TOMORROW'S AGRICULTURE: INCENTIVES, INSTITUTIONS, INFRASTRUCTURE AND INNOVATIONS

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Edited by
G.H. Peters, International Development Centre,
Queen Elizabeth House, University of Oxford, England
and
Prabhu Pingali, International Wheat and Maize Improvement Centre,
Mexico City, Mexico

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ELMHIRST MEMORIAL LECTURE

JAMES T. BONNEN*

The Transformation of Agriculture and the World Economy: Challenges for the Governance of Agriculture and for the Profession

It is a great honour to deliver the ninth Elmhirst Lecture. Indeed, to stand where once stood eight outstanding economists, three of them Nobel laureates, is quite intimidating. I dedicate my comments to the memory of the first Elmhirst Lecturer, Theodore W. Schultz, who passed away last year. He was a professional friend, a role model and a mentor to many in my generation of agricultural economists.

I hope you will pardon a very personal story about Ted. Professor Schultz was not one who endured fools or errors in economic reasoning quietly. My peers greatly admired him for this, but he left more than a few bruised egos among his own and a prior generation of economists. During a social occasion in 1963, Ted recalled for me his first course in economics, a farm management course taken in 1926. I learned to my amazement that his instructor had been my father. I later confronted my father with this information. A quiet-spoken person with a dry sense of humour, my father said very slowly, 'Yes, that is true. But I take none of the credit and none of the blame.' When I repeated this for Ted, he broke into laughter and observed that my father's sense of humour still had the nice edge to it that he remembered. I failed to recount my father's other observation. 'Schultz,' he said, 'was a challenging student.'[1] Indeed he was, and the characteristics that made him a challenging student would later make him a demanding professional – demanding of himself and of others. Ted's life was informed by integrity, great intellectual curiosity, scientific imagination and courage. He was committed to truth and to those without voice in agriculture.

These characteristics were evident in the first Elmhirst Lecture, where Ted Schultz argued that over all stages of the development of agriculture much of what governments had done was often badly flawed. He added that 'The hard

*Michigan State University. Any effort of this scope has benefited from the critical reviews of more than a few colleagues. I am especially indebted to David Schweikhardt for his acuity and endless patience in critiquing multiple drafts and to both David Schweikhardt and Carl Eicher for their many useful ideas and for identifying additional resources. Under great constraint of time, Sandra Batie, Clarence Bonnen, Derek Byerlee, Ralph Christy, Richard Horan, Glenn Johnson, Jim Oehmke, Al Schmid and Luther Tweeten critiqued a late draft that improved the completeness and clarity of this lecture.

realities of the costs of producing goods and services are not abolished by either national or international politics. Herein lies not only the hope but the necessity of economics' (Schultz, 1977, pp.15, 16).

Despite mistakes, some governments have done enough things well for consumers in developed nations today to have the cheapest food in history. Many nations have moved from lower to higher levels of development. Nevertheless, the difficulties facing world agriculture today are as daunting, or more so, as when Professor Schultz spoke to this body 24 years ago in Nairobi. As a profession we must call on the professional characteristics exemplified by Theodore W. Schultz, if we are to deal successfully with the problems we face.

President Hedley has asked that I examine the implications of the evolving global political economy and its transforming technologies for the governance of agriculture and for the profession. This involves a large, complex and interactive set of forces. For clarity I have limited my focus to three major forces of change, set within the parameters of a simplifying framework.

Many of the challenges confronting us arise out of a new era in the continuing transformation of the agricultural sector. The previous transformations of agriculture are well understood by this audience. Early in the process of development, the economic and political characteristics of the agricultural sector provoke governments to discriminate against their relatively large, primarily subsistence, agrarian sectors (Anderson and Hayami, 1986).[2] Later, as development transforms the productivity and the economic and political characteristics of agriculture, governments of developed countries begin to protect and subsidize agriculture. In both cases, these policies are the product of the economic characteristics of the sector and the national economy and thus of the economic and political opportunities and constraints, or the opportunity set, faced by policy makers at different levels of development (Bonnen and Schweikhardt, 1998).

We have learned that, in a low income country with a large portion of its human and other resources embedded in agriculture, economic development will eventually fail, if development of the agrarian sector does not accompany that of the rest of the economy. Except for the small number of well organized farmers in the commercial export sector of some developing countries, farmers have little or no political voice. This is the opportunity set faced by policy makers in low-income, developing countries (Anderson, 1987; Anderson and Hayami, 1986).

Later in the development process entirely new opportunities and constraints emerge as the economic characteristics of agriculture change. Chronic excess capacity and low returns, plus great price and income instability and growing vulnerability to macroeconomic events, occur as the commercial sector of agriculture becomes a highly productive, integrated part of the national economy and of trade. By this time a large number of highly capitalized commercial farms are organized and have a political voice. Problems of agricultural externalities arise in such areas as environmental quality, health, food safety and resource use and in rural development. An entirely new set of constraints and capacities evolve to define the new opportunity set faced by policy makers (Bonnen and Schweikhardt, 1998).

Today we are entering another era in which the economic characteristics of the economy and its agricultural sector are changing, again creating a new pattern of economic and political opportunities and constraints. Most of the earlier economic characteristics of a developed economy continue, including chronic excess capacity with both unstable returns and prices. Externalities continue to grow, as does vulnerability to macroeconomic events. With globalization these also become the characteristics of international markets. Nations at all levels of development are affected. One of the challenges we face in this world of global markets is the necessity to recognize and integrate into national and international policy the needs of widely differing levels of development.

The continuing integration of world markets and national economies, combined with new technologies, especially in information and communication and in biotechnology, is leading to a higher level of international interdependence driven by major new reductions in the cost of time and space. As a consequence, poverty in low-income nations has become, not just an obstacle to the development of those nations, but a clear drag on the growth potential of highly developed nations. We are entering a new era of increasing international economic integration of agriculture.

THREE FORCES OF CHANGE

Important forces of change are currently shaping major economic policy issues and are modifying the conditions of governance. Information and communication technologies and institutions are creating changes in economic capacity, and in the structure and performance of the economy, worldwide. Secondly, new biological technologies have the potential for a similar impact on agriculture, health and medicine. Thirdly, the institutions that structure and order markets are being modified, not only by information and communication technologies, but by international treaties and by private sector innovations in the institutions of capital and commodity markets. This is leading the world towards globalization of markets or international economic integration, as economists understand this ill-defined and much abused term. Other forces contribute to these changes, but are not addressed here.

The different forces of change are interactive. The new information technologies and the economic integration of the world's markets are complements with reinforcing effects on each other. For international agricultural markets, the biotech revolution adds even greater potential, but many uncertainties still attend its commercial applications and acceptance in different societies.

Technology is important, but equally important and frequently overlooked are the changes in the physical capital, human skills, institutions and values. These are often more important because, as scholarship on the history of technology clearly shows, human capital, value beliefs and institutions will shape the ultimate uses and consequences of technology, not just the other way around – as is commonly assumed. Change in any one of the forces can induce change in another. All of these forces of change are essential complements

(G.L. Johnson, 1997). They all have the potential to increase the capacity of society to achieve its goals. To what extent and how, whether for good or bad, is determined by the choices we make as individuals and as a society.

