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End of empire: external and internal transitions in US policies for science, technology and innovation

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Over the last 20 years, the shape of the global political economy has shifted dramatically, but US science and technology policy is continuing as though nothing has changed since the Cold War. Military research and development are prominent, and policies are still oriented towards large firms in existing industries rather than small, dynamic ones in new industries. US scientists and engineers are still world leaders in Mode 2 learning, as indicated in their active collaborations with industry; but large US markets seem to be keeping the system from putting effort into developing partnerships in the emerging economies. While the capability exists, then, the directional arrow is not pointed towards continued prosperity through innovation in the US economy. Science and technology policies are themselves in need of innovation.

Introduction

Over the last 20 years, the shape of the global political economy has shifted dramatically. The fall of the Soviet Union eliminated the bi-polar Cold War military environment. A number of dictatorships fell at about the same time, and democracy planted its roots in many parts of the world. Even countries that did not change politically shifted economically towards market economies, including the two socialist giants of the previous period, India and China. Combined with falling costs of communication and transportation, these trends merged into the process of 'globalization', an economic, demographic, and cultural process that is now seen as shaping the politics of the national state from the outside. Globalization is beginning to create what can be described without exaggeration as a new world order.

The United States occupied a particular position in the previous world order; and its institutions of science, technology, and innovation (STI) were deeply embedded in that position. One would expect, therefore, that the dramatic changes in the global environment would have led to significant adjustment in US STI policies and programs. The central observation of this paper is that this has not been the case. By and large, US STI policies are a linear extrapolation of decades-long themes, and its institutions have experienced evolution rather than revolution over this time period. The fundamental rethinking that a new world order might require has not yet taken place.

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The keyword of the previous US position was *dominance*, a treasured self-image more or less supported by facts; but in the new world order, the US needs to take its place among a more equal set of peers, scientifically and economically. It is this change that I refer to in my title as 'end of empire'. Like earlier empires, the era of US global dominance has been characterized by a strong, worldwide military presence. In a more equal world, the US might also need to phase out that central military role in order to discover its comparative advantages economically, including its strong capability in Mode 2 learning. Without that adjustment, the pace and depth of change could resemble, not just the end, but indeed the fall of previous empires.

The first section of this paper describes the changes that have occurred in the world surrounding the US since *The New Production of Knowledge* (Gibbons *et al*., 1994) was published, with emphasis on the political and economic. The second section chronicles what has evolved and what has stayed the same within the US science and technology enterprise from 1990 to the present, and compares this with some other world regions. The final section presents an analysis of how well current policy initiatives address the major challenges now facing STI policy. It also outlines some steps that must be taken to assure continued American prosperity, rather than bring on a precipitous decline.

External trends

Geopolitical configurations can experience earthquakes, just as geological landscapes do. The period since *The New Production of Knowledge* was published began with just such an earthquake: the fall of the communist regime in the Soviet Union and the consequent realignment of both regional power in Europe and the global power balance with the United States. Like physical earthquakes, however, the fault lines underlying this geopolitical event extended much further than the immediate shock area. Indeed, looking back on this period, we can see continent-size shifts in not only military relationships, but also economic ones. This section zooms in on a few of the major shifts to which the science and engineering enterprise in the United States was connected.

The end of bi-polar military power

It is hard to overestimate the strength of the symbiotic relationship between the US military competition with the Soviet Union and US science and engineering. As we know, the post-World War II social contract between university research and federal government support was inspired in part by the contribution of research to ending the war through the development of the atomic bomb, as well as by the broader array of university-based military R&D programs during the war. The translation of victory for the Allies into tense confrontation with the Soviet Union likewise fueled both later weapons development and the important infusion of money and human capital represented by the race to space. The amount the US federal government spent on defense R&D has always overshadowed the other major influx of funds, through biomedical research, even as these resources were growing at a very rapid rate. Defense R&D anchored one of the three main institutional sites for research in the US, the government laboratories, some of the largest of which started as weapons labs. Likewise, the development of weapons systems underwrote major US export industries, aerospace and information technology in particular.

