

**HUMAN CREATIVITY FOR ECONOMIC DEVELOPMENT: PATENTS PROPEL
TECHNOLOGY***

by

Robert M. Sherwood**

I. INTRODUCTION

Intellectual property both leads and lags the development of new technology. It lags in the sense that developments usually precede the law. Today science is accelerating so rapidly that the lawyers and policy analysts can barely grasp what the new questions are, much less supply answers. How are we to adapt the historic forms of protection to deal with new things like patents for genetically modified life forms, or for the Internet? Yet, this process of adaptation is not new. There was a time when maps were all the rage in Europe and judges puzzled over how much difference was needed to distinguish one map from the next. In the early years of this country, nails were at the leading edge of our technology. Several hundred patent applications for assorted types of nails put a strain on our patent system. All nails are not alike, as it turned out. At any event, intellectual property rules often lag behind the advent of new kinds of technology.

To explain the sense in which intellectual property leads the development of new technology, I want to draw on an excellent paper written by Kenneth Dam, which he entitled *The Economic Underpinnings of Patent Law*.¹

The starting point of his paper is that an intellectual property system is, in effect, a passive industrial policy. The policy has served well to stimulate innovation without requiring affirmative government action or public funds. Rather than rely on bureaucrats to pick winners, that is, to determine which prospective technologies deserve public support, this passive system offers researchers, and the private investors who would back them, the prospect of carefully defined property rights as incentive for their decisions.

My own career has centered chiefly in developing countries, many of them in

* Address presented October 12, 1999, on the occasion of the investiture of Dr. Luiz Proenza as the 15th president of the University of Akron. Copyright 1999, Robert M. Sherwood.

** Robert M. Sherwood, a private consultant and author, is researching the role of intellectual property in developing countries. He has also launched measurement of the effect of judicial system performance on economic growth in both developing and developed countries.

¹ Kenneth Dam, *The Economic Underpinnings of Patent Law*, 23 J. Legal Stud., 247, 271 (1994).

Latin America. This has given me a particular perspective on the connection of intellectual property with economic development. I want to offer three observations from that perspective. First, creative minds are found in every country and they are a potent national resource. Second, the origins of intellectual property indicate its role in fostering development. Third, the economic literature, while sending mixed signals at times, points to an important role for intellectual property in economic development.

II. CREATIVE MINDS

I have spent significant time in about 25 developing countries during my career, and I've come to realize that throughout the world, in every country, in even the poorest, there are people with the capacity to invent and create, some at a world-class level. I've met some of them. It has repeatedly struck me that they are a vital natural resource for these countries. Whether this resource is mobilized for national economic development, or wasted, is largely a function of the availability of protection for the intellectual property they create.

When I visited Managua, Nicaragua, for the Inter-American Development Bank several years ago, I learned about the "melon saver". A farmer there had just made this invention. It's a small cheap plastic platform that looks like an over-sized golf tee with extra legs for stability. It's placed under melons as they ripen in the fields to prevent rot and improve crop yields. The fellow obtained a patent in Nicaragua and in the United States. That gave him the impetus to mass produce the little stands and offer them to melon farmers. A marvelous invention that emerged from a very poor country.

This is a success story, but one of the few. There are abundant examples of creative individuals in developing countries who have made inventions only to fail in their efforts to bring them to commercial usefulness because of the weak intellectual property system of their country.

One telling example involves an invention by Flavio Alterthum, a Brazilian professor, and two American academics. Working at the University of Florida at Gainesville, they invented a genetically altered microbe which digests the bio-waste of the sugar harvest to efficiently produce ethanol. The U.S. Patent Office awarded the invention United States Patent 5,000,000.² Patents were eventually obtained in five other large sugar producing countries, but not in Brazil, where such inventions were not patentable at that time. Commercial development of the invention is progressing in the United States and elsewhere, but not in Brazil, where this new technology could bring substantial benefits. The Brazilian co-inventor returned to Brazil and attempted to interest local sugar companies in development of the process, but in the absence of local patent protection at the time he got no response.

²*Ethanol production by Escherichia coli strains co-expressing Zymomonas PDC and ADH genes*, issued March 19, 1991, available at <<http://www.uspto.gov/patft/index.html>>.

