WHAT MAKES AN ECONOMY PRODUCTIVE AND PROGRESSIVE? WHAT ARE THE NEEDED INSTITUTIONS?

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ABSTRACT

Institutions again have become the focus of the theorizing and empirical work of economists concerned with the determinants of economic growth, and of cross country differences in income levels. One central argument f this paper is that institutions and institutional change need to be understood as tightly intertwined with the technologies used in an economy, and with technological change. A second argument is that, in general, societies have very limited ability to design institutions that are effective, and that the processes of institutional reform work erratically.

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I. Introduction

Today these questions are among the most challenging facing professional economists, and also are at the heart of political and ideological controversy. They come up in several different contexts. The central challenge of development economics clearly is to illuminate the causal differences between the countries that were desperately poor in the 1950s, but which have since that time achieved quite productive and progressive economies, and those that have progressed hardly at all. Many of the economies that used to be organized under a communist mode, but abandoned that system largely because of poor economic performance, still are floundering, and searching for whatever it is that lends productivity and progressiveness to at least some capitalist economies. After a period of very rapid growth, in which the productivity and income gaps with the United States were largely closed, the economies of Western Europe and Japan recently have been progressing much more haltingly. Various proposals regarding the reasons, and the reforms that might work, are the subject of hot political debates in these countries. In the United States, after the doldrums of the 1970s and 1980s, the growth surge of the late 1990s rekindled an earlier strong self-confidence that Americans knew the secret of economic progress. However, the last several years have renewed some doubts about that matter.

The current vogue, both among professional economists, and in the public argument, is to see "the right institutions" as the basic answer to the first question. This contemporary focus on

institutions comes as the result of a long intellectual journey through which modern economists, interested in understanding the sources of productivity differences across nations, and the processes of economic growth, gradually have broadened and deepened their analysis. (See Nelson, 1998, and Abramovitz, 1989, for details on this intellectual history).

Thus in the early years after World War II, the gap between high income, high productivity, economies, and poor ones, was seen as largely the consequence of differences in the stocks of physical and human capital, and investment seen as the key to advancing economic performance. There were obvious differences between advanced and less developed countries in terms of their command over modern technologies, but the problem of "technology transfer" was seen as not particularly difficult, if the needed investments were made. However, it soon became clear that command over technologies was not that easy to achieve, and involved much more than simply investments in physical and human capital. Thus while the communist block countries were marked by high rates of investment in both physical and human capital, by the late 1970s it was clear that productivity in most of their industries was low, and that they lacked abilities to produce high quality products. Attention began to focus on the features of national economies that seemed to underlie technological capabilities, particularly the incentives and competences of the organizations responsible for production. With the rapid rise of Japan as an economic and technological power, economists and other scholars began to look more closely at differences across countries in the way that business organizations were structured and managed, and at the financial and labor market systems supporting them, and these variables came to be added to the list of factors viewed as influencing economic productivity and progressiveness. As Japan stumbled in the early 1990s, and as biotech and IT firms boomed in the United States, the

attention of economists shifted from large stable firms, to start-ups and connections between firms and universities, from patient finance to venture capital, and from employment regimes that involved long run mutual commitments, to more fluid labor market arrangements. During this same period, an extensive literature grew up focused on “National Innovation Systems” (see eg Nelson, 1993), which further broadened the focus, with firms viewed as being imbedded in and supported by a variety of non-market organizations and programs, for example universities funded by government to undertake research and training in fields relevant to an industry..

Each of these developments shows economists trying to broaden or deepen their analysis of the factors influencing economic productivity and progressiveness, by looking into matters of economic organization and other forces shaping the capabilities and behavior of economic actors. During the 1980s and 1990s many economists began to generalize this quest for more basic understanding, and “institutions” came to be used as the term to characterize the fundamental factors shaping economic productivity, and progressiveness. North ,1990, was perhaps the most forceful contemporary spokesman for the new interest in institutions, but there were many others.

In a very real sense, the renewed interest of economists in institutions is a coming home to old traditions. Economic institutions, or entities that modern economists might call that, were a central interest of Adam Smith, and the classical tradition that followed him. Indeed, it was only in the second half of the twentieth century that the main line of economics began to take a position that the science of economics ought to be as “institutions free” as possible, or at least to focus on general market systems without getting tangled up in particular institutional details. It is

good that we now are again talking seriously about institutions. But it is less clear we really understand what we are talking about.

Getting at the second question, "What are the needed institutions?", is a tough task. It is important to recognize that the analytic problem of even making sense of institutions involves a somewhat different kind of theorizing than that contained in standard growth theory. Many years ago Moses Abramovitz (1952) called attention to the difference between what he called the "immediate" sources of growth, and causation at a deeper level. Using his language, the advance of physical and human capital, and total factor productivity, more generally the variables in a growth accounting, are "immediate" sources of economic growth. The deeper question is what lies behind these variables. It is clear that "institutions" presently is the name many economists give to these deeper causes.

The position I want to argue in this essay is that the current consensus that "institutions" are the key is a bit like the recognition, half a century ago, that "growth of total factor productivity" was the principal "immediate" source of economic growth. At that time, while some economists interpreted this variable as a measure of technological advance, it semed likely to other economists that a number of factors were involved. Abramovitz (1956) called it "a measure of our ignorance." In any case, it was clear that the variables that economists felt they understood pretty well that were included in neoclassical growth theory simply were not up to the task of explaining most of growth, or differences across nations in productivity levels. Calling the residual "growth of total factor productivity" gave it a name. But it has taken many years and much research for economists to get a decent grip on technological advance and other

significant components of total factor productivity. And the factors behind the "immediate" sources of growth still are not well understood.

Indeed, this is an important part of the reason for the current focus on institutions. But we have not made much headway yet on making the term a useful analytical concept.

There are three kinds of questions about "institutions", and their roles in determining economic productivity and progressiveness, that in my view are wide open.

There is, first of all, the question: what are institutions? These days many scholars of institutions propose that institutions should be understood as "the basic rules of the game", the broad legal regime and the way it is enforced, widely held norms that constrain behavior, etc (North, 1990). But other scholars associate institutions with particular governing structures molding aspects of economic activity, like a nation's financial "institutions", or the way firms tend to be organized and managed (see eg Williamson, 1975, 1985). While this conception is not radically inconsistent with the notion that institutions are the rules of the game, it is not quite the same. Still other social scientists associate the term institutions with customs, standard and expected patterns of behavior in particular contexts, like the acceptance of money in exchange for goods and services. (Veblen, 1999 and later, is the canonical reference here. Among contemporary economists, Hodgson, 1988, 2006, is the strongest advocate for a Veblenian perspective). The conception here is with the ways things are done, rather than broad rules or governing structures that constrain behavior; although these things are connected, they are somewhat different. Also, while many authors use the term "institution" to refer to somewhat abstract variables, like the consistency and justice of the rule of law in a society, or the general

use of money in exchange, other scholars associate the term with particular concrete entities, as the Supreme Court of the United States, or the Federal Reserve System.

