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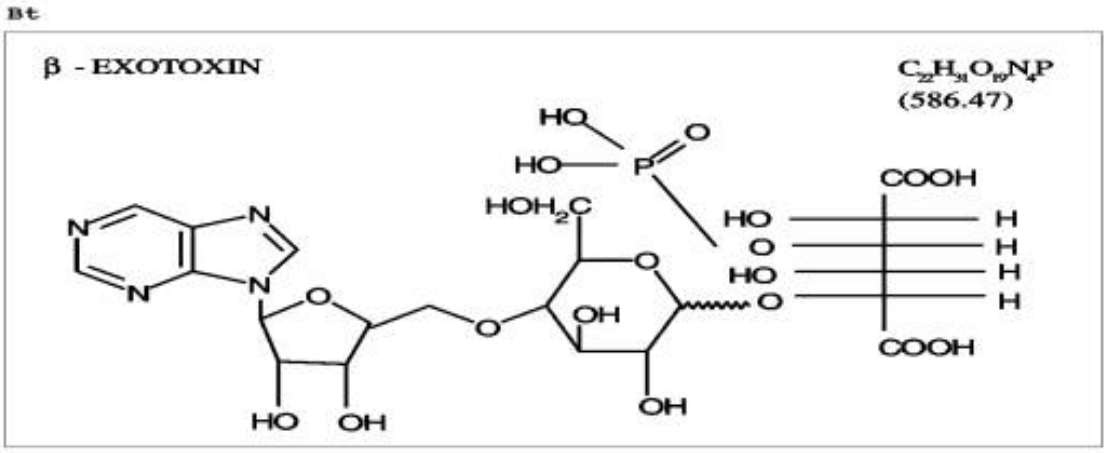

Source: ***Bacillus thuringiensis*** **Berliner (bacteria)**

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Abstract:

The three hegemonies of the modern world-system have been the Dutch in the seventeenth century, the British in the nineteenth century and the hegemony of the United States in the twentieth century. Sociologists and political scientists have carefully studied the process of hegemonic rise and decline.Recent research by Rennstich (2001) retools Arrighi's (1994) formulation of the organizational evolutions that have accompanied the emergence of larger and larger hegemons over the last six centuries. Modelski and Thompson (1996) argued that the British successfully managed to enjoy two "power cycles," one in the eighteenth and another in the nineteenth centuries. With this precedent in mind Rennstich considers the possibility that the US might succeed itself in the twenty-first century. Rennstich's analysis of the organizational, cultural and political requisites of the contemporary new lead industries – information technology and biotechnology – imply that the United States has a large comparative advantage that will most probably lead to

another round of U.S. pre-eminence in the world-system. But important resistance to genetically engineered products has arisen as consumers and environmentalists worry about the unintended consequences of introducing radically new organisms into the biosphere. This paper will examine the agricultural biotechnology industry as a new lead industry and will consider its possible future impact on the distribution of power in the world-system. This will entail an examination of the loci and timing of private and publicly funded research and development, biotechnology firms that are developing and selling products, and the emergence of national and global policies that are intended to regulate and test genetically engineered products. The recent history of environmental impacts of genetically engineered products will be reviewed, as well as the contentious literature about the supposed risks of agricultural biotechnology. Several scenarios regarding the timing of the onset of biotech profitability and their potential impact on US economic centrality will be developed, and data on both the business history and the emergence of resistance will be employed to examine the likelihood of these possible scenarios.

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New lead technologies have long been important causes of the rise and decline of hegemonic core powers in the modern world-system. Political and military power is sustained and facilitated by competitive advantages in the production of highly profitable goods. Rising hegemons (or "world leaders" in the terminology of Modelski and Thompson 1996) manage to innovate new profitable modes of trade and production that allow them to finance political and military advantages over other states.Thus the sequence of new lead technologies and their distribution across potentially competing core states is an important subject of study for understanding both the past and the future of hegemonic rise and fall.

