international agreements, it is obligated to adhere to its agreements. Secondly, as your country develops its own sectors in which manufacturers, inventors, or artisans are creating intellectual property, it’s important that you give them the full value of their rights. Id.

36 See 35 U.S.C. § 271 (1994) (Patent rights typically give a patent holder exclusive control over the use, making, selling, and importation of a patented advance. Patent holders can use these rights to force consumers to pay elevated prices for patented goods or services, subject to the limit that consumers will not pay more for patented items over unpatented substitutes performing the same function than the incremental utility of the patented items will justify (e.g., if a patented item provides 20% more functionality that an earlier unpatented item, it is unlikely that consumers will pay more than 20% more for...
The maximum amount that a patent holder can hope to gain for sales of a patented produce in a given country is the aggregate amount that consumers will pay for items with the patented feature over products without the feature. Where there are either few consumers who will pay elevated prices for a patented item or the amount each will pay is small, the aggregate rewards for a patented advance will also be small. Consequently, small populations or small economies usually produce small patent rewards.

These rewards will be dwarfed by the comparable patent-influenced revenues available in the United States. This is simply a consequence of the relative size of the economies involved. Sales charges, or equivalent charges for use of patented advances, produce patent-mediated rewards for patented inventions. Smaller sales volumes, as would occur in a developing economy as opposed to in the United States, produce smaller rewards.

37 This maximum profit estimate assumes that the patent holder captures all the increased market value of the patented item over non-patented substitutes. In real commercial processes, this value will probably be split among consumers, product suppliers, retail outlets, and the patent holder. Thus, if a patented advance works 20% better than its unpatented counterpart, it might be priced at an amount 15% above that for its non-patented counterparts. Of this 15% increment, the patent holder might receive a patent licensing royalty of 5%, while the product manufacturer and the retailer that sold the item might retain about 5% of the heightened sales price each. The latter two percentages give these parties incentives to shift emphasis in their respective activities to the patented item rather than its unpatented predecessor. The difference between the amount paid and the increased utility received by the consumer (20% - 15% = 5%) is net benefit retained by the consumer, giving this party an incentive to shift from use of the older unpatented item to a new patented version with new benefits but also new use uncertainties. These benefit-sharing numbers, while hypothetical, are illustrative of how the full utility of a patented advance may not produce profits in the hands of a patent holder, but instead produce profits that will be shared by all parties in the supply chain, including consumers, who have a stake in the new utility.
B. Substantive Legal Uncertainties May Muddy Patent Enforcement and Weaken Incentives

Relatively recently drafted and occasionally enforced patent laws in foreign countries may also create weak innovation incentives due to substantive uncertainties in patent laws or uncertain perceptions of such laws.\(^3\) Strong patent incentives require that potential innovators have knowledge of the criteria for patent issuance and confidence that the likelihood of patent-influenced rewards will be enhanced if the patenting criteria are met.\(^3\) Where patent laws are uncertain, the size of patent rewards and incentives are correspondingly discounted and have a reduced impact in encouraging innovation.\(^4\) In a parallel fashion, uncertain patent incentives undercut research funding and invention marketing efforts. Parties who fear that their research funding may provide profits for other concerns are likely to place their funding elsewhere and avoid the threats of free riders. Likewise, persons considering developing new products and marketing campaigns based on patented advances are less likely to do so if they feel that their product perfection or marketing outlays will result in profits for others because patent-influenced exclusivity of the resulting products and market demand cannot be maintained.

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\(^3\) Previous researchers have noted that uncertainty in legal penalties can undercut the deterrent effect of the penalties by causing those threatened to discount the size of the penalties by the amounts of the relevant uncertainties. Where it is highly uncertain that large penalties will be imposed, the deterrent impact of the penalties is decreased accordingly. Uncertain legal standards therefore undercut the deterrent function of the penalties imposed under the standards. See, e.g., Richard Craswell & John E. Calfee, Deterrence and Uncertain Legal Standards, 2 J. Law, Econ. & Org. 279 (1986). The same is true in reverse for the incentives created by patent laws. Uncertain rewards create weaker incentives than rewards of the same value that are more certain to be gained. Uncertainty about whether patent laws apply (and whether associated patent-mediated rewards will be gained) undercuts the incentive function of the uncertain laws over similar laws that are either clearer or more consistently enforced.

\(^4\) See id.
C. Weak Enforcement May Further Undercut Patent Value

In many developing countries, patent laws on the books are poorly enforced.\(^1\) The promise of patent rewards through home country patent enforcement in these countries must be further reduced to reflect lost rewards corresponding to unremedied patent infringement. The projected net revenues perceived by an inventor in Country X following the patenting and commercial development of his or her invention in that country will be discounted by the chances that the invention involved will simply be copied without compensation due to poor patent enforcement, causing the inventor involved to realize little or nothing from patent enforcement.

In some countries, patent enforcement maybe be very weak—at least relative to United States levels. Systematic assessments of foreign intellectual property (IP) systems and the value of IP rights in these systems have revealed significant weaknesses and reasons to doubt the value of rights there. For example, after scrutinizing foreign enforcement of intellectual property (IP) laws across numerous countries, the Global Intellectual Property Center of the United States Chamber of Commerce rated the effectiveness of many countries’ IP rights enforcement substantially below United States levels.\(^2\) Rights enforcement ratings for many countries were half or less of comparable ratings for the United States. Low ratings were applied to several countries with large economies, such as Brazil (47% of the United States rating), China (38%), Russia (37%), and India (22%).\(^3\) Several countries received even lower IP enforcement ratings.\(^4\) In countries with weak IP rights enforcement, receipt of substantial patent-influenced rewards based on local laws may be an illusion for home country inventors.\(^5\)


\(^2\) See id.

\(^3\) Id. at 48.

\(^4\) The lowest reported level was that for Venezuela at only 9% of the United States rating. Id.

\(^5\) Home country and foreign patent holders may fare equally poorly in IP litigation in some of these countries. For example, recent research concerning the enforcement of patent rights by Chinese and foreign holders of patents in China has shown that these two groups achieved comparable success rates, undercutting concerns about discrimination in
This contrasts with the generally strong enforcement of civil legal claims in the United States, including claims for patent infringement, and the potential in the United States for either large patent-induced royalties through the threat of rights enforcement or substantial patent infringement damage recoveries. Beyond the heightened patent value resulting from its far larger economy, the United States provides a stronger patent enforcement environment than many countries. The United States offers patent holders a mature patent ecosystem, including a sophisticated patent prosecution bar and experienced patent litigators, a frequently tested body of patent law clarified in many details through extensive case hold-

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47 In an evaluation by the Global Innovation Policy Center of intellectual property rights enforcement within the legal systems of several countries, enforcement within the United States received the highest rating. See Global Innovation Policy Center, supra note 41, at 48. The strengths noted in the United States’ IP enforcement system included: 1) support for key IP rights, including sector-specific rights, 2) a largely supportive technology transfer and commercialization environment in the United States (despite some weakness due to uncertainty in systems essential patent (SEP) licensing, 3) a generally deterrent IP enforcement framework, 4) active inter-governmental coordination regarding IP issues, and 5) government public awareness raising and engagement on IP. See id. at 156.
ings, and a powerful, sanction-backed system for enforcing civil damage recoveries and injunctive relief. Further enforcement mechanisms, such as the efforts of the United States Border Patrol in monitoring and interdicting imports of infringing goods, add to the substantiality of United States patent law enforcement. The result is that United States patent rights have real meaning in United States markets, resulting in corresponding value in royalties or patent-influenced prices.

D. Local Commercial Interests in Developing Countries May Favor Continued Weak Patent Enforcement

Patent rewards in some developing countries may also be small because government officials support weak patent enforcement to serve local commercial interests. For a given developing country, stronger enforcement of patent laws may be a mixed blessing. If local parties see few if any net benefits from strong patent enforcement, the alternative of weak enforcement will be likely to

48 Clarity in patent law, while a general virtue of the United States patent system, is not uniform across all technology areas. For example, in 2018 the United States Department of Commerce, while giving the United States intellectual property system its highest rating among intellectual property legal ecosystems around the world, pointed out that one notable weakness in the United States’ generally strong system was the “uncertainty over patentability for high-tech sectors.” See Global Innovation Policy Center, supra note 41, at 156.


50 In comparison with the counterpart features of other legal systems, the Global Innovation Policy Center gave the United States civil legal system the highest possible rating for the recognition of IP as an asset and for the quality of civil and procedural remedies for IP rights infringement. See PUGATCH ET AL., supra note 41, at 156.


52 A number of technology development and access experts have argued that strengthening IP rights in developing countries imposes burdens on these countries that are not commensurate with the associated benefits. Walter G. Park and Douglas C. Lippoldt have summarized these criticisms as follows:
prevail, and patent rights in that country will provide few incentives for innovation.

Different parties within a developing country may see the merit of strong patent enforcement very differently. For innovators, strong patent enforcement will be desirable because it will provide at least some rewards for innovation (albeit perhaps modest rewards in countries with small economies). Additional parties may also have interests in strong patent protection. For parties seeking to expand manufacturing activities based on technologies drawn from other countries, the reassurance of strong patent controls in a country with manufacturing capabilities may encourage transfers into the countries of patent-protected technologies and encourage expanded manufacturing based on the new technologies. In a similar fashion, strong patent protection in a country may encourage increased investment in manufacturing operations based on imported technologies, since patent protections will lessen investors risks in such manufacturing enterprises. However, for consumers of patent-protected products, strong patent enforcement may mean higher prices and lower access to desired items. The net benefit of increased patent enforcement in a particular country will depend on the combination of these positive and negative impacts.