The sudden loss in 1990, then, of the clear adversary, the other military superpower, precipitated an identity crisis, not only for the US defense establishment, but also for US science and engineering. Documents of the day express the seriousness of the discussion of the 'peace dividend' the US economy was expected to experience and the enthusiastic attention given to 'dual use' technologies that could be developed in defense but give a boost to civilian industry. There was concern about the physical sciences and engineering in particular, since these fields were already in decline and defense R&D was one of their few steady pillars of support. We will see in the next section what came of these concerns.

The spread of the market economy

We all remember the claims of that early period after the end of the Cold War: the claims of the end of history and the triumph of political and economic liberalism (Fukuyama, 1992). In the struggle between what were perceived as two encompassing ways of life, the US system had survived. As more and more information emerged about the underlying weakness of the former Soviet economy and about the environmental catastrophes in Eastern Europe, the United States seemed more ideologically and morally dominant than at any other time since the bomb fell.

A number of smaller transitions appeared to support the notion of a major and irreversible shift. As the Soviet Union was melting, military dictatorships came to an end in several Latin American countries, including Chile and Brazil. Shortly after the Wall fell in Europe, apartheid also collapsed in South Africa, bringing with it an end to wars in Namibia and Mozambique. Suddenly, several countries were poised to engage with the world economy in new ways, and many experienced rapid economic growth.

In India, decades of socialism had produced only sluggish rates of growth, and in 1991, the International Monetary Fund had to bail out the bankrupt state. A new prime minister, Narasimha Rao, started economic reforms, including deregulation, opening the country to foreign investment, and reducing tariffs. Foreign investment soared from US$132 million in 1991–92 to over US$5 billion in 1995–96. The country was poised to take advantage of its new high-speed Internet connectivity when the collapse of the US IT industry (the dot-com bust) around 2000 brought the return of many Indian computer professionals trained in the United States. The visibility of the Indian economy's success has distracted attention from continuing underlying problems, including huge disparities within the country, but the competition provided by the Indian IT and pharmaceutical sectors has nonetheless generated consternation in the United States.

In the meantime, China has remained politically stable, for better or for worse, with a communist party clearly in charge of socialism Chinese style. Economically, however, this communist state has acted like no other in history. Starting in the late 1970s, a phased reform has replaced central planning and opened the Chinese economy to the world. Much of China's rapid rate of growth has been generated through low-skill manufacturing, but, as with India, success in high-technology industries has attracted the attention of US STI policy. Rapid expansion of the higher education system has produced huge increases in the numbers of technically trained people available in the Chinese economy, and economic growth has made the Chinese domestic market attractive to global firms. Many have expanded both operations and research activities to China. The firms report that they are not only seeking

lower cost highly-trained personnel, but also local knowledge that gives them better access to this market.

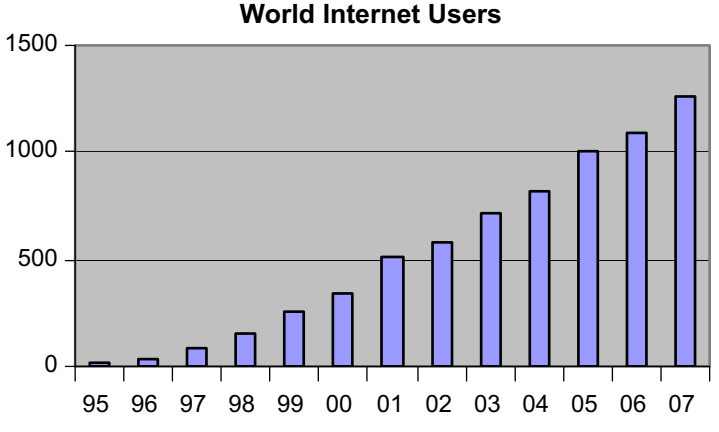
In summary, changes over the last two decades have brought widespread adoption of economic and, in some cases, political systems that the United States has long advocated for the rest of the world. However, the changes have brought with them unprecedented economic competition. China and the US have become each other's largest trading partners, and US consumption relies heavily on money borrowed from Chinese banks. Open markets have chained one large democracy closely to an even larger communist state.

