# Technology and Trade:
# Villians or Saviors in the Struggle for Employment

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In this era of intense concern about mounting unemployment, technology and trade are viewed at once as villains and saviors. In their role as "villains," they are thought to displace jobs. We may ultimately dismiss the charge that technology and trade are villains, but we can learn from examining it. When we consider technology, we must remember that the Luddites, the machine breakers of the English industrial revolution, were right; they did lose their jobs. England became rich, but the Luddites were part of the costs, the social frictions in contemporary parlance, that came along with industrial advance. And trade can displace jobs in two ways, both through imports that substitute foreign for domestic production and by competition that forces technical and organizational adaptation that compels surviving domestic firms to shed jobs. Again, there may be compensating exports, but the textile workers in North Carolina will not become the computer programmers in Silicon Valley, California.

In their roles as "saviors," technology and trade are thought to underpin the productivity gains that are the core of continued economic growth. The central importance of technology in economic development process of growth is highlighted in recent growth theory. The advance of technological ideas -- the creation of new recipes as distinct from the simple investment in new production equipment, training, and technology -- is increasingly understood as the engine of continuing economic development. The gains from expanded international trade are real; Asia, for example, is the fastest growing market in the world, drawing in vast exports from Europe and North America. And, of course, the competitive pressure of trade often drives technological advance that accelerates productivity gains.

Certainly, seen historically, trade and technology together have been part of the development motor that has sustained growing wealth in the West. Jobs may be displaced, but wealth and income are created, which in turn generate more jobs and, historically viewed, on balance better jobs. In this traditional view, the basic task is to find policies that nurture and sustain technological advance and to bear the pain of the adjustments required to capture those gains.

But will that traditional role of technology and trade continue? Or have we, as some fear, entered a new era in which technology strips jobs without generating the corresponding wealth that promotes new ones? Has trade become a competitive mercantilist game in which there are real losers? There will be jobs, I believe, but difficult questions remain: What kind of jobs will

these be? Where will the jobs be located? In what social institutions and organizations -- with what rights and security -- will jobs be situated?

*Are We in a New Era: the Question of Technology*

Let us consider technology. We are certainly witnessing a very fundamental technological transformation in production systems, as well as in the components and subsystems that go into the products and certainly in the types of final products. Much technological advance has come in the form of new production systems. Those production innovations have altered the terms of market competition by creating new standards of cost, quality, and delivery in a whole range of industries but principally in consumer durable sectors. Flexible volume production in Japan has revolutionized the terms of global manufacturing even as flexible specialization of networks of smaller firms in parts of Italy and Germany has captured the imagination. The fundamental production changes centrally are not about the machines that make goods but about the social organization, about the way machines are employed, and the manner productive units relate to each other. Flexibility in product and production systems does not mean necessarily the destruction of systems of worker rights, but it will certainly require a constant shift in skills and tasks. The question will be the social frame and the labor market rules required to embed these new realities.

The transformations during the past two decades in how goods are produced are merely precursors to the even more radical changes that will occur with telecommunications-linked, computer-integrated manufacturing and development. The hints of that next jump are evident in the United States. Indeed, the use of networks to support product development and manufacturing is driving demand for the Information Superhighway in the United States. All the talk of an entertainment revolution is for tomorrow; the production transformation is happening now. Consider that in some companies the network usage is increasing as much as 25% a month. Some networks reflect similar increases. All this represents the emergence of an altogether new paradigm, another conception of how production activities are tied together and of what they consist. This paradigm jump, like the just-in-time transformation that proceeded it so recently, involves the reconfiguration of tasks and requires new skills for workers and management alike. In time these changes will drive, in my view, massive productivity increases. It is a mistake to compare particular machines to previous arrangements or to compare particular

subsystems. The present situation is reminiscent of the emergence of the electric motor, which followed a similar pattern. The full impact of electric technologies only became clear as entire electric networks systems became available as alternatives to steam. Indeed, the strategies of corporate re-engineering and re-skilling will be seen in historical perspective as elements of the adaptation to these new technologies. A new burst in productivity is likely. But, we must ask, to the benefit of whom? A new surge in productivity will have its own problems.

The successful adoption of these technologies will lead to different fears. Recall the anti-utopia sketched by Kurt Vonnegut in his first novel, Player Piano. New production technologies in his tale radically replace jobs. His anti-utopia was one in which the Elite were the ones who worked and the Masses were simply consumers. The production machinery became so productive that it turned on itself. The Revolution was of consumers determined to once again find value as producers.

Most likely, increased productivity will increase wealth and generate new jobs performing new functions. Work is altered; its character, organizational form, and geographic location altered. But jobs do not disappear.