These forces are leading to a transformation of the fundamental nature and capacity for governance, not only of nation states, but governance of most major economic sectors such as agriculture. We are in the middle of creating a very different and more complex world compared with that of the past century, about which there is a voluminous and growing literature.[3] We face an agenda of problems and policy issues, some of which are entirely new and many of which will challenge our profession over the next generation. Our responses to these challenges will often involve choices between conflicting prescriptive beliefs and ideologies.[4] Consequently, our participation in addressing such problems will be plagued by uncertainty and by personal and professional risk.

Turning back toward protectionism at this point would involve great loss of economic welfare worldwide. But moving ahead will not be costless. Inequality of income and wealth in the developed world is increasing. Poverty and its ills are the largest challenge faced in the development of low-income nations. Any increase in the economic welfare of nations, developed and especially developing, now depends on a nation's fabric of institutions, on the rules for trade and finance and the resulting gains from specialization. As dramatic as the impact of the emerging new economy has been, we are only in the early stages of this economic and political transformation.

Since the Second World War, the world economy has slowly become one of more integrated global service, commodity and capital markets. As a consequence, despite many problems, we are experiencing growing worldwide economic interdependence of national economies and their major economic sectors – including agriculture. We are still a long way from the 'deep integration' that would permit global markets to operate across economic sectors and national borders without significant discrimination or costly restraint. Deeper integration would require still greater international coordination of market grades and standards, of property right laws and of the institutions and rules for commodity, service and financial markets. In this process international governance grows more complex and problematic.

ANALYSING THE FORCES OF CHANGE IN A GLOBAL SETTING

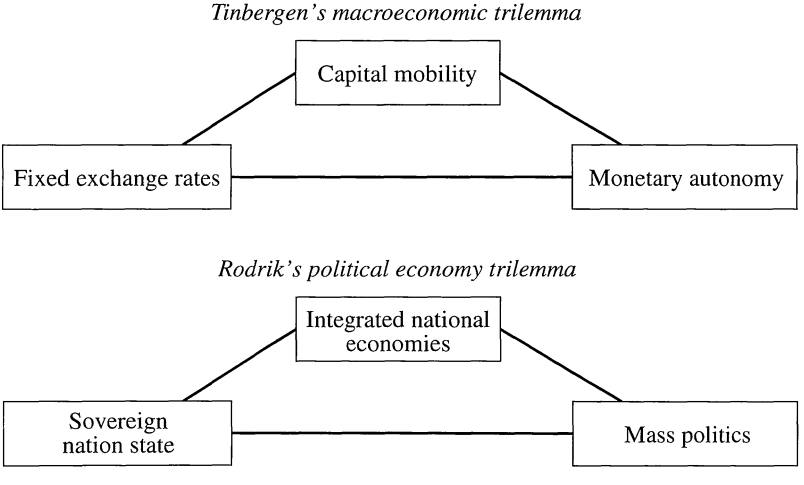
In examining the new opportunities and constraints affecting the agricultural sector, I will draw upon some well-developed principles of policy analysis that have recently been recast in a form applicable to the problems facing agriculture. Nearly a half-century ago, in examining the multiple macroeconomic objectives confronting policy makers, Jan Tinbergen demonstrated that, for policy makers to achieve all of their objectives, the number of *independent* policy instruments (or tools) must at least equal or exceed the number of policy objectives. If the number of available instruments is less than the number of policy objectives, or if they are not fully independent of each other, policy makers face an unavoidable choice of which objective will go unfulfilled. The

relative independence and thus the ability of each instrument to achieve each objective – or its 'efficiency' of achieving each objective – is determined by the economic characteristics that define the policy problem (Tinbergen, 1956; Fox and Thorbecke, 1965; Obstfeld and Taylor, 1998).[5]

Tinbergen's work demonstrated what is widely known as the classic national problem of macroeconomic policy: the simultaneous effort to maintain (a) fixed exchange rates, (b) open capital markets and (c) national autonomy of monetary policy (Figure 1). As Tinbergen defined this problem, policy makers have a choice of achieving any two, but never all three, of these policy objectives. This choice of the combination of instruments and targets represents the opportunity set that macroeconomic policy makers must confront in making their decisions.

Dani Rodrik (2000) has recast Tinbergen's original model of macroeconomic policy making into a much broader model of policy making and political economy within an integrated world economy (Figure 1). Rodrik's 'trilemma' involves three targets: the international integration of national economies, the sovereignty of policy making by the nation state and the practice of 'mass politics' in which a fully participating polity expresses its political preferences in a democratic state.

There is a prior condition that is crucial to understanding this dilemma. Today, if you opt for a policy of attaining above-average, or high rather than lower, rates of growth, you find you are dependent for investment on what is now a single, immense, worldwide capital market. This capital market is driven by thousands of anonymous stock and bond traders all over the world who, with the click of a 'mouse', can instantaneously move large amounts of money



Source: Adapted from Rodrik (2000).

FIGURE 1 *The trilemmas of Tinbergen and Rodrik*

over the Internet from one investment category to another, *or from one country to another*. A nation can have access to far more capital than in the past, but it must live by open, free market rules to maintain its credit rating. Lose a high rating and you lose market access and can suffer a crisis of capital flight. The power to set one's own policy rules is compromised before any policy goal has been set. This global capital market is replacing governments as the source of capital for both corporations and governments.

It is almost impossible to run an open economy without a reasonably open or democratic society. This raises the question of 'mass politics', which needs to be defined clearly. Rodrik's mass, or participatory, politics exists where the franchise is expanded well beyond the right to vote, to include the lobbying efforts of all organized interests. Thus, if the political franchise is unrestricted, any social or economic interest may have a voice in the policy decision process along with government policy makers. In addition, a high degree of political mobilization must exist; that is, all significant social and economic interests are organized and politically active. While all interests may have the same right of access, in reality different interests will have quite different capacities to make their voices heard. Finally, political institutions are responsive to mobilized interests; that is, policy makers cannot ignore opposing interests, but must deal with the opposition, presumably at some political cost. Thus, if mass politics prevails, the policy maker in Rodrik's trilemma is forced to choose between international economic integration and state sovereignty. One goal must be abandoned (Rodrik, 2000).

Participatory or mass politics is in some degree a product of development itself. As development proceeds, specialization breaks large, older markets into many new markets. As income rises, consumer preferences extend beyond food, shelter and security to new values and to new value-added products. The previous structure of products and markets fragments and the number of economic interests proliferates. Inevitably, there are externalities to these changes that induce new interests to organize in opposition to some element of that change. Thus development produces a far more complex set of markets and interests and often a countervailing set of economic and social critics. These unavoidable economic characteristics of development produce a significant level of interdependence between the policy tools needed to address the three policy goals in Rodrik's trilemma.