In another example from Ecuador, a small firm had been exporting cut flowers to markets in North America and Europe. The firm owners saw an opportunity to produce a new type of exportable flower through genetic modification of an existing plant that grew well in Ecuador. Just as the first field-grown test crop of the new plants was ready for harvesting, seventy plants were stolen. I happened to visit them the morning after the theft was discovered. Without any effective means under the then-existing Ecuadorean patent system to go after the thieves and stop their infringement of the invention, the firm had to consider abandoning Ecuador. One of Ecuador's growing export industries suffered a severe and unnecessary blow.

Three years ago, I visited the University of Costa Rica to talk with Edgar Arias, the director of university technology transfer. His position was new. In his first 18 months he surveyed the campus and found about 600 research projects in science and technology, from which about 30 inventions had been made with commercial potential. One was a molecule showing promise in HIV suppression. Already four private firms had approached the university for a license. The other was identification of the gene which hosts a virulent blight in tropical corn. Dr. Arias told me he had considered obtaining patents but learned patent protection in Costa Rica is so weak he could not justify using university funds to apply for patents. Instead, he disclosed the HIV invention to a Canadian institute, and he sent the investigator who identified the corn gene to Monterrey, Mexico, to disclose his findings to researchers there. In both cases, the value added would be done outside Costa Rica, even though individuals capable of advancing the inventions were available on campus or in local firms.

I've gathered over a hundred similar examples over the last fifteen years. They illustrate the presence of inventive people in every country. They also point to the losses suffered by those creative individuals, and to the losses suffered by the countries themselves - usually unnoticed opportunity losses - which stem from ineffective intellectual property systems.

III. ORIGINS OF INTELLECTUAL PROPERTY

The history of intellectual property is essentially the emergence of recognition that a community benefits when it encourages its creative and inventive people by honoring the products of their minds.

Intellectual property was not invented by the United States. We have refined many of its concepts, but it is quite ancient. Over two thousand years ago, in the Middle East, where water is precious, villagers found some of their potters produced exceptionally useful water jugs. Their jugs conserved water better than others. The villagers determined to honor the marks the potters placed on their jugs to make sure inferior jug makers would not deceive the villagers.

When I visited Islamabad in 1994, the president of the local chamber of commerce listened to my presentation for a while, then interrupted to tell me he was a rug maker. His family had been in the rug business for hundreds of years. He wasn't sure how long. The key to the family's success was an incredible blue dye, the hallmark of their rugs. He told me that they produced the color from a rare root. As I recall, only he and one of his sons knew the secret of when to harvest the roots, where to find them in a remote mountain area, and how to prepare them to produce the blue dye. He went on to assure me it is well known in his area that if anyone were to steal the secret, his family will have them killed. Trade secret protection today, after all, remains grounded on the concept that all reasonable precautions under the circumstances must be taken to preserve the secret.

Copyright protection arose after moveable type was invented in response to that new technology. Patent concepts germinated in the northern Italian city-states under fascinating circumstances.

Let me suggest that at each stage in the historical development of intellectual property we see that a community - whether a village, a city, or a nation - decided to give encouragement to its creative and inventive people because the entire community would benefit from the technology they produced.

IV. ECONOMIC THEORY

In 1989, Prof. Edwin Mansfield, a well-regarded economist at the University of Pennsylvania, who knew I had been spending considerable time in Brazil and Mexico investigating the role of intellectual property there, urged me to write a book to report what I'd learned.

As I began to write, it occurred to me that I should check to see what the economic literature had to say about intellectual property and economic development. I found very little directly relevant to the situation in developing countries. There was theory, much of it generated in the aftermath of World War II when American industry dominated the world. Edith Penrose³ and others seemed to dislike patents because they perceived them as monopolies. Raul Prebisch, an influential Argentine economist, preached that patents were an insidious tool by which the poor countries at the "periphery" were rendered dependent on the rich countries of the "center".⁴ Some of

³See, EDITH PENROSE, *THE ECONOMICS OF THE INTERNATIONAL PATENT SYSTEM*, (1951); F. Machlup, *An Economic Review of the Patent System*, Subcommittee on Patents, Trademarks and Copyrights, Committee on the Judiciary, U.S. Senate, 85th Cong., 2nd Sess., (1958).