Let us consider some examples. Making a telecommunication switch a generation ago required thousands of workers, but the development costs were limited. Now the development costs, labor intensive software, are in the hundreds of millions of dollars if not billions of dollars, while the number of direct assembly workers are in the hundreds or even tens. The components moreover have moved from wire connections to complex semiconductors, which themselves require elaborate development. Again, work is altered, its character and organizational location shifted, but it doesn't disappear.

This issue of the complexity of components and subsystems is very significant. It changes the meaning and significance of assembly activities. For example, we are witnessing a technological change in the makeup of even traditional products such as automobiles or refrigerators. The electronics content of the automobile is growing to be a very substantial portion of the total cost and value. Auto electronics is no longer about headlights and radios but about brakes, engines, suspensions, safety systems, navigation systems, telecommunications, let alone very high-end sound systems. Increasingly even everyman's town car will have these as basic equipment. A refrigerator, for example, increasingly will embed both smart power chips to reduce energy use and microprocessor technology to adapt the actual operations. Consequently,

the question of importance may cease to be where product is assembled but where the components are built and where the machines that make the components and assemble them are designed and built. Value and work relocate from assembly, which can be automated, to the development and production of complex components, subsystems and the creation of the production systems themselves.

In addition, it is not simply microelectronics but microsystems technology, new materials, and biotechnology that are infiltrating through traditional industries. And of course these new technologies are creating entire new industries of products. It is not just the genetically controlled tomato, but the new consumer durables of the fax machine, the high-definition television, the new communications.

The increased intensity of trade competition will, moreover, make it harder to avoid rapidly implementing the potentials of these new technological notions. And the competition will drive an even more intense search for new technological notions, new recipes that permit competitive advantage. Is the story then so simple? Is it really the textbook story, the country that adjusts best wins the race?

*Can We Choose Our Technological Futures?*

In fact, I think not. The story is more complicated and, ultimately, more hopeful. The evidence is clear that we create our own technological futures; that is, the technologies themselves are often plastic, socially molded. They develop to reflect the social priorities and market organization of the countries in which they emerge. A German machine tool, a Japanese machine tool, and a U-S machine tool will not in the end be the same things. And production strategies in the three countries are often different. They represent quite different mixtures of skill, know-how, and power and influence of workers and management. As important, there are significant social consequences of different technologies. There is not simply one best way to produce. Rather, production strategies with worker skills and involvement represent a very different future than those that de-skill or dominate workers.

Certainly technological choices contain consequences for wage levels and labor management relations. The choices in fact are often the product of efforts to maintain particular labor management relations. Consider the fiat production reorganization. It looks very different from Toyota strategies for using labor. While Toyota by all reports sought to effectively employ

skilled labor as experimental researchers, if you will, on the production line, Fiat eagerly sought to displace the workers with robots. Fiat's choice made after the Italian labor troubles, certainly reflected the notion that robots don't strike and above all they don't conduct sabotage work-ins.

*Conceiving Technology and Technological Choices*

How much choice then do society's have to shape their technological futures? We must begin with the obvious but difficult question. What is technology?

Technology, for our purposes, is a recipe for creating a particular product or outcome in a specific manner. It is not pure knowledge but knowledge applied to a purpose or product. A particular recipe implies a set of tasks, a level of skills, a way of organizing activities. Consequently following that recipe means accepting, or imposing on others, a set of constraints. The constraints inherent in a particular recipe then are imposed by entrepreneurs in pursuit of profit and by the state in pursuit of power.

A variety of recipes, technologies, can compete as means of providing a particular product or outcome. In that sense, a particular recipe may contain very specific constraints, but there may be more than one solution and consequently a variety of technological possibilities. But won't the most efficient solution be successful in the marketplace? And, consequently, won't the constraints inherent in that recipe become binding in open markets?

The story is a bit more complicated, turning on issues of capacities, markets, and control. Let us walk through the logic. First, two alternate recipes may imply dramatically different <u>capacities</u>, not just different efficiencies. Thus an abacus may compete with a mainframe computer in adding the grocery lists, but as a means of examining weather dynamics or fluid dynamics for submarines or ink jet printers, it just won't do. If you want a model of world weather, the computer, with its constraints, will win. Thus the shift from one technological paradigm to another, from electro-mechanical to electronic computing for example, suggests shifting constraints. A technological paradigm might be seen as a particular recipe book, and the shift of paradigms represents a change in recipe books. Second, two different recipes may require sufficiently similar capacities to be viewed as rough alternatives. In that case the question of <u>efficiency</u> kicks in. But to determine efficiency we must specify input costs. Thus in a country with low labor costs, a labor-intensive solution may prove most efficient; while in a country with low capital costs a capital- intensive solution may be the choice. Thus at a given