Globalization

These focused developments have taken place against the background of a broader set of processes that has come to be known as globalization. The term has been adopted and interpreted by many scholars, as a cultural and political as well as economic process. The causes of globalization are widely identified as falling transportation and communication costs – a technological change at its core. A major factor on the communication side is the penetration of the Internet (Figure 1), a US invention that emerged during the period we are considering.

These cost reductions allowed multinational corporations to spread manufacturing operations over many countries, taking advantage of local conditions, including lower labor costs and looser regulatory regimes. The foreign direct investments that have characterized Indian and Chinese growth are part and parcel of this spreading out of operations. Many countries have benefited from wage differentials that have attracted low, medium, and sometimes high-skilled jobs generated by itinerant global corporations.

According to Ghose (2003), the current wave of globalization began in the mid-1980s. It bears some resemblance to the last great globalizing wave of economic activity, in the late nineteenth century. In particular, like the last one, this wave has been accompanied by significant migration and mobility. In the last wave, it was mostly unskilled workers displaced from the land who moved in large numbers into



Source: Internet World Stats.com.

Figure 1. World Internet users

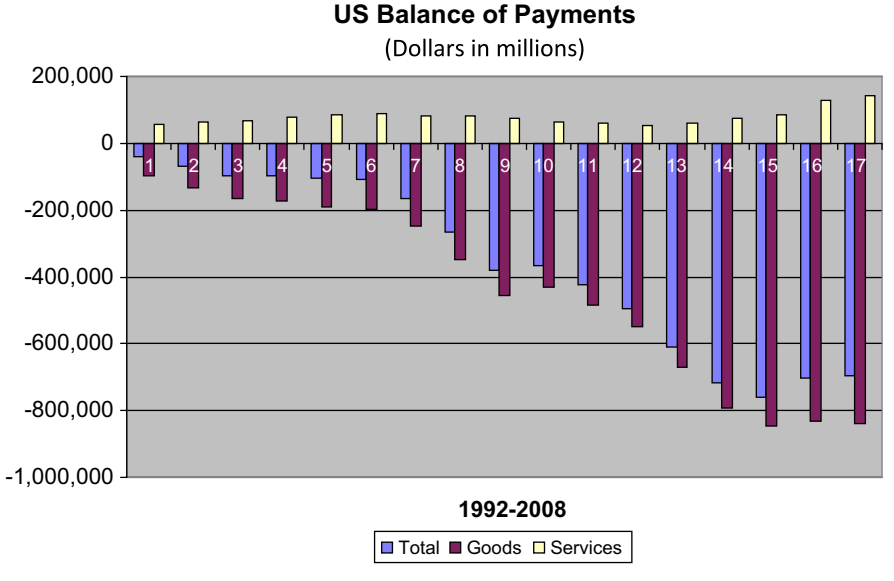
the new world. In this wave, skilled workers are going to the places in the world economy where they can earn the most and send money home. Remittances now constitute a large share of national income in a number of Caribbean countries, for example.

The signature characteristic of the current wave of globalization, however, is mutual trade in manufactured goods. In the nineteenth century, countries of the periphery sent raw materials to the core, and the core sold manufactured goods back. Because of the globalization of production, this pattern has changed for the first time in human trade history. The core countries of affluent Asia, North America, and Europe are buying goods manufactured in the emerging economies of Asia and Latin America. There is still a rough division of labor, with the highest skilled, highest value-added manufacturing taking place in the core; but the situation is changing fast.

The challenge for the United States

Mutual trade in manufactured goods creates the biggest challenge in history for the US economy. US consumers have achieved high *per capita* incomes as part of past economic success. They constitute the world's largest market, and companies in the rest of the world love to keep them supplied, but until the recent economic crisis, the US balance of trade was increasing dramatically (Figure 2), making the country the world's largest debtor nation.[1] The situation is not sustainable. The US must focus on producing goods and services the rest of the world wants to buy.

The negative balance of payments with China is particularly severe. In 2008, the US deficit in trade with China was US$268 billion, or more than a quarter of



Source: Bureau of Economic Analysis, available from http://www.bea.gov/newsreleases/international/trade/trad_time_series.xls [accessed October 2009].