Thus the policy maker in Rodrik's framework is faced with an unavoidable choice among policy targets. If policy makers choose to maintain the sovereignty of the nation state and *also must respond* to the participation in national politics by *all organized interests*, including those who oppose international economic integration, they cannot achieve *full integration* into international markets. Alternatively, if they attempt to achieve full international integration and also practise mass or full participatory politics, then the nation state must yield some of its sovereign power to those international institutions to which the polity must express its preferences for a framework of international integration. Finally, if the nation state is to maintain its sovereignty and simultaneously achieve integration with international markets, the range of political options available to the polity – or the responsiveness of the nation

state to the demands of a broad range of domestic interests – must be reduced. The number of private sector institutions and their role in governance grow while those of a nation's public sector shrink.[6] Rodrik's model provides a framework within which to examine the continuing international transformation of the agricultural sector.

THE INFORMATION ECONOMY AND GLOBAL MARKETS

An important force in the current transformation of the world economy is a significant reduction in economic transaction costs driven by the new information, communication and computation technologies and their implementing institutions and human capital. In global markets, intermediate stages in the production of commodities and especially services are being unbundled and scattered to lowest-cost sites across the globe, making government regulation and taxation difficult to design or enforce. Electronic commerce is even more difficult to regulate or tax.

Economic characteristics of knowledge and information

Lowering transaction costs reduces organizing and operating costs and is leading to great increases in financial wealth and to changes in economic and political organization. Lowering economic transaction costs also lowers the barriers to entry, especially in knowledge and communication-intensive sectors. The potential for smaller scale, private sector entrepreneurial and political initiatives increases.[7]

Financial, commodity and service markets become so interdependent, country of origin so confused, and transactions so elusive that governments lose much of the ability to identify domestic production or to regulate and tax it. A primary signature of sovereignty is identifiable geographic boundaries and the power to tax and regulate within and at those boundaries (Krasner, 1999).

High costs of the first copy of information and information technologies often lead to market price and product differentiation. This frequently becomes a strategy of customer differentiation aimed at capturing the subset of the market that generates the highest profits. The cost of producing (or copying) additional units is so small that defending property rights is costly. Because of this cost structure the marginal cost-based pricing strategies of 'Economics 101' (the course which we have all taken!) are not a viable choice for firms in information markets. This leads to aggressive strategies focused on gaining a dominant market share early on so that your firm's information technology becomes the national and international industry standard. If successful, this assures your market, since information technologies exist as systems of interconnected technologies that are complements in production. If your technology becomes an industry standard and you have a dominant market share, your customers get 'locked in'. This was Microsoft's strategy. Over the long run, a high rate of innovation in information technologies can make obsolete the technological base of your market position. Thus continuous innovation in

technology and smart marketing are often necessary for long-term survival of even the largest, best financed firms. This means that many information products and technologies may have limited proprietary lives (Shapiro and Varian, 1999).

We are still in the early stages in the development of computer-based internal and interorganizational networks. Distributive computing is a new frontier in information technology. Business and most service organizations are moving towards real-time decisions, which requires real-time information and increases the vulnerability of such systems to power outages, security breaches and privacy problems. The stupendous power of the Internet and other interorganizational networks to force change on the organization of business and services is yet to be fully appreciated. Not only are transaction costs of operations falling, but inventories and capital requirements are declining. The survivors will be very customer-oriented. At the macroeconomic level, lower inventory and capital requirements should dampen the business cycle. The norms for policy action based on measures of unemployment, inflation and productivity in the new information-intensive economy appear to be changing.

Information products and products that have become more information-intensive will often have lower exclusion costs, which can transform the margin between what have been publicly or privately provided goods. Lower exclusion costs permit privatization of some formerly publicly provided goods and raise policy issues over others as to who should provide, or pay for, a specific product or service. On the other hand, high first copy costs *plus diffuse benefits* will limit other information products to public provision.

New opportunities, constraints and choices

The major constraints to be faced in exploiting the opportunities in the economics of information-intensive products, the new communication technologies and global markets are (a) an erosion of a nation's capacity to regulate or tax commerce in domestic and international markets, (b) increasing loss of control over financial flows, over a nation's monetary policy, and thus exposure to events such as the recent Asian financial crisis, (c) growing private economic power, much of it beyond national accountability in mergers and concentration in domestic and international markets, and (d) the high incidence of poverty and its associated ills in many of the low-income nations which deprives these countries of the capacity necessary to access the information and communication technologies, institutions and skills needed for successful development.

An additional constraint is inherent in information management itself. Three decades ago, Herbert Simon (1971) pointed out that the social cost of information includes the cost to the user of the effort needed to retrieve information for any specific decision. Thus, in an information-rich environment, as the amount of information increases, the amount of attention a user can devote to any specific bit of information declines. In the current explosion of information and its ease of access, one faces far more difficulty in identifying, organizing and integrating relevant information for any specific decision. This has serious implications for governance since the difficulty increases as one goes from

lower to higher levels of decision. Thus the problem of getting the right information to the right decision nexus is most complex and costly at the international level – something that must be considered in designing the institutions of governance.

Rodrik's trilemma

Exploiting these information and global market opportunities leads towards one side of Rodrik's triangle of choice, towards international integration of national economies, international regulation of markets and ultimately towards an international system of governance. One is left with a choice between sovereignty of policy making by nation states or mass politics at all levels of governance, but not both. At present, many developed nations seem to be embracing mass or participatory politics, with a loss of national sovereignty. A reaction in developed nations has begun to mobilize the forces of nationalism and of political extremism.

The growth of concentrated economic power combined with high levels of wealth in some nations and great poverty and political disorder in others induces large human migrations. Depending on the political and economic context, large migrations have in the past led to significant economic growth or contributed to social instability, or both. In reaction to migrations today, populist and nativist political movements are developing in wealthy receiving nations. Most highly developed nations now also face a future of rapidly aging populations with a declining size of workforce. Thus, if they are to maintain their economic capacity over the next several decades, these nations need an influx of younger but reasonably well trained migrants. Many migrants today, however, lack the needed education or skills. That will continue to be the case unless the developing nations are able to create the human and institutional capacity needed to gain access to the technologies, institutions, human capital and financial markets of the developed world.

There will be political and economic costs, whether the world moves towards greater international economic integration or retreats to protectionism, xenophobia and a search for national sovereignty. We should remember that the same political forces helped destroy the global markets of the nineteenth century. Then the First World War and the Great Depression finished the job. Serious critics cannot be ignored or shouted down. The outcome remains at issue.

AGRICULTURAL BIOTECHNOLOGY AND GLOBAL MARKETS

Another primary force in the transformation of the economy is that of biotechnology. The introduction of agricultural biotechnology has been badly managed and politicized. Most biotech innovations are little more than extensions of traditional plant and animal breeding techniques that have been going on for thousands of years, the risks of which are limited and well understood today. The still emerging field of molecular knowledge in plant and animal genetics

(genomics) enables far more precise and efficient breeding without recourse to transgenics (often called 'genetically modified organisms' or GMOs). Transgenic modifications are another matter, since they involve the transfer of genetic material between different genotypes. But transgenic research is as yet a relatively small proportion of total biotech R&D (Byerlee, 2000; Horstkotte-Wesseler and Byerlee, 1999). Here there are highly uncertain benefits and risks that must be explored. So far demagogues and poorly informed participants have confused the debate by treating all biotech as if it were transgenic. We need to be working with biological scientists on biotech risk assessment and on the larger market and equity issues. Agriculture must take far more care in informing society's understanding of these risks and benefits. Food is psychologically sensitive and consumers will have the last word on what risks are socially acceptable.