The hegemonic sequence alternates between two structural situations as hegemonic core powers rise and fall: hegemony and hegemonic rivalry.

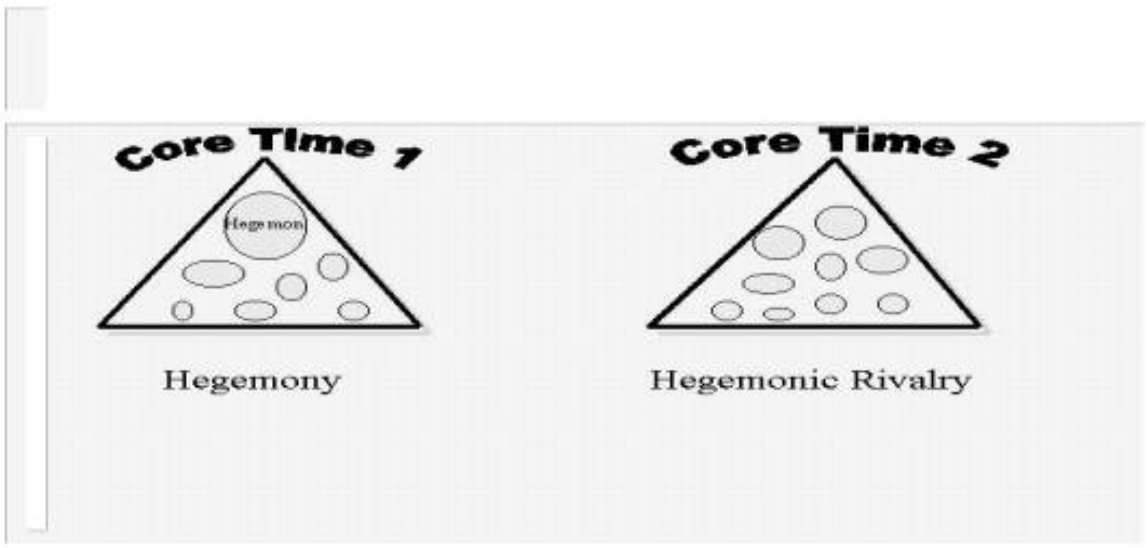

Figure 1: Unicentric vs. Multicentric Core

The three hegemonies of the modern world-system have been the Dutch in the 17th century, the British in the nineteenth century and the hegemony of the United States in the twentieth century. Sociologists and political scientists have studied the process of hegemonic rise and decline mainly

by periodizing hypothesized stages. Exceptions are Modelski and Thompson's (1988) study of the distribution of naval power capacity since the fifteenth century, and Modelski and Thompson's (1994) quantification of the rise of new lead industries. [1]

Recent research by Rennstich (2001) retools Arrighi's (1994) formulation of the reorganizations of the institutional structures that connect finance capital with states to facilitate the emergence of larger and larger hegemons over the last six centuries. Modelski and Thompson (1996) argued that the British successfully managed to enjoy two "power cycles,"[1] one in the eighteenth and another in the nineteenth century. With this precedent in mind Rennstich considers the possibility that the U.S. might succeed itself in the twenty-first century. Rennstich's analysis of the organizational, cultural and political requisites of the contemporary new lead industries – information technology and biotechnology – imply that the United States has a large comparative advantage that will most probably lead to another round of U.S. pre-eminence in the world-system.

This paper will propose a research strategy for the examination of the biotechnology industry as a new lead industry and will consider its likely future impact on the distribution of power in the world-system.

Most of the research on the international aspects of agricultural and medical biotechnology impacts has focused on North/South issues about patenting of genomes and genetically modified organisms and the effects of the industrialization of agriculture on peasantries in the Third World. But there is also a North/North aspect that has emerged with strong resistance in Japan, the United Kingdom and Europe to genetically modified foods.