This is a very heterogeneous bag of things that are being called institutions. It is apparent, it seems to me, that presently many economist are using the term "institutions" largely as a "place holder", just as we used "total factor productivity" as a place holder some years ago. And just as in the earlier case progress in understanding required the explicit recognition of several different variables and processes, my bet is that the same will be required before we get a useful grip on the "institutions" bestiary.

Then there are, second, questions about the relationships between institutions and economic productivity and progressiveness. In much of the contemporary writings by economists, it is almost taken for granted that modern economies need to be largely structured through markets, and that good institutions support the effective operation of such an economy.

But it is not clear that economists presently have a good conception of what "effective operation" of a "market" economy involves, particularly if the performance we are trying to understand involves economic growth, which virtually all scholars recognize as being largely driven by innovation. As Schumpeter (1934, 1942) argued long ago, the standard neoclassical theory of market organization and behavior is not capable of dealing with the phenomena of innovation. It also is clear that, once one pays attention to the activities that support innovation, a number of non-market organizations (like universities, and Government R and D support programs) are involved, as well as market organizations. There is the task, therefore, of developing a theory of innovation driven economic growth, and the activities involved, that

recognizes the key roles played by non-market structures as well as those conventionally seen as market ones. .

And finally, there is the question about how institutional change comes about, and how the society that would benefit from a different set of institutions can manage to put these in place. There are a variety of different theories of institutional change, some proposing that institutions "evolve" in some sense, and some proposing that institutions are consciously chosen in some way. But in any case, it is clear that, even if we knew just what kind of institutions were needed to enhance economic productivity and progressiveness, building and sustaining those institutions is a real challenge.

These big questions will be the topics explored in the following three sections of this paper. My argument in Section II is that the conglomerate of things different economists have called institutions largely reflects the fact that many different kinds of structures and forces mold the way individuals and organizations interact to get things done, what Sampat and I (Nelson and Sampat, 2001) have called "social technologies". Some institutions and the social technologies they support have broad and pervasive influence, others are sector or activity specific. From this point of view, it is a mistake to search for a small set of institutions that are necessary and sufficient for economic productivity and progress. Many different institutions are needed, and the institutions that are effective are very context dependent.

Section III develops the argument that economic growth involves the co-evolution of technologies and the institutions needed for their effective operation and advancement. Some institutions provide the broad background conditions under which technological can proceed, and others come into existence and develop to support the important new technologies that are

driving growth. Section IV is concerned with the processes of institutional change. A principal argument is that institutional change, and its influence on economic activity, is much more difficult to direct and control than technological change, and hence prevailing institutions often are drags on economic productivity and progressiveness.

In Section V, I consider the evolution of technology and institutions in pharmaceutical biotech, a case that illustrates nicely in concrete form many of the general arguments I have developed. I conclude with a summing up and a looking forward.

II. Unpacking the Concept of Institutions

Above I remarked on the wide variety of meanings that different economists, and other social scientists, have given to the term "institutions", from the rules of the game that influence behavior, to governing structures that make or enforce rules, to customary behavior patterns themselves. Writers on institutions also differ in the extent to which they use the term to refer to broad, somewhat abstract things, like legal and moral protection of private property rights, or more concrete things, like the details of patent law in a country. Some writers on institutions see these as variables whose influence on economic activity is pervasive. Others use the term to refer to things that are specific to particular economic sectors; thus the publicaly financed agricultural experimentation station system has been identified as a key institution behind the high productivity of American agriculture (see eg Ruttan and Hayami, 1984).

Certainly we have a wide range of "things" here. This diversity of meanings, and analytic foci, makes coherent discussion about the nature and role of institutions difficult. Indeed, it can lead to some rather bizarre arguments.

Thus in 2004, two articles on institutions and economic development were published in the Journal of Economic Growth, one by Rodrik, Subramamian, and Trebbi, and the other by Glaeser, Porta, Lopez-de-Silames, and Shleifer. The first of these articles proposed that differences in the "quality of institutions" is the primary variable behind the very significant differences in gross domestic product per worker that one finds in the modern world. The authors take a broad macro view of what institutions are, tying these to the clarity and strength of property rights and the rule of law. The "measures" of the quality of institutions used in their cross-country regression purport to give indicators of this. In contrast, the second paper proposes that it is investment in human capital, rather than "institutions," that is the principal explanation behind cross-country differences in per capital income, and the extent to which economies, initially far behind the frontier, have closed the gap over the last forty years. The authors propose that while government policies had a lot to do with investments made in human capital, the policies were relatively independent of a nation's basic institutions, which they defined in terms of whether the political regimes were democratic or autocratic.

There are several striking things about this argument. First, both sets of authors see institutions as broad structures with pervasive impacts on economic activity. Their perspective is that of macroeconomics. But on the other hand, while Rodrik and colleagues focus on property rights and the rule of law, Glaeser and colleagues take a view that the term institutions refers to the form of government. It would seem that the authors of the articles in question are talking past each other.

The recent book Imperfect Institutions, written by Thrainn Eggertsson (2005) stands in sharp contrast to both of these macro oriented analyses. Eggertsson is interested in the same

broad question as the authors of the two articles cited above: the determinants of economic development. He also is focused on "institutions" as the key variable. In his general discussion of what institutions are and how they mold economic behavior Eggertson considers both rules and norms, and political processes and machinery, an eclectic position I too will espouse. However, and here too my position is similar to his, Eggertsson clearly believes that, to be useful, analysis of how institutions affect economic growth and productivity needs to get into the details of how institutions affect behavior. He develops this part of his analysis largely in analysis of how "institutions" affected the development of the fishing industry in Iceland, in the earlier era strongly constraining it, and then later changing to encourage and support it. A reader cannot help but come away from reading Eggertsson's fascinating analysis with an understanding that broad definitions of what institutions are and general statements about what they do cannot carry us very far.

If the research by individual economists and other social scientists on the nature and role of institutions in long run economic development is to go forward in a way that is coherent and cumulative, there clearly needs to be more shared agreement regarding just what the term "institutions" is presumed to mean, and how they affect economic activity. The position I want to espouse here is that the most useful conception of what institutions are would encompass a wide range of somewhat different things, but with different ones relevant in different analytical contexts. The unity and focus of the research program would be provided by agreement on what institutions broadly do.

Bhaven Sampat and I have proposed (Nelson and Sampat, 2001) that, despite the diversity in the literature regarding how institutions are defined, a large share of the writing is

intended to illuminate the factors molding the goal oriented behaviors of economic agents in contexts where the actions of several parties determine what is achieved. The authors generally take the position that the simple lean theory contained in standard microeconomics of the forces determining modes of transacting, economic interacting more generally, leaves out important constraints, pressures, and mechanisms, and introduce the concept of "institutions" to fill in the gaps they see, or in some cases to provide a quite different theory of the determinants of behavior. The objective of virtually all of the authors is to use the concept of institutions to provide a better explanation of why models of interactive behavior of economic agents differs across countries and over time in ways that profoundly affect the effectiveness of economic activity. The different concepts of institutions that one finds in the literature partly reflects the particular economic phenomena the authors are focusing on, including whether the phenomena are broad and pervasive or more specific to particular sectors and activities, partly the particular "institution" they are analyzing, and partly where they choose to apply the "institutions" term in the chain of logic they are proposing.