Public discussion often assumes that absolute certainty and zero risk are reasonable goals of food safety. Especially at the individual consumer level, there can be no absolute certainty or zero risk in the interaction among production inputs, foods consumed and the diversity of human biological characteristics. Individual variation in biological organisms is just too great. With all of its limitations, the role of risk analysis and its integration in policy assessment are important. Two very different questions arise: what is the level of risk, and is that risk socially acceptable? While both are subject to various levels of uncertainty, the first is largely a question of science. The second is primarily a question of politics involving social values. The socially acceptable level of risk relative to benefits will differ between the rich and the poor, and will be different in different cultures.

The potential impact of biotech on productivity may eventually exceed that of information and communication technologies. Some economists question whether the productivity gains created by the 'information revolution' will spread beyond the information industry into other sectors as far as did the chemical, electrical and mechanical technologies of the industrial revolution of the nineteenth century (Gordon, 1999; Jorgenson and Stiroh, 1999). Intuitively, it would seem that biotechnology innovations in agriculture, health and medicine have a potential to spill over into many other sectors of human activity, perhaps adding more to total productivity than the information revolution, the gains of which so far appear to be limited to the information industry and its customers (Gordon, 1999).

Economic characteristics of biotechnology

The investments countries make in agricultural research, especially basic research, often lead to significant spillovers of benefits to other nations. Left unattended, this results in a cumulative underinvestment in agricultural research, both in the investing nations and worldwide (Schweikhardt and Bonnen, 1992). Major differences in national property rights laws and their enforcement can constrain the economic value of biotech products in global markets. The development of agricultural biotechnology has the potential of compounding the problem of the growing gap between the economic performance of developed and developing nations. This is a complex set of problems, but

evidence for chronic public underinvestment in research for agriculture, at both national and international levels, continues to grow. Improved international institutions and public support for financing, producing and disseminating public agricultural research for low-income nations are a clear need and a necessary complement to private investments in agriculture.

Many biotech products to date have high fixed costs and very low marginal costs, much as in pharmaceuticals and the information industry (Rausser, 1999). How costly it will be to protect property rights in biotechnology remains to be seen. The outcome will affect research strategies and their public–private mix. The structure of the biotech industry will certainly be concentrated initially. The developed countries are experiencing a complex series of mergers of seed companies with a small number of large international chemical and pharmaceutical firms. This strategy is focused on the potential of biotechnology and could end with only a few vertically integrated firms exercising monopoly power over the supply of high-productivity germ plasm in large regions of the world. They would control the farm input market from germ plasm to the provision of seeds bundled with pesticides and herbicides. Wally Falcon explores these issues in detail in his fine paper 'Globalizing Germ Plasm: Barriers, Benefits and Boundaries', found later in this volume. With high rates of biotech innovation, the potential for concentration may eventually decline.

The income elasticity of demand for the multiple dimensions of food safety rises across the process of development. It exceeds the declining income elasticity of demand for food in most highly developed nations. Similarly, the income elasticity of demand for protection of the ecosystem and the environment rises with income over the development process. It too appears to exceed the declining income elasticity of demand for food in highly developed nations. This assures serious consideration of regulation to achieve environmental and food safety policy goals in agriculture.

The political characteristics that have followed the introduction of biotechnologies involve the mobilization of food safety, ecosystem and environmental advocacy and anti-biotech interest groups (NGOs) at all levels of governance from subnational to international. Some groups now participate with and add strength to the anti-globalization movement.

The battle over agricultural biotechnology has thus far been primarily between factions in developed industrial nations. Our profession should be working to improve the capacity of developing nations to participate in and shape biotech research and policy agendas. The stake of the developing nations in biotech must be kept a central part of the debate. I expect biotech products will eventually become a major dimension of agricultural productivity. They clearly have the greatest potential value in the developing world, especially in resource-constrained environments such as arid regions, high altitudes and parts of the tropics. If market rules permit a private-sector, developed-nation monopoly of biotech products, the gap between rich and poor nations will grow even larger. National security and economic interests of both the developed and the developing world are endangered by a growing chasm between rich and poor. This cannot be allowed to continue, if a stable, food-secure world is

ever to be attained (Runge and Senauer, 2000). Interdependence now leaves all nations too vulnerable.

Biological innovations, especially biotech, must be available as a publicly provided good in the developing world (Harl, 1999; Stiglitz, 1999). How to finance this on a scale needed for success has not, to my knowledge, been seriously addressed. Both governments and private sector leadership in highly developed nations have a major responsibility to help organize and finance biotech capacities in those developing nations willing to make a serious commitment themselves. Those who today argue that markets alone can deal with this problem are wrong. They are ignoring the challenge in agricultural development faced by the poorest nations and by smaller-scale farms in a capital-intensive industry. Also 'minor crops' important in developing nations present a classic problem where the returns on private research investment in such small markets are limited relative to the investment costs and associated risk. The public sector also faces serious limitations in dealing with this challenge. One potential solution can be found today in various kinds of public–private partnerships now under way in a few low-income, developing countries. Several donor nations are committed to this initiative (Horstkotte-Wesseler and Byerlee, 1999; Lewis, 2000). Partnerships are highly varied combinations of national agricultural research systems, universities, donors and private firms. For the long term it is especially important to develop capacity for biotech collaboration between universities and national research systems in low-income, developing nations.

Eventually, the rate of innovation in biotech should be very high, since the developing knowledge base is so fundamental to the entire plant and animal kingdoms. If this occurs, many genetic inventions may have limited lives of proprietary value. The rate of biotech invention will certainly proceed far faster than has that of traditional breeding. If the commercial value of many plant biotech products erodes within a few years, it may then be possible to provide them as public or low-priced goods in low-income, developing nations.

The growing practice of patenting genes, not only by private but by public sector organizations, raises questions about the ability to maintain biotech products as broadly accessible, low-cost products. Public research organizations face a dilemma. If they fail to patent their biological innovations, private sector firms may expropriate public innovations in their private patents. This behaviour by firms could endanger the long, highly productive, tradition of public support for agricultural research. Even when public research organizations patent their discoveries, there is still a complex problem of market development and distribution for which the public sector has limited capacity. This dilemma has caused the International Wheat and Maize Improvement Centre in Mexico to begin patenting their genetic innovations as a defensive strategy to protect their broader availability to poor farmers (*New York Times*, 2000). How well this will work is uncertain, since implementation clearly requires new protocols and institutions including expansion of public–private collaboration. This is a major institutional challenge.