Our research focuses upon the geopolitical aspects and consequences of the agricultural biotechnology industry. How will this industry affect the global distribution of economic and military power in the next decades? Will it be a big success economically and help to facilitate another round of United States economic hegemony, or will it be a bust and so contribute to U.S. economic decline relative to competing world regions and states. This question comes out of research on the role of "new lead industries" in hegemonic rise and decline.

Our research will time-map the world-wide loci and timing of:

- Medical and agricultural biotechnology research and development,
- Medical and agricultural biotechnology firms that are developing products, and
- national and global policies that are intended to regulate and test genetically engineered products, and to regulate medical biotechnology research and development.

The recent history of environmental impacts of genetically engineered products will be studied, as well as the contentious literature about the supposed risks of agricultural biotechnology. Several scenarios regarding the timing of the onset of biotech profitability and potential impacts on U.S. economic centrality will be modeled. Data on biotech business history and resistance to genetically modified foods and food inputs will be employed to examine the likelihood of these scenarios.

New lead industries typically follow a growth curve in which a period of innovation and relatively slow growth is followed by a period of implementation and adaptation and rapid growth as the technologies spread, which is later followed by a period of saturation in which growth slows down. The logistic or S-curve is the hypothetical form, which is only approximated in the actual records of new lead industries in economic history. Figure 2 illustrates the important differences in

the form of the growth curves of fourteen new lead industries in world economic history since the fourteenth century as calculated by Michael A. Alexander (2000).

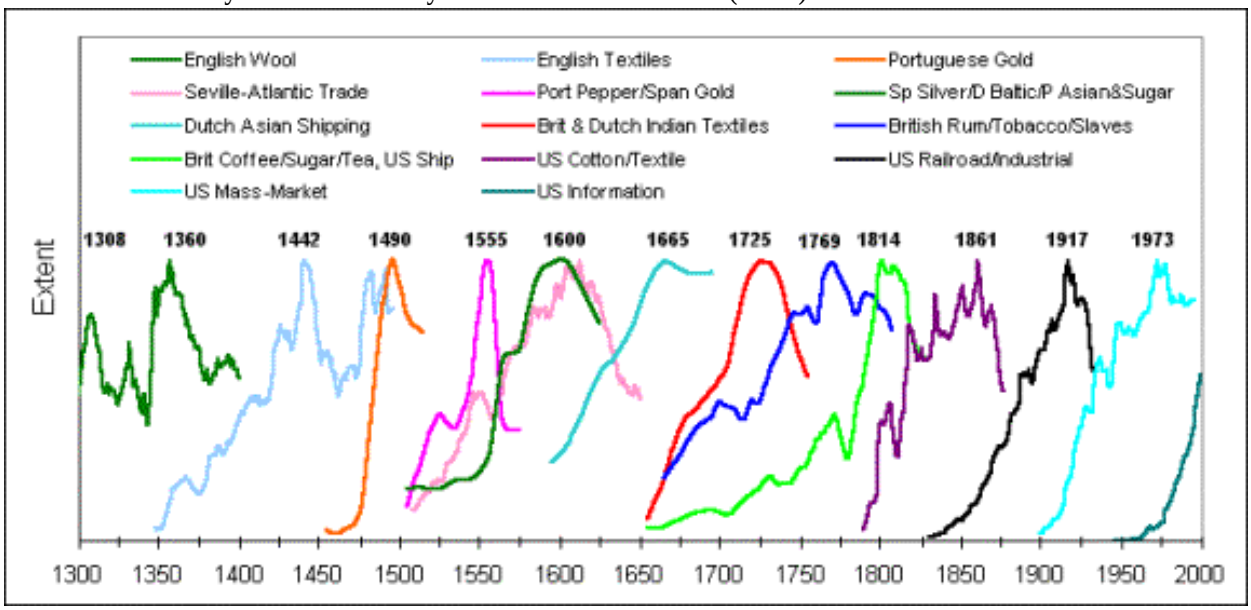

Figure 2: New Lead Industries in the World-System

Source: Alexander (2000), P. 141.