Figure 2. US balance of payments (US$ millions)

its total world trade deficit.[2] China is the second largest trading partner for the US, after Canada, with about 12% of total trade. Until recently, trade in advanced technology goods was a bright spot in this overall picture – part of the solution, not part of the problem. Since 2001, however, this number has also turned negative.[3] Science, technology, and innovation are not exempted from the challenge.

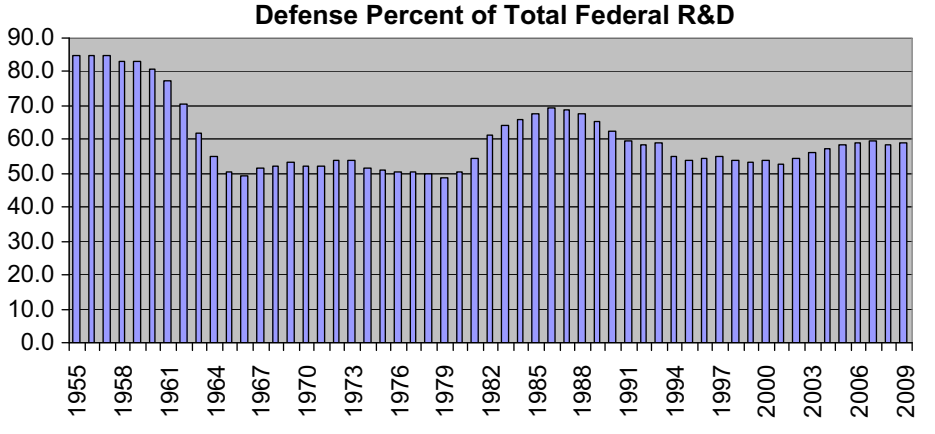
Internal trends

With so much changing in the relationships between the United States and the rest of the world's political economy, one might expect US science, technology, and innovation to have gone through dramatic upheavals over the last two decades. For a variety of reasons, this has not happened.

Continued defense and added security focus

The 1990s opened with the Gulf War, where US military technology was seen as achieving necessary objectives without much loss of life. The former Yugoslavia was Clinton's quagmire, but again, the latest generations of weapons systems appeared to succeed in minimizing loss of American lives while carrying out crucial missions. The debate thus began over a new role for US military power in a world with only one superpower. The argument for the US as guarantor of the world's peace found ready allies in the hundreds of US communities where military laboratories and installations formed an essential part of the local economy. The peace dividend turned into a continued investment in US military capability that dwarfs that of any other nation. Defense R&D continued, even at its low point, to make up over half of US federal expenditures on research and development (Figure 3).

Adding to this unique characteristic of US science and engineering, the only new science and technology agency to be established since 1975 was formed in the wake of the terrorist attacks of 11 September 2001. The science and technology



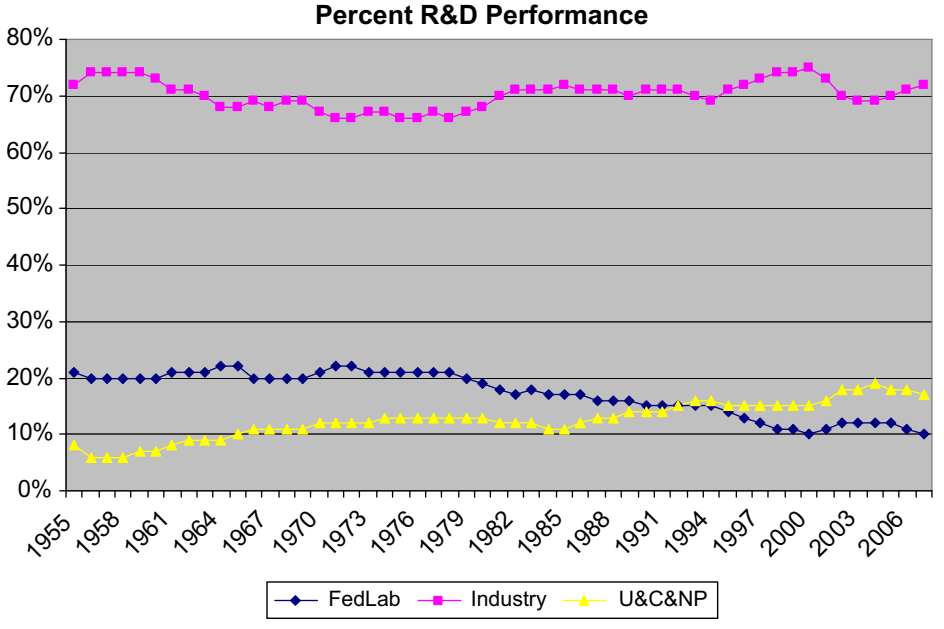
Source: National Science Foundation, *Federal R&D Funding by Budget Function: 2007–09*, September 2008.