In the USA, many public universities are systematically patenting all research results with commercial potential, not to protect a public good, but

simply for the income generated. This practice threatens to subvert the intellectual independence, integrity, incentive structure, culture and purpose of public universities. Involved is a complex issue including long-term decline in public funding and competition with private universities.

Assuring a substantial flow of publicly provided germ plasm and biotech innovations into the market would help restrain market power. If this is to be achieved, publicly financed national agricultural research and development must resist the trend towards privatization. Biotech R&D began as a public sector investment, but is now predominantly a private sector enterprise. The financing of national R&D and that of the CGIAR system of international research centres urgently needs to be greatly expanded and efforts better coordinated in providing some of the global public goods needed in agricultural development. CGIAR investment in biotech is less than 10 per cent of its current budget (Serageldin, 2000). Without improved agricultural productivity, national economic development eventually stalls in a low-income, developing nation (Anderson, 1987; D.G. Johnson, 2000).

New opportunities, constraints and choices

Thus there are a number of constraints to be faced in exploiting the opportunities that arise out of the characteristics of agricultural biotechnology in global markets. First is the uncertainty over whether some biotech food products pose high risks to consumer health and endanger the ecosystem and the environment when the public does not understand the difference between transgenic and non-transgenic biotech. Second, rising income elasticity of the demand for food safety and environmental quality ensures that the demand for these characteristics will grow faster than the demand for food, especially in developed countries. Third, the new information technologies reduce transaction costs and thus the cost of creating and operating an organization. This now permits many more interests to organize an effective political voice in decisions on biotech. Fourth, the cost structure of the biotech industry will concentrate market power in an industry that is dominated by developed nations. This threatens to widen the gap between rich and poor nations, if developing nations are denied access to biotech products by high proprietary prices and the developed nations fail to invest in public-good biotech products for the location-specific needs of developing nations. Fifth, in many low-income nations, there is also a lack of capacity to gain access to biotechnology and its supporting scientific institutions and skills. Without the access to biotech, most of these nations have little chance of escaping a permanent state of low productivity and human welfare – falling even further behind the developed nations. Sixth, chronic underinvestment in public agricultural research persists because of the high spillover of benefits from national R&D programmes and of donor fatigue and other problems now plaguing the CGIAR research system. Finally, the large volume and political sensitivity of global trade in food and farm inputs make biotech constraints not just national, but international, issues.

It is uncertain whether, and in what form, these constraints on biotech can be overcome to realize the potential benefits. My guess is that, in the short run,

biotech will slow, but ultimately add to, the movement towards international economic integration. The outcome depends on the strength of leadership and the conclusion about biotech risks. In the long run, if benefits relative to risks are within a socially acceptable range for many countries, the rest of the world is likely to be forced to join in biotech product use – or fall behind in development.

Biotech has the greatest value in the developing world. Agricultural economists must keep the developing world's stake in biotech a central part of the debate. If we fail, the gap between the rich and poor nations will grow. In an increasingly interdependent world, the political and economic security of both the developing and developed nations will be endangered.

Clearly, biotech funding and scientific capacity must be increased in developing nations and biotech R&D must be a publicly provided good, or nearly so. Biotech products must be available at prices well below developed nation proprietary prices. The market alone will not solve this problem. We need complex public–private partnerships involving national research systems, donors, universities and private firms. Some pioneering efforts are under way.

The opportunities and constraints in crop production are generally location-specific. Most plant biotech products created for use in developed nations will not be immediately useful in many low-income nations. The adaptation of basic biotech knowledge for use in low-income nations is a logical role for the CGIAR research centres, and for donor nation development projects, especially working in public–private partnerships in individual countries. There is a complex property right, patenting puzzle here that we need to work on.

Rodrik's trilemma

While it is too early in the development of biotechnology to foresee its full implications and pervasiveness, clearly its safe and effective implementation will require international standards and regulation. Thus exploiting the opportunities in biotechnology and global markets pushes one towards international integration of national economies, international regulation of markets and, ultimately, towards an international system of governance. In this situation, one will be forced, step by step, to relinquish more of the nation's control of policy and to deal with a broader array of participants and conflict in policy making. Here again, this must be managed well politically, or one faces the risk of a backlash of nationalistic and extremist movements, including populist and nativist political forces that could stall or derail the movement towards international integration of national economies and markets.

THE GOVERNANCE OF AGRICULTURE[8]

Governance grows more complex

The problem of governance at all levels has grown more complex, politically and technically. International economic integration and the revolution in infor-

mation technologies are making national governments more dependent on international agreements. At the same time, governments are having greater difficulty reaching agreement and enforcing resulting policy rules. The transaction costs of governance are increasing.[9] It is at the international level that transaction costs present the greatest challenge to the design and maintenance of governance institutions.

International treaties are no longer just the product of negotiations between sovereign nations. A heterogeneous and growing number of national and multinational economic and civil society political interests have organized. They now intervene in national policy making, in international treaty making and with various international governance structures, such as the IMF, World Bank, the WTO and even the CGIAR. These range from commercial market interest groups, animal welfare groups, labour organizations, human rights and anti-poverty advocates, environmental groups and multinational corporations to anti-globalization advocates, anarchists and others – all competing to create, shape or destroy the international institutions of governance necessary for an orderly world. Within open, fully enfranchised democratic societies this is a legitimate form of public voice, but if policy makers are unable to ignore the pressure of interests that conflict directly with the state's clearly committed policies, the state is less than sovereign in its powers.[10]

Political transaction costs of governance

The new information technologies have reduced the costs of economic transactions. Lower economic transaction costs, in turn, make it easier and less costly to create and manage political action groups. This increases the potential number of policy participants and gives individuals and groups greater political access and policy voice, locally, nationally and internationally. The resulting proliferation in the number and reach of privately organized political voices raises the political transaction costs of negotiating and implementing policy decisions. It fragments, disorders and flattens the traditional hierarchical structure of political institutions within which public policy has been made in the past.

Some organized interests make major contributions to the balance and stability of international agreements, and to their enforcement, especially when nations fail to address international externalities or problems of the 'commons'. Some others are uninformed or destructive.

As nations move towards more open and democratic political institutions that are accessible to all organized political interests, politicians and political institutions face the necessity of managing ever-larger political transaction costs (Olson, 1965; Buchanan and Tullock, 1962). Political transaction costs can increase to the point that some important issues cannot be addressed at all. Others, if considered, lead to highly conflicted, poorly informed decisions. We have already reached this point in many developed nations. At the national level this leads well-organized interests to bypass the legislative and executive institutions of policy formation. With increasing frequency, such interests find it most effective and cost-efficient to pursue their policy goals in the courts,

and through campaigns to rally public opinion in highly visible public confrontations (or threats of such) with the regulatory agencies or private firms whose behaviour they wish to modify. Policy making and politics that bypass traditional political institutions leave policy formation and democratic accountability problematic and uncertain.