The accusation is that the emerging standards raise the cost of intellectual content in products sought by developing countries, while developing countries may not have the capacity to capitalise on their own potential in a similar manner. Moreover, [Carlos Maria] Correa alleges that the implicit bargain underlying the strengthening of the international IPR regime has not been satisfied. Some developing countries have argued in the World Trade Organisation (WTO) and World Intellectual Property Organisation (WIPO) that promises of technology transfer as contained in the TRIPS Agreement . . . do not appear to be yielding corresponding benefits for developing countries, whereas the strengthened IPR may raise costs for developing countries seeking to upgrade their technological capabilities.

Projecting the future advantages of strong patent enforcement in expanded innovation, manufacturing, or investment may be highly speculative (as with any complex projection of the future) and be far overshadowed by the current disadvantages of patent enforcement, namely higher prices and product restrictions. Disadvantages now will loom larger and be more persuasive than hoped for advantages later. Hence, policy makers may rationally choose to maintain poor patent enforcement in some countries.

E. Consumer Interests May Dominate Political Processes and Preclude Support for Patent Enforcement and Higher Product Prices

Weak patent enforcement may prevail in a particular country because it is the politically popular choice. Consumers of technical advances—that is, buyers of technology-enhanced products and services—may resist patent-influenced higher product prices even where commercial leaders and policy makers can see the long-term advantages of patent incentives and enhanced technology development. Product users who benefit from weak enforcement and low cost product access unconstrained by patents may be much larger in number and political power than the advocates of strong patent enforcement. The benefits and burdens of patent enforcement may fall on different parties depending on parties’ interests in technology development or product manufacturing (which would tend to make parties favor patent enforcement) versus product use or consumption (which would tend to make parties oppose patent enforcement to lower product prices and increase product access). It is possible that net support for strong patent enforcement in a given country may boil down to a power struggle between the portions of a country’s population, or the power holders within that population, who are benefitted and burdened by strong patent enforcement. Strong patent enforcement will only prevail if the range of parties benefitting from patent-influenced prices for access to

The number of parties benefitted or burdened may have some influence over patent policies and the strength of patent rights enforcement. Where the benefits of patent enforcement fall on a narrow group (such as business owners able to marshal extensive resources and engage in large scale manufacturing), the detriments of IP enforcement are spread across a larger number of parties (such as the numerous consumers adversely affected by consumer goods with prices increased through strong patent enforcement). The political clout of the adversely affected parties may trump the economic clout of the benefitted parties. This may cause a country to accept the socially popular and administratively easy course of weak patent enforcement even though the country’s overall economic interests would benefit more from stronger patent enforcement.

F. Adding Up the Cumulative Effects: Why Few Incentives Flow from Many Home Country Patent Laws

The reasons described here for low innovation rewards available through home country patent enforcement are cumulative. In a given country, they may all reduce the potential rewards and incentives available to new technology developers who look solely to home country patent laws. Small economies will unavoidably create small rewards which will be reduced further by doubts about patent enforcement. Looking to these doubtful rewards, potential innovators relying solely on home country incentives will often have little reason to pursue high risk innovation aimed at outlier

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54 This analysis is oversimplified in that it ignores the possibility that product consumers may see an interest in strong patent enforcement as a means to incentivize innovation and thereby increase the range and quality of products available to consumers. While these long-term benefits of patent enforcement may be real, they may be overshadowed in consumers’ minds by the short-term detriments of higher product prices due to patent enforcement. Such a cost-benefit analysis emphasizing short-term impacts will tend to cause consumers to oppose strong patent enforcement. Parties taking this position for their countries’ laws may be content to rely on United States patent laws and those of other countries with large economies to drive product innovation and produce new products which can then be introduced in the countries with weak patent enforcement.
advances markedly departing from prior, well-understood technical knowledge. These sorts of technically uncertain projects will simply seem unjustified given further uncertainty about whether successful projects will gain patent-mediated rewards.

In the face of both technical and legal uncertainties, research resources will tend to be diverted towards more predictably successful enterprises, such as mundane product improvements through incremental changes made in accordance with current knowledge to produce predictably successful results. These obvious technology changes, while of some technical value, do not contribute to significant technology shifts and new branches of technical knowledge in the same ways as outlier advances involving patentable subject matter.

Absent strong incentives for high risk projects departing from technical adjustments with predictable results, technological advances will stagnate around the standard designs and well understood design principles. Patent incentives are designed to break

55 Patent laws create specially targeted incentives to encourage innovators to go beyond mundane technology adjustments in accordance with widely available technical knowledge and to reach for advances that are not obvious to most parties in the field of the advances. The patent system encourages persons to both seek these sorts of non-obvious advances and to disclose them to the public. This combination encourages a few especially skilled or unusually well-informed innovators to pursue advances that are beyond the capabilities of most parties in their fields. Beyond focusing these exceptional innovators on outlier advances, the patent system also encourages such innovators to disclose their unusual results, thereby ensuring that their rare advances are not lost to the public or used in secret but rather added to be body of technical knowledge to inform later technology development. See generally Richard S. Gruner, Why We Need a Strong Patent System and When: Filling the Void Left by the Bilski Case, 28 SANTA CLARA COMP. & HIGH TECH. L. J. 499 (2012).

56 Simple alterations to technologies involving small changes and predictable results will tend to dominate technology development for several reasons. First, development of these sorts of designs will entail little risk to innovators as they will generally be able to predict the success of their new designs from the outset of developing the designs. The risk of project failure will be low and innovators will be able to produce “satisfactory” new designs with a high degree of certainty. Second, parties seeking to manufacture and commercialize products with new designs will also tend to minimize their risks if they deal with new designs that are modest changes to older products that have already been manufactured and marketed. Manufacturing and marketing of the new products will benefit from whatever was learned in producing and commercializing their similar predecessors. The risks of new product failure will again be minimized. Finally, parties seeking funding and other resources for technology development projects may find it
this pattern by creating special incentives for inventors to resist traveling the easy path of obvious adjustments to old designs by instead seeking significantly new design approaches not previously obvious to the bulk of technology specialists.\footnote{See id.} These sorts of new outlier advances are the realm of patent incentives.\footnote{See 35 U.S.C. § 103; Graham v. John Deere Co., 383 U.S. 1, 13–17 (1966).} Yet, in countries where local patent laws create few incentives for the reasons detailed here, the promotion of these highly important outlier advances may be very weak.

Fortunately, innovators worldwide are not limited to home country patent incentives. They can look beyond their own countries’ patent laws and incentives to those in countries with large economies like the United States.\footnote{While the analysis in this article focuses on foreign inventors’ reliance on innovation incentives derived from United States patent laws and related economic processes, parallel arguments can be raised encouraging inventors to also look to other strong economies—such as those within Europe—as sources of further innovation incentives to supplement those gained through reliance on United States patents and patent rewards. A strategy of relying on patent laws in further countries will be important in proportion to the size of the economies of the further countries and the strength, and certainty, of patent rights there.} Innovators in countries with small economies or poorly enforced patent laws should give home country patent rights secondary consideration, if any, and look for primary incentives and research support via aggressive use of patent rights in the United States.\footnote{For simplicity, this article focuses on the advantages of patenting in the United States. However, many of the same factors favoring patenting in the United States by}
new patentable technologies can serve as technology exporters and seek compensation for their efforts in the overseas potential for exports of their work. They can also seek financing and other support for their research based on this overseas potential for their results. But, they can only securely accomplish these intellectual property exports through reliance on United States patents.

The key to these strategies—both leveraging the overseas potential of outlier research before it is performed and reaping the overseas rewards for successful results—is reliance on the full patent rights available in the United States to foreign inventors. The basis for these rights available to foreign inventors—and the strength of the innovation incentives they create worldwide—are the subjects of the next section of this article.

III. US PATENTS AS STRONG ALTERNATIVES FOR INCENTIVIZING FOREIGN INNOVATION

A. Benefits of National Treatment Under United States Patent Laws

Patent laws of the United States and of most industrialized countries provide for “national treatment” of inventors. National treatment means that foreign inventors are treated equally with inventors who are citizens or “nationals” of the countries enacting the laws. Thus, for example, a party making an invention in Germany can apply for and gain patent rights regarding the invention in the United States in the same way and to the same extent as a United States citizen making the same invention in the United States. The German inventor will be treated in the same manner as a citizen of the United States in applying for and enforcing patent rights under United States laws.

foreign innovators will also apply to patenting in other countries with large economies and will, accordingly, support patenting in these further countries.

National treatment under patent laws and other intellectual property laws follows from international trade norms requiring equal treatment of foreign and domestic parties generally. Several treaties promoting international trade require signatory countries to provide for national treatment in laws governing sales of goods, the provision of services, and other trade features. This principle is reflected in fundamental international standards for commerce and trade, including all three of the major World Trade Organization (WTO) treaties: the General Agreement on Tariffs and Trade (GATT), the General Agreement on Trade in Services (GATS), and the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS). As summarized by the WTO, international treaty standards specify that:

Imported and locally-produced goods should be treated equally—at least after the foreign goods have entered the market. The same should apply to foreign and domestic services, and to foreign and local trademarks, copyrights and patents.

National treatment provisions in patent laws are even older than WTO standards, having roots in the Paris Convention of 1883.