moment there may not be a determinate market solution. However, over time one solution may have greater potential for reducing costs or increasing performance and may thus impose itself in the market. However, at any moment the dynamic efficiency implicit in one approach or another is often a judgment, not a clear calculation. Third, it may be possible to segment the market to create sub-sectors. In that case multiple recipes may co-exist. Once again, the situation must be viewed dynamically. A specialized solution niche may be under pressure from a general solution or from variants of a volume solution. Fourth, we must consider the question of efficiency from a different vantage. We must note a particular version of segmentation. Market efficiency only has meaning if we can clearly specify a solution. If two solutions contain different probabilities of success, then one solution may be more effective than the other. For example, in peacetime we ask generals to be efficient, to be low-cost; but in war time we ask them to be effective, to win. Effective here means the one with the greatest probability of success or lowest probability of failure. The most efficient, that is lowest cost, way of delivering a car may be with four tires and wheels, but the recognized risk of tire failure creates an assured demand for redundancy to increase system performance or up-time, if you will. If the costs of down-time are low, the ease of repair is great, then a lower cost, less "effective" solution may be called for. Thus market demand conditions define our choice between effective and efficient solutions. If success is hard to assure or not clearly probable, then the more effective solution may be the choice. Thus the market is segmented by differential estimates of risk or differential capacities to take or absorb risk.

As we have seen, multiple technologies or recipes are in constant competition. Markets will in part decide among the acceptance of those recipes. But entrepreneurs may enter their bets in the market for a variety of reasons. As mentioned above fiat, there is no doubt, adopted a highly-automated, low-skilled approach to factories in the years following labor conflict in Italy. The objective was to get the workers out of the factories or at least limit their leverage within. Narrowly defined, efficiencies were not at issue. The ability to impose that technical solution in part depended on control of access to the Italian market. Broadly put, control of markets and control of workers are among the strategic questions at play in the choice of recipes.

The core of the conventional story is that emerging technology and unfolding economic processes drive society before them, forcing adaptation. There are variations, of course, but for the most part rational actors seeking profit ferret out market opportunities. Workers and

communities are driven to adjust to these new requirements. Entrepreneurs sidestep, dismantle, or innovate around government barriers. Their inventions force societies to adjust. In some versions, these technology processes are exogenous; they emerge outside the story of economic dynamics.

The alternate story, a more complicated one, tells how the character of a society shapes and forms the character of the technology that emerges. The market opportunities to which actors respond do not spring from some ethereal fountain; rather, they are rooted in the social and institutional arrangement of the community. Consequently, it is not simply the pace but the character and direction of technological development that is at question.

Above all we must avoid defining technology or judging its constraints in a manner that obscures the competition among recipes, the multiple strategies that are in play for market position. Again, the industry requires a market definition in the form of products competing for similar end use to similar sets of buyers. Again, technological recipes, and innovations in technological recipes, represent means of addressing those markets, redefining the market structure, or altering the terms of competition.

So we conclude that technologies do constrain, force adaptation. However, there are multiple choices and multiple solutions. Often there is no clear market determinate, and often the most successful solution only appears in the longer term as one trajectory of development comes to dominate another. The interesting research question is not whether technology constrains -- for it does -- or whether it is socially molded -- for it is. Rather the questions are when, why, and with what consequences it constrains; and when, why, and with what consequences it is molded.

*When Does Technology Constrain?*

Technology constrains under at least three circumstances.

(1) The emergence of new industries, particularly those at the frontier of technological knowledge, involves new constraints. Old recipe books are not relevant. As innovative recipes are developed, they involve different requirements for:

- finance,
- skills,
- organizations,
- and market-place rules.

(2) New technological paradigms for established industries represent either revisions to or extra chapters in the recipe book. Thus high-volume flexible production based on pull through notions of factory operation are distinct from the traditional mass production models. They involve ultimately different equipment, different skills, different product development and process development strategies, and different relations in the company.

(3) Intense competition from new sources that forces one national industry to adjust to foreign competition may have the consequence of compelling adjustment to new technological ways.

*When Is Technology Plastic?*

Technology begins to be socially molded when the recipes and recipe books are rewritten to the specifications of particular societies. In that sense technology is plastic or pliable. Specifying what we do <u>not</u> mean by "plastic technology" or "socially moldable technology," we will help locate the concept.

- The social capacity to <u>absorb</u> technology will influence how rapidly a country moves along an established or emerging technology trajectory. By absorption I would mean the capacity to apply and maintain the technology with indigenous capacities, whoever may own the firms. This would equally apply to the ability to absorb new cutting-edge developments such as NMR or semiconductor production technology.
- The capacity to <u>diffuse</u> technology will likewise differentiate countries. By lack of skills and capital or because of organizational barriers, some countries will diffuse technology more slowly than others. It is not simply the overall speed of diffusion, but the arenas in which diffusion is rapid. Office electronics technology has diffused very rapidly in the United States, more rapidly than in Japan. Robotics has diffused more rapidly in Japan.
- The selection of technology from a menu of possibilities means that similar industries may be characterized by different <u>mixes</u> of production factors. Therefore making different selections from an existing, readily available menu of technology is not in itself a matter of bending the technology to the society's character and structure.