Today, we face new issues and economic characteristics as we enter a new era of even greater international interdependence of markets and national economies. Rising income levels cause developed nations' consumer food preferences to grow ever more diverse. The food industry responds by designing new food products for specific preferences. Non-food uses for farm products grow. The potential export market for developing nations expands. Biotechnology now has the ability to create products 'designed' to fit new preferences. In the process, the homogeneous bulk product markets of agriculture fragment. Market fragmentation eventually leads to such a diversity of interests and such a high level of political transaction costs that it becomes impossible to negotiate, or even conceive of, a single, well-integrated legislative vehicle for national agricultural policy. Eventually, we are likely to be left with such diverse characteristics that both domestic and international agricultural policies, and the agricultural policy process itself, will break into many different pieces.

The structure of institutions for the international governance of agriculture are almost certain to become much more segmented, if not fragmented. Resource-limited developing nations will face even greater difficulty than they do now in dealing with the international institutions of governance (Bonnen and Schweikhardt, 1998).[11]

The changing politics of multinational negotiations

A different political chemistry and balance is evolving in multinational negotiations. Developing countries are no longer willing to accept multilateral rules imposed by developed countries to achieve developed-country goals. This is especially clear in trade negotiations. The great increase in GATT–WTO participants, not only of governments but of advocacy and interest groups, does not bode well for the transaction costs of the current round of negotiations. Over 130 nations now participate in the WTO, not the 20 of the first round, or the 85 at the beginning of the previous, Uruguay Round. Most of the new participants are low-income, developing nations whose future depends significantly on what happens in agricultural trade and finance. A rapidly evolving East Asian bloc of nations may add a strong voice as a third force. If recent Asian country regional negotiations are any indication, financial market integration may now be more important to developing nations than trade. Indeed, problems of phytosanitary rules, e-commerce rules, human rights and rules for labour and employment conditions have become more important issues facing multinational negotiations than tariff barriers. Past trade negotiations have been dominated by US versus European issues. In three-way negotiations, the dynamics and outcomes of multinational negotiations are sure to differ from the past, especially if current GATT–WTO decision rules remain in force.

The poverty of developing nations as a drag on developed nation growth

Today, we shall either develop together in an integrated market regime or fall well short of our potential economic capacities. Indeed, some argue that the primary justification for pursuing global market development is to reduce poverty and close the growing gap in human welfare within countries and between developed and developing countries.

In developed countries, economists must help their leadership, in both public and private sectors, to recognize their dependence for political stability and growth on the achievement of higher incomes and reduction of poverty in the developing world. Developing country economists must help their leadership to understand that corruption, disorder, direct government control of markets and the lack of market standards (rules) and enforceable property rights limit development and undermine the potential for growth and the collaboration that both developed and developing countries need. Developed nations still face a few of these problems, including maintaining discriminatory barriers to trade in agricultural markets. Compromise must still be reached on differences in national interest, but the glittering corpse of mercantilism still leads some to view international trade and finance rules as a zero-sum game – which they cannot be, if we are to achieve the potential in growth we all desire, in both developed and developing nations.

Concentration of market power

A rapidly developing problem of concentrated market power in world agriculture can undermine rural economies and discriminate against price-taking farmers. Despite complaints of a lack of access to capital, the industrialization of the food system continues apace. The structure of the food system is changing. A worldwide merger movement, taking advantage of new technologies and growing global markets, is restructuring and concentrating both farm input and farm product markets. In most industrial countries national and multinational retail food firms are, through vertical integration or contractual coordination, reaching back from the retail to the farm level to control product specifications, contractual conditions, risk and timing. In commodities where vertical coordination via contracting is prevalent, farms producing, for example, poultry, hogs or specialized niche market crops will often face only one effective buyer within their marketing reach. Commercial farm input sectors have long been concentrated. Many international markets are dominated by large developed nation firms. As in the past, concentration raises issues about the regulation of market structure and behaviour or governance of the sector – issues that now urgently need research attention and intelligent policy advice.

When independent farmers, who are competitive price takers, face monopoly power, farmers lose. Farm prices and costs squeeze the farmer, and farm asset values decline. This is both an economic and a political problem. The traditional response has been farmer cooperative organizations or national anti-monopoly legislation. But these are world markets, not just national ones, that are becoming concentrated. National cooperatives have not usually offset

monopoly power. Multinational, farmer-controlled cooperatives, if comprehensive and well run, might have an impact. Maintaining reasonably competitive world markets is necessary for efficient use of resources, but it is equally necessary for fairness to consumers and farmers who have little organized market power. This problem may give rise to pressures for international regulation. The current growth of market power in farm inputs is primarily based on control of innovations in agricultural research and development, especially in germ plasm and biotech applications.

Globalization of externalities

Externalities become globalized along with the markets in which they occur. Environmental and ecosystem effects of private and public economic activity constitute perhaps the most pervasive negative externality creating policy conflicts today. Earlier we described the problem of chronic underinvestment in agricultural research caused by the spillover of benefits from national research investments. Significant third-party losses can arise in agricultural markets from domestic production subsidies and from bilateral and regional trade agreements. Domestic subsidies for one sector almost always create a tax on the exports of other sectors.

The simultaneous growth of economic inequality within and between countries, great poverty in low-income developing nations and the increased mobility of people and their knowledge of economic disparities has led, along with civil disorder and war, to large human migrations from disadvantaged and disturbed regions to prosperous and advantaged areas and nations. Rural areas and agricultural and natural resource industries are often profoundly affected at both ends of a migration. Understanding and managing the complex economic and political consequences of widening inequality and migration present a serious challenge in many regions of the world.

Many other international externalities exist. If these become significant problems, the only solution involves internationally negotiated agreements, which again push one towards international economic integration of national economies, with a residual choice between national sovereignty and mass politics.

What of the future of global economic integration?

Our era is not the first time the world has experienced global integration of commodity and financial markets. World trade and financial markets were far more open during the latter part of the nineteenth century until the cataclysm of the First World War and Great Depression (O'Rourke and Williamson, 1998). This could happen again, with even more destructive results, if strong and informed leadership is not forthcoming (Gilpin, 2000).

International economic integration is not inevitable. The Seattle WTO disaster and the recent World Bank–IMF meeting disturbances should warn everyone of that. Seattle may have been a civil disaster in the streets, but the WTO meeting itself was a fiasco. Without access to global finance, commodity and

service markets, much of the developing world is likely to be condemned to slow growth at best and stagnation in those cases where there is poor leadership or a grossly inadequate base of human and natural resources.

Negative reactions to global markets and to the new information and biological technologies should not have been a surprise. Historically, revolutionary change has been followed by counter-revolutions to overturn the original revolution or modify and reshape its perceived excesses. Nineteenth-century global markets started to unravel in a political backlash to the distributional effects of globalization well before the First World War and the Great Depression. Today, a backlash is growing and critics cannot be ignored or shouted down. This profession has a responsibility to address the substantive market and non-market distributional issues in agriculture.