⁴See Paul Prebisch, *Five Stages in My Thinking on Development*, in *PIONEERS IN DEVELOPMENT*, Meier, Gerald and Dudley Seers, eds. For one of his final statements, which revealed he had shifted his analysis, see his Address to the Twenty-First Session of ECLAC,

the mainstream American academic economists had become fascinated with questions of appropriability in relation to patents, but had not really addressed the broader question of the role of intellectual property in developing countries.

To this day, there are still few empirical studies that help us understand what will happen when a developing country adopts robust intellectual property protection. Among the few are two careful studies done by Professor Mansfield for the World Bank in 1994 and 1995.⁵

A. Solow, Schumpeter and Mansfield

To produce a chapter on economic theory in my book, I traced two streams of literature, one initiated by Robert Solow and Joseph Schumpeter, the other by Professor Mansfield. Some of you may be familiar with Solow's 1957 Study of the production function.⁶ He reviewed the American economy from 1909 to 1949 and found that the three classic factors of production - money, labor, and natural resources - accounted for barely half of our nation's economy over that period. There was an unexpectedly sizeable "residual" which required further explanation. This was identified as the introduction of new technology into the economy. My gloss on this is that much of the new technology had come from patented inventions.

Some years before Solow's essay, Joseph Schumpeter, a refugee economist from Eastern Europe, propounded his view of the displacement of mature industries by newer ones as a seminal force in economic development.⁷ Again, the insertion of new technology was perceived as a driving economic force.

Mansfield followed Solow by investigating the social welfare gains from new technology. In a series of studies, he and colleagues measured welfare benefits gained from the introduction of new technology into the American economy.⁸ He showed high rates of public return to investment in scientific and technical research.

Mexico City, April 17-25, 1986 published as Annex II of the Report of the 21st Session, United Nations document LC/G, 1424 (Ses. 21/30), June 9, 1986.

⁵Edwin Mansfield, *Intellectual Property Protection, Foreign Direct Investment, and Technology Transfer: Germany, Japan, and the United States*, Discussion Paper 27 (1995), both from the International Finance Corporation of the World Bank Group.

⁶Robert Solow, *Technical Change and Aggregate Production Function*, *Rev. Econ. & Statis.*, (1957).

⁷JOSEPH A. SCHUMPETER, *BUSINESS CYCLES: A THEORETICAL, HISTORICAL AND STATISTICAL ANALYSIS OF THE CAPITALIST PROCESS*, (1939). Appreciations of his work appear throughout GIOVANNI DOSI, ET AL., *TECHNICAL CHANGE AND ECONOMIC THEORY*, (eds. 1988).

⁸For entry to this literature, see Edwin Mansfield, *et al*, *Social and Private Rates of Return from Industrial Innovations*, *Quarterly J. Econ.*, (1977).

In 1987, Mansfield was invited to address a conference in Washington on the subject of intellectual property. He theorized that by increasing the private rate of return to investment in research through strengthened intellectual property protection, the public welfare benefit would rise as well.⁹ He was shy about predicting the effect in developing countries, however, where he had little experience.

I am less shy about predicting a positive effect, possibly a strongly positive effect. I can think of no important reason why transporting the insights of these three men to the developing countries would not lead to forecasts of similar results.

B. Knowledge Matters

Quite recently, another stream of economic analysis has emerged which is relevant to this topic. The World Development Report, the annual policy analysis produced by the World Bank, issued for 1998/99 focused on knowledge for development.¹⁰ It asserts that “knowledge matters,” that knowledge itself has intrinsic economic value.

From this report we gain a sense that knowledge itself is increasing in importance, or, more precisely, that awareness of its importance is increasing. It is also argued that the size of our body of knowledge is increasing swiftly and that this enhances its importance.

At one point [page 16] the report states:

For countries in the vanguard of the world economy, the balance between knowledge and resources has shifted so far toward the former that knowledge has become perhaps the most important factor determining the standard of living - more than land, than tools, than labor. Today's most technologically advanced economies are truly knowledge-based. And as they generate new wealth from their innovations, they are creating millions of knowledge-related jobs in an array of disciplines that have emerged overnight. . . .

Curiously, a proposed chapter on intellectual property was prepared for the Bank's report but suppressed at the executive board level under pressure from several developing countries. Fortunately, the suppressed chapter will appear soon as a

⁹Edwin Mansfield, *Technical Change and Economic Growth*, in *INTELLECTUAL PROPERTY RIGHTS AND CAPITAL FORMATION IN THE NEXT DECADE*, (Walker eds., 1998).