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62 “The products of the territory of any contracting party imported into the territory of any other contracting party shall be accorded treatment no less favourable than that accorded to like products of national origin in respect of all laws, regulations and requirements affecting their internal sale, offering for sale, purchase, transportation, distribution or use.” General Agreement on Tariffs and Trade, art. III, ¶ 4, (Oct. 30, 1947), http://www.wto.org/english/docs_e/legal_e/gatt47_01_e.htm [https://perma.cc/2BS6-TKZ8].

63 “[E]ach Member shall accord to services and service suppliers of any other Member, in respect of all measures affecting the supply of services, treatment no less favourable than that it accords to its own like services and service suppliers.” General Agreement on Trade in Services, Annex 1B, art. XVII (Apr. 15, 1994), http://www.wto.org/english/docs_e/legal_e/26-gats_01_e.htm [https://perma.cc/P2CK-KSJ4].

64 “Each Member shall accord to the nationals of other Members treatment no less favourable than that it accords to its own nationals with regard to the protection of intellectual property, subject to the exceptions already provided in, respectively, the Paris Convention (1967), the Berne Convention (1971), the Rome Convention or the Treaty on Intellectual Property in Respect of Integrated Circuits.” Agreement on Trade-Related Aspects of Intellectual Property Rights, Annex 1C, art. 3 (Apr. 15, 1994), http://www.wto.org/english/docs_e/legal_e/27-trips_03_e.htm [https://perma.cc/M65A-35A8].

The Paris Convention requires signatory countries to enact patent laws providing for national treatment of foreign inventors. Terms of the Paris Convention require that “[n]ationals of countries outside the Union [(that is, nationals of non-signatory countries)] who are domiciled or who have real and effective industrial or commercial establishments in the territory of one of the countries of the Union shall be treated in the same manner as nationals of the countries of the Union.”66

Provisions for national treatment under United States patent laws are particularly important for foreign inventors given the size of the United States economy and the scope of corresponding markets in this country for patented products and services. United States laws define the patent rights governing sales and uses of patented items in this country and, in turn, shape the commercial gains that can be derived from those sales and uses. This follows from a second feature of United States patent laws: the “territorial” scope of United States patent laws in fully describing patent rights within the United States. This feature, which is typical of patent systems around the world, means that within the United States patent laws of this country (and only those laws) govern the allowed uses of patented technologies.67

Combined with national treatment, the territorial characteristics of United States patent laws means that foreign inventors can look to the full force of United States patent laws to gain invention re-


67 Territorial scope is a feature of patent laws around the world. Thus, German patent law governs what may be done with a technology if patented in that country, while French patent law governs what may be done with the same technology if patented in that country. If no patent is obtained in a given country, a publically disclosed technology typically can be used freely in that country (subject to other legal standards such as health and safety laws that might still curtail certain uses). Of course, once a product is sought to be exported from a country where no constraints apply into a country where patent rights are applicable, the patent laws of the latter may restrict the importation, sale, distribution, and use of the product. See, e.g., World Intellectual Property Association, What Is a Patent?, https://www.wipo.int/patents/en/ [https://perma.cc/TJ8S-MLTJ] (last visited on Jan. 2, 2019) (“Patents are territorial rights. In general, the exclusive rights are only applicable in the country or region in which a patent has been filed and granted, in accordance with the law of that country or region.”).
wards in the United States economy. Inventors around the world are thereby brought into the United States patent system and encouraged to produce the types of advances desired by consumers here.

Of course, the opposite is true for United States inventors, who are reciprocally incentivized by foreign patent systems to produce items desired by foreign consumers. For example, innovators in the United States are incentivized and benefitted by national treatment under provisions of German patent laws. These provisions specify that a party producing an invention in the United States is entitled to obtain a patent in Germany under the same standards and procedures as a German citizen and to gain whatever commercial rewards are available under such a patent. Thus, German laws encourage United States innovators to produce advances valued in Germany, to the extent that these are different than those valued in the United States.

National treatment also encourages innovators to consider the world-wide demand for various types of innovations (that is, the aggregate commercial demand in the United States, Germany, and multiple other countries to the extent that patents are obtained in those countries) when considering the overall commercial potential for new innovations. Many advances, addressing common concerns such as health and safety, will have parallel utility and commercial value in multiple countries. Where the desires of consumers for new technologies are similar in multiple countries, national treatment provisions of patent laws ensure that the incentives for meeting the common desires add up to produce elevated incentives reflecting the combined interest in innovations.

National treatment provisions in patent systems of foreign countries—now combined with patent application aids such as provisions of the Patent Cooperation Treaty (PCT) that streamline patent applications in multiple countries—ensure that parties


69 For an overview of the Patent Cooperation Treaty system and its advantages in promoting patent applications in multiple countries, see World Intellectual Property
producing advances valued in multiple countries can gain patents and patent rewards across those countries. The resulting sum of rewards available in multiple patent systems promotes innovation above and beyond the incentives of any one patent system, encouraging attention to advances with value and commercial potential across many countries.

While the availability of patent rewards in multiple countries due to national treatment provisions is important in driving and prioritizing international technology development, for the sake of simplicity, this article focuses on the impact of national treatment provisions in just the United States and the implications of these provisions for international technology development. The article examines the potential for United States patent laws and associated commercial rewards from the United States economy to incentivize and encourage new technology production and cultivation elsewhere. In considering cross-border patent rewards emanating from the United States, the article treats these rewards as inducements for foreign inventions that can substitute for home country incentives where patent laws are weak or are of little commercial value. While other factors, such as gaps in technical expertise, supporting infrastructure, or research financing, may still limit the development of new technologies in some foreign countries, the availability of commercial rewards in the United States can help put innovators in foreign countries on the same plane as their United States counterparts and encourage these foreign innovators (and companies or investors who support them) to target and pursue new technology development efforts with high profit potential and utility.

Organization, Summary of the Patent Cooperation Treaty (PCT) (2018), http://www.wipo.int/treaties/en/registration/pct/summary_pct.html [https://perma.cc/9AZZ-JGJY] (last visited Sept. 3, 2018). The PCT makes it possible to seek patent protection for an invention simultaneously in many countries by filing an “international” patent application (typically referred to as a “PCT Application”). Ultimately, an applicant filing such an application can determine whether it will be submitted to and considered by patent offices in specific countries that adhere to the PCT (which now include most major industrialized nations). Additional provisions of the PCT include timing provisions regarding the filing of patent applications that are generally more favorable to patent applicants than the timing deadlines that would prevail if the applicants filed applications directly with patent offices in specific countries. See id.
B. Purposes Underlying National Treatment in Patent Laws

Requirements of national treatment for international technology innovators serve several valuable purposes. These include ensuring fairness to foreign providers of useful technologies, simplifying legal disputes involving patent rights, encouraging international propagation of new technologies, and promoting equally-situated competition among international producers of products incorporating patented features or utilizing patented production methods.

1. Ensuring Fairness to Foreign Inventors


Fairness requires equal treatment for equal value rendered to innovation users. A moral entitlement to a reward derives from an act of invention coupled with the addition to the public sphere of utility gains resulting from use of the invention. A moral basis for patent rights and associated patent-influenced rewards to successful inventors for transfers of useful inventions to society stems from a Lockian view of labor and property. John Locke argued that labor invested in a project should result in property ownership of the project results. As summarized by Adam Moore and Ken Himma, the Lockean justification of patent law “begins with the claim that individuals are entitled to control the fruits of their labor….Laboring, producing, thinking, and persevering are voluntary, and individuals who engage in these activities are entitled to what they produce. Subject to certain restrictions, rights are generated
from an invention—and, correspondingly, the entitlement to a reward—is the same regardless of the location of the act of invention or the citizenship of the inventor. National treatment of inventors helps to ensure that this moral entitlement is realized by inventors who gain patents; they receive patent-influenced rewards regardless of citizenship or invention location.

Of course, the scope of rewards for particular inventions will vary with both the popularity of the inventions with the public and the provisions of applicable patent laws in individual countries. However, taking these factors into account, the resulting patent-influenced rewards for a given invention in a given country should be equal for inventors from all countries. All inventors, regardless of location or nationality, have equal moral claims for rewards based on valuable acts of invention and corresponding contributions to public utility. National treatment provisions help to ensure that these sorts of equal claims to patent rewards are satisfied and that foreign and domestic inventors are given fair and equal access to commercial opportunities influenced by patent rights.

2. Simplifying Patent Enforcement Litigation

Another benefit of national treatment under patent laws is that patent enforcement disputes are simplified by applying the same country laws to all patents in a given country regardless of where patented inventions were made. As noted by David R. Toraya, national treatment has several beneficial impacts on patent litigation:

[N]ational treatment provides practical benefits for both the courts and the litigants in allowing for the application of forum law. Courts prefer to apply their own law, with which they are fa-
miliar. Similarly, using only one law makes it unnecessary to apply a variety of foreign laws within a single transaction or court case. Judicial efficiency is served when courts do not have to rely upon translations of foreign statutes and case law, and the risk of distorted or inaccurate translations is abated. National treatment thus results in sounder decisions and increased certainty in the law.\textsuperscript{72}

In addition to promoting certainty by allowing courts to apply familiar home country patent laws in resolving patent cases, national treatment also increases certainty in patent litigation by avoiding threshold disputes over which laws apply to inventions made by persons of multiple nationalities.\textsuperscript{73} For example, in the absence of national treatment requirements, the United States might provide diminished patent rights to German inventors. Beyond the need to keep track of a special set of patent standards governing these diminished rights, courts would also have to determine in particular cases whether the diminished rights applied. These sorts of threshold disputes about the governing laws would be particularly difficult to resolve in cases where an invention was produced by persons of multiple nationalities such as a team of German and United States scientists. National treatment standards make the composition of such teams irrelevant and reduce litigation uncertainty accordingly by focusing attention of courts and litigants on a single set of patent laws which is ascertainable from the outset of relevant cases.\textsuperscript{74}

3. Encouraging International Propagation of New Technologies

National treatment under patent laws also helps to ensure that foreign technology innovators have incentives to bring new technologies into a country without fear that the technology will be copied freely because the foreign party is unable to gain rights controlling the use of the technology. One impact is to encourage in-

\textsuperscript{72} Toraya, \textit{supra} note 70, at 1171; see also Simons Jr.,\textit{ supra} note 70.