New lead industries are important as the bases of hegemonic rises because they have huge spin-offs for the national economies in which they first emerge, spurring growth far beyond the original sectors in which they appear, and because they generate "technological rents." Technological rents are the large profits that return to innovators because they enjoy a monopoly over their inventions. The first firm to invent a calculator that calculated a square root at the press of a key was able to sell that calculator for several hundreds of dollars. Patents, legal protections of monopolies justified by the idea that technological innovation needs to be rewarded, can extend the period in which technological rents may be garnered. But nearly all products eventually follow the "product cycle" in which technological rents are reduced because competing producers enter the market, and profits become reduced to a small percentage of the immediate cost of production. Inputs such as labor costs, raw materials, and transport costs become the major determinants of profitability as a production becomes more standardize and routine (Vernon 1966, 1971).

The ability to innovate new products and to stay at the profitable end of the product cycle is one of the most important bases of successful core production in the modern world-system. Products typically move to the semiperiphery or the periphery as production becomes routinized. So the cotton textile industry was a new lead industry in the early nineteenth century, but it spread from the English midlands to other core states and to semiperipheral locations (such as New England), and eventually it moved on to the periphery.Thus the product cycle is important in the reproduction of the core/periphery hierarchy, but it is also important in determining relative competitive advantages within the core. Some core countries are better than others at innovation and implementation of new lead technologies, and it is the ability to concentrate these by means of strategic development of research and development activities, usually including important public investments and coordination of educational institutions and industry, that allows some

core countries to do better than others.
The United States has had huge advantages over competing core countries since World War II. Because the United States is a continental-sized country with a huge "home market" that is a substantial share of the world economy, it has been rather difficult for contenders to outcompete the U.S. because of reasons of mere size. This said, the U.S. share of world GDP decreased from 1950 to 1992 (see Figure 3). Some of this was due to the increasing share of Japan, and some due to increasing shares of certain countries in the semiperiphery.[1]
In about 1992 the U.S. share began again to increase, while the East Asian crisis led the Japanese share to decline. Some observers have attributed this to a reemergence of U.S. economic hegemony based on successes in information technology. Rennstich contends that the United States has cultural and social advantages over Europe and Japan that enable its workers to adapt quickly to technological changes and that these, combined with the huge size of the U.S. domestic market, will serve as the basis for a new "power cycle" of U.S. concentration of economic comparative advantage based on information and biotechnology.