Figure 3. US defense R&D as percentage of total

directorate of the Department of Homeland Security (DHS), while modest in size, took leadership of advancing technologies for domestic protection. The department has no direct parallel in any other country, complicating efforts at international collaboration. Its science and technology (S&T) programs draw heavily on expertise recruited from various branches of the military and depend on research in the protected environment of the federal laboratories, especially the former weapons laboratories. As a new development, then, DHS points in remarkably traditional directions, and like a defense department without an enemy, occupies creative resources that could be used differently in the US economy.

Trends continue in S&T institutions

Through these turbulent times, the basic structure of the US science and engineering enterprise has remained remarkably consistent. Industry has performed over two-thirds of R&D since the early 1950s, with figures ranging as low as 66% and as high as 75%, and no clear long-term trend. Universities and non-profit institutions began with only 5% or so of national R&D spending in the early 1950s, but show a clear long-term upward trend to close to 20% in 2007 (Figure 4). With industry about constant, the spending at universities has come at the expense of the share for government laboratories. Interestingly, the percentage lines cross in the early 1990s, but the peace dividend (if it had any effect) only solidified a trend clearly evident over a longer period and made no sharp moves at the time peace broke out.



Source: National Science Foundation (2007), *National Patterns of R&D Resources*, Washington, DC, September.

Figure 4. US R&D performance by sector (%)

Since the late nineteenth century, a hallmark of US universities has been their partnerships with industry, a pattern that points to US strength in Mode 2 learning. Co-authorship data indicate that this continues. Although cross-sectoral papers are only a small share of overall university research articles (about 10% with government laboratories and 6% with industry), by 2005, over half of articles written by researchers in industry or government laboratories had university co-authors (see Table 1).[4] In addition, US authors are working more with scientists and engineers around the world. Internationally co-authored articles made up 17% of the US total in 1995, but 27% in 2005. In contrast, articles written by Asian authors and co-authored with others outside Asia made up only 19% of the Asian total in 2005.[5]

Publication numbers show a resumption of US productivity in publishing since 2000, but publication counts in other parts of the world have been growing even faster – particularly the Asia-10 group of countries.[6] It would be hard to apply the word 'dominance' to the US publication position today.[7] When one looks at quality rather than quantity, US publications continue to fare better than those from other regions, but both Europe and Asia are moving towards more equal shares of citation attention. The capacity for innovation and science-based economic growth is clearly spreading.

S&T in the economy

Have these shifts in the world of science and engineering been reflected in the more competitive sphere of the economy? Despite dire balance of payments figures, the US economy has been growing at a solid rate over recent decades, showing better performance than other affluent countries (National Science Foundation, 2008). In addition, the US standard of living is high and rising as fast as Europe's and faster than Japan's. Labor productivity is excellent by world standards, and has also been rising steadily. This figure is often thought to reflect the incorporation of technology into the production process.

The specific places where science, technology, and innovation play a role also show good performance in the aggregate. Value-added revenue from high-technology manufacturing is below the aggregate number for Asia and has been for nearly two decades, but remember that about half the world's population lives in Asia and only 5% in the United States, so this level of activity produces a lot of wealth to spread around the 300 million US inhabitants (National Science Foundation, 2008, Figure 6.10), even though the loss of middle-income manufacturing jobs has meant that the distribution is increasingly uneven. Finally, in knowledge intensive services (an activity that adds to the positive balance of payments in services), the US dominated until 2005, but again Asia is now producing a rising share of these services (Figure 5).