\textsuperscript{73} See Toraya, \textit{supra} note 70, at 1172 (noting the clarifying effect of national treatment in determining that the law to be applied in patent disputes is generally that of the country where patent infringement is asserted to have occurred regardless of the nationality of the inventors involved).

\textsuperscript{74} See \textit{id.}
novators to rely on patent protections (with public disclosures of intentions) rather than on trade secret protections (with continuing secrecy about inventions). Absent national treatment protections for foreign-originated technologies, overseas technology producers would try to restrict their technologies as trade secrets, thereby limiting public access to the advances and hindering the propagation of the advances to new countries. National treatment guarantees in other countries reassure innovators that they will have meaningful patent rights in overseas settings and that they can rely on patent laws to protect disclosed technologies rather than restricting access to the technologies under trade secret controls.

National treatment protections also promote international propagation of technical “know-how” needed to fully utilize patented inventions. Where an innovator obtains a patent on an advance in one country (thereby revealing the advance to the public through the description in the patent), the innovator might still seek to restrict widespread use of the advance in other countries by maintaining close control over private know how needed to fully use the publicly disclosed technology. Patent rights in overseas settings, ensured in part by national treatment standards, help to reassure an innovator that he or she can bring a new patented technology into a country and rely on patent controls in that country to prevent unauthorized use of the technology there. Once a patent is obtained in a foreign nation and an innovator can rely on national treatment there, the inventor’s need to rely on know how access restrictions to maintain control over a new technology there will be lessened, and fewer controls will tend to be imposed.

Rather than trying to restrict access to their new advances, innovators will have reasons to encourage and support more use of new technologies in countries where patents are obtained. With patent rights in a foreign venue allowing the rights holder to charge for the use of a patented technology in that venue, a patent holder has a direct stake in expanded use of a patented advance in the venue. Because of this, a technology innovator with a foreign patent strengthened by national treatment guarantees will be encouraged to bring a new technology into the venue along with the personnel and trade secret knowledge needed to assist licensees or other authorized parties to maximize use of the technology. The
more authorized and paid for use of the patented technology, the
more the patent holder will stand to gain in the foreign venue. Ab-
sent viable patent rights backed up by national treatment guaran-
tees, the technology originator will have incentives to resist this
type of potentially uncompensated technology transfer by all
means possible.

4. Promoting Competition Between Producers in Multiple
Countries

Provisions for national treatment also tend to discourage free
riding in international commerce as firms in multiple countries
produce goods that are destined for competition in other countries.
Absent national treatment, an innovator might be able to gain con-
trol over a new technology in his or her home country but see the
technology used freely in a second country because the foreign
party was precluded from gaining or enforcing patent rights in that
country. Goods produced with the freely used technology in the
second country would be produced at a lower cost than equivalent
goods produced in the first country where patent controls, and
charges for use of the technology, applied. As producers of the
same goods in the first and second countries competed for sales in
a third country, the producers in the second country where patent
holders received no rewards would be significantly advantaged.
National treatment ensures that the technology innovator can gain
rights to his or her technology in the second country and can
charge for the technology’s use there in the same manner that the
originator charges in his or her home country. This, in turn, helps
to equalize production costs for uses of technology worldwide and
protects an equal plane of competition among producers in multi-
ple countries regarding products incorporating patented advances
(or manufacturing using patented advances) no matter where that
later competition occurs.
IV. Utilizing the National Treatment Benefits of United States Patents

A. Widespread Lost Opportunities—The Missing Patents

Remarkably, given the potential opportunities afforded through United States patents, many inventors located outside the United States are apparently failing to seek out the patents needed to gain valuable rewards from the United States economy. Foreign innovators pursue low rates of United States patenting, despite the presence in many countries of substantial research and development (R&D) spending and extensive innovation resources such as large numbers of recent doctoral degree recipients and highly active academic communities. This subsection reviews the evidence indicating that innovators in many countries with substantial R&D capabilities are not taking the opportunities afforded by national treatment under United States patent laws. These countries reflect noticeably low patenting rates given their R&D expenditures.

Countries where innovators are apparently foregoing the incentives offered under United States patent laws stand in contrast to a few countries where inventors are embracing these incentives. There, United States patenting is at high rates relative to R&D levels. The rates of patenting in some countries are even higher than for United States inventors, suggesting that innovators in these countries have chosen to emphasize patented technology innovation and exports of valuable technologies to the United States to gain compensation through United States patent enforcement. A

75 As explored more fully in subsection 1 below, innovators in many countries with substantial R&D spending are not translating such spending into advances covered by United States patent applications. For example, innovators in China are seeking United States patents at about one tenth the rate per dollar of R&D spending as United States inventors. For fiscal year 2016, the rate of United States patent applications per dollar of R&D spending for United States inventors was about 641.25, while the comparable rate for Chinese inventors was only 68.30. Additional rates of patenting per R&D spending dollar for other countries are contained in Figure 1 below. These rates are based on R&D spending figures and patent application counts. See National Science Board, supra note 7, at 37, tbl.4–5; U.S. Patent Office, Performance and Accountability Report FY17 172 (2017), https://www.uspto.gov/sites/default/files/documents/USPTOFY17PAR.pdf [https://perma.cc/DS37-UTTF].
few of the countries with this United States patenting strategy are profiled in subsection IV.C of this article.

1. Indicators of Low Patenting Despite Substantial R&D Spending

The low United States patenting levels for innovators in many countries with substantial R&D spending is apparent from measures of patenting per R&D spending dollar. Such measures adjust patenting patterns to eliminate the effects of economy size differences across countries and associated differences in R&D spending. Countries with relatively low patenting per R&D spending dollar are either 1) not producing patentable advances (focusing instead on lesser advances or not achieving substantial numbers of advances at all) or, 2) despite producing patentable advances, are making choices about legal and commercial strategies in foreign commercialization that forego United States patenting and the potential rewards for such patenting.

The following figure summarizes the patenting per R&D spending patterns for the ten countries with the top R&D spending levels:

76 R&D spending amounts used in this figure were extracted from NATIONAL SCIENCE BOARD, supra note 7, tbl.4–5, at 37. All of the R&D spending amounts reflect estimates in current purchasing power parity (PPP) United States dollars. Patent application counts used this figure were extracted from United States Patent Office, supra note 75. The country source of patent applications with inventors from more than one country was presumed to be the country of the lead inventor. See United States Patent Office, supra note 75. The US applications per R&D spending rates in the last column of Figure 5 simply reflect the ratios of the figures in the first two columns. For example, the rate shown in the third column of Figure 5 for United States inventors reflected the number of applications by United States inventors in fiscal year 2016 divided by the amount of R&D spending in the United States or 318701 / 497 = 641.25.
Many of these countries reflect about the same levels of United States patent applications per R&D spending, suggesting that large differences in raw patent numbers across these countries may mainly reflect differences in the sizes of country research efforts or associated differences in country economy sizes. Using the United States values in this figure as an indication of baseline or “typical” levels of R&D conversion to patent applications, similar but modestly lower levels are present for innovators in Japan and Korea. Innovators in these countries appear to be translating R&D funding into patentable advances and United States patent applications at about the same rates as their United States counterparts.

The same is not true, however, for innovators in Europe (at least within the countries shown). Lower (but roughly consistent) patenting levels are present across several European technology producers, including the United Kingdom (322.26 patent applications per billion dollars R&D spending), Switzerland (325.67),...
Netherlands (392.71), and Sweden (379.93). Yet, even the best of these R&D to patenting conversion rates is well below that for the United States. For example, controlling for differences in R&D spending levels, innovators in the United Kingdom sought patents at a rate that was only about 50% of the counterpart rate in the United States.

Two European technology giants—Germany (289.17) and France (221.13)—show patenting rates that are even lower. These rates are lower than for several European counterparts. For example, the R&D to patenting conversion rate for German innovators is only about 74% of that for researchers in the Netherlands. Even more dramatically, the rates for Germany and France are only about 45% and 34% of the rate for United States inventors. Why innovators in Germany and France are pursuing United States patents at such low levels is not clear. Some possible reasons for low patenting rates are considered in subsection IV(B) below.

Finally, among these top sources of United States patent applications in 2016, the patenting rates for China are especially low. Adjusted for R&D spending levels of the two countries, the rate for Chinese innovators (68.30) was only about 11% of the rate for United States innovators. Clearly, there are substantial differences in the ways that Chinese R&D spending is converted into United States patents in comparison with the same conversion process in the United States.

China is not alone among countries with large economies that have extremely low conversion rates. Other large countries with low R&D spending to patenting rates include:

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77 These rates are based on reported R&D spending figures and patent application counts. See National Science Board, supra note 7, ch. 4, at tbl.4–5; United States Patent Office, supra note 75.
78 Id.
79 Id.
80 See National Science Board, supra note 7, ch. 4, at tbl.4–5 (R&D spending amounts in PPP U.S. dollars); United States Patent Office, supra note 75 (U.S. patent application counts).
Along with innovators in China, researchers in these countries rarely seek compensation for advances in United States markets via United States patents, measuring their efforts in relation to the R&D spending to patenting conversion processes utilized by United States innovators. The conversion rates for R&D spending to patenting for innovators in India was only about 24% of the rate for United States innovators. The corresponding rates for researchers in Russia and Brazil were only about 4% of their United States counterpart.