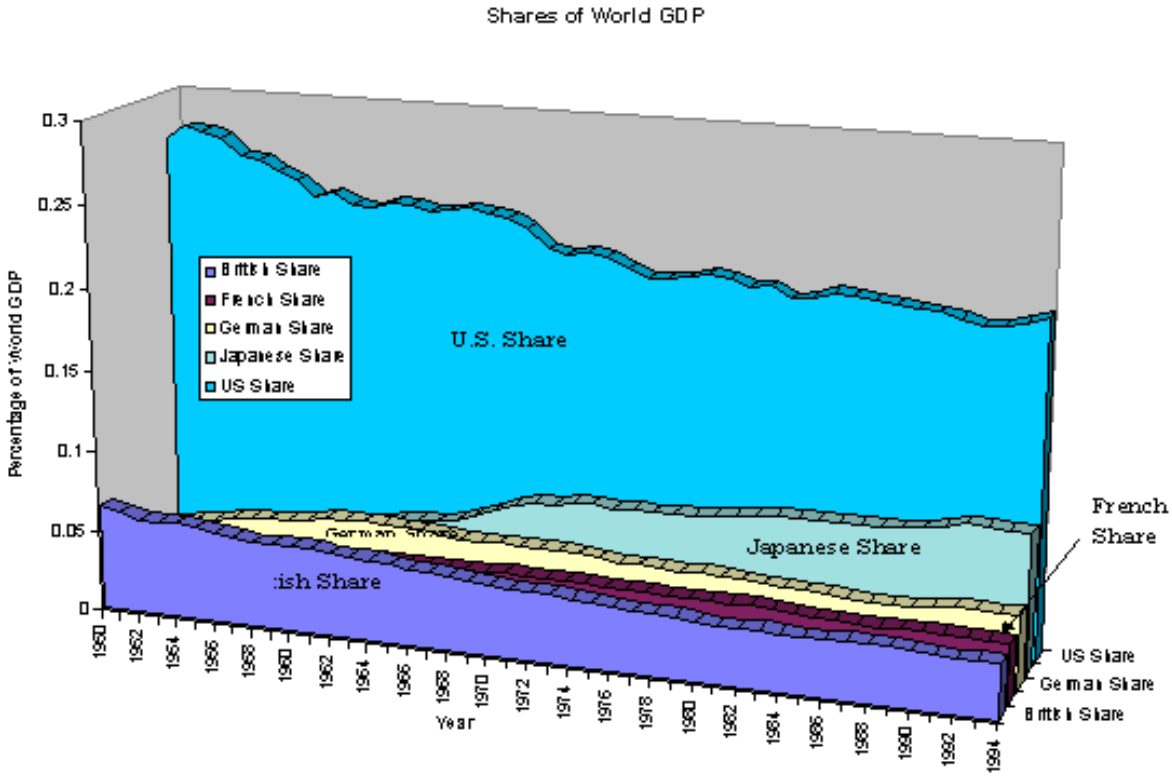

Figure 3:Core State's Shares of World GDP, 1950-1994

But other observers have a different interpretation of the recent trends. The reversal of the downward trend in Figure 3 is interpreted by Giovanni Arrighi as the functional equivalent of the "Edwardian *belle epoque*" that occurred during the salad days of finance capitalism during the late nineteenth century decline of British hegemony. Many observers have noted that the rise to centrality of finance capital has been a key element of economic globalization in recent decades (e.

g. Sassen 2001, Henwood 1998). Arrighi (1994) points out that this shift from the centrality of trade and production toward accumulation based on financial services is typical of late periods in the "systemic cycles of accumulation" and signifies the decline of the contemporary hegemon. The comparative advantage of the hegemon in new lead industries declines as challengers rise, but the old hegemon is able to continue to make profits because of its monetary and financial advantages.

The reversal of the downward trend of the U.S. share of the world economy in Figure 3 is also contemporaneous with a huge reversal in the U.S. balance of payments. A huge inflow of foreign investment in bonds, stocks and property beginning in the early 1990s turned the U.S. into one of the world's most indebted national economies and was arguably an important contributor to the high growth rates and incredibly long stock market boom of the 1990s. The dot.com stock bubble that burst in 2000 was a typical example of how financial speculation can create profits by means of selling stocks rather than be selling products that people buy and use. In such an economy the stocks themselves become the product.

The "new economy speak" of the last decade was typical of periods of financial speculation in which hypothetical future earnings streams are alleged to be represented in the value of securities. But the stock market operates according to a middle-run time horizon. Profits need to be made within the next few years. Investments that do not pay a return sooner than a decade hence are nearly valueless in conventional financial calculations. This is why basic science is considered a public good that is usually financed by governments. It is not usually reasonable to expect a financial return soon enough for private investors, even venture capitalists, to assume the necessary risks.

Biotechnology as a New Lead Industry

Biotechnology has been heralded as the potential basis for a new round of U.S. economic hegemony. In this discussion we will need to use a distinction between medical biotechnology and agricultural biotechnology because of the somewhat different ways in which these branches of the application of applied biology are related to factors that may influence the economic potential of these technologies. Agricultural biotechnology is the application of genomics to create new crops, new sources of animal protein, and to protect crops and domesticated animals from pests. Agricultural biotechnology is intended to improve the human food supply by lowering the costs of production and by improving the products. Medical biotechnology is intended to improve human health by developing new techniques for preventing diseases, curing ailments, producing products for transplants and improving the genetic makeup of individuals.