Sampat and I proposed that the concept of a "social technology" was a useful one for making more coherent the writings about institutions. Our social technologies concept involved a broadening of the way economists think about an economic "activity".

In its standard use in economics, an activity is thought of as a way of producing something, or more generally doing something useful; Sampat and I take a broad view of what the term encompasses. Undertaking an activity or a set of them – producing a radio, growing rice, performing a surgery, baking a cake, procuring a needed item, starting a new business – involves a set of actions or procedures that need to be done, for example as specified in a recipe

for the preparation of a cake. These steps or procedures may require particular inputs (like flour and sugar for the cake, cash or a credit card to procure the ingredients for the cake), and perhaps some equipment (something to stir, a stove, a vehicle to go to the store). Economists are prone to use the term “technology” to denote the procedures that need to be done to get the desired result.

However, a recipe characterization of what needs to be done represses the fact that many economic activities involve multiple actors, and require some kind of a coordinating mechanism to assure that the various aspects of the recipe are performed in the relationships to each other needed to make the recipe work. The standard notion of a recipe is mute about how this is done. Sampat and I proposed that it might be useful to call the recipe aspect of an activity its “physical” technology, and the way work is divided and coordinated its “social” technology.

From this perspective, virtually all economic activities involve the use of both physical technologies and social technologies. The productivity or effectiveness of an activity is determined by both aspects.

The social technologies concept does not include all of the kinds of behavior that at least some of the writings on institutions appear to want to encompass, but I propose that it does include a large part of the spectrum most relevant to analysis of economic productivity and progressiveness. The “technology” part of the term denotes behaviors that are intended to get something accomplished; the “social” part denotes that those behaviors involve or are responsive to the actions or expected actions of multiple agents.

I would include under the social technologies umbrella both behaviors associated with getting things done within an organization, and actions to get things done involving two or more separate individuals or organizations. Behaviors associated with market activity – for example

individuals or individual organizations acting to achieve their ends through buying from or selling to sometimes anonymous others – would be included. A practice of only transacting with people you know well because only they can be trusted, or of not doing any transacting involving money on holy days because of the force of public opinion, would under my proposed umbrella concept be considered as an aspect of the social technologies employed in a society. More generally, the social technologies concept is meant to encompass those aspects of goal oriented ways of doing things, where the behavior of agents is tailored to or intended to influence the expected actions or reactions of other agents.

From this point of view, the social technologies that are employed in an economy are enabled and constrained by things like laws, norms, expectations, governing structures and mechanisms, customary modes of transacting and interacting. All of these tend to support and standardize certain social technologies, and make others difficult or infeasible in a society. Sampat and I suggested that, where these exist, standardized social technologies, the prevalent modes of interacting for getting done particular things in a society, are what much of the writings on institutions is about.

As I have noted, some economists use the term institutions to refer to what they regard as the major influences shaping such social technologies, while others use the term to refer to prevalent social technologies themselves. While the linguistic distinction is clear, and one might think that in practice there ought to be clean lines between these two conceptions of what institutions are, in practice the two conceptions sometimes shade into each other. Some ways of doing things have the support and coercion of strong custom. A good example is the use of money for procuring various kinds of things, which would seem to be at once a social technology

when viewed as a goal oriented behavior, and an institution when viewed as a custom. At the same time, behind the social technology and custom of using money to acquire things lie a body of law, and a structure of financial institutions, that in many societies make this practice not only possible but easy and safe to employ. In turn, these institutions are supported by prevalent beliefs and norms in a society regarding the appropriateness of market transactions, the importance of honesty, and the like.

More generally, I want to argue that the institutions molding and supporting social technologies come in layers or concentric circles. Some are tied so closely to the practices in question that one cannot be considered without the other. Others are more removed. An important difference between economists who consider institutions as macro-economic factors, and those who study behavior at a more detailed level, is that the former generally do not see the institutions that are "close in", as it were, to particular ways of doing things, while the latter often do.

It is not surprising, therefore, that economists who take a macroeconomic approach tend to think of institutions as factors that influence the social technologies that are operative in a society, but do not strictly determine them. Societies clearly have a degree of control over institutions like the formal structure of laws, and formal organizational designs and designated authority relationships. However, these kinds of institutions may determine only relatively broadly the social technologies that actually are employed. There remains considerable room for variation in the prevalent habits of action and thought that scholars like Veblen defined as institutions. And it is these patterns of actual behavior, the social technologies that are prevalent, that directly influence economic performance.

I propose that explicit recognition of the concept of a social technology, together with understanding that a variety of different factors influence which social technologies customarily are employed in a particular context, helps to illuminate why the term "institution" has been used to cover so many apparently disparate things. My proposed approach is to focus on the prevalent social technologies and be eclectic and inclusive about the "institutions" that support them. As I have suggested, and will show in the examples developed in the following sections, there generally will be a number of different "institutions" that support and constrain particular social technologies, and they operate in different ways. Some institutions have a broad and somewhat diffuse affect on the social technologies that are used or not used. Thus the influence of "respect for the rule of law" is largely atmospheric, affecting broadly a wide range of economic activities and the social technologies used in them. Other institutions are more specific to the particular social technologies under study. Thus each of the cases considered later involves particular governing structures and particular laws. Some institutions provide the background context within which the particular social technologies under study evolve. Others change as an essential part of the evolutionary process.

My proposed eclectic approach is somewhat at tension with the gravitation in recent years of economists writing about institutions to go along with the "rules of the game" definition, broadly defined. I find the rules of the game notion about what institutions are attractive in that it avoids suggesting that institutions determine behaviors strictly. However, I resist that pull because the range of particular "things" that reasonably are called institutions under my proposed definition contains many that can be characterized only very partially in terms of a set of rules, for example the form of government, or the operative financial system, or (to give some

examples I will discuss in detail in the following section) the modern corporate organizational form, or the industrial research laboratory. Of course if one adopts a broad enough definition of what can be considered a "rule", as Hodgson (2006) does in a recent article, I have no trouble with the notion that all institutions define rules. But I question then whether this language usage is particularly helpful.

I have similar remarks on the apparent broad acceptance of the notion that institutions, as the rules of the game, form constraints on behavior. In many cases new institutions would seem to open up productive new ways of doing things. While the pathways they make possible are usually limited in some respects, to see the new institutions only as constraints takes attention away from the fact that they support the use of new social technologies. Thus the emergence of the modern corporate form, and the industrial research laboratory, permitted things to be done productively that were impossible or badly hindered under the older set of institutions.

Some writers want to make a clean distinction between institutions and organizations. However, under the conception I propose, broadly accepted organizing principles, to use a term employed by Bruce Kogut (1993, 2000, Kogut and Zander 1992) would definitely be considered a part of the institutional environment, even if particular extant organizations embodying those principles might not (but then what about the Bank of England?). I note that Kogut makes a distinction between organizing principles which, in my language, may be close in to particular social technologies, and institutions that influence what organizational principles are accepted as legitimate within a society, and which are not. This is quite consistent with my proposition that institutions come in layers.

Some institutions, for examples laws bearing on particular activities are, in a sense, external to social technologies, and mold them. However, social technologies also can be self-institutionalized, if I may use that term. This is an important reason why the lines often are blurred between a prevalent practice and the "institutional" supports for that practice.