Some economic and political interests argue today that, because of international competition, a nation cannot afford the cost of a significant social safety net for those who are left behind in international economic integration, whether owing to job displacement, inadequate education and skills or even major loss of political influence. They are quite wrong. First, historically we know that failure to provide an adequate social safety net for those who are losers in international integration of national economies has led eventually to a political reaction that can undermine the institutions of international economic integration (Williamson, 1998; Gilpin, 2000). Second, empirical evidence shows that the nations with the greatest exposure to international markets are now also the nations with the largest percentage of the national budget spent on a social safety net (Rodrik, 1997). If international integration of national economies continues to be a common goal, we must pay close attention to the social investments necessary to maintain the welfare of those groups which see themselves injured by technological change and international economic integration.[12]

Markets and government constitute an unavoidable nexus. The issue is not a question of one versus the other. It is one of achieving an appropriate combination and the complementarity of their different roles within the economics, culture and historical experience of a specific country. Ideology aside, what now complicates any decision on the appropriate balance between public and private regulation of markets is the large reduction of economic transaction costs and the growing importance of information as an economic good in the new information and service-based sectors. The markets for and the economics of information, as we know, differ greatly from those of homogeneous physical commodities. As a consequence, once again we are struggling to determine which activities should now be a private function, a public function, or some complementary mix. This is both an economic and a political question.

Rodrik's trilemma and governance

On balance, at this point, I believe the constraints and pressures on governance will continue pushing us towards international integration of national economies and towards participatory politics internationally, and thus away from the sovereignty of nations. The continuing decline in the costs of time and space push us in this direction. We have reviewed the many pressures on governance

that require international cooperation, regulation and institutions of implementation. These interact with the new information and communication technologies that empower many new internationally active social and economic advocates and interests. If you wish for internationally integrated national economies with an unrestricted domain of politics, then you must cede some of the sovereign authority of the nation state to institutions of international governance – ultimately, perhaps, a federation in form.

The European Union now faces this dilemma. We may all face it eventually. It appears to have led German Foreign Minister Joschka Fischer to suggest that the EU explore the issues of federation. Federation implies unified executive, legislative and judicial functions. Today's European nations would then become subnational units of a federal government, just as the original, newly independent, American colonies did after ratifying the US Constitution. Achieving a highly integrated world economy will come at a high price to existing institutions of governance. Success in getting there will involve decades of effort. This process is obviously problematic, with significant economic and political consequences that must be considered carefully. One can envision politically unstable outcomes and failure. In any case, absolute sovereignty is an illusion in a world that grows steadily more interdependent as a result of technological change alone.

If international economic integration begins to unravel, we will pay a high immediate price in lost economic welfare and in long-run economic growth. In addition, it is difficult to see how one can ever get the social and economic interests now operating at many national levels and at international levels back into the bottle of national sovereignty.

It has to be remembered that politics is not invariably subject to the rule of reasoned interest. Emotion without the anchor of pragmatic and informed reason can drive contentious issues. In addition, history is filled with sudden disruptive events that re-order economic incentive, national interest and balances of power. Thus great care in political management and strong, informed political leadership are still required. We must contribute to this effort.

CONCLUSION: MAJOR CHALLENGES FOR THE PROFESSION

We are entering a period of fundamental disruption and transformation of the world economy and society on a scale approaching that of the industrial revolution of the 19th and early 20th centuries. For our profession this is a research, teaching and policy challenge perhaps unmatched since Ted Schultz and others of the pioneering generation of agricultural economists struggled with the transformation of the world around them in the early decades of the 20th century. They worked to understand and adapt the forces of the industrial revolution to the needs of human beings in agriculture and society at large. The existence of our profession and, indeed, of this association is a monument to their success. I believe we face a challenge of similar scale today.

Although this profession has significant and growing international capabilities, our problems are becoming even more intensely global. It follows that

agricultural economists should greatly increase their international collaboration in teaching and research and in extending their research and policy analysis. Building on existing efforts, I believe this Association could make a great contribution working with its affiliated national organizations to expand the profession's international capability. Greater interactive linkages with cooperative institutions, including government ministries, foundations, other social and natural sciences, and even some social and economic interest organizations are needed to extend our capacity to help deal with global and regional challenges. The form of such cooperative institutions will depend on the nature of the problems they address.

Our profession has long had a critical role informing the decisions that adapt new technologies to human use. In agriculture, food, natural resource use and the environment today, agricultural economists are responsible for providing an understanding of the economic problems faced, the choices available and their consequences. We have a theoretical framework capable of helping to inform choices, including those that involve conflicting human values and institutions. We should focus much of our economic and policy analysis on the most important forces of change. This begins with the impact of information technologies and biotechnology, but extends to many other complementary emerging technological changes, institutions and human and physical capital, the importance of which will vary by region and country. Even the worldwide impact of global markets will vary by country. We must put our policy analyses and advice within the specific contexts in which policy makers work and in a form they can understand and respect, if we are to have any real impact on the future. More of us have to become involved in combat over policy and institution building.

A growing international need now exists for publicly provided information, products and services and for the creation of new institutions and new human capital. This may be the single most urgent, long-term problem for agriculture, the food system, food safety and the environment. What new institutions and human capacities are needed, and for what purpose? How should they function? How should authority be distributed? How should they relate to the private and public sectors? How and to whom should they be accountable? These are both disciplinary and applied subject matter questions that fall within the domain of the social sciences. In agriculture, they are a challenge for our profession (Ruttan, 1984). It is important that we do our work and introduce the results well ahead of the political debate so that our analysis is absorbed and seen as useful, non-partisan information and is not instantly politicized by policy conflict.

When the world economy and agriculture begin to change as fundamentally as at present, our current professional capacity grows obsolescent. That is, the concepts, databases and analytical modes by which we comprehend the world begin to lose relevance. New problems arise that require more data and analysis – and integration with other databases and analytical modes. We now face a growing need to rebuild and extend the information base for research and policy decision. Without this intellectual investment we shall slowly lose professional capacity and social relevance. Trade, development, environmental

and other economists have been struggling with this problem for several decades in agriculture. But the problem is rapidly getting worse. The international integration of relevant databases and the development of international statistical standards are needed now, if we are to deal with the policy conflicts that lie ahead. In this arena international collaboration is absolutely necessary, if the data for policy purposes are to be assembled from both public and private sources.

Governance issues and choices involve choosing who wins and who loses rights. This is always risky terrain. But we must plunge in, if we wish to have any impact on the choices made. This involves redistribution, which is a political and moral, not just an economic, decision. Redistribution, in turn, involves interpersonal comparisons, which we as economists are typically trained to avoid, since such political judgments can endanger the objectivity of economics. Nevertheless, some of our leadership must participate in these decisions, if the profession's knowledge base is effectively to inform policy for agriculture.

The profession's experience in development has demonstrated time after time that investment in non-market redistributions is necessary before the market can work to capacity. This is especially clear in the early stages of development and in the midst of revolutionary change. It will be the case for any successful introduction of biotech or information technologies in developing nations. The market alone is not able to extract the full potential of a developmental innovation without non-market redistributive investments in some set of initial complements, whether in technology, human capital, institutions or biophysical capital. Some of these will be non-market redistributions, since the return to whoever pays for the needed complement will be less than their 'donation'. Returns to those who subsidize non-market redistributions, if any, are secondary, diffuse and long-run.