An important literature has emerged that discusses the ethical dimensions and political implications of biotechnology (e.g. Shiva 1997; Rifkin 1998) . Extremely fundamental issues are becoming important in public discourse, and the governance of biotechnology research and applications will be an increasingly central part of politics in the twenty-first century (e.g. Fukuyama 2002). In this paper we will discuss the politics of biotechnology only insofar as it is likely to be an important influence on the potential role of biotechnology as a new lead industry that might function as the basis of a new round of U.S. economic hegemony.

In order for biotechnology to function as a new lead industry that could serve as a basis for a new round of U.S. economic hegemony several conditions would have to be met.

Investments in biotechnology would have to produce products that can be profitably sold, and these would need to be purchased within the United States and in the world market. Firms producing these biotechnology products would need to be able to obtain technological rents over a period of time long enough to recoup the costs of research and development. And the biotechnology industry would need to serve as a source of spin-offs for the rest of the U.S. economy to a degree greater than in the national economies of contending core powers.

Figure 4 illustrates our contentions about factors that will reduce the likelihood of the biotechnology industry serving as a basis for a new round of U.S. hegemony. We note that the huge decreases in transportation costs and communications costs in the most recent wave of globalization have increased the rate at which technologies and new industries can spread to competing regions. It has been thought that the research and development costs of the biotech industry make it difficult for new centers to emerge, and this has been alleged to be part of the basis for the U.S. lead in biotechnology. It is true that the U.S. research universities and publicly funded research have been important sources of both medical and agricultural biotechnological advances. The U.S. Department of Agriculture and federal agricultural policies played a central role in the development of agricultural biotechnology (Kloppenburg 1988a, 1988b; Pistorius and van Wijk1999). And the United States has taken the lead in the creation of an international patent regime to protect "intellectual property"(the so-called TRIPS agreement) that should, in principle, allow firms to recoup research and development costs through technological rents.

The allegedly high start-up costs should prevent the early emergence of competitors, and this has been claimed to account for how biotechnology research and development and commercialization in Europe and Japan have lagged behind the U.S.But there have been some developments that cast doubt on these characterizations. The Peoples' Republic of China began a substantial state-sponsored initiative in biotechnology in the 1980s and many important creations of this program have been implemented in Chinese agriculture on a huge scale, with allegedly great beneficial effects. Perhaps the large size of semiperipheral China allows massive resources to be concentrated on targeted research and development efforts, making this development not so surprising. But Singapore, a city-state, has also succeeded in establishing a successful biotechnology initiative by importing scientific talent from abroad. These start-ups imply that entry into the biotechnology industry is not as restricted as had been assumed, and that competition for shares of world demand for the products of biotechnology will speed up the product cycle, making it more difficult for particular countries, including the U.S., to garner technological rents for very long.

Another factor that may affect profitability of the biotechnology industry is consumer resistance to genetically modified foods. Japanese consumers have refused to purchase genetically modified soybeans and so Japan ceased to import these in 1999. This caused Canada to stop growing genetically modified soybeans and several countries announced that they were also going to ban GMOs in order to exploit the market niche created by countries that have banned GMO imports.

In England MacDonald's restaurants were forced to stop using genetically modified inputs by a consumer boycott. Significant popular resistances to genetically modified foods have emerged in Europe and parts of Asia. This could be an important factor affecting the profitability of agricultural biotechnology. Campaigns to raise this issue within the United States have so far not been very successful. This may be partly due to the cultural factors that Rennstich has mentioned

as explanations for the U.S. comparative advantage. But this could quickly change if experiments with genetically modified organisms lead to calamities, as they are almost certain to do eventually.