¹⁰World Bank, *World Development Report 1998/99: Knowledge for Development*, available at <<http://www.worldbank.org/wdr/wdr98/contents.htm>>.

separate Bank publication.¹¹

I think it is clear that in many developed countries, solid intellectual property protection has helped to expand the generation and spread of knowledge. The type of knowledge fostered by intellectual property protection has a particularly high capacity to improve products and processes, create new kinds of technology, and launch new industries. Today, major new industries spring from micro-firms and student rooms in many corners of the world. In this context, the role of intellectual property grows in importance.

The Wall Street Journal recently carried an article which sought to explain why apparently overvalued stocks are not overvalued.¹² It noted that the assets carried on a company's books give little hint of the company's ability to generate new technology. The costs of generating new technology are washed out of the books as current expenses rather than carried as depreciable assets. Beyond this, "goodwill" is a poor reflection of the intellectual property values generated by research. Indeed, the valuation of intellectual property, while getting more sophisticated, is still an immature art. The article concludes that the market is apparently smarter than the traditional approach to valuation based on book assets, having discovered that the ability to generate new technology is what gives companies their real value.

C. A Tantalizing Hypothesis

Drawing from the work of Solow, Schumpeter and Mansfield, and the World Bank's new emphasis on knowledge, I have gained confidence that it is valid to hypothesize that improved intellectual property protection in the developing countries will boost the creation and application of new technology, as it has in the developed countries, with consequent economic growth and increased public welfare benefit.

However, there is a major limitation to empirically testing this hypothesis. Only two major developing countries - Mexico and South Korea - have thus far made improvements to their intellectual property systems which in my view are substantial enough to warrant extensive empirical research.

Mexico is probably the leading candidate. Already anecdotal information suggests noticeable shifts in activity patterns in Mexico which can probably be traced to

¹¹A positive appraisal of the role of intellectual property in development appears, nonetheless, at page 17 of the 1998/99 World Development Report. The background paper will appear under the authorship of Carlos Primo Braga and Carsten Fink.

¹²Greg Ip, *New Paradigm' View For Stocks is Bolstered*, The Wall Street Journal, October 4, 1999, at C1. The article comments on a paper by Leonard Nakamura, economic advisor at the Federal Reserve Bank of Philadelphia.

the higher levels of protection introduced in 1991 and 1994. For example, some major companies are now conducting internal research. The research results from universities beginning to find their way to the marketplace. Start-up companies are beginning to attract private venture capital. More technology is moving from one entity to another. I think these will be key when applying the litmus tests when discerning whether intellectual property protection is starting to do its job there and elsewhere.

Different things happen at different levels of intellectual property protection. Based largely on my work for the Inter-American Development Bank between 1992 and 1996, I developed a numerical rating system for assessing and comparing intellectual property regimes.¹³ It examines, from the perspective of a private investor, the main components of an intellectual property regime, namely: the laws and treaties which create the rights, the public office which grants or registers the rights, and the judicial system's ability to enforce the rights. So far I've applied this rating system to the regimes of 18 countries, most of them in Latin America. On a scale of 100, Guatemala's regime, for example, rated a 13, Argentina a 39, Brazil 49, Chile 62, Mexico 69, and South Korea 74.

These ratings are useful insofar as they tell us something about what is likely to happen at various levels of protection. At the lower levels, the economy will be characterized by sales and distribution, parts manufacture, and assembly operation. These activities contribute to economic development, to be sure. But only at higher levels of protection would we begin to see complete manufacturing of sophisticated products. More important, it is only at the upper levels of protection that research and development will be supported by private investors. That is the level at which those creative and inventive local people become such a valuable natural resource.

Someone will say, but these are poor countries. They can't afford money for research. When I visited Cuenca, a lovely Ecuadorean city up in the Andes, I talked with a small group of company owners from the textile and ceramics industries. I asked them if they ever made inventions. They all said they did, but only occasionally, and only in response to a problem. I asked what happened then. They all said that their better inventions were copied by their competitors. So I asked how their activities would change if they believed they could effectively protect their inventions from copying by others. Each man stated he would eagerly devote his own time and his company's resources to systematic research to develop better techniques and new and better products. It is difficult to calculate Ecuador's loss for not giving these men this incentive, but it is probably substantial.

