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How Can We Improve The Context For Innovation?

Gerhard Rosegger*

During the past decade, innovation has entered into the pantheon of contemporary buzzwords. No doubt this reflects an increasing appreciation of technological advance as the most important source of growth in a nation’s productivity and living standards. We ought to remind ourselves, however, that from an individual firm’s viewpoint, being technically innovative is at best a necessary, but not a sufficient condition for success in competition. The record of business failures is littered with firms that stumbled right off the leading edge of technology! Although I have spent a good part of my career studying the sources and effects of technological change, my reading suggests that innovation in product design, marketing, service capabilities, financing, management, and a host of other areas often plays an equally important role in explaining the competitive performance of firms.

That said, we should also remind ourselves that the enthusiasm for technological innovation as a competitive weapon is a relatively recent phenomenon. In one of my old textbooks, written by a professor at one of the country’s leading business schools, I found the following statement: “During the last five years there has been a popular move to establish research departments in industry . . . but I suspect that some of these new research departments are window dressing, which will disappear as competition stiffens.”¹ The book was published in 1951.

In the late 1950s, the pioneering work of Solow and others recognized the effect of technological advance as an “unexplained residual” in aggregate production functions, i.e., a portion of economic growth not accounted for by capital and labor. And it was not until the 1960s, that serious efforts at explaining the unexplained got under way. Here again, we must remind ourselves that these efforts took place in an intellectual climate that regarded most problems on the economy’s supply side as essentially solved, with attention therefore focused on the demand side. John Kenneth Galbraith’s writings about the problems confronting an “affluent society” very much reflected the temper of the times, as did Washington’s fine-tuning policies.

A rude awakening in the 1970s, triggered by import surges and

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The following text was compiled from the transcript of the remarks made by Professor Rosegger at the Conference.

¹ MELVIN THOMAS COPELAND, THE EXECUTIVE AT WORK 111 (1951).
“energy crises,” shifted the balance of interest. Since then, we have seen an outpouring of theoretical, empirical, and exhortative writings, many of them addressing the very issues that form the themes for this conference. As a consequence, legislators, bureaucrats — and perhaps even lawyers — have most likely paid more attention to the dicta of economists that is justified by the current state of the art; and we economists have basked in the glory reflected off our simulated pearls of wisdom. In fact, we probably know more about what not to do in order to stimulate innovation than we do about positive strategies and policies.

Let me illustrate the reason for such modesty with just one example. In the course of the last two days, several speakers have bemoaned the fact that the absence of any operationally meaningful output measures forces us to judge the comparative innovativeness of firms and industries by their expenditures on the relevant inputs. Indeed, the OECD statistics define “high-tech” industries strictly in terms of their R&D intensity, that is, their R&D investment as a percentage of sales revenues.

But the problem is not just empirical. While we blithely speak of the production of inventions and innovations, we really cannot be certain that the received economic “laws” apply, pari passu, to the production of new knowledge. Thus, the evidence does not permit us to say with any degree of assurance whether this kind of production is subject to diminishing returns, whether it is enhanced by the conventional forms of specialization, or whether it benefits from economies of scale. Nor can we extricate ourselves from these difficulties by simply labeling inventive and innovative activity as “production under conditions of high uncertainty.” The only thing we do know is that the search for new technical ideas is replete with redundancies as well as blind alleys and therefore, by its very nature, violates the rules of productive efficiency.

Let me conclude this sober part of my reflections with just two conjectures. The first is that when that 1951 textbook author wrote of the “stiffening of competition,” he obviously had in mind the neoclassical concept of short-run price competition. Whether this is still a useful concept in today’s world, or whether — as Joseph Schumpeter first argued — other, dynamic criteria should be applied in judging the competitiveness of industries, is an issue economists can discuss with greater levity than antitrust lawyers. This point was driven home to me by yesterday’s discussion of the effect of FTC rulings and court decisions on innovation.

The second conjecture comes directly to the point of my topic. Given our current understanding, the best policy for improving the context for innovation may well be to “let a thousand flowers bloom.” My own research has convinced me that the real strength of the Canadian
and U.S. "innovation systems" (a contradiction in terms) lies in their diversity. This heterogeneity is rooted as much in the mix of small, medium, and large firms as it is in the absence of any monolithic "visions" and "concepts" for the propagation of technological advances. Having worked on this policy problem in the European context, I am persuaded of the superiority of our self-organizing system — in other words, of an apparent chaos that would offend every central planner's and policymaker's sensibilities.

Having conveniently shrugged off responsibility for offering comprehensive advice on how to improve the context for innovation, I want to focus my attention on two specific matters in which I have been interested for some time. The first deals with the effects of standardization on the climate for technological advance, and the second has to do with the rationale for active government intervention in a nation's technological enterprise.