As reflected in the low patenting rates for many countries spending large amounts on research and development activities, many innovators in these countries are failing to pursue compensation for their advances through the sorts of United States patent-mediated rewards sought by United States innovators. The reasons for this gap—that is, for the missing patents corresponding to high levels of research in many of these countries—are explored in subsection B below.

2. Indicators of Low Patenting Despite Substantial Country Expertise

Several other indicators confirm the low patenting rates for some countries with large innovation capabilities. One key factor affecting research capabilities from country to country is expertise in cutting edge science and technology. Differences across countries in numbers of recent doctoral degree recipients in science and
engineering fields provide rough measures of the expertise differences. Countries with large numbers of recent degree recipients in science and technology fields should have stronger research capabilities than countries with fewer such degree recipients.

Using recent PhD degrees as a research resource indicator produces further evidence of low patenting in countries that expertise levels suggest should be major innovators. Taking into account only degrees in science and engineering fields, ratios of patent applications in the United States in 2016 to PhDs in 2014 vary substantially across countries. These ratios indicate the number of patent applications each country would be predicted to produce if the countries had equal numbers of recent PhD recipients in science and engineering fields, all else being equal across the countries. The following figure summarizes these variations for several of the largest sources of United States patents (countries are listed here in descending order of R&D spending):81

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81 The earned doctorate counts in this figure are extracted from NATIONAL SCIENCE BOARD, supra note 7, at app. tbl. 2–37. The patent application counts per country are extracted from U.S. Patent Office, supra note 75, at Table 9.
As with the evidence drawn from R&D spending, there are at least three levels of patenting apparent in this data. First, patenting per PhD in the United States, Japan, South Korea, and Taiwan was similar, indicating that innovators sought about the same numbers of patents per new PhD. Within this group, patents per new PhD were notably higher for Japanese innovators than for innovators in the other three countries. Whether the high figure for Japanese innovators stems from more aggressive patenting practices, fewer
recent PhDs, or other factors affecting either patenting or PhD levels is not clear from this data.

Second, Germany and Canada had roughly similar amounts of patents per PhD, but at levels much lower than that of the United States. The rate for Germany, for example, was only about 28% of the rate for United States innovators. Despite being below the comparable rate for the United States, the rate for German innovators was higher than the rates for innovators in the other European countries listed.

Third, China was again at a much lower level of patenting. The rate of patenting per PhD graduate for Chinese innovators was only about 10% of that for innovators from the United States. China’s rate was comparable to those of several other technology sources across the world, including (in descending order) France, the United Kingdom, Italy, Australia, and India. While this suggests that recent PhDs and the expertise they add to technology development may be producing the same levels of new United States patent applications from China as from the other countries listed in this paragraph, the low rates of patenting per PhD in all of these countries compared to the United States is striking. The patenting rate per new PhD was even lower for innovations from Russia.

While the results for some countries are a bit different (Germany seems to lag in patenting per R&D spending but performed stronger in patenting per PhD, and the United Kingdom shows the opposite pattern in these two analyses), this additional perspective on patenting levels across countries suggests that innovators in a number of countries are not seeking compensation for advances at levels that country-specific expertise would predict. Put another way, in countries like Germany and Canada, the levels of expertise reflected in their recent PhD levels would suggest patenting rates should be about four times higher were German and Canadian innovators to seek rewards via United States patents in the same manner as United States innovators. In countries like China, France, the United Kingdom, Italy, Australia, India, and Russia, recent expertise additions (as reflected in counts of recent science and engineering PhDs) indicate that innovators should be seeking United States patents at about ten times their present rates to match their United States counterparts.
3. Indicators of Low Patenting Despite Substantial Academic Outputs

Academic research article outputs provide yet another rough measure of research capabilities across countries. Countries with large numbers of published academic articles in science and engineering fields will generally reflect more active research programs than countries with lower numbers of articles.82 The following figure summarizes patenting levels for several countries that are the largest producers of academic articles (countries are listed here in descending order of R&D spending):83:

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82 See, e.g., NATIONAL SCIENCE BOARD, supra note 7, ch. 5, at 92 (“The output volume of research, article counts, is one basic indicator of the degree to which different performers contribute to the world’s production of research-based [science and engineering] knowledge.”).

83 The article counts in this figure are extracted from NATIONAL SCIENCE BOARD, supra note 7, at app. tbl. 5–27. The patent application counts per country are extracted from United States Patent Office, supra note 75, tbl. 9, at 174.
This data on patenting per academic article confirms two patterns seen in the previous analysis of patenting per R&D spending. First, patenting levels (and associated attempts to obtain invention rewards via United States patents) are roughly the same across a top tier of countries including the United States, Japan, South Korea, and Taiwan (as measured from patenting per academic article).

Second, patenting rates are much lower for innovators in China and India as measured from patenting per academic article. Patenting rates per academic article were similarly low for Brazil, Russia, Italy, and Spain. Innovators in these last six countries are produc-
ing academic works at substantial rates (as indicated by their status among the world’s top producers of published articles in science and engineering fields), but innovators in these countries, including technology giants China and India, appear to seek United States patents at much lower rates per academic article.

For example, the rate of conversion of academic work to patented advances for Chinese innovators (treating the topic of each article as a project potentially leading to an advance) is about 8% of the rate for innovators in the United States. Put another way, if academic work in China was converted to United States patent applications at the same rate as similar academic research in the United States, we would expect Chinese patent filings in the United States (and corresponding attempts to gain rewards for innovation in the United States) to be over ten times the levels actually observed. Chinese innovators, and their counterparts in India who have similarly low patenting rates, are seeking United States patents for inventions at much lower rates than the academic research in these countries would predict.

B. Possible Reasons for the Missing Patents

The low patenting rates seen for Chinese, Indian, Russian, Brazilian and some other innovators outside the United States may be the result of at least four different factors: 1) lack of production of patentable advances; 2) production of patentable advances with so little commercial potential that patenting is not cost justified; 3) production of valuable, patentable advances for which no United States patents are desired or sought; or 4) production of valuable, patentable advances for which United States patents are desired but resources needed to gain and enforce such patents are lacking. These possible reasons for the findings above are explored briefly in this subsection. Further research will be needed to determine the relative importance of these possible explanations (or if there are yet additional reasons for the low patenting rates documented here).

1. Research Spending Does Not Produce Patentable Advances

One possible reason why innovators in some countries seek far fewer United States patents per R&D expenditure than innovators
in the United States is that research spending in these countries may produce fewer patentable advances per dollar spent. There are two possible ways that this might result:

First, foreign research may not be as successful as in the United States, leading to fewer inventions per R&D spending dollar. This is another way of saying that foreign researchers may not spend their research dollars as effectively or efficiently as their United States counterparts. The reasons for this are impossible to determine from the present data.

Alternatively, foreign researchers may work as efficiently as researchers in the United States—in the sense of inventions produced per research dollar spent—but create mostly inventions that do not qualify for patents. This would reflect a different emphasis in research than in the United States. If foreign research spending mostly supports predictable research to produce obvious adjustments to prior technology designs and processes, then R&D spending will produce mostly unpatentable advances. A large fraction of unpatentable advances, or even a mix of advances with a greater fraction of unpatentable advances than in the United States, would produce the sorts of low patenting rates described previously. Whether a heavy emphasis on relatively mundane research explains the low patenting per research expenditures seen in the above data will require more detailed study of the aims and results of research in the various countries with low patenting rates.

2. Patentable Advances Produced Are Not Commercially Important

Another possible reason behind the low patenting rates for innovators in some countries is that patentable advances are being made at about the same invention per R&D spending rates as in the United States, but the potentially patentable advances made in these countries are perceived by their originators as having little commercial value in the United States. Consequently, the cost of obtaining and enforcing patents in the United States appears unjustified and no patents are sought.

This may reflect a difference in targeting of innovation, with inventors in foreign settings producing new and non-obvious outlier advances much like their United States counterparts, but lacking
a sense of commercial need. Foreign innovators, more than their United States counterparts, may also lack resources to tailor raw academic findings to consumer needs and thereby perfect patentable products that have commercial potential.

Such gaps in targeting invention efforts might result if many potential inventors in a country were applying research spending to produce pure academic findings without adjusting academic goals to reflect the commercial potential of particular lines of research. Similar divergence of research away from commercial targets might also result from infrequent involvement of commercial entities in research in some foreign countries, causing a greater fraction of research targeting, and resulting research spending, to be undertaken without aiming at the commercial potential of research results.

3. Patentable Advances Produced but US Patents Are Not Desired

Yet another possible basis for the low patenting rates for some countries seen in the above findings is that innovators in these countries, or the institutions that support them and that are the potential recipients of patent assignments based on innovations by the foreign researchers, do not value and pursue United States patents even for commercially important and potentially patentable advances. This failure to prioritize and pursue United States patents might stem from gaps in information about: 1) the substantive requirements for obtaining a patent, 2) the availability of full patent rights in the United States for foreign inventors, or 3) how to go about getting and enforcing a United States patent. Alternatively, a low priority placed on obtaining a United States patent may reflect a substantive choice to emphasize values favoring free access to intellectual discoveries and to reject intellectual property interests like patents that may limit public access to certain advances.