When I listen to discussions about intellectual property in developing countries,

¹³Robert M. Sherwood, *Intellectual Property Systems and Investment Stimulation: The Rating of Systems in Eighteen Developing Countries*, 37 IDEA: The J. Law and Tech. 261, 261-370 (1997). Also available from <<http://www.kreative.net/ipbenefits>>.

I often hear debaters focusing almost exclusively on pharmaceutical patents. I grimace because that is only the tip of the iceberg. A robust intellectual property system facilitates far more useful activity than most people realize.¹⁴

Consider, for example, the trade secret. It's an orphan. Judges support it, but it has no fan club. No bureaucracy serves it. No lawyers association thrives on it. Yet the trade secret is the grease that makes intellectual property work. Before an invention is a patent, it's a trade secret. As a raw invention is groomed for the market place, incremental improvements are usually held in secret. Before companies make deals of all kinds - whether in-sourcing, out-sourcing, or joint venturing - they typically rely on trade secret protection to check each other out. The trade secret plays a critical role at most stages in the life-cycle of many products and processes. All of this leads me to assert that without effective intellectual property protection, developing countries suffer many losses of which they are never aware.

V. THREE OBSTACLES

Before I finish, let me mention three obstacles to a happy ending. We might like to suppose that once enough leaders in developing countries grasp the case I have been laying out for you here, they will act to improve their intellectual property systems and realize the predicted benefits. A few officials have done so, particularly in Mexico, Brazil and Ecuador. But the happy outcome remains in jeopardy. The obstacles come in three flavors: (1) weak judicial system performance, (2) an absurdly archaic world patent system, and (3) confusion which results from linking intellectual property protection to global trade negotiations.

A. *Judicial System Weakness*

In perhaps 80% of the countries of the world today, the judicial system is not up to the sophisticated task of enforcing intellectual property rights, or indeed, to many other tasks. Most of these countries are not likely to upgrade their judicial systems for the sake of intellectual property, at least not any time soon.¹⁵

¹⁴In this regard, see Keith E. Maskus, *Intellectual Property Rights in the Global Economy* [provisional title], commissioned by the Institute for International economics, forthcoming. See also ROBERT M. SHERWOOD, *Intellectual Property and Economic Development*, (1990), (out of print), but available from <<http://www.kreative.net/ipbenefits>>.

¹⁵While members of the World Trade Organization have committed themselves to comply with the TRIPS Agreement which sets minimum requirements for intellectual property protection, and while TRIPS, in Articles 41 to 61 sets forth an elaborate blueprint for the enforcement of intellectual property rights, Article 41(5) recognizes that countries may not be able to enact that blueprint, stating that member countries need not provide more institutional resources than they already do to upgrade judicial system performance and need not create special

There are partial remedies which may help to notch up judicial performance. One is to provide special training for judges who handle intellectual property cases. Another is to give judges adequate authority to deal swiftly and effectively with threats to these rights. A third might be the creation of specialized intellectual property courts, although I have backed away from this suggestion, and now recommend docket management as practiced in Australia.¹⁶

However, the basic need is to upgrade judicial system performance in general. To this end, two economist friends of mine and I wrote a paper in 1993 titled "Judicial Systems and Economic Performance."¹⁷ In it we called for measurement of the economic damage done to national economies by judicial dysfunction. This broke new ground and spawned several major workshops. Thus far, nine grants have been awarded to take up the challenge of our paper. Already research has found that in Brazil the national rate of economic growth is reduced 20%, and the credit supply is lessened about 10%, as the result of judicial inefficiency. In Peru, the numbers are worse. In Spain, 86% of 500 surveyed companies stated they are rendered non-competitive in the European market by poor judicial system performance. Research is underway now in Argentina, Mexico and the Philippines, with second-generation projects being launched in Brazil and Spain. Those of us involved hope there will eventually be a beneficial result, and not only for intellectual property.

B. Patent System Absurdities

The second obstacle to a happy ending lurks in the world patent system.¹⁸ Its present form dates back to the 1880's. It features two absurdities. First, just after an inventor makes an invention, the patent system requires substantial immediate payments to secure patent rights. These patent-acquisition costs siphon off scarce funds urgently needed to prepare the raw invention for use. Countless inventions have died at this point, particularly in developing countries where the weakness of the patent system discourages venture capital. A better approach would be to reduce and postpone acquisition costs as much as possible.

It is also absurd that every country imagines it must conduct a technical

arrangements for intellectual property matters.