I. **THE PROBLEM OF STANDARDIZATION**

In 1994, the International Standards Organization promulgated specification ISO-9241-3, which was adopted by the European Union as a mandatory standard. It specifies that by the end of 1996, all personal computer screens must have a diagonal measure of at least fifteen inches. In addition to a number of other requirements, they must also be adjustable so as to assure a minimum distance of sixty centimeters from the operator's eyes, they must have a minimum repeat rate of seventy Hertz, and they must be manually adaptable in brightness and contrast to the ambiance of the room in which they are being used. Monitors certified to the additional standards TCO and MPR-II (I have no idea what they are) will be given preference in the purchase decisions of public agencies.  

Last fall, the following news item came across one of the Internet channels; I quote: "The International Standards Organization (ISO) and the International Electrotechnical Commission (IEC) designated October 14 as World Standards Day, to recognize those volunteers who have worked so hard to define international standards. . . . The United States celebrated World Standards Day on October 11; Finland celebrated it on October 13; and Italy celebrated it on October 18."  

These two stories exemplify the two types of standardization which affect the context for innovation. One is the standardization of technology and the other is the standardization of institutions — the ways in which societies collectively attempt to deal with the implications of technological change. From the economist's point of view, the two are likely to have quite different implications and consequences.  

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Let me refer briefly to the second type, because lawyers know more about it than I do. In economic terms, the benefits of a global standardization of institutions appear far to outweigh their potential costs. If countries cannot agree on when to celebrate World Standards Day, the results are bound to be quite harmless. But, if they cannot agree on such things as the operational meaning of secure intellectual property rights, on the rules for settling technological conflicts between firms in different countries, and on the technical implementation of such goals as the protection of the environment or the assurance of worker safety, the resulting divergences will add to the uncertainty that inhibits innovation. They will also motivate the kinds of behavior which economists call "rent-seeking" — the promulgation of national rules that favor domestic producer interests at the expense of domestic consumers and foreign competitors.

Despite occasional frictions, one of the great achievements of NAFTA is that it created institutional standards assuring reasonably free play for entrepreneurship and innovation in one of the world's largest markets. In this respect, at least, NAFTA surpasses many of the European Union's much-heralded institutions, which often produce not so much a unification of rules as the imposition of union-wide institutional standards as complements to, rather than substitutes for, national rules. The political phantom of monetary unification stands as a prime example. Closer to our interests, for example, is the provision that European patents do not supersede national patents, but that the latter, granted under national laws, continue in force alongside the former. Detailed provisions to the contrary not withstanding, this gap in institutional standardization has created all sorts of opportunities for protectionist restrictions on entry.4

On the criteria of economic efficiency, the arguments for the greatest feasible institutional standardization are altogether persuasive. To the extent that the inherent risks of innovating can be attenuated by a secure legal and regulatory context, the probability that firms will commit resources to the development and introduction of new processes and products is bound to be increased.

For a number of reasons, the role of technical standards in promoting innovation is more ambiguous. Part of the debate, at least among economists, is about the proper balance between standards promulgated by governments, those agreed upon by voluntary associations, and those resulting from mere custom. Another issue once again concerns the extent to which governmental standard-setting can be used as a protectionist or anti-competitive weapon. The discourse about these issues has been carried on mainly in terms of received competition theory.

Here I want to make some observations about another problem that students of technological change have recognized as crucially important. It has to do with the effect of the timing of standard setting on the innovation process over a technology's life cycle. This is a typical problem of dynamic efficiency, about which conventional economic theory has much less to say than about the rules for static efficiency, that is, the optimal allocation of resources under given conditions.

Some guidance to the analysis of the timing problem can be derived from a fast-growing new body of ideas about the workings of an economy that have been lumped together as evolutionary theories. Drawing on biological analogies, though not as crudely as I am suggesting here, this school of thought sees innovations as due to a process of selection that has little, if anything, to do with optimality criteria of static theory. In fact, evolutionary theorists would argue that the emergence of a successful basic innovation tends to be the result of "initial conditions," perhaps even fortuitous accidents, which then lead to what is called the "path dependence" or "trajectory" of further developments.

Professor Paul David, of Stanford, has highlighted the problem with his now classic study of the typewriter keyboard. The arrangement of the keys made good sense in the days of mechanical typewriters, but it is very inefficient for all modern writing machines. Nevertheless, once the layout had set off on its trajectory, all further advances in technology — including the computer on which I wrote these notes — have been based on the same basic standard. Ergonomically, it is far from optimal, but to potential innovators the costs of changing it appear prohibitive. The remarkable thing about such standards as the QWERTY keyboard, the arrangement of pedals in automobiles, and many others, is that they evolved through a process of informal self-organization, that is, without specific decisions by any central agency.