We must recognize that some of the greatest advances in human welfare over the past century have been the product of redistributions of rights: for example, anti-slavery laws, emancipation of women and universal suffrage. Many nations have adopted universal primary and secondary education, national public health systems and public higher education. One large, predominantly non-market, redistribution challenge lies directly in our path: world poverty and its ills.

More of the profession's leadership must participate directly in these policy debates at national and international levels, whether redistributive or not. We must as a profession be prepared, as Ted Schultz was, to speak for those without voice in agriculture as well as to puncture the rhetoric of economic nonsense. Our role is to inform policy makers and policy decisions, by defining problems clearly and more completely, and by developing policy and other institutional alternatives. Some of us must play an advocate's role for stakeholders and for relevant ideas that lack a voice in the policy process, much as did some of the pioneering generation when they too faced a fundamental transformation of agriculture and its environment.

NOTES

[1]Also see the oral history interview of C.A. Bonnen in Hopkin and Durden (1985), Appendix D.

[2]These economic characteristics include the price elasticity of aggregate demand for farm products; the income elasticity of the demand for farm products; the market structure of the farm sector with farmers acting as price takers; the price elasticity of the supply of farm output; the rate of technological change in the farm sector; the degree of asset fixity – or asset specificity – that may affect the ability of the agricultural sector to adjust its output in response to changing prices; the share of total population engaged in agricultural production; the share of consumers' income spent on food; and the population growth rate (Anderson, 1987; Anderson and Hayami, 1986; Bonnen and Schweikhardt, 1998; Schweikhardt, 2000).

[3]In addition to the references cited elsewhere in this paper, a sense of the nature and complexity of the evolving political economy can also be usefully explored in a number of additional sources: Bonnen *et al.* (1997); Cable (1999); Cohen (1998); Creveld (1999); Guéhenno (1995); Hammond (1998); Held *et al.* (1999); Helliwell (1998); Joffe (1999); Kahn (1996); Keohane and Nye (1998); Mathews (1997); Ohmae (1995); Strange (1996); Weiss (1998).

[4]One needs to be clear about several terms used here. An ideologue is to be distinguished from an ideology. Ideology refers to any system of beliefs. Belief systems and all policy decisions involve value judgments and arise out of prescriptive (or proscriptive) conclusions about the right (or wrong) action to take. Any prescription (proscription) to act combines factual beliefs (about what is true or false) with value beliefs (about what is good or bad), which are then constrained and legitimized by the rules, laws and customs of society. There are rational belief systems and less than rational (or non-rational) belief systems. Those who are rational will submit their beliefs to (and accept the results of) such tests as those of (a) correspondence with observed reality, (b) logical coherence as a system of beliefs and (c) sufficient clarity (lack of ambiguity) to make tests of correspondence and coherence possible. Those who persist in adherence to belief systems despite substantial, if not overwhelming, evidence that their beliefs fail these tests are 'true believers' or ideologues. The belief system of an ideologue is impervious, not only to tests of factual validity, but to the relevance of any other system of belief. These, of course, are the extreme ends of a distribution with a confounded middle ground dominated by incomplete information and uncertainty.

[5]Tinbergen's work is widely recognized for its application to macroeconomic policy, but he applied these same principles to a wide range of policy issues, including the choice of targets and instruments in agricultural policy. Tinbergen examined the necessity of making a simultaneous choice of domestic price policies and border policies in agriculture and the simultaneous choice of income stabilization and production regulation in agriculture. The characteristics that Tinbergen identified as affecting the efficiency of any policy instrument in agriculture are nearly identical to the fundamental characteristics of the agricultural sector defined in note 2.

[6]Thomas Friedman has referred to the inevitable tensions between integration, national sovereignty, and mass politics as the 'Golden Straitjacket' that limits the discretion of government. 'As your country puts on the Golden Straitjacket, two things tend to happen: Your economy grows and your politics shrinks ... [The] Golden Straitjacket narrows the political and economic policy choices of those in power to relatively tight parameters. That is why it is increasingly difficult these days to find any real differences between ruling and opposition parties in those countries that have put on the Golden Straitjacket' (Friedman, 1999, p.87). In reality, some dimensions of the power of decision are always constrained. Despite supernationalists, sovereignty is never absolute and declines as the world becomes smaller in cost of time and space, and thus more interdependent (Krasner, 1999).

[7]Transaction costs include the ex ante and ex post costs of analysing, negotiating and implementing decisions (Williamson, 1985, p.21). At this point the single, most accessible, overview of the economics of information from an applied policy point of view can be found in Shapiro and Varian (1999). It will not provide the rigour a theorist needs but its breadth and many case examples make it an excellent introduction for policy. See Lamberton (1996) for a volume of readings that lead to many of the contributions to the theory and application of the economics of information, communication and computation. Lamberton's introduction provides a brief overview of the conceptual evolution of the theory base. On the economics of information in a global public good context, see Stiglitz (1999) and also Kaul *et al.* (1999).

[8]A system of governance consists of the institutions, including laws, standards and customs, through which authority is exercised to control, direct or order the conduct of a sector or the totality of a society. Robin Johnson's excellent analysis of 'The Role of Institutions in Policy Formation and Delivery' in this volume is a comprehensive treatment of the concept and role of institutions.

[9]The role of transaction costs in the design and maintenance of the institutions of governance has been explored by Williamson (1996). In his Munich lectures, Dixit (1998) examines the role of political transaction costs in economic policy making.

[10]Chapter 10, 'Globalization and its Discontents' of Gilpin (2000) provides a brief description and a thoughtful assessment of the different pro-globalization and anti-globalization positions.

[11]President Hedley and I have focused on changes in governance at very different levels, but we have come to similar, if not completely parallel, conclusions. His 'horizontality' and increased 'complexity' are, I believe, different descriptors for what I have described as the fragmentation of the structures of governance caused by the prior fragmentation of economic and social interests and the growth of political transaction costs over the process of development. Hedley is surely correct that this leads to a 'declining coherence in objectives that puts institutions at risk'. In 'citizen engagement' he describes, as I do, the current proliferation and fragmentation of interests, but he goes on to identify its dangers and disturbing consequences as civil society's conflicting interests intervene directly in the policy decision process.

[12]Williamson (1998) examined this question from an historical perspective for the major Atlantic nations during the industrial revolution of the 19th and early 20th centuries. Rodrik (1997, 2000) approaches it with an empirical (statistical) analysis of a cross-section of 21 developed nations in 1980. Little of this is news to economic historians. There are many parallels between today's revolutionary changes and those of the early British industrial revolution. Some of these can be seen in T.H. Ashton's 1948 classic, *The Industrial Revolution* (see especially pp.88–9, 104–9, 138–41). Other examples can be found in Sir Arthur Lewis's 1978 lectures, *The Evolution of the International Economic Order*, which explore the question why some nations developed and others lagged behind in 19th and 20th century industrial development.

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