Social technologies can be self institutionalized in several ways. First, customary behaviors, modes of interacting, organizing, tend to be self reinforcing because they are expected, and familiar, and doing something different may require going against the grain. Second, social technologies tend to exist in systems, with one tuned to another, and self supporting. This may make going against the grain in one social technology especially difficult, because it involves losing touch with complementary social technologies. Third, social technologies, like physical technologies, tend to progress over time, as experience is accumulated, and shared deliberately or inadvertently. Trying a new social technology, like pioneering a new physical technology, is risky, and involves abandoning the fruits of what may be considerable prior experience. I note that these forces of self institutionalization are important reasons why a society's ability to control the social technologies in use through conscious designing of institutions may be limited.

Institutions clearly have a certain stability. Yet economic growth, as we have experienced it, clearly has seen old social technologies fade away, sometimes abruptly sometimes slowly, and replaced by new ones. It is time to explore more deeply the role of institutions and institutional change in the process of economic growth.

III. Institutions and Economic Growth

Before getting into the roles of institutions and institutional change in economic growth, I need to characterize the economic growth process more broadly. I want to begin by baldly asserting that economic growth must be understood as an evolutionary process driven by innovation. Hardly any contemporary economist would have trouble with the second part of this proposition, about innovation being the key driving force in economic growth. The first part is somewhat more controversial, and many contemporary economic growth models assume something close to a moving general equilibrium. However, as Schumpeter (1934, 1948) argued long ago, one simply cannot comprehend innovation within an analytic framework that assumes that economic actors have a good understanding of the consequences of innovating, or not innovating for that matter, and that the system as a whole is in continuing equilibrium.

Schumpeter's discussion of innovation, of course, took off from his base discussion of a circular flow of economic activity, wherein each economic agent did the customary thing, supported in his or her actions by the customary actions of other economic agents. Schumpeter's discussion of the circular flow was his way of articulating what was going on in a Walrasian general equilibrium, although his stress was on the customary patterns of behavior in such a context, rather than that the actions of each agent were optimal for that agent, given what the others were doing. But in any case, in such a general equilibrium, while economic agents may face some risk in taking the action they deem appropriate in the context, in the sense that they do not know for sure if it will rain or not, there is no Knightian uncertainty regarding what can happen or what is, on average, best to do.

For Schumpeter, such a pattern of activity was exactly what was not going on in an economy where innovation was proceeding at a reasonable clip. Innovators are trying something

new, and the consequences of their actions will depend on how effectively they do something they have not done before, and also on how others react. In such a context, there is no empirically rational basis for assigning probabilities to possible outcomes, much less being able even to conceive all the possibilities. If considerable innovation is going on, the non innovators also face real uncertainty, regarding how they will fare, or even regarding whether their traditional actions will be viable, in the face of the innovation of others. What actually happens will benefit some, and punish others; those who are hurt may need to rethink what they should be doing. Economic growth driven by innovation thus involves essentially the "creative destruction" of older ways of doing things, and, often, of economic agents who were good at those older ways but cannot or are slow to adopt the new. If innovation stops, the pattern of economic activity may settle down into a new general equilibrium. But if innovation is continuing, which it is under virtually all theories of economic growth, the economy in motion is always at least somewhat out of equilibrium.

Innovators, in competition with each other, and with prevailing practice, cannot know ex-ante whether they will be winners or losers, nor can those who choose to stay with prevailing practice. Winners and losers, both ways of doing things, and economic agents, will be determined ex-post by the competition. This is exactly the position of modern evolutionary growth theory (Nelson and Winter, 1982).

The question that obviously needs to be considered next, given the objectives of this paper is "Where are institutions in the above story?".

One can see institutions, if implicitly, in Schumpeter's theory of customary behavior in the circular flow. In his writings Schumpeter highlighted that behaviors in the circular flow were

mutually supporting and constraining. Under the conception of institutions as forces holding patterns of interactive behaviors in place, these expectations, norms, and hazards of deviating from the established pattern of activity, that Schumpeter associated with equilibrium certainly are institutions. And it would not be hard to enrich Schumpeter's analysis to include as shaping factors things like laws, the way the financial system worked, etc. Indeed, much of the current writings about institutions is exactly oriented to identifying the forces molding equilibrium behavior.

I want to propose, however, that Schumpeter draws the distinction between behavior in a static equilibrium and in a dynamic disequilibrium too sharply. Continuing innovation in a field often has its own regularities, and behavior can be tuned to these. Indeed, for progress to be sustained, there probably must be such tuning. Put in the context of this essay, particular institutions often are needed to support the kind of continuing fruitful interaction that sustains innovation in a field and makes it productive.

But while stable institutions may be possible, in some cases even necessary, in a regime where physical technologies are advancing briskly, a look at the historical record shows clearly that institutional change is an integral aspect of the processes of long run economic development. New forms of business organization arise, businesses take on board new activities, and some old forms and activities fade away. New markets get developed, and some old ones disappear. I note that Schumpeter's conception of innovation was broad, including new "social technologies" like the above, as well as technological innovation more narrowly defined. Economic development as we have experienced it also has seen the emergence and development of new non-market

organizations, new professions, new laws. All of this is institutional change, as I have broadly defined the term.

These observations of course lead to the question of just how institutional change is connected with other aspects of the economic development. Several economists, Vernon Ruttan (2001, Ruttan and Hayami, 1984) and Douglass North (1990, 1999) prominent among them, have argued that changes in economic conditions associated with development often make established ways of transacting, interacting, organizing, social technologies in the language I am using, more costly and less advantageous, and call for new social technologies. In turn these often require the development of new institutions. Ruttan in particular has argued for a theory of induced institutional innovation.

Following the lines I have proposed earlier, I want to argue that, while sometimes the coupling is tight and sometimes looser, changed social technologies and changed physical technologies generally go together. Sometimes change in both is induced by changed economic conditions. However, as Schumpeter had argued, in modern economies efforts at innovation have a drive of their own. In any case, the argument I want to develop in the remainder of this section is that innovation driven economic growth needs to be understood as involving the co-evolution of physical and social technologies, and that the dynamics of institutional change should be seen from that point of view.

Of course the notion that physical and social technologies are tied together is an old one in social science. Karl Marx proposed a very tight linkage, with the causal structure running cleanly from physical technologies to the social technologies of production. There is an extensive literature in sociology on how changes in physical technologies affect the organization

and social order of economic activity. Below I briefly describe two historical episodes that nicely illustrate the dynamic connections: the rise of mass production in the United States in the last part of the 19th century, and the development of the first science based industry – synthetic dyestuffs – in Germany during roughly the same period.

Alfred Chandler's work (1962, 1977) is central to my telling of the first story. Under his analysis, the processes that led to mass production in a range of industries were initiated by the development of the telegraph and the railroad, which made it possible for business firms to market their products over a much larger geographical area. At the same time advances were being made in the ability to design and build highly productive machinery. Together, these developments opened the possibility for significant economies of scale and scope.