Again, technology begins to be socially molded when the recipes and recipe books are rewritten to the specifications of particular societies. This involves more than imagining new recipes. Components, subsystems, and production systems may have to be created to support the recipes. The social molding takes place in a number of ways.

(1) <u>Countries may drive the technology frontier at different points</u>. They will invest in different arenas of basic technology and science. The variation will reflect different social needs, expressed in prices as well as policy, and different

built-up pools of technical and scientific skill. Thus one country may drive the technology frontier in some areas and not in others.

(2) New paradigms, or different conceptions of how to approach distinct problems, may drive technology in a new direction. Those new paradigms may reflect the industrial structure or technology ideas particular to a specific place or country. They may take several forms. Certainly, one example is the emergence of high-volume, flexible production paradigm through the creation of just-in-time, pull-through production at Toyota. Sabel and Piore argue that the factory system was simply one possible paradigm of exploitation for the technological possibilities that underpinned the industrial revolution. The factory system after the fact looks inevitable, because the underpinnings in the form of equipment and know-how required to support a technology system--emerged from that system. Alternatives become lost or appear as fantasy speculations. Whether their argument is correct in this dramatic historical instance, the logic of the point has merit. Alternative paradigms become entrenched as a base of new technological trajectories through the emergence of a distinct supply base of components and equipment.

(3) Specific market niches or market segments may be the base of new technologies, or, put differently, technology may permit the creation of new segments. The translation of technical possibilities into product takes technology in different directions. The United States may dominate long distance jet aircraft, but Brazil has created a position in lighter propeller craft. They involve the creation of different technologies. This innovation in application may generate new market segments. The demand in those market segments drives investment in innovation and in a supply base required to support a distinct line of development. Different segments will emerge in different countries.

We have mentioned the notion of a supply base several times. The notion here is that a technology direction becomes entrenched when the ideas and recipes can be implemented through a distinct set of components, equipment, subsystems, and skills.

*The Interplay of Constraint and Plasticity*

The development of technology is clearly a social process of discovery and investment. But what is the nature of that process is? Technology is not simply the unfolding of a pre-existing set of technical possibilities that carries society along a precut path. The technical frontier is itself a social creation. The exploitation of the possibilities that frontier represents is socially molded; when a twig of development grows into a solid limb, it can alter the fundamental character of a technology.

My own intuition is that there is entrenched, enduring, and significant variation in national lines of technological development. The underlying proposition is that variations in the national context shape the course of a country's technological development. Technology then is an outcome to be accounted for by differences in national structures. The notion is that the course of technological development will vary from country to country in ways that significantly influence the dynamics of growth and social development. Since it is also evident that emerging technologies oblige social adaptation and adjustment, the difficult task will be to assess the interplay of society, economic growth, and technology.

The central emphasis here is on the underpinnings of national technology trajectories. In my conception, I propose a model of the relationship between firms, their institutional context, and the technological trajectories that emerge. That relationship takes two forms. On the one hand, we may be concerned with how core technologies emerge. Compare, for example, German and Japanese machine tool development. At least from a superficial glance, Japanese tools, which are simpler, reflect the volume flow oriented production processes characteristic of the consumer electronics and automobile industries. German tools, which are more complex and multifunctional, reflect the capital goods batch production orientation of the origins of German industry. Those biases seem to some to be evident in product design in the semiconductor and microsystems industries, suggesting common and rooted approaches to and resolutions of technological problems that might be characterized as a trajectory in the very character of technology. On the other hand, we must be concerned with how common emerging technologies are applied in different countries. Consider, for example, the differences between the development of French and U.S. development of digital communications technology. The French Minitel system built by the core national service provider France Telecom provides a single national infrastructure for all users as they enter the world of digital communications. In the United States a web of private networks and competing systems built or woven together by a multitude of companies and service providers offers a very diverse set of options. The result is that the very character of initial applications in the two countries will be different as well. In both these cases the theory we propose of how firm incentives and market logics drive and sustain technological trajectories within nations serves as a lens from which to understand national variation in the industries.

Of course these two stories, the conventional one of technology obliging social adaptation and the more recent one of societies molding technologies to their own form, overlap and interweave. Consider a contemporary example. Digital telecommunications is moving a series of separated functions such as voice and telegram running on distinct analog electronic infrastructures to a set of digitally founded applications running on interconnected networks. The difference in the initial pattern of use of telecommunication networks and computers in the United States and in Europe more broadly may generate distinct technological approaches to the question of interactive multi-media, switched multi-media signals.