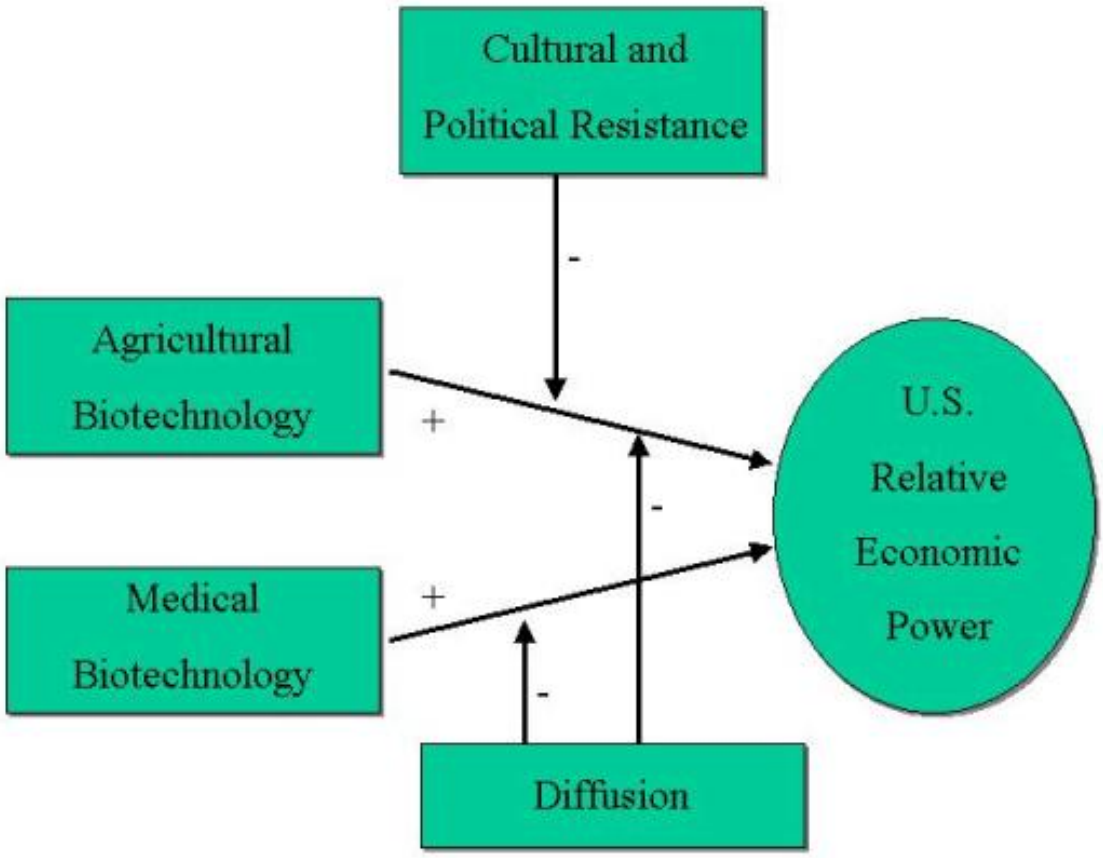

Figure 4:Diffusion and Resistance Lower the Impact of Biotechnology on U.S. Economic Comparative Advantage

Complete testing this model is impossible because we have no information about the future. But we can quantify trends in recent decades and see how they seem to interact temporally and spatially with one another. The unit of analysis for this research is the world-system as a whole, especially those countries and transnational networks that are engaging in medical and agricultural biotechnology research and product development, but also important potential markets for the biotechnology products. These latter will include studies of public opinion regarding genetically modified organisms and public policies regarding research, product testing and regulation of the biotech industry. Large retailers of food products have been noticeably important players in the drama of resistance to transgenic foods, and so they need to be studied as well.

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[1] The most important studies are those of Boswell and Sweat (1991), Modelski and Thompson 1996, Thompson (2000) and Arrighi and Silver (1999).

[1] "Power cycle" is Modelski and Thompson's term for what Arrigui (1994) calls "systemic cycles of accumulation" and Chase-Dunn (1998) calls the "hegemonic sequence."

[1] For a more complete quantitative study of the U.S. trajectory in the world economy see Chase-Dunn *et al* 2002.