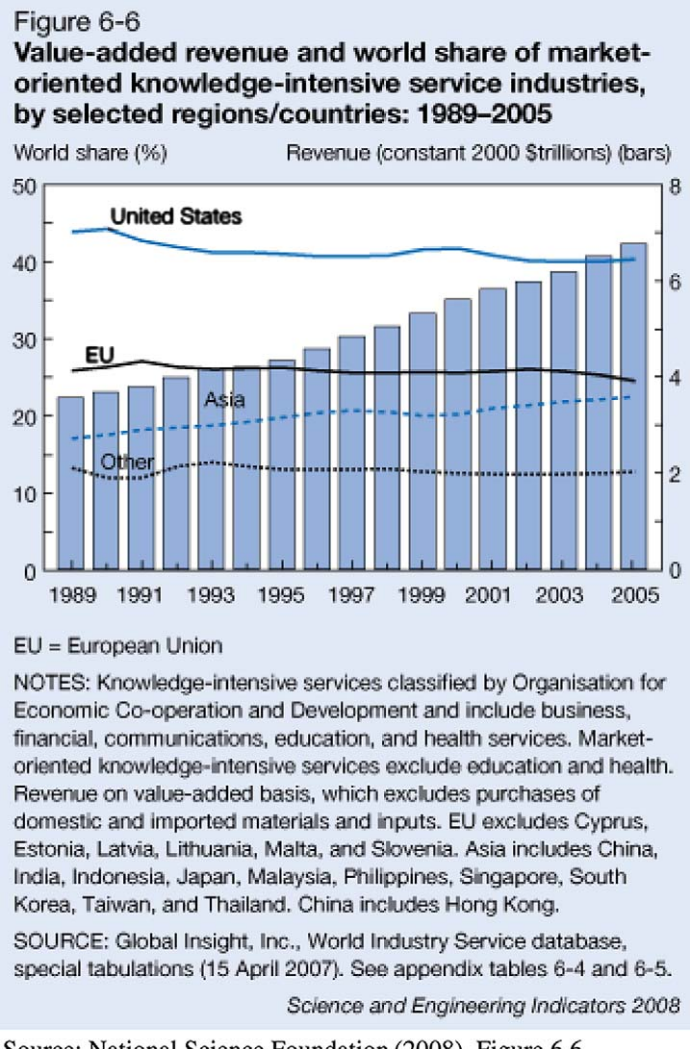
Facing the challenges

In terms of macro-indicators, then, US scientists and engineers seem to be doing all the things required to be successful in a globalizing economy: high industry R&D level, collaborating actively across sectors in Mode 2 learning activities, and working with other researchers from around the world, plus maintaining both quantity and quality of research. What we see is not a weakening of performance on the part of the US, but rather the strengthening of capabilities in other places – the

Table 1. US article co-authorship, by sector, foreign co-authorship, and US co-author sector: 1995 and 2005 (%)

Year/sector	Foreign co-author	US co-author sector					
		FFRDCs	Federal government	State/local government	Academic institutions	Industry	Private non-profit
1995							
FFRDCs	28.2	12.7	7.1	0.2	44.5	8.7	3.3
Federal government	16.2	2.5	16.9	1.9	51.3	8.5	7.6
State/local government	9.9	0.6	13.5	12.8	63.2	8.0	15.3
Academic institutions	16.6	2.4	7.7	1.4	36.3	5.7	8.4
Industry	16.1	3.3	9.1	1.2	40.3	13.7	7.2
Private non-profit	14.4	1.2	7.6	2.2	56.1	6.8	22.9
2005							
FFRDCs	38.3	16.9	8.2	0.3	54.3	6.9	4.2
Federal government	25.2	3.4	19.3	2.7	58.8	9.3	11.1
State/local government	15.3	0.8	16.9	15.6	70.6	10.3	19.3
Academic institutions	25.6	3.1	8.0	1.5	42.9	6.1	9.7
Industry	26.3	3.2	10.5	1.8	50.7	16.0	11.8
Private non-profit	24.4	1.5	9.6	2.6	61.8	9.1	27.4
1995–2005 change (percentage points)							
FFRDCs	10.1	4.2	1.1	0.1	9.8	−1.8	0.9
Federal government	9.1	0.9	2.4	0.8	7.5	0.8	3.5
State/local government	5.5	0.2	3.4	2.8	7.5	2.3	4.0
Academic institutions	9.0	0.7	0.3	0.2	6.6	0.4	1.3
Industry	10.2	−0.1	1.4	0.6	10.3	2.3	4.6
Private non-profit	10.0	0.3	2.0	0.5	5.6	2.3	4.6