Whatever the reason, the choice to forego a United States patent for a potentially patentable item with substantial value in the United States simply sacrificing some of the compensation available to inventors for useful advances. This failure is effectively a gift to United States consumers. Even if an inventor gains a patent in his or her home country, the failure to obtain a patent in the United
States will forego the substantial patent-influenced rewards available from the world’s largest economy for advances that consumers in the United States find useful.

More fundamentally, the failure to plan for patenting of a targeted advance means that United States patent rewards are not part of the financing and resource allocation decisions underlying research endeavors. Where foreign research programs are targeted and planned with careful attention to obtaining and enforcing, or assigning away, patents on inventions valued in the United States, the economic force of American market demand and commercialization of new advances can be placed behind foreign research efforts.

By contrast, if United States patenting is foregone, then patent-based financing support is sacrificed to the detriment of both foreign researchers and United States consumers. Parties making this choice against United States patenting will not only forego support for their research efforts; they may also find themselves disadvantaged when competing with other researchers who are counting on United States patents for valuable advances and gaining associated research support. Researchers who understand the potential of United States patenting, who are sharp enough to create research plans with patenting components, who gain increased funding and resource allocations, and who complete more extensive and successful research accordingly are likely to prevail over less well supported researchers working without reliance on United States patents.

4. Resources are Lacking to Gain and Enforce Patents

Finally, low patenting rates per R&D dollar spent may result because, although innovators in other countries are producing valuable, patentable advances at about the same rates as their United States counterparts and desire United States patents; the overseas innovators lack the resources needed to obtain and enforce related United States patents. The funds needed to obtain patents and to mount viable enforcement efforts may be essential to establish the
value of patents in United States markets. Patents obtained without the expenditure of sufficient resources to produce carefully drafted patents may lack meaningful value because they are drafted in ways that fail to limit the most commercially valuable uses of new advances. Even well-drafted patents may lack practical value if a patent holder does not have resources to mount meaningful patent litigation against infringers. Absent the capability to support such litigation, a patent holder will appear to be no more than a paper tiger. Parties with commercial interests in a patented invention will simply use the invention as infringers without paying licensing fees or feeling threats of infringement injunctions or damage awards.

While the resources needed to gain and enforce patents in the United States are not small, there are three reasons why the size of these resources need not be a barrier to reliance on United States patents for support of foreign innovation. First, patent enforcement specialists (sometimes referred to as “nonpracticing entities” or, less favorably, “patent trolls”) are increasingly willing to acquire

84 Gene Quinn has estimated the typical costs for filing a United States utility patent application for different types of inventions: 1) computer implemented method for facilitating certain functionality via the Internet ($19,930 to $22,880), 2) consumer electronics product ($14,080), and 3) mechanical tool ($12,080). He additionally estimated post-filing costs of about $5,000 to $7,500 for USPTO fees and post-filing attorneys’ services needed to gain an issued patent. See Gene Quinn, The Cost of Obtaining a Patent in the US, IPWATCHDOG (Apr. 4, 2015), http://www.ipwatchdog.com/2015/04/04/the-cost-of-obtaining-a-patent-in-the-us/id=56485/ [https://perma.cc/9D4G-LZ8D]; see also Kiah Treece, How Much Does a Patent Cost? Types, Factors & Ways to Save (June 26, 2018), https://fitsmallbusiness.com/how-much-does-a-patent-cost/ [https://perma.cc/ZE55-LT6F]. Substantial additional amounts will often need to be expended to enforce the resulting patents. See Chris Neumeyer, Managing Costs of Patent Litigation, IPWATCHDOG (Feb. 5, 2013), https://www.ipwatchdog.com/2013/02/05/managing-costs-of-patent-litigation/id=34808/ [https://perma.cc/6HBK-XXYM] (“According to the American Intellectual Property Law Association, the cost of an average patent lawsuit, where $1 million to $25 million is at risk, is $1.6 million through the end of discovery and $2.8 million through final disposition.”).

85 See Quinn, supra note 84; see also Treece, supra note 84.

United States patents covering inventions with value in this country, thereby creating an immediate market payoff for some patents and shifting the patent enforcement burden to the acquiring entities. Patents may also be acquired by practicing companies (that is, companies that will use or “practice” the patented invention in some way), resulting in similar compensation to the former patent owners. Second, a party obtaining a valuable patent can often grant an exclusive license to the patent to another entity (often a large company with production and marketing capabilities regarding products incorporating the patented invention), thereby generating licensing royalties and shifting the burden and cost of patent enforcement to the licensing party. Third, where a company both patents a new advance and begins to demonstrate the advance’s commercial potential, the company may become an acquisition target. If acquired, the compensation paid for the company’s stock will be in part a payment for the patent rights that will transfer with the company to the acquiring party. The result is another means of patent-mediated compensation for the foreign innovator.

While these sorts of strategies will sometimes reduce patent enforcement costs, substantial resources may still be needed to gain valuable United States patents and prove the value of related products. The costs of patenting efforts should be part of the planning and project justification for particular research efforts. While some upfront patent application costs will need to be built into budgets and project justifications where parties intend to seek and rely on United States patents, substantial commercial opportunities and potential future revenues will also be added to planning considerations, with the result that the net value of many projects with commercial and patenting potential may be materially increased by considering United States patents as additional sources of research funding.

C. A Few Counterexamples – Countries Riding the United States Patent Wave

Researchers in a few countries already appear to be looking regularly to United States patents as sources of compensation and rewards for successful advances. The evidence of this lies in the particularly high R&D spending to patenting conversion rates for a
few countries. Countries with higher conversion rates than the rate for innovators in the United States are ones where research dollars are producing more patents (or at least more patent applications) per dollar spent than in the United States. Put another way, assuming arguendo that the various patents gained have similar validity and value per patent, countries with high R&D spending to patenting conversion rates have an especially high likelihood of having research costs paid for and subsidized by United States consumers.

The following figure summarizes patenting rates for a few countries with especially high conversion rates (the rate for the United States is included at the top of the figure for comparison)\(^87\):

**FIGURE 9**

<table>
<thead>
<tr>
<th>Country</th>
<th>R&amp;D Amount (Billion $)</th>
<th>Number of Apps 2016</th>
<th>US Apps per R&amp;D</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>497</td>
<td>318701</td>
<td>641.25</td>
</tr>
<tr>
<td>Israel</td>
<td>13</td>
<td>8251</td>
<td>634.69</td>
</tr>
<tr>
<td>Taiwan</td>
<td>33</td>
<td>20875</td>
<td>632.58</td>
</tr>
<tr>
<td>South Korea</td>
<td>74</td>
<td>41823</td>
<td>565.18</td>
</tr>
<tr>
<td>Japan</td>
<td>170</td>
<td>91383</td>
<td>537.55</td>
</tr>
</tbody>
</table>

These technology producers, with conversion rates almost equal to innovators in the United States, appear to know how to translate research spending into valuable inventions and potential United States rewards. Patents in the United States offer these foreign innovators substantial chances to recoup invention costs from United States sales. Furthermore, a regular pattern of looking to United States patents for future returns on invention costs means that projects can be targeted, justified, and scaled in accordance

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\(^87\) R&D spending amounts used in this figure were extracted from *National Science Board, supra* note 7, tbl.4–5, at 37. Note that the spending amounts represent totals from 2015. The patent application counts per country are extracted from United States Patent Office, *supra* note 75, tbl.9, at 174.
with the resources that United States markets and related patent rewards imply. The result will be a greater linkage of invention budgeting and targeting to the needs and potential rewards of United States consumers and businesses. The economic potential and incentives associated with United States patents encourages overseas innovators to be as attuned to United States desires and economic support as similar innovators in this country.

CONCLUSION: STRATEGIES FOR SUBSIDIZING OVERSEAS INVENTIONS

This article has described means to use patent rewards generated from United States patents to subsidize overseas innovation. It has also described the apparent failure of innovators in many countries to take advantage of these subsidies. This section concludes with a summary of means for overseas inventors, and entities that support them, to better utilize the research support represented by United States patents.

A. Major Steps to Ensure Technology Development Subsidies

1. Follow the Markets

The commercial value of a patented advance ultimately depends on the aggregate amount that parties will pay for access to devices or processes incorporating the advance over alternative devices or processes that perform the same functions without the patented feature. This aggregate amount depends on two important market characteristics: first, the number of parties interested in using the advance and, second, the amount each user will pay to gain access to the advance. The value of a patented advance will also depend on how much of the payment gained from a party for use of the advance can be transformed into profit—that is, the amount a user will pay for access to the patented advance, less the incremental production costs (if any) involved in including the patented advance in products or services.

In light of these factors, patent-protected advances with the greatest value are not those that rely on the most surprising or fundamentally new technology, but rather those advances that are dis-
tinctively different enough to qualify for a patent and used very widely such that patent-influenced product prices can be charged for sales of the advances to numerous parties. Aggregate value provided in the hands of users is the way to project the potential value of advances and to target corresponding research efforts.

2. Consider Protections in Additional Countries as Supplements to United States Patents

Carrying the principle of “follow the markets” one step further, protections in countries outside the United States for advances by foreign inventors can add to aggregate rewards and incentives. Patent protections should be sought in the United States plus additional foreign countries where patent-influenced sales in additional countries will be likely to produce further profits and add to research subsidies from United States patents. This “United States plus” strategy for patenting will justify different lists of targeted countries for patenting different types of advances. Some considerations to address in picking countries for additional patent applications beyond applications in the United States include the following:

a) Size of Country Markets

The three market size factors mentioned above—number of invention users, access price, and profit per payment—may be difficult to estimate for particular countries, particularly in advance of designing, making, and selling products incorporating the inventions in the countries. Unfortunately, patent targeting decisions will need to be made at much earlier stages based on speculative information about relevant market sizes.