So in the end the distinction between emerging technologies pushing society and shaped by society is both essential and artificial. It is essential both because a number of technological possibilities emerge at once in a number of countries and because there needs to be an analytic starting point. It is artificial because the very process by which society adapts a new technology directs that technology into a broad national trajectory of technological development. The question is when and under what circumstances has technological development compelled broadly similar adaptations across countries and when have the particular adaptations generated nationally distinct economically and socially significant lines of technology development.

These stories are separate and intertwined, not parallel. Consequently, they do not always represent competing hypotheses. There is, for example, one story about the emergence of the semiconductor from the laboratories at AT&T. What accounts for the emergence in particular locations of breakthrough technologies? A second story begins after the emergence of the semiconductor. Microelectronics technology forced the adjustment of a series of electro-mechanical industries such as computing and spawned the emergence of a range of consumer industries. What requirements did microelectronics impose on corporations and workers? A third story is required to account for the national location of different segments of the industry. Thus Korea has captured a segment of DRAM industry, while the United States industry has captured not only microprocessor architectures but distinctive value added memory segments as well. Are there distinct national characteristics that account for the industry segments in which a nation's firms operate, the kinds of production processes they adopt, and their use of labor in production?

The interconnection can be stated a different way. Are we, on the one hand, observing a series of technological steps in which the national variations are simply faster or slower

adaptation, more or less effective approaches, indeed even just culturally specific forms of a general solution without further significance? Or do the particular national solutions provide the base for economically and socially significant alternatives. The extreme example is the argument, made most notably by Charles Sabel, that industrialization -- the application of machines and power to production -- could have occurred without the factory, that the factory is simply one possible form that industrialization could take. More modestly, does the Japanese expertise at flexible volume production developed in the auto sector create a distinct trajectory separate from that of the Danes, who move into high value added niche products, or the Germans, whose exports are in skill based capital goods.

So the question is not simply whether technology creates jobs but what sort. The good news is that we can choose, but the bad news is that we must choose. And in choosing our technology we are choosing the nature and character of our societies.

*Walking the Tightropes: the Technology Policy Challenges*

If technology matters crucially to growth and to the character of our societies, then technology policy is a matter of central policy concern. But working through technology policy is like walking a series of tightropes. The challenge of the first tightrope is finding a broad development strategy that is at once technically workable and politically stable. All successful growth strategies must embed a political and technical solution. The political solution must allocate costs and gains of development while allowing the continuous and sustained reorganization of production and distribution. If growth is to continue, the losers cannot constantly interfere with the processes of change; consequently they must be ignored, coopted and compensated, or suppressed. Technically, policy must promote and sustain the reorganization and redeployment of resources according to new recipes, new paradigms that constitutes economic development. The result of the double challenge is often a mix of policy that looks, and is, contradictory. Indeed, governments step on the brakes and the accelerator at the same time. Certainly France and Japan adopted in the post-WW II years growth strategies that insulated with subsidy the very groups -- peasants and small shopkeepers -- whose position and role was being altered by growth policy that the government strongly supported. The result was an inflation that resolved the political contradiction while sustaining growth. The general problem confronting all development policies now is how to assure that programs of promotion,

which do generate winners and losers, have a political foundation that will allow them to survive.

Technology is often touted as a powerful and legitimate instrument for government intervention. The case is that there are significant externalities that private firms cannot capture. Thus government support is economically rational. As important, groups of firms will often have difficulty acting together to capture these externalities. The problem of organizing collective action is very difficult and may preclude economically rational activity. Government, by its nature, can help resolve these collective action problems, often just by providing the meeting table. The fact that such policy is defensible does not automatically mean that it is wise.

The policies of technological promotion have their own tightropes. Let us note just some of them. First, for example, how can policy provide support without dampening market signals. Second, when should a policy support national producers, and when should it support the diffusion of technology to assure broad use. European policy in particular has often underestimated the significance of a sophisticated market as an instrument to support and orient users. The result has been a disaster in many electronics areas. Firms have been encouraged to compete directly with the strongest competitors in those competitors' most entrenched positions. At the same time, diffusion and use are slowed, making the market less sophisticated and making it less likely innovative products will emerge. Third, there is the delicate question of how and when to shape a line of development or a technological trajectory and when to ride the market. Too often French policy, for example, has tried to override the market, imposing particular product outcomes, which drove firms to compete head on in arenas of greatest opponents strength. Fourth, government policy is often justified as a means of assuring longer term policy, but early failure is often a precursor to longer term failure. The problem remains of how to decide when to abandon programs. Government support can often make that more difficult for companies.