When we turn to the deliberate setting of standards, it is useful to recognize two overlapping phases, early in the life cycle of technologies, characterized, respectively, by technical uncertainty and economic uncertainty.

Reducing technical uncertainty involves both solving generic problems and learning which of several functionally equivalent ideas has the greatest potential. The current state of the biotechnology industry illustrates this condition. In the United States, well over 1,000 firms are searching for new products, and they continue to do so even though

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it is estimated that over half their R&D output will end up in the waste bin, together with the stock certificates of many investors.\textsuperscript{7} This kind of turbulence is often attributed to the unique character of modern "high technology," but history teaches us otherwise. Thus, for example, in 1910 more than 200 firms offered automobiles of one kind or another in the U.S. market, and the year 1914 alone saw the entry of 121 new makes and the exit of 126 others.\textsuperscript{8} Eventually, of course, certain species of basic technology prove themselves superior, and something like a "standard version" of technology emerges. Most students of the matter would agree that the imposition of technical standards during this phase will tend prematurely to fix the trajectory of further evolution, thus eliminating the incentive for further experimentation with alternative solutions.

\textit{Technical uncertainty} has to do with both the costs of investing in and producing technically feasible versions of innovations and the potential demand for them. At this stage, the emergence of standardized technical features reduces uncertainty and therefore creates opportunities for realizing internal and external \textit{economies of scale}; at the same time, it provides more consistent information to markets and thus stimulates demand. To give a current example: without some basic standards for a recent innovation, erasable compact discs, all of the competing producers would face a prolonged, expensive, and highly uncertain marketing battle.

Although the sources of standardization would seem to matter little in terms of their ability to reduce uncertainty, government-mandated standards do give rise to two sets of problems. The first falls under the heading of \textit{informational asymmetries}: if, as is generally the case, government agencies know less about a technology than the members of the affected industry, the promulgated standards may inhibit realization of that technology's full potentials. Under these conditions, even reliance on outside consultants is likely to produce a sort of adversary proceeding among experts, offering no more than a second- or third-best solution. Another set of problems, from the affected industry's perspective, arises from \textit{unpredictable changes in mandated standards}, which create a different source of uncertainty for innovators. The story of nuclear power development in the United States offers an outstanding illustration, but it is too convoluted to be told fairly in a short time.\textsuperscript{9}

Without the guidance of any sort of theory about the "optimal timing" of standardization, we are obviously confronted with a di-

\textsuperscript{7} British Biotechnology: Bugged if I Know, \textit{The Economist}, Mar. 18, 1995, at 70.
\textsuperscript{9} See \textit{William Spangar Pierce, The Economics of the Energy Industries} Ch. 12 (1986).
lemma. Decisionmakers dislike uncertainty, and so the early introduction of standards for an evolving technology will tend to hasten its commercial development. But standards agreed upon or mandated "too early" are bound to close off certain directions of development or to make their pursuit seem prohibitively expensive. And even twenty-twenty hindsight would not help to resolve the dilemma, because most of the time we do not know what different pool of technical ideas might have been tapped under different conditions.

The only conclusion we can draw from history is that, in contrast to the famous "invisible hand" that guides competitive markets, the hand that guides the selection of technologies generally is very visible. And the only policy recommendation one can derive from this is that the hand ought to be kept as light as possible — so as not to foreclose experimentation altogether. Even if we remain agnostic with respect to the claim that open competition will produce "optimality," however defined, in the selection of technologies, we ought to accept the fact that decentralized decisions are like to result in solutions that are superior to centralized ones — if only because they will reduce the potential for the centralization of mistakes.

II. THE PROBLEM OF KNOWLEDGE MERCANTILISM

The main objective of mercantilist trade policy was for a country to amass as much wealth as possible — the form of a hoard of precious metals. As its name implies, mercantilism was based on the assumption that what was a measure of wealth for an individual merchant also constituted wealth for an entire nation. Therefore, it saw international trade as a zero-sum game in which one country's gains are matched, ipso facto, by another country's losses. Although the classical economists and thousands of their followers have thoroughly demolished this theory, it has seen several revivals — most recently in the concepts underlying industrial policy and strategic trade policy.

As many academic economists have pointed out, there is a lot wrong with this kind of policy — not only because it violates the well-established tenets of trade theory but also because, despite its seeming hard-headedness, it is unlikely to achieve its goals. What matters for my purposes is how strategic trade policy affects the context for innovation. Underlying the technology-oriented portion of strategic trade policy is the mercantilist fallacy of composition: because individual firms

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10 To the best of my knowledge, this term was coined by David C. Mowery & Nathan Rosenberg, New Developments in U.S. Technology Policy: Implications for Competitiveness and International Trade Policy, 32 CAL. MGMT. REV. 107, 107-24 (1989).