Given the high degree of uncertainty generally prevailing about these factors influencing patent value, it may be wise to use economy size as a rough indicator of probable market size and patent potential in particular countries. Generally, larger economies will support more commercial transactions at higher price points than smaller economies, meaning that adoptions of patented advances (and perhaps the amounts parties will pay for access to the advances) should tend to increase with economy size.
Economy size rather quickly narrows the list of desirable countries for patent targeting. A relatively small number of countries—and corresponding patenting targets—conduct the bulk of commercial activity worldwide. The concentration of most world economic activity in a few countries implies that most of the patent-mediated returns from commercial activities can be realized by focusing on patenting in those countries. The fifteen largest country economies\(^88\) account for just almost 70% of world economic activities (measured on a PPP basis).\(^89\) Patenting strategies targeting some or all of these fifteen economies will probably capture most or all of the patent-influenced profits to be gained from commercially important advances.

The following figure breaks down the GDP figures for these fifteen countries:\(^90\):

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\(^89\) The top 15 economies account for a total of $88,595 billion in GDP versus about $127,000 billion GDP worldwide. *See id.* This means that about $88,595 \(\div\) $127,000 = .6976 or 69.76% of worldwide GDP is produced in the top 15 economies.

\(^90\) The GDP values in this figure are stated in PPP US dollars. *See id.*
FIGURE 10

<table>
<thead>
<tr>
<th>Country</th>
<th>GDP Amount (Billion $)</th>
<th>Percent of World GDP</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>$23,160</td>
<td>18.24%</td>
<td>18.24%</td>
</tr>
<tr>
<td>United States</td>
<td>$19,390</td>
<td>15.27%</td>
<td>33.50%</td>
</tr>
<tr>
<td>India</td>
<td>$9,459</td>
<td>7.45%</td>
<td>40.95%</td>
</tr>
<tr>
<td>Japan</td>
<td>$5,429</td>
<td>4.27%</td>
<td>45.23%</td>
</tr>
<tr>
<td>Germany</td>
<td>$4,171</td>
<td>3.28%</td>
<td>48.51%</td>
</tr>
<tr>
<td>Russia</td>
<td>$4,008</td>
<td>3.16%</td>
<td>51.67%</td>
</tr>
<tr>
<td>Indonesia</td>
<td>$3,243</td>
<td>2.55%</td>
<td>54.22%</td>
</tr>
<tr>
<td>Brazil</td>
<td>$3,240</td>
<td>2.55%</td>
<td>56.77%</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>$2,914</td>
<td>2.29%</td>
<td>59.07%</td>
</tr>
<tr>
<td>France</td>
<td>$2,836</td>
<td>2.23%</td>
<td>61.30%</td>
</tr>
<tr>
<td>Mexico</td>
<td>$2,458</td>
<td>1.94%</td>
<td>63.23%</td>
</tr>
<tr>
<td>Italy</td>
<td>$2,311</td>
<td>1.82%</td>
<td>65.05%</td>
</tr>
<tr>
<td>Turkey</td>
<td>$2,173</td>
<td>1.71%</td>
<td>66.77%</td>
</tr>
<tr>
<td>South Korea</td>
<td>$2,029</td>
<td>1.60%</td>
<td>68.36%</td>
</tr>
<tr>
<td>Spain</td>
<td>$1,774</td>
<td>1.40%</td>
<td>69.76%</td>
</tr>
<tr>
<td>Top 15 Countries</td>
<td>$88,595</td>
<td>69.76%</td>
<td></td>
</tr>
<tr>
<td>World</td>
<td>$127,000</td>
<td>100.00%</td>
<td></td>
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</tbody>
</table>

Not all of these 15 countries need be targeted for patenting. Indeed, even for these countries with some of the world’s largest economies, the advantages of adding additional countries (as indicated by their percentages of worldwide GDP) may be small. For example, adding patents in Spain to a patenting strategy may only add about 1.4% to projected patent-influenced revenues, corresponding to the additional fraction of world GDP potentially controlled by adding these patents.

A party producing a broadly valuable advance and considering which countries to target for international patenting can roughly
estimate the fraction of the world’s commerce he or she will influence from any tentative list of countries chosen for patenting. The fraction of patent-influenced profits potentially resulting from any choice of countries will, at best, roughly correspond to the cumulative percent of world GDP in the set of countries chosen. For example, were a party to seek patents for an advance in the top five countries listed in Figure 10, he or she would hold patent rights over almost half of the world’s economy as measured from country GDPs.

However, as explored more thoroughly in the next subsection, weaknesses in substantive patent laws or gaps in patent enforcement may make patent controls in some of the listed countries limited in practical value. Practical limitations of patent enforcement may justify downward adjustments in the patent profit estimates that GDP figures would otherwise support. This may, in turn, support omitting some countries from patenting strategies.

b) Adjustments for Enforcement Effectiveness

Once tentative choices for patenting countries are made in light of the market size criteria mentioned to this point, further adjustments may be desirable in light of the weakness of patent enforcement in particular countries. If it appears that patent rights are weakly defined, poorly enforced, or even unavailable, the rights will be of little practical value. Patent rights will fail to control some or all of the sales and use of products in countries with weak enforcement, making it wise to discount the apparent value of patent rights in these countries to reflect the uncontrolled sales and uses. In some cases, this discounting may so reduce the projected value of patent rights in a country as to warrant dropping the country from the list of patenting choices. If patent rights seem unlikely to be enforced at all in a country, or if the costs of enforcement seem unlikely to justify the very modest advantages gained from enforcement, it will not be desirable to pursue patents in that country no matter how large its GDP.

However, before making a final choice to drop a country with a large GDP from a patenting strategy, two additional factors should be taken into account. First, the fact that patent protections are presently weak does not necessarily mean that they will stay weak.
over the potential life of available patents. Even if patents appear to be presently of little practical value, signs that patent rights are being enforced with increasing regularity and impact may suggest that having a patent in the country will be valuable over the life of the patent. Even if a patent is only enforceable late in a patent term, this will frequently be enough to realize most of the commercial value of a patented invention. Most of the sales of the invention, and attempts at infringing sales, will not occur early in the life of a patent when the patented technology is still being transformed into marketable products but rather late in the life of the patent when sales of the invention have been heavily promoted and the invention has gained substantial popular acceptance. If there is a prospect that a patent gained today in a given country will have an impact on this type of future marketing as the efforts to popularize the patented invention mature, then doubts about present unenforceability should be overlooked and a patent pursued as a good investment in future marketing success.

Second, even imperfectly enforceable rights may be of significant value in an important market. Thus, for example, even a partial patent enforcement effect in a large product market and manufacturing source such as China may have significant commercial value even if many infringing uses of a patented item slip through patent enforcement. The projected value of patent rights in a country—leaving aside the possibilities of future rights enforcement just addressed—should equal the projected value of patent rights in

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91 While the tendency of most patented items to generate increased profits at the end of a patent term is applicable across many types of inventions, it is particularly significant for pharmaceutical advances. As noted by Neel U. Sukhatme and Judd N. L. Cramer: “[P]harmaceuticals—due to the long regulatory approval process before the Food and Drug Administration, a drug may not even be salable for years into its patent term. Indeed, much of the profit for the drug might be obtained in the very last years of its patent term.” Neel U. Sukhatme & Judd N. L. Cramer, *Who Cares About Patent Term? Cross-Industry Differences in Term Sensitivity* 5 (Sept. 24, 2014), https://scholar.princeton.edu/sites/default/files/sukhatme/files/sukhatme_who_cares_about_pate nt_term_0.pdf [https://perma.cc/B398-L2RN]. Holders of patents on other types of inventions also anticipate gaining significant fractions of their patent-influenced profits late in the term of their patents. For example, a study of patent holder behaviors found that holders of software and computer patents also tended to be particularly interested in the terms of their patents, apparently because the last portions of these terms were expected to be sources of significant profits. See id. at 2, 45.
the country if fully enforced, discounted by the likelihood of enforcement. This discounted value may still be very high if the full enforcement value is high, justifying patent protection in that country.

3. Patent in Further Countries to Protect Manufacturing Sources

One exception to the “follow the markets” principle for targeting patenting countries is a complementary strategy that emphasizes the potential for manufacturing in various countries. This further strategy may justify adding countries as patenting targets based on advantages gained from controlling manufacturing in the additional countries. Patenting in these additional countries may be warranted as an indirect means to control patented advances in high GDP countries.

Patent controls aimed at product manufacturing can supplement controls on the manufactured products where they are sold and used. Where products are made in Country A but sold and used in Country B, two different countries’ patent laws will need to be used to gain full control over both manufacturing (governed by Country A’s laws) and sales and use (governed by Country B’s laws).

If a patent holder was confident in controlling and obtaining patent-influenced sales or licensing revenues from all sales and uses of a patented product in the countries where sales or uses occur, then no further controls over product manufacturing would be needed to realize the full patent rewards for the product. However, patent controls over product manufacturing may have several ad-

92 The analysis of multi-country patent enforcement strategies for patents covering manufactured products is different than the analysis for patents aimed at manufacturing itself rather than the products being manufactured. Patents applicable to manufacturing equipment or techniques will generally need to be enforced in countries where the manufacturing occurs since the sale of unpatented products resulting from the patented advances will not be controlled by the relevant patents. Applying manufacturing-related patents in the countries where manufacturing occurs is just a special case of the general “follow the markets” principle for patent targeting and enforcement. The primary—indeed, perhaps the exclusive—markets for patented manufacturing equipment and techniques are in countries where the associated manufacturing takes place.
vantages over a patent enforcement strategy relying exclusively, or even predominantly, on controls over product sales or use.