The domestic policy problems are difficult, but the international one is just as troubling. Every country trying to use technology as instrument creates problems in the nature of trade, a technological mercantilism. Small countries such as Austria may be immune to the temptation. For them the crucial questions are:

(1) how to assure access to emerging technology,

(2) how to avoid being trapped by disjuncture that suddenly obsolete sets of producers;
(3) how to diffuse know-how that permits effective technology application,
(4) and where to place limited investments in basic research.

But the trade games among the advanced countries will influence powerfully each of those challenges.

*What Game are We Playing in Technology Trade?*

How should we consider the problems of trade and of trade in technology? Different images suggest quite different metaphors of competition and indicate alternate lines of analysis. To begin we might imagine a horserace run on a straight track. The several economies seek to travel the same course faster to the end line of common rewards of income and welfare. The order of finish does not establish special rewards. The victory of one does not disadvantage the others. In this image differences in national savings and investment rates, the efficiency and effectiveness of financial systems (which are definitely not the same thing), or the capacity for innovation in production and product development will all influence which country runs first. The speed at which mass production or multi-divisional organizations are adopted will influence who surges forward, but it does not dictate how far behind the others are. Rather the domestic capacities and will to achieve efficiencies and adaptations are key to the final order of finish. In this first image then government subsidies or protections act to reduce the welfare of all.

But let us change the metaphor of competition, change the character of the rivalry. We don't need to adopt a mercantilist image in which a fixed quantity of gold or a fixed number of jobs are to be divided between countries. Let us assume that the actions of one player substantially constrain the ability of the rivals to reach their objectives. Suppose there may be multiple roads (technology trajectories, for example) to goals of employment and growth. However, only one runner is allowed on each trajectory. If country A bumps country B onto a muddier (slower) tract or a longer route, then the consequences may be more enduring. Suddenly we enter a world of strategic trade, a world in which early developers affect the patterns of later developers (Krugman, 1986; Tyson, 1992; Gershenkron, 1962). In this world my subsidy allows me in an oligopolistic industry such as aircraft to capture market share, rents, or high-value-added jobs, which I may be able to maintain in the longer run. Your entry into my market may preclude my firm from ever entering a new sector (Buigues and Jacquemin, 1993).

If you block my entry into your market, it can affect the very logic of competition between firms in our two countries -- substantially disadvantaging my companies in the long term (Borrus, 1988; Borrus, Millstein, and Zysman with Arbisser and O'neill, 1983). Without market access, I may not be able to achieve economies of scale, the risks of large scale investment may rise, the equipment and production base on which next generation product rests may erode.

The crucial step in this second and nastier game is the move from the logic of strategic trade in a single sector to the logic of competing trajectories of national development. That is, acting strategically, a government may be able to influence the outcome in a competition in an oligopolistic industry such as aircraft or a dynamic industry such as semiconductors. Of course, success in influencing the outcome of a particular competition does not necessarily imply that the government gains growth advantages for its economy. For example, the cost of the support may exceed the rents captured, in which case the aggressive government may actually reduce the national welfare. The claims, for example, that the European subsidies to Airbus are welfare reducing imply just this. Nor does failure to defend an industry necessarily result in a drop in welfare, growth, or high-wage employment. The resources used in the targeted sector may be redeployed to other equally valuable uses, as standard models would suggest. In any case, in this second metaphor, governments can intervene and deeply affect who wins and loses in the marketplace; it can influence -- either positively or negatively -- the balance of gain between its national firms and others.

In all this the crucial analytic problem remains that jump from the particular to the general. That is, the government's ability to influence outcomes in specific markets to its national advantage does not inevitably create longer-term growth advantages, and, conversely, its failure to generate advantage does not automatically produce disadvantage. The link between the particular market stories and the longer term path of growth turns on how one conceives the economy to be organized and the dynamics of its development. If activities are tightly linked together, the loss of one sector can erode the position of others. For example, service jobs may be so tightly bound with manufacturing jobs that if the manufacturing jobs vanish the services for manufacturing will disappear as well (Cohen and Zysman, 1987). Linkage may be demonstrated in the form of a supply base of components, subsystems, production equipment, and product and production know-how that defines possibilities and constraints on a line of

technological development or the possibilities of diffusing transformative technologies. In other words, linkages may define lines of technological and development trajectories.

Through the routes of linkages and technology trajectories, sectoral competitiveness is linked to productivity. The contention that productivity growth is the true measure of a nation's long-term economic well being is certainly true. So indeed is the contention that for large countries like the United States, international trade is very much the tail of a large dog. However, as the work of Dosi, Romer, and Stiglitz, among others, suggests, the ties between particular competitive outcomes today and the productivity growth rates of tomorrow is much more complicated than conventionally presented.