Source: National Science Foundation, http://www.nsf.gov/statistics/seind08/c5/c5s3.htm#c5s32 [accessed October 2009].



Source: National Science Foundation (2008), Figure 6.6.
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Figure 5. Value-added revenue and world share of market-oriented knowledge-intensive service industries, by selected regions/countries, 1989–2005

process of global economic development. This is surely to be expected in a relatively peaceful, relatively democratic, relatively open-market world.

Only the balance of payments numbers sound a note of alarm in this rosy picture, indicating rapid decay rather than gradual evolution. US consumers have benefited from the lower prices for goods and services purchased elsewhere, but in the last few years, with the rise in capability in Asia and the mutual trade in manufactured goods, the trade deficit has grown to alarming dimensions. US workers need the opportunity to produce products and services that the world wants to buy, so that they can afford to buy from the rest of the world; but manufacturing employment in the United States has declined sharply since 1990 and key sectors

have been lost. Two-tiered wage systems have emerged, separating union from non-union workers. Real incomes of most Americans have declined in recent decades, and income inequality has drastically increased. Has US innovation policy addressed this situation? This section turns back to a description of some views during the last administration, and then scrutinizes the current administration's strategy in the light of emerging global realities.

Priorities in 2004

On the assumption that, in an era of globalization, the US needs to be learning a great deal from the rest of the world, it seemed worthwhile analyzing a set of US STI policy documents to see whether they indicated that the US could be a good partner in international collaboration. The results were both discouraging and encouraging. Within Congress and the Administration, the documents indicated little attention to any international issues other than security and related areas, such as visas. Congressional hearings reflected traditional agency missions. NASA focused on the space project; Energy was concerned with a hydrogen economy; the Environmental Protection Agency was exploring mercury emissions; the National Science Foundation was working on earthquake hazard reductions and supercomputing. The National Science Board renewed its emphasis on recruiting US students to science and engineering careers because visa restrictions were restricting immigrant numbers, focusing on national challenges and national benefits, not international ones. The report of the National Science and Technology Council (2004), *Science for the 21st Century*, focused on national challenges and national benefits, not international ones.

Interestingly, the most forward- and outward-looking innovation policy report issued in 2004 was the report of the National Innovation Initiative of the Council on Competitiveness (2004). The Council is a private body that, in a Mode 2 way, unites industry, labor, and university leadership to shape national debate on competitiveness by concentrating on a few critical issues. In 2004, in preparation for the presidential elections, the Council launched a wide-ranging examination of the US innovation system in order to identify a few key recommendations for the incoming administration. The report took the global context for US innovation very seriously and rose to the challenges it poses by calling for a broader and deeper innovation process at home. 'We must optimize our entire society for innovation', the Council wrote.

The report began with the assumption that innovation would be the single most important factor determining the success of the United States through the twenty-first century. The United States has been a beacon to people around the work throughout its history, the report claimed, but now finds itself in a new position, because of two shifts. First, 'the world is becoming more interconnected and competitive', and economic interdependencies are growing. Second, the nature of innovation itself is in flux, and the playing field is leveling. The preface to the report raises the question of whether the US will continue its historic role as leader.