However, to exploit these opportunities, firms had to be much larger than had been the norm, and large size posed significant problems of both organization and management. The organizational problem was partly solved by the emergence of the modern hierarchically-organized company, and later by the multidivisional form of organization (the M form). But to manage these huge companies required many more high level managers than an owner could garner by canvassing family and friends, which had been the usual practice. The notion of professional management came into being, and shortly after business schools emerged as the institutional mechanism for training professional managers. The financial needs of the giant companies were beyond what could be met through existing financial institutions, and both modern investment banks, and modern stock markets, emerged to meet the needs.

All of these developments raised complicated issues of corporate, labor, and financial, law. Gradually these were worked out. At the same time, the market power of the new large firms and their tendency to collude with each other gave rise to new regulatory law and antitrust.

Peter Murmann (2003) provides the most detailed and analytic account of the rise of the industry producing synthetic dyestuffs. Here the initiating event was a breakthrough in the science of organic chemistry. As a result, persons with advanced training in the theory and techniques of chemistry had a special capability for developing synthetic dyestuffs. In order to take advantage of this new capability, business firms had to develop the concept and structure of the industrial research laboratory, as a place where university-trained scientists could work with their peers in discovering and developing new products. German patent law was tightened up better enabling German firms to protect the new dyestuffs they created. Also, in the new regime involving hired scientists, new law also had to be developed to establish who had patent rights on products coming out of the labs.

And the German university system had to gear itself up to train significant numbers of chemists inclined to work for industry. The various German governments provided significant funding to enable this latter development to happen.

In both of these cases one can see clearly the intertwining of the development of new physical technologies, and the emergence and development of new social technologies. The former required significant investments in new physical capital, and in the case of dyestuffs, human capital. Employment of the new social technologies involved new expectations and norms, new ways of organizing and governing work, in some cases new laws, and new government programs, more generally new institutions. .

Various aspects of the broad institutional environment clearly were necessary for the innovations that drove developments in these two cases to proceed effectively. First of all, the economic and social cultures had to encourage entrepreneurship, and the risk taking that is inevitable when new activities are launched. The relevant "institutions" here probably mostly involved norms, and expectations, although the legal system had to such that potential entrepreneurs could expect to get rich if they succeeded.

Second, in both cases developments involved sharp breaks from the "circular flow" of economic activity, and finance needed to be available to support new firms doing new things. It would appear that in both of these cases, a lot of that early money came from rich individuals. As large scale industry became more common, in both countries investment banks became more prominent, and in the United States the modern stock market began to develop. Again, the supporting institutions involved a mix of norms and expectations, laws providing some security for investors, and appropriate organizational structures. .

And labor market institutions had to be compatible with new firms being able to attract workers with suitable skills. In both of these cases, the development of the new industry saw demand for people with high levels of training, and the emergence of new professions, professional managers in the one case, and industrial chemists in the other. For rapid development of these industries to proceed, the universities in the countries had to be, and were, responsive to these new demands. In the German case, this involved as well a significant increase in government funding of universities.

Many of the institutional changes that were made occurred largely as a result of private actions, but a number required collective action, generally involving government and the

political process. I have just mentioned the increases in public monies that went to support chemistry at German universities. Earlier I mentioned several other areas where old law was modified, or new law created.

Note that institutions enter these stories in two ways. First, as background preconditions that enable the developments to arise in the first place and take the shape they did. Here the relevant institutions tend to be associated with broad economy-wide context conditions, like a legal system that defines and enforces contracts, a financial system capable of funding new enterprises, flexible labor markets, and in the dyestuffs case, a strong university research system. Economists doing macroeconomic analysis tend to focus on institutions like these.

But second, as the case studies show, the dynamics of development often require old institutions to change or new ones to emerge. Here the institutions in our stories are more technology or industry specific, like bodies of law tailored to a technology or industry, or the development of university research and training in particular fields. These are the kinds of institutions that economists analyzing the dynamics of particular sectors or activities tend to focus on.

As I have written up these two case studies, an advance in a physical technology or a science is treated as the initiating cause of a process in which physical and social technologies co-evolve. But if I had started my accounts earlier in time, a developing social technology might have appeared to be the instigator. Thus the great size of the US market that made the installation of railroads and telephone lines so attractive to investors and public officials was the result of the customs built into the expanding American population to move on to new open land, and of the political structure and processes built into the American political system that led to polices that

encouraged and supported such movement. German universities were the site of the development of organic chemistry as a powerful new science as a result of earlier German policies, and a supporting philosophy, which encouraged the rise of the research university, a development that occurred earlier in German than in other countries. It is at least as much the case that the institutional background molds the development of physical technologies, as it is the case that the development of new physical technologies cause institutions to change.

Earlier I noted that many of contemporary writers attempting to describe effective institutions have proposed that economies are productive and progressive when institutions support market mechanisms. In both of the cases sketched above, one can see the central role market organization of economic activity plays in fostering productivity and progressiveness. However, the advantages of market organization, and the disadvantages of trying to plan and control economic development from a central authority, are not those highlighted by the neoclassical theory of market organization and its virtues. It is the fundamental uncertainties involved in innovation, the inability of economic actors to see clearly the best things to be doing, that make the pluralism, the competition, that is associated with market organization of economic activity so important. Competition also often tends to keep prices from getting completely out of line with costs. But as Schumpeter argued long ago, by far the principal benefit that society gets from market organization of economic activity, and competition, is innovation and economic progress.

Also, non-market institutions play key roles in both of these case studies. As I argued earlier, it is a mistake to see the advance of physical technologies as being influenced only by

market institutions and mechanisms. Many important social technologies involve essential non-market elements

My discussion above has focused on particular technologies and industries, rather than the economy as a whole. However, as Schumpeter argued long ago, economic growth cannot be understood adequately as an undifferentiated aggregated phenomenon. Rather, one needs to understand an economy as consisting of many different sectors, each with its own dynamics. Schumpeter also argued that the history of economic growth tends to divide into different eras, and that within any particular era there is a relatively small set of technologies and industries that are driving economic growth. From this point of view, the Chandler and Murmann stories are particularly interesting because mass production undertaken by large hierarchical firms, and industrial R and D tied to firms engaged in production and marketing, are the hallmarks (sometimes combined and sometimes not) of the industries that drove economic growth in the advanced industrial nations during the first two thirds of the 20th century.

Carlotta Perez and Christopher Freeman (1988, and Freeman and Louca, Part II, 2001) have proposed that the key technologies and institutions of different eras generally require different sets of supporting institutions. The countries that are successful are those that have the basis of these institutions already in place when they are needed, or which manage to build the appropriate new institutions quickly and well. The large internal market of the United States clearly provided a very favorable environment for the rise of mass production, but the prevailing institutional environment and the rapid development of new institutions tailored to the needs of mass production certainly also was a force behind U.S. leadership in this area. Murmann and other have argued persuasively that the existing strong university research system in Germany,

and the ability to support its expansion in chemistry, was a principal reason why German industry led the world in dyestuffs, and later in organic chemical products more generally, at least up until World War II.