If the stakes in particular industrial competitions are broad lines of economic development, then trade competition takes on a nastier feel. The temptation to use policy instruments to advantage national firms is powerful, particularly if one fears that rivals will act first to capture the better trajectory. The result can be the recycling of the cult of the offensive from the realm of military strategy to the domain of first mover advantages in strategic trade competition (Weber and Zysman, 1992; Zysman, 1992).

I have argued that the way of understanding trade is as the interaction of different institutionally structured market systems, each with a distinct market logic. This optic of a distinctive market logic can then be used to predict behavior, if you will, or ,here, to illuminate a single case. In the previous section we depicted a distinctive Japanese pattern of development that led to "excessive competition" internally and a down-pouring of exports and dumping externally.[1] Consider the semiconductor, story in which over the last decade Japanese industry seized leadership from U.S. producers in the leading edge commodity memory products (DRAMS - Dynamic Random Access Memories), which honed production skills (Borrus, 1988; Borrus, Millstein, and Zysman with Arbisser and O'neill, 1983). Three features of the Japanese system were crucial in producing the particular logic of competition in Japan: first, the incentives and financial capacity to pursue market share strategies as described above; second, the industry organization in which component producers were also major producers of final consumer products such as televisions; and third, the capacity to limit market access by foreign firms. Market share strategies tended, as described above, to lead to excess capacity and dumping. The

[1] A variety of cases will illustrate this. A number are developed in Zysman and Tyson (1983), see in particular the semiconductor, steel, and consumer electronics cases.

Japanese firms were in this period producing for price-sensitive consumer markets in which marginal performance advantages were not central. By contrast, competition in America was structured around merchant component producers who were not competitors in final product. Indeed two of the strongest integrated producers, IBM and AT&T, were effectively precluded by anti-trust decisions from entering the merchant market, and each had sufficient internal demand arguably to capture available economies of scale in development and production. Basic market demand was driven by military and computer requirements in which marginal performance requirements were important and demand was less sensitive to price. Thus competition was between two differently structured sets of firms in two markets with different requirements.

The Japanese firms entered the American market just as a temporary shortage was created in the United States, by a surge of IBM purchases in the merchant market. The trade statistics show clearly that Japanese firms met that demand, but also satisfied their own internal needs with imports of American product. When the temporary shortage ended, the Japanese were entrenched in the American market, and as they expanded capacity then displaced their American competitors from the Japanese market. In the years that followed, the Japanese approached each new generation of product by announcing massive capacity. Usually sufficient capacity was announced that excess supply in the Japanese market and the low-price exports that such excess capacity created were virtually inevitable. Later the Japanese firms tended to define capacity against the demand in the world market, which simply aggravated the problem. In part the U.S. firms tended to withdraw from the market when confronted with probable excess capacity and surges of low priced imports. The Japanese firms were willing in part to bear the financial penalties because they were final-product producers in consumer electronics who saw component expertise as a means of advantaging themselves in final product competition. Certainly the Japanese producers did establish new standards of production quality, which made them formidable players in commodity products. But the causal links are not obvious. Protection that excluded foreign competitors that had product and process advantages created an odd stability in an intense domestic competition. In the automobile sector a strong case can be made that such arrangements facilitated the production revolution. The basic pattern of competition, resulting in substantial measure from managed access to the Japanese market, induced production innovation strategies.

In any case, the logic of international competition reflected the market dynamic in each country. The American market was centered around smaller merchant producers competing principally in markets in which performance was critical. The Japanese market was organized around larger integrated firms competing initially in price sensitive consumer markets. Over time the U.S. firms withdrew from commodity markets into design and value-intensive market segments. This strategy however was vulnerable to a potential Japanese domination of the underlying production know-how and production equipment as well as to difficulty capturing enduring market position in the Japanese market. In sum, American policy responded to the mismatches of market logic with domestic policy, in the form of Sematech, to bolster production know-how and trade policy to limit predatory strategies and open the Japanese market. The economic importance and strategic significance of the semiconductor focused attention.

The story of the semiconductor industry competition, and more broadly the analysis of the Japanese case, has suggested how a particular national market logic can disturb the international trading system. But not all market logics are disturbing to the international system, and the interplay of market logics can also be advantageous to both sides. Denmark is an interesting case. It has few raw materials, a vulnerable strategic position, and is in all sorts of traditional, supposedly slow-growing industries. Yet with whatever problems there are, Denmark remains a very rich country with very high incomes as a result of strategies of creating value in market niches. The Danish strategy is one of importing commodity low-value inputs and in the case of grain feeding them to pigs and cows to create a dairy farming and food processing industry and in the case of semiconductors putting them into hearing aids and exceptionally expensive consumer electronics.

In conclusion, let us clarify the notion of market dynamics.