¹⁶Robert M. Sherwood, *Specialized Judicial Arrangements for Intellectual Property*, 36 *Revista da ABPI*, (1998).

¹⁷Robert M. Sherwood, et al. *Judicial Systems and Economic Performance*, *The Quarterly Rev. of Econ. and Finance*, Vol. 34, (1994). A longer version appears at <<http://www.kreative.net/ipbenefits.html>>.

¹⁸The discussion which follows is taken from Robert M. Sherwood, et al. *Promotion of Inventiveness in Developing Countries Through a More Advanced Patent Administration* 39 *IDEA: The J. Law and Tech.* 473-506 (1999).

examination of patent applications to determine whether the claimed invention is new when measured against the world's body of scientific and technical literature. The redundancy is costly, particularly for inventors who ultimately pay for these multiple examinations. A world patent is still some years off, but it would be quite feasible for developing countries to unilaterally decide to grant patents based on the results of a technical examination conducted, for example, at the European Patent Office. The value of such patents would be considerably higher than those granted by most developing country patent offices today. The interest of potential investors would increase.

A sub-set of this proposal would create a searchable database for developing country patent applications which are not readily accessible currently. A proposal is being prepared for submission to the World Bank covering Iberian-language patent applications. Computer accessible applications would give inventors better means to plan their research, patent lawyers more ability to write better quality applications, and venture capitalists more inspiration to provide funds in the early stages of innovation.

C. Trade linkage = Confusion

The third obstacle to a happy ending cropped up when trade and intellectual property were linked. Many of you know that during the Uruguay Round of GATT trade negotiations, this linkage led to an international treaty known commonly as the TRIPS Agreement. The current difficulty with the trade linkage is that developing countries are tending to withhold improved intellectual property as a bargaining chip, in the expectation that the chip can be used to negotiate for other trade concessions. From everything I can see, this is probably a mistake. For most developing countries a higher level of IP protection today would probably do more to enhance their export potential than an uncertain trade negotiation outcome some years from now.¹⁹

D. Dr. Proenza's Career

I would like to finish with a reflection on Dr. Proenza's career. It shows remarkable achievement in securing grants to support university research in science. What role has intellectual property played in this achievement? After all, a good portion of the funds which support university research comes from government and foundation sources. The incentive of intellectual property protection would seem to play little direct part in this dynamic.

In developing countries, it is typical for the funds applied to science and

¹⁹For an elaboration of this point, see Robert M. Sherwood, *Intellectual Property: A Chip Withheld in Error*, in *COMPETITIVE STRATEGIES FOR THE PROTECTION OF INTELLECTUAL PROPERTY*, (Owen eds. 1999).

technology to amount to less than 1% of GDP. Of that amount, most is from government entities. Local private firms spend almost nothing to advance technology through research, in large part because of the weakness of intellectual property protection. Often the government funds are derived from the World Bank and other donor institutions.

In 1997, the Brazilian government argued strenuously that a series of World Bank “jumbo” loans for science and technology should be continued. Why? Because the prior loans had produced a large number of theoretical scientific papers that were published in juried journals. Unfortunately, however, no technology had been produced that led to improved industrial activity or boosted the economy. When the Bank did grant the new loan at the end of 1997, it put Brazil on notice that from now on, useful technology will be expected, and funds were included to help enhance Brazil’s intellectual property system.

While developing countries apply less than 1% of GDP to science and technology, the most advanced countries spend three to four times as much, with 80% of that typically coming from private sector sources. I believe the availability of effective intellectual property protection in these countries accounts for this rather large difference.

I would suggest that foundations and government agencies willingly provide funds to university scientific research in the context of the widespread commitment of private funds to research and development. Foundation and government administrators and, indeed, the public in general understand that the research done in universities provides rich primary materials from which private companies develop economically useful technology, precisely the new technology which Solow and Schumpeter spotlighted for us four decades ago.

At the beginning, I quoted Kenneth Dam. He said the achievement of our patent system has been that private inventors and investors, not government officials, pick winners, assume the risks of failure, and - I would add - provide vast sums of capital in pursuit of inventions. The American system today embodies a very practical and effective synergy between the grants which empower university contributions to science and technology, and the private risk capital which propels derivative technology in multiple new directions. This model, I submit, is sustaining our economy - and has become the envy of the world.