The argument that rapid economic progress in different eras requires different sets of particular supporting institutions is not to deny the broader point of view, associated with an evolutionary or Schumpeterian view of the general nature of economic progress, that to support innovation and take advantage of its potential fruits the institutions of an economy need to be supportive of entrepreneurship, broadly defined, and enable resources to be shifted from rising economic sectors and firms to declining ones. But it does suggest strongly that those generalizations cannot carry the analysis very far. Rather, analysis of the institutions required for economic productivity and progress must get into the details, which inevitably are going to differ from sector to sector and era to era.

IV. The Processes of Institutional Change

How do a country's institutions come to be what they are? To what extent can salutary institutional reform be subject to deliberate analysis, planning, and implementation?

There is a longstanding divide about these issues in the writings of institutional economists. In the early part of the twentieth century, John R. Commons (1924, 1934) , focusing on the evolution of the law, staked out a position that to a considerable extent the institutions that a society had were the ones it had deliberately put in place, wisely or not. Frederick Hayek's theory (1967, 1973) of why societies had the institutions that they had was different, stressing "private orders" that changed over time through a relatively blind evolutionary process. There is

a similar divide among the "new institutional economists" regarding this matter. Indeed, Douglass North himself has taken both views, starting from a position that institutions were the result of a deliberate, rational choice processes (Davis and North, 1971) , and later moving to a position very similar to Hayek's (North, 1990, 1999): that institutions could not be effectively planned, and that the societies that had good ones should regard themselves as fortunate. Thrainn Eggertsson has followed a similar intellectual traverse.

Partly the difference here relates to the assumed influence and effectiveness of human purpose, intelligence, and forward looking planning, versus more or less random change and ex-post selection. Partly the difference is in regards to whether institutional change is seen as occurring largely through collective, generally governmental, action, or whether the process is seen as being largely decentralized, involving many actors. The position I espouse here is that on both counts the contrast often is drawn too sharply. I want to agree strongly with the economists and other social scientists who argue that institutions evolve rather than being largely planned. However, I also want to argue that beliefs about what is feasible, and what is appropriate, often play a major role in the evolution of institutions. Human purpose, and human beliefs, play an important role both in the generation of the institutional alternatives on which selection works, and in determining what survives and what does not. And in many cases the process involves both decentralized and collective action.

The mix of course depends on the kind of institution one is analyzing. The development of formal law obviously involves deliberate governmental action. Generally there is debate about what the law should be, and some kind of a formal decision process. On the other hand, the evolution of custom generally is highly decentralized and whatever conscious deliberation there

is tends to be myopic. But, it may be a mistake to see the processes here as completely separated. Thus Commons noted explicitly that, particularly in common-law countries, the development of formal bodies of law tended to be strongly influenced by the customs of the land that were broadly deemed appropriate. And Hayek too recognized that formal law often was developed to support custom, while warning of the dangers of putting in place formal law, or public policies more generally, that were not based on the wisdom of custom.

In the cases described earlier, the development of new organizational forms was an important part of the story. While Chandler's account of the emergence and development of the organizational structure of the modern corporation highlights innovation by individual companies, a body of corporate and financial law developed along with, responsive to, and supporting and constraining these private developments. Murmann' account of the development of the modern industrial laboratory involves a mix of private experimentation and decision making, and the formation of laws and public programs responsive to the emergence of industrial research.

While both of these cases show an evolutionary process that is sensitive to changing needs and conditions, I now want to argue that the process of evolution of social technologies and their supporting institutions is erratic, compared with the way physical technologies evolve. The ability to design institutions that work as planned is much more limited than the ability to design new physical technologies. Selection forces, including the ability of the human agents involved to learn from experience what works well and what doesn't, usually are significantly weaker for institutions and social technologies than for physical technologies.. And usually there is much less ability to compare alternative institutions analytically.

One important reason is that physical technologies are more amenable to sharp specification and control, and are easier to replicate and imitate more or less exactly, than are social technologies. The performance of physical technologies, including the nature of the output they produce, tends to be relatively tightly constrained by the physical inputs and processing equipment used in their operation. On the other hand social technologies are much more open to the vagaries of human motivations and understandings regarding what is to be done, which seldom can be controlled tightly. Granovetter, 1985, has argued against the "over institutionalization" of theories of human behavior.

Certainly, the institutions that can be consciously designed tend to mold behaviors only relatively loosely, and themselves often are difficult to specify and control tightly. Thus, it is clear from Chandler's discussion of the multi-divisional form (the M form) of business organization, that arose in the early 20th century and became "standard" among companies producing a range of products and selling them in different areas, that there was very considerable variation among firms. The variation involved both formal structure and the actual division of decision making between the central office and the branches, which were only partly a matter of managerial choice. Indeed, there was a certain fuzziness to the general concept, and even individuals in the companies who were nominally in charge seem not to have known in any detail just how the system they had actually worked..

A second important difference is that in most cases, not always, it is far more difficult to get reliable evidence on the efficacy of a new institution or social technology than for a new physical technology. In part this is a consequence of the phenomena just discussed. For a company contemplating adoption, the problem of estimating the efficacy of the M-form of

organization surely was made more difficult by the fact that what the M-form actually was and how it actually worked differed significantly from firm to firm, and within a particular firm tended to change over time. But even without this complication, it tends to be very difficult to sort out the effects of a particular institution or social technology from the influences of a wide variety of other variables that bear on the profitability of a firm, or to estimate reliably the benefits and costs reaped by society from a complex of strongly interacting policies and laws. In contrast, it is much easier to gain a reliable assessment of the efficacy of a new pharmaceutical, or the performance of a new aircraft design.

Both of these differences are related to the fact that a lot can be learned about physical technologies, product designs or modes of production, by building prototypes and doing controlled experimentation "offline" as it were, in research and development. It is much harder to do this for institutions. Thomke, 2003, provides a convincing and detailed analysis of the role of deliberate experimentation in the design and development of physical technologies. If a physical technology can be made to work in a controlled setting, it often is possible to routinize and imbed it in physical hardware, and in this and other ways shield it from environmental influences that could be different on-line from experimental conditions. The looser coupling of institutions that can be designed and the behaviors they generate means that transfer from controlled setting to actual practice does not work nearly as well, even if the institution as a whole could be operated in an experimental setting..

Another important differences is that, because of the ability to routinize, shield, and control, it often is possible to experiment with a part of a physical technology off-line, and to transfer an improved version of that piece to the larger system with confidence that it will work

in that context and in actual practice. In contrast, the likelihood that a piece of an institution or social technology that works well in an off-line experimental setting will work well when imbedded in an on-line system is small.

This is not to deny the important role of learning by doing and using regarding the efficacy of physical technologies. However virtually all learning regarding social technologies and the institutions that mold and support them has to proceed on line. And for the reasons suggested above, even that learning is difficult and uncertain.

Relatedly, "scientific" understanding bearing on institutions, and indicating ways that they might be improved, generally is much weaker than the scientific understanding bearing on physical technologies. The applications oriented natural sciences and engineering disciplines often can provide very helpful illumination of prevailing practice and potential roads to improvement of physical technologies. They can point relatively sharply to what is essential to the performance of a product design, or production process, and what is likely peripheral. The behavioral and social sciences provide much less light on how present institutions work and how to improve them. In trying to understand why, it is important to recognize that the productive knowledge of applied scientists and engineers comes not only from the underlying basic sciences, but also from observation, experiment, and analysis of prevailing practices and artifacts, or models of these that are built expressly for experimentation and analysis. Behavioral and social scientists have little opportunity to build this kind of knowledge regarding institutions.