There is a framework that underlines the notion of international trade. It is the notion that the dynamics of national systems, market logics, are linked to the national institutional and social structure. Let us simply note the logic:

> *Step1*: Each economy consists of an institutional structure. That institutional structure is a function of the country's distinct political and industrial development and induces nationally specific political and economic dynamics. The institutional organization of politics and markets then defines the choices of each actor.
>
> *Step 2*. That institutional structure of the economy, combined with its industrial structure in a more classic industrial organization sense, creates a distinct pattern of constraints and

incentives. This defines the interests of the actors as well as shaping and channeling their behavior.[2] The interaction of the major players generates a particular "policy logic" and a particular "market logic". Since the national institutional structures are different, there are, as a consequence, many different kinds of market economies.

Each market economy which is defined by the institutions and rules that permit it to function, or said differently, each national system can be defined by the "institutional structure" of the economy that structures how buying, selling, and the very organization of production take place. The crucial elements of that institutional structure are the markets for capital (including markets for companies), markets for labor (including markets for managers), and the state as the maker of rules. The task is defining the patterns of incentives and constraint.[3]

*Step 3*: Market logic, specific to a particular national institutional structure drives corporate choice, shaping the particular character of strategy, product development, and production processes in a national system. A specific market logic (and political logic) then induces distinct patterns of corporate strategy (and government policy) and therefore encourages internal features of companies (and the government) that are unique to that country. There are typical strategies, routine approaches to problems, and shared-decision rules that create predictable patterns in the way governments and companies go about their business in a particular political economy. Those institutions, routines, and logics represent specific capacities and weaknesses within each system.

*Step 4*: Trade competition must in part be understood as an interaction of these national market logics. Differences in corporate strategy and access to markets and technology create patterns of international trade competition.

A national institutional structure creates the foundation for nationally specific patterns of industrial adjustment and economic development. Each particular structure sets a definable pattern of incentive and constraint for the several actors within the system; the interaction of the actors creates a distinctive national market logic. Nationally specific patterns of government policy and corporate strategy, distinctive routines that characterize one country and not another, are the result. Particular patterns of interaction between national systems are also the result of the particular national systems.

[2]Alexis deTocqueville makes the classic argument. See in particular The Old Regime and the French Revolution, Reinhard Bendix's explication of the argument in Nation Building and Citizenship, (1964) is helpful.

[3]Joseph Stiglitz's excellent work on finance is one example. A particularly lucid non-mathematical presentation is "Financial Markets and Development," (1989). David Soskice's "Reconciling Markets and Institutions: The German Apprenticeship System," (1992) is a second example.

*The International Problem*

Technology competition can easily become a rivalry among differently structured national systems to put themselves on the fast route to growth. If each country pursues a strategy of growth and advantage, how do we reconcile at an international level these competitive purposes? The line of argument is that there are national institutional foundations of market systems that generate particular logics and dynamics. The suggestions are made that (1) different "market" logics have long term effects on the patterns and rates of growth of each economy; (2) the character of the interplay of national market logics between a country and its principal trading partners can influence the character of growth of each; and (3) the market logics of the dominant national economies can influence the world economy as a whole. The risk is that rival technology mercantilism will become the 21st century counterpart of currency rivalries, that is, efforts will be made to lay on to others the consequences of international economic downturns and to capture the fast productivity roads to the future.

The difficulty is that these issues of competitive advantage cannot easily be handled by the logic of the existing trade system. GATT is not dead, but it is limited in what can accomplish. The result is that in the next century trade debates will increasingly be about national institutional structures, deep access to the markets of trade partners, and different social values, which translate through policies about environment and labor into factor prices.

My own view is that there will be a series of bilateral and issue-specific conflicts over the next years. Those conflicts will not fit easily into the GATT framework. The result will be a series of bilateral and regional trade deals that appear to threaten the long term health of the GATT-centered trade system. One way out is to create multilateral fora for bilateral discussions so that the trade system is built inductively by the resolution of particular conflicts, rather than threatened. This requires dropping the ideological war over the merits of so-called free trade and so-called managed trade and the examination of the real sources of conflict and mutual gain in trade.

*Policy Choices*

We are left with some clear conclusions and some difficult policy choices. First, technology development will remain the central source of growth. Moreover, technology can be shaped to social purposes, and, consequently, choices about technology will create the

foundations of our society in the next years. Thus, government needs not only to promote but to mold the character of technology. The difficulty is that policies of technology promotion and control easily blur into market suppression, which simply undermines the purposes of the policy. As a result the most effective policies are often those that diffuse technology, create the skills to effectively employ it, and generate sophisticated markets that induce innovative producers. Second, the efforts of governments to promote policy can quickly degenerate into rival mercantilism. Consequently the international management of technology -- issues from subsidy through intellectual property -- will be central not only to domestic growth but to international economic harmony, if not stability.

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