11 The best summary of these criticisms, free of jargon and mathematical models, can be found in Paul R. Krugman, Peddling Prosperity: Economic Sense and Nonsense in an Age of Diminished Expectations Ch. 10 (1994).
succeed in competition by possessing technical and other knowledge that differentiates them from their rivals, it is assumed that entire nations can somehow enhance their "global competitiveness" by amassing a hoard of knowledge and guarding it against leakages to the rest of the world. Two approaches are derived from this assumption.

The first involves aggressive governmental support of a select group of domestic firms' international competitive positions. There has been much debate about the criteria by which these firms should be picked. However this is to be done, support of R&D and investment in some industries helps them to bid away factors of production (labor and capital) from all others. Therefore, possible productivity advances in the chosen (export) sectors are likely to be offset by the retardation of innovation and productivity growth in others. Yet, if we want to stimulate economy-wide improvements in productivity, we should not be looking just at R&D investment in export-oriented technologies, or even in manufacturing as a whole. The largest sector of our and most other industrial economies is, in fact, the service sector. With some notable exceptions, services do not enter into foreign trade, and yet innovations in services and other non-traded goods probably contribute more to the enhancement of an advanced economy's overall productivity than do the export-oriented industries.

Targeted support may be harmful to innovation for another reason. Quite naturally, such largesse goes mostly to large corporations in concentrated industries, with an established track record in export markets. Most of them are multinational firms, with substantial direct investments abroad. Yet, we know that some of the strongest innovative impulses come from thousands of small and medium-sized domestic firms that are unlikely to benefit from such policies. Not too surprisingly, their owners are more concerned with removing regulatory obstacles to innovation than with receiving active assistance. I know of no comprehensive data for the United States, but in a Canadian survey of over 2,000 small and medium firms, more than twenty-five percent of them in manufacturing, the respondents ranked government assistance last in importance among the factors responsible for their development of new technology. The majority of them considered flexible management as the most important internal source of innovation, and good customers as the most important external source.12

The second approach rests on the belief that government-supported, cooperative R&D should be aimed at producing "generic technologies," which can form the foundations for commercial development by the members of consortia. Furthermore, this knowledge can be

12 C.D. Le, INDUSTRIAL INNOVATION DIRECTORATE, INDUSTRY AND SCIENCE POLICY SECTOR, INDUSTRY CANADA, STRATEGY FOR GROWTH: A STUDY OF GROWING SMALL AND MEDIUM FIRMS IN CANADA (Aug. 4, 1994).
made into a *national competitive asset*, analogous to the proprietary knowledge assets of a firm. Experience shows that such nationalistic and protectionist programs are unlikely to achieve their objectives. Some programs, like the Carter Administration's Cooperative Automotive Research Program, never got off the ground. Other programs, like the British Alvey Program for the development of generic computer technology, produced no commercially useful results at all. Yet other programs, such as the European Union's far-flung ESPRIT program, the United States' Sematech consortium, and the Superconductivity Competitiveness Initiative, have a very mixed record of benefits and costs.

The significant point is that these programs included provisions directly or indirectly aimed at prohibiting or restricting foreign access to R&D results. Like most governmental efforts to constrain the international diffusion of scientific and technical knowledge, these provisions turned out to be ineffective. Thus, for example, a majority of the corporations participating in Sematech simultaneously have been engaged in R&D production joint ventures with Japanese firms. Only on the absurd assumption that these firms somehow are able and willing to segregate knowledge gained "in the national interest" from knowledge gained by cooperating with foreign competitors, could one conclude that knowledge mercantilism is a workable policy.

These observations force me to conclude with a well-rehearsed commonplace. The often-exaggerated claims of business leaders, journalists, and politicians about the revolutionary "globalization" of economic affairs largely do apply to the context for innovation. No nation can isolate itself from the consequences of institutional and technological developments that have greatly facilitated the international transfer of technology.

In this setting, governmental policies aimed at the promotion of particular technologies or industries are likely to be quite ineffective as mechanisms for advancing competitiveness. On the other hand, policies that enhance an economy's aggregate productivity, such as improvements in education and training or the stimulation of investment in new technologies, would in the long run prove much more beneficial. But highly visible, targeted measures cater to well-organized interests as well as to public sentiment, while the long run lies well beyond the horizon of the next election.

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13 The failure of Alvey is documented in a very self-effacing memoir, by its former director. **Brian Oakley, Alvey, Britain's Computer Initiative** (1990).

14 See discussion *supra* note 10.