First, patent enforcement targeting manufacturing may be superior to enforcement emphasizing product sales or use because of differences in the substantive patent laws or patent enforcement effectiveness across different countries. If manufacturing occurs in Country A with strong patent protections, but product sales and use will primarily occur in Country B with weak protections (or will occur in numerous countries with uncertain levels of patent protections), a focus on enforcement against unauthorized manufacturing in Country A may make sense.

Second, focusing patent enforcement on manufacturing may have administrative advantages over enforcement aimed at product sales and use. Product manufacturing is typically concentrated in a few parties and locations, while the latter may be scattered across the world. Patent controls over manufacturing may be a convenient way to charge one party (a manufacturer licensing the right to make a patented item) for the production of many product units or to prevent such production if a party will not pay. By limiting manufacturing of a patented item through close policing of authorized manufacturers, a patent holder can control the downstream commercialization of many units of a patented invention through a few administrative contacts with authorized manufacturers.

Third, patent enforcement actions against unauthorized manufacturers can avoid the need for suits against product consumers that may sour later product sales to the consumers. Where unauthorized manufacturers are producing high volumes of knockoff patented items and selling these to consumers, it may be far more palatable for a patent holder to sue the manufacturer of the knockoffs for infringement—and thereby cut off unauthorized sources of patented items—than to sue consumers who have purchased or used unauthorized versions of the patented product. These consumers will hopefully be future customers for authorized versions of the same products. To maintain their goodwill, direct patent enforcement suits against these consumers, while technically available, will be unwise in the context of future product marketing.
For all of these reasons, parties may wish to add countries to their patenting strategies because the countries are potential manufacturing locations (assuming that the countries are not already targeted for patenting based on their market sizes). Additional country selections based on manufacturing alone will be technology-specific (based on the varying manufacturing costs and locational advantages associated with different countries and types of technologies). These factors may also evolve significantly over time (based on changes in factors such as shifting labor costs and increasing uses of robotic processes altering manufacturing costs in different countries over time). Unfortunately, countries with favorable manufacturing sites for a given type of patented product will need to be identified and targeted for patenting based on estimation of manufacturing features over the entire term of the patents at stake (a period of 20 years from patent application in the United States\(^93\)). Information uncertainties governing these costs suggest that gaining patent protection in all likely manufacturing countries may be either expensive (because a broadly inclusive approach to manufacturing likelihood and associated patenting is pursued) or under-inclusive (because estimates focusing on patenting in present manufacturing centers will not include other countries that become important later). Nonetheless, it will typically be important to consider adjusting initially chosen lists of countries for patent protection to add countries with any large manufacturing sites (both present and projected) that are not already included due to market size considerations.

4. Protect Like an Affluent, Efficient Producer and Marketer

As a last overarching consideration, a new technology producer—particularly a party in a developing country who may be resource-constrained—should seek patent protections for a new advance that covers as much as possible of the full commercial value of the new advance, as this full value will be perceived and realized by more affluent and efficient product producers and marketers. The value of patents always lies in the future completion of commercial processes influenced by the patents. To envision the

full value of patents, and to both produce the most valuable inventions and obtain the best patents on them, innovators should project the future use of their innovations as protected by patents held by commercial entities that can make the best use of the patents. Innovators, however small in resources and wherever located, should project the desirability of patents as if they were affluent commercial parties with substantial expertise and resources sufficient to realize patent-influenced profits in United States markets and other profitable foreign markets.

These projections are not mere fantasies; rather, in most cases of fully realized inventions with broad public utility and large commercial value, relatively simple legal measures can entice efficient producers and marketers to carry out the full commercialization of valuable patented products. The innovators who have generated the products, and who have the appropriate patents to ensure that only they can transfer rights to produce and sell the products, will be in position to gain compensation for their patent rights that reflect the commercial value seen and realizable by efficient product producers and marketers.

This means that patent targeting decisions should be made as much as possible without limitations due to a technology producer’s present resource constraints regarding the production and marketing of products incorporating a patented advance. A technology producer should “think big” in assessing the commercial potential of a new advance, at least in assessing where commercial potential may lie in the future and where patent protections should be sought. The key in setting the proper perspective is that the technology originator will often not be the technology commercializer. The latter may have much greater resources than the technology originator (or may, in fact, be multiple parties who have much greater resources and market expertise in the aggregate).

The perspective of a resource rich commercializer may be much more international than that of a small-scale technology originator seeking to just produce a viable product for marketing in just the originator’s own country. The total international value of a new technology properly protected with appropriate patents and other IP protections can be realized by combinations of licensees and assignees rather than by just the original technology producer.
However, if a technology originator only seeks limited patent protections (and major international markets are left out of the countries targeted for patenting), there will be little or no IP rights in key countries to transfer in license or assignment transactions. Parties will have little reason to devote the types of new product manufacturing and introduction resources that may be needed to popularize a new advance in major markets. For example, even if patent protections are obtained in one important market—say in the United States—the worldwide value of an invention may be sacrificed. The commercial value of the invention in other key markets such as Europe and Japan will be lost to the innovator by failing to seek patents there since the patented product can be made and sold freely in these areas by any party in the absence of patent protections.

A technology originator determining where to patent a new invention should evaluate the full range of potential invention rewards available through patent protections from the perspective of a well-healed large company that is operative in the same field and that can efficiently and effectively produce and market goods to meet the full worldwide demand for the patented advance. This sort of company will be the logical target for licensing or transfer of the resulting patents. The perspective of such a resource-rich party will determine the potential international value of the patent protections on a new advance because this perspective will determine the value of licenses or assignments of the patents at stake. This full value can be realized by an inventor, provided that the appropriate set of multi-country patent protections needed to support international commercialization is obtained and then offered to one or more companies capable of carrying out the commercialization.

Given a patent-defined opportunity to gain exclusive commercial rights in major markets, a large company (as a potential licen-see or assignee) is most likely to offer the innovator his or her best possible compensation for patent rights governing a new technology. Absent some or all of the optimal patents (with optimality seen from the perspective of the large company), the large company’s offer will be reduced by the value of the missing patents. Hence, while a technology originator may be resource constrained and un-
able to develop the full international commercial value of a new technology in all of the markets where the technology has significant projected worth, the originator should make patent targeting decisions as if the resources for broad scale commercialization are present. If proper patent protections are sought, these resources will be brought to the commercialization process by other parties licensing or receiving assignments of the relevant patents. The full worldwide value of the technology originator’s new advance can be realized in this way, provided the originator has targeted and obtained the patents needed in the full range of major commercial markets.

Finally, at the outset of projects, parties developing new technologies should emphasize the full range of commercial rewards for the products (as protected by appropriate patents) when seeking research funding and other support. This approach uses projected patenting and commercialization across multiple countries as key features of estimating the value of commercially-oriented research projects. The same approach will be useful in estimating the value of commercial components of projects with major commercial implications even if further abstract knowledge is also targeted (as will be true in academic projects with commercial significance). The largest future value of many technical advances will be in the United States and in other countries with large economies. Researchers will be able to present the best possible picture of the commercial potential for specific projects in two ways: first, by emphasizing that they are targeting the widespread needs of parties in those countries and second, by protecting the commercial value of new advances through corresponding patenting. They will therefore be likely to gain the largest investments and other support for additional resource-intensive innovation.

B. Beneficiaries of International Influence from United States Patents

Even without relying on patent-mediated research rewards from additional countries, foreign innovators stand to benefit from greater attention to patents in the United States for the reasons described in this article. Inventors in some countries—particularly in Israel, Japan, South Korea, and Taiwan—are already attuned to the
advantages of targeting patent-enhanced profits in the United States to increase research support and associated business profits. Innovators elsewhere will be well-served to follow their example and file for many more United States patents regarding their research results.

Expanded reliance on United States patents by innovators and research organizations worldwide will not only assist foreign research projects but will benefit innovation developers and consumers in all countries. Patent-induced investment in research, regardless of where the research is conducted, is likely to produce more research projects and more results. It will achieve this both by bringing more R&D research dollars into play and by shifting some existing funding from mundane, predictable lines of research to support instead the more innovative, non-obvious research likely to produce outlier advances that will qualify for patents.

The new outlier inventions added to technology knowledge in this manner are benefits that simply would not be gained without the heightened and redirected research financing and efforts encouraged by patents. Technology developers everywhere stand to benefit greatly from these incremental efforts. They will gain new knowledge about outlier advances as an enhanced base for further rounds of innovation. They can use this expanded knowledge to produce additional advances, often along fresh lines of design inspired and made possible by the root outlier advances enabled through patent subsidies.

Perhaps more importantly, technology users worldwide will benefit from more numerous patent-induced research projects because these projects will be likely to produce more useful devices, materials, and processes. Patent incentives will encourage new design approaches to solve both old and new problems, resulting in advances with design elements that reflect significant departures from earlier technological tools. While not all patent-induced projects will succeed—just as not all batters get a hit at every at bat—patent influence will encourage innovators to “think big” and try to depart from prevailing technology wisdom to produce more outlier advances that can qualify for patents. By increasing the numbers of advances produced and shifting projects towards greater emphasis on outlier approaches, United States patent incentives can create
innovation forces around the world that promote new originality in technology development and new lines of valuable technology tools.