The emergence and adoption of new social technologies can proceed rapidly and fruitfully if there is a reasonably well defined problem that needs some solution, one can readily identify a new social technology that solves that problem at least broadly, and the needed

institutional supports for that social technology are relatively obvious. Under these conditions, the needed new institutions can come relatively quickly into place, at least if those who are in a position to make the institutional changes have an interest in doing so. . Thus in the United States the M form spread relatively rapidly among multi product multi market firms. The M form did at least mitigate the problem of overload of decisions to be made by top management of such firms. The industrial research laboratory provided a way for firms to hire groups of scientists and put them to the task of inventing, and relatively quickly became an "institution" in industries where the competitiveness of firms depended on their prowess at creating new products and manufacturing processes.

Vernon Ruttan (2003, 2006) has argued the case that modern societies in fact have considerable capacity for well directed institutional reform, based on the strength of the social sciences, as well as ability to learn from experience. Prominent among the examples he uses is the history of agricultural experimentation stations, in the U. S., in Japan, and in a number of today's developing countries. The evidence of the efficacy of this institution is very strong.

On the other hand, the history of both the M form and the industrial research laboratory is one of firms continuing to struggle to fine tune the structures so that they would work well in their particular context. I read the history of agriculture experimentation as showing the same sort of uncertain groping to find particular structures that work. It is illuminating to contrast the experience here with the evolution of mass production machinery. In the latter, many engineers were involved in designing machines, and getting relatively reliable information on performance from their own testing, and from feedback from users. Efforts to improve design could be guided by that user feedback, and by the ability of designers to experiment off line, with reasonable

confidence that what they learned from that experimentation would hold up in actual practice. And designers could learn from studying the characteristics and performance of the machines made by other designers. There is little evidence of anything like this progressive cumulative learning regarding business or research organization. The evolution of social technologies and the institutions that support them is a difficult uncertain process, compared with the evolution of physical technologies..

My reading of the recent writings of Douglass North (1999) and Thrainn Eggertsson (2005) suggests that they too have come to this judgment. Of course, there are matters of degree here. Feedback from experience and the strength of understanding certainly are greater in the cases of evolution of some social technologies than for others, and for some physical technologies neither of these influences may be particularly strong. But my argument is that there are significant differences on average between physical and social technologies in these respects.

Indeed, in some circumstances institutional evolution can result in building into place social technologies that are quite ineffective, or worse. For the most part, evidence of the benefits and costs of using new physical technologies is sharp enough so that few really bad ones ever get into widespread use (although there unfortunately are a number of cases where deleterious side effects, or problems that arose in particular contexts, were discovered only after a technology was around for awhile). In contrast, the introduction and spread of social technologies can be driven by fad, or ideology, and given the difficulties in getting reliable feedback on actual performance, social technologies, and the institutions supporting them, once in place may be difficult to dislodge, even if there is little evidence that they are accomplishing

what they were established to do. And reform too may be driven as much by ideology as by solid understanding of the real problems with the existing regime.

V. The Rise of the Specialized Research Firm, and of University Patenting, in the Evolution of Pharmaceutical Biotechnology

This section of the paper will be concerned with the evolution of institutional structures in the wake of the rise of biotechnology as a new technology for the development of pharmaceuticals. This case displays, in a contemporary setting, many of the same features we have seen in the two historical examples discussed earlier. And more than those earlier cases, this contemporary one nicely illustrates the uncertain and sometimes problematic nature of the processes of institutional evolution highlighted in the previous section.

The rise during the 1960s and 1970s of molecular biology as a strong science, and the creation of the basic processes used in modern biotechnology, clearly was a watershed for the American pharmaceutical industry. These developments opened up a new route to pharmaceuticals discovery and development, one in which, at least at the start, established pharmaceutical companies had no particular competences, and at the same time, one where certain academic researchers had expertise. Several lines of university-based research began to appear very promising commercially. A number of new biotech firms were formed, staffed by university researchers and their students, with plans to develop new pharmaceuticals, and either license the successful results to established pharmaceuticals companies, or themselves go further downstream into the pharmaceuticals business.

Several prevailing broad institutional factors enabled and encouraged these developments. One was the traditional openness of American universities to entrepreneurial activity on the part of their researchers. Another was an established venture capital industry, which quickly came to see the finance of biotech startups as a potentially profitable business. These two features of the prevailing institutional framework in the United States should be regarded as part and parcel of a general institutional friendliness toward entrepreneurship. However, the emergence of firms specializing in research, and of university researchers closely linked to these firms, was a quite new institutional development. (For a history see Mowery et al, 2005.)

To make this arrangement viable commercially required that the research firms have control over the new products and techniques they developed. Here, a key legal decision in 1980 assured skeptics that the products of biotechnology could be patented. At about the same time, Congress passed the Bayh-Dole Act, which encouraged universities to take out patents on the results of government-funded research projects, and to try aggressively to commercialize those results. While the language of the act is not specifically focused on biotech, an important part of the argument that led Congress to believe that technology transfer from universities to industry would be encouraged if universities had strong patent rights and could grant exclusive licenses to a firm to develop their embryonic products was specifically concerned with pharmaceuticals.

Clearly one sees in the case of the rise of pharmaceutical biotechnology the same kind of coevolution of physical and social technologies, and of supporting institutions, that I described earlier in the case of mass production industry in the United States, and of the dyestuff industry

in Germany. But there are some interesting differences, particularly on the side of the social technologies that evolved.

The major innovations in firm and industry structure that marked the earlier cases – the rise of the large hierarchically organized firm and later the multi-divisional form in the Chandler case, and the industrial research laboratory tied to a company that planned itself to employ the inventions that came out of that lab in the Murmann case – over time were shown by experience to be generally economically productive and conducive of profitability for firms in the relevant lines of business. However, the new industrial structure that has grown up in biotech has not proved itself, at least not yet. Despite being touted for over a quarter century as being a highly productive new way of organizing industrial research, biotech firms specializing in research, and aiming for profit through joint ventures or licensing agreements with pharmaceutical firms engaged in production and marketing, have with few exceptions failed to earn a profit. And university patenting of research results, as contrasted with placing these in the public domain, has been shown to have some problematic aspects.

It is interesting, and I think relevant, that the notion that a firm could be profitable simply by doing research, and without having close organizational linkages to production and marketing, gained enthusiastic credence so readily. This proposition was inconsistent with the history of industrial research that was recounted above, where firms making and selling products learned the advantages of doing R and D internally. While there were a few exceptions, by and large firms that tried to make profit by specializing in R and D were not successful. Regarding the present case, it has been recognized widely for some time that most biotech firms who have specialized in research, and have not moved themselves into production and marketing, are not

making any money. However, until relatively recently this problem has been treated as something that time would cure, and not an indication that the business plans and expectations involved in this structure possibly were not viable, except in quite special circumstances. Recently there has been more recognition of this possibility. Gary Pisano's new book (2006) makes this argument forcefully. And while a number of important drugs have come out of the new regime, the flow has been far less than some enthusiasts had forecasted, and in addition there are signs recently of a slowing down of the flow.