The global environment dominates the report's analysis of innovation opportunities and challenges. The US 'competes and collaborates' in an open global trading system, a global labor market for the best and brightest, a world of networked communications and manufacturing that allows both low- and high-skilled jobs to be sent overseas by US-based firms. The security environment is also new, the report notes. To meet these challenges, the report calls on the US to 'unleash a new era of

innovation-driven growth' that can address 'the great challenges facing society'. Among the advances needed, the report envisions 'higher levels of health across the planet', along with options for new environmentally friendly sources of energy.

Three challenges are most important in shaping the US innovation agenda, according to this report. First is the new shape of innovation itself, which is diffusing at ever-increasing rates, multidisciplinary and technologically complex, collaborative, facing greater consumer demands, and global in scope. We now live in an innovation economy, which is fundamentally different from an industrial or information economy, the report claims. The second challenge is the seriousness of the competition. Foreign-owned patents account for nearly half of all US patents; several countries spend more on R&D as a share of GDP than the US; and Asia spends as much as the US on nanotechnology. Finally, the scope of the opportunity is a key factor as well.

> In the end, the importance of innovation lies less in competitive victory of one country over others than in building a better world for everyone. America can be an engine of change and a driver of prosperity. We see the promise of a better future for our children – and the world's children. (Council on Competitiveness, 2004, p.12)

The Council frames its recommendations in a thoroughly global analysis, with global as well as national progress in mind. A section on nationalism and globalization articulates the point again: 'Our security and economic opportunities are enhanced by growing economies around the world, not by societies locked in poverty without a stake in the global order'. The National Innovation Initiative saw innovation as a win–win solution to problems both within and outside the borders of the United States. In sum, even in 2004, the Council on Competitiveness put forward a progressive and inclusive view of the place of innovation in the US in a global system. It is of interest that this forward-looking synthesis arose from a collaborative effort among business, labor, and universities – that is, from groups and institutions outside government.

Priorities in 2009

The Obama administration has won international acclaim for its realistic assessment of the international environment and attitude of humility and partnership. These approaches would also seem appropriate in reorienting STI policy to shifting global realities. Does the Obama administration's first white paper on innovation policy adequately acknowledge the global context?

Creating a niche in high-skill manufacturing The central reality of mutual trade in manufactured goods suggests that manufacturing employment should be a priority. In this area, the Obama innovation plan says that we have to work smarter, not harder:

> Now, manufacturing and services have merged, knowledge is a key factor of production, and services we thought could only be provided in particular countries are available anywhere. We need new ideas to provide Americans with new jobs, new services that take advantage of our globally interconnected world, and new skills that improve our manufacturing capabilities. (Executive Office of the President, 2009, p.3)

The document stresses innovation in both high-technology and traditional sectors for high levels of productivity growth in order to achieve 'higher returns to

workers and increases in standards of living'. It recalls the US track record for innovating towards higher-wage jobs within industries, and cites maintaining employment in the revitalized semiconductor industry as an example of such successful upgrading. In short, the goal is strengthening high-technology manufacturing, not bringing back lower-skill jobs already lost. This objective reflects reality.

In addition, the strategy looks to new industries: 'The greatest job and value creators of the future will be activities, jobs, and even industries that don't exist yet today. The countries that catalyze their development will reap the greatest rewards' (Executive Office of the President, 2009, p.4). Here the example is Internet-based information and computing services, which some experts estimate have added as much as US$2 trillion to the US gross domestic product. The goal is surely a good one, but the probability of the next such new major industry starting and staying concentrated in the United States is dropping steadily, as innovative capabilities grow in other parts of the world. In addition to wanting to lead the world, the US needs to be prepared to enter and compete in industries started or developed elsewhere. Obama's innovation strategy is short on examples of these. The multinational firms that have moved operations out of the United States are still attracting most attention in US innovation policy; and innovations in business processes embodied in dynamic firms, such as Google, FedEx, and Amazon, get almost no attention.

Innovation in national priority areas The three specific national priority areas the plan identifies illustrate this kind of significant challenge. Let us take them in reverse order, starting with health care technology.

> The inefficiencies in our health care system raise costs and reduce the quality of care. New advances in health information technology will increase efficiency while broad reform will free businesses and individuals to innovate and grow. (Executive Office of the President