In any case, if in fact the research structure that has evolved in biotech potentially is highly productive, but there are still some bugs to iron out, learning certainly has been very slow. If in fact this is not a good way to organize industrial research, it is taking a long time to learn that.

There also are good reasons to be open minded or even skeptical about the economic value, and more generally of the wisdom, of the new policies encouraging universities to patent what they can out of what comes out of their research, an institutional development that, while not tied to biotech, has been exercised especially vigorously in this field. There has been a long history of debate about whether it is appropriate for universities to patent their research results when they can, or rather simply place these in the public domain. Since the end of World War II, when the Federal Government became the dominant funder of academic research, much of the debate has been concerned with the patenting of results coming out of government funded research. It seems fair to say that, until the testimony and deliberations that led to Bayh-Dole, there was widespread belief that scientific findings would be most productive if placed in the

public domain. And when the research in question was funded publicly, there was no need for a patent incentive to induce the work.

The argument that carried the day for Bayh-Dole was that technology transfer would be more strongly motivated if university researchers held a patent on their research findings, and companies who needed to make significant investments on their own to "commercialize" those results could be assured by the grant of an exclusive patent license that their profits would not be quickly eroded by competition. However, the evidence for this argument was not extensive.

It is clear that since the 1970s many important new products and processes have been made possible by academic research. Over this period, university patenting has increased greatly, as has university revenues from technology licensing. These facts have led some sophisticated observers to argue that Bayh-Dole has amply met its goals. Thus in 2002 the Economist opined that "possibly the most inspired piece of legislation in America over the past half-century was the Bayh-Dole act of 1980".

However, the enthusiasts for Bayh-Dole generally have suffered from an historical myopia. University research was contributing importantly to industrial innovation long before Bayh-Dole and much of what industry was drawing on was in the public domain, not patented. Bayh-Dole was brought into a university research system that already was strongly oriented to spurring innovation, and quite successful at it. Thus it is not clear that the new university patenting has been as important in facilitating technology transfer as the advocates have claimed. Put another way, contrary to the message of the cite from the Economist, it is quite possible that much of the university contribution would have occurred without university patents.

On the other hand, the downsides of Bayh-Dole, and the policies of universities to patent as much as they can, and earn as much money as they can from their patents, are now more visible than they were a few years back. (For a discussion see Nelson, 2004.) There are several prominent cases where the licensing policy of a university has resulted in a strong monopoly position by a particular company. In at least one such case, a company who clearly was in the lead in developing the technology was effectively shut down by the company that had the exclusive license. In other cases, the holder of the license has blocked academic researchers working in a field. A recent court case has signaled clearly that the argument by academic institutions that, since they do basic research, they have a research exemption to any patent blockages, is not persuasive in an era when universities themselves are major patenters, and use their patents aggressively. And the issue of possible bias in the articles and public statements of academics has been receiving increasing attention in the press.

For all of these reasons, recently there has been some backing off from the enthusiasm for university patenting that marked the 1980s and 1990s. A recent issue of the Economist (2005) focused on many of the issues raised above, implicitly arguing that the costs of university patenting and often exclusive licensing needed to be weighed against the benefits. The National Institutes of Health have issued guidelines calling for its grantees to license their patented inventions widely not narrowly.

It is uncertain whether on net Bayh-Dole, or rather the set of incentives and practices symbolized as well as reinforced by Bayh-Dole, has been a plus or a minus. The uncertainty here, as the uncertainty regarding whether or not the advantages of specialized research firms in a field like biotechnology have been oversold, shows clearly how difficult it often is to evaluate

new social technologies, and the institutions supporting them. Mistakes can be made, and can last a long time

.

VI. A Reprise

The thrust of my argument in this essay is two fold. First, economists are surely right in seeing "the right institutions" as the key to economic productivity and progressiveness. But second, if we are serious about taking the argument deeper we need to recognize that we have a very real challenge. The magnitude of the challenge, I think, is only beginning to be understood. I read the recent writings of Douglass North (1999) and Thrainn Eggertsson (2005) as presenting a similar point of view.

Indications of the intellectual challenge come into view once one recognizes the large number of things distinguished economists, and other social scientists, have called institutions, at least if one continues to believe that, somehow, they all are talking about roughly the same thing. That thing, then, must be very complex and variegated. I have proposed that much of the writing on institutions is concerned with the factors that mold the behaviors of economic agents, in contexts where the effectiveness of their actions depends on the behaviors of other economic agents. Institutions influence the patterns of behavior that are prominent in a society, and what behaviors are deterred. The complexity and variegation are there because in most cases there are many different factors influencing economic behaviors, and the important ones vary across economic activities. More, given the wide range of human motivations and beliefs, and differences across traditions and cultures, the factors that can induce particular behavior patterns almost surely differ somewhat from context to context.

If these arguments are accepted, it should be clear that the hunt for a single small set of institutions that are necessary, or sufficient, to support economic productivity and progressiveness is an unpromising quest. Economists, social scientists more generally, are not going to make much headway towards understanding the institutions needed for productivity and progressiveness if we look only at a macro economic level, or if we entertain only broad general conceptions like "support of market organization", or respect for the rule of law, or democratic government. At the most, we may be able to identify a set of broad variables that seem to be associated, more often than not, with good economic performance, or their absence often associated with poor performance. But invariably there are going to be exceptions. Similarly, broad theoretical proposals about the nature of institutions, like that they are "the rules of the game", or "governing structures", or "habits of action and thought common to the generality of man" are not going to take us very far. The devil is in the details.

And a major problem for research on institutions is that the relevant details, that is the details that make a consequential difference regarding the efficacy of action, often are hard to discern. This is at once a problem for positive research that seeks to explain why certain economies have done better than others, and a serious problem for normative analysis concerned with identifying the institutional reforms needed to improve productivity and progressiveness.

Regarding the former problem, earlier I highlighted that perhaps analysts have misread what has been going on in American biotech, putting too positive a gloss on the institutional structure that has evolved. But for an example that has now played out, recall the recent history of attempts by analysts to explain why during the 1970s and 1980s the Japanese industry was doing so well, in competition with American and European, in automobiles and then electronics.

Remember the sequence of explanations that today seem rather quaint, or at least at odds with the new conventional wisdom: government guidance under MITI, life time employment, long term financial relationships between banks and firms, cooperative R and D. I am not arguing here that there is nothing to these proposed explanations; they well may have been an important part of the story. Rather, my argument is that it is very hard to identify the key institutions that are behind economic success, and also that is important to recognize that what works well in one country in one era may work quite differently in a different country or as times change. This, of course, makes prescription especially difficult.

The development of a solid understanding of how institutions affect economic productivity and progressiveness obviously is a very challenging task. The basic reason is that the relationships are not simple. But the going will be specially hard if economists do not develop a coherent and broadly agreed-upon way of thinking about what institutions are, and how they affect economic activity, that illuminates the complexities as well as the broad regularities. My central purpose in this essay has been to sketch out a perspective on institutions and economic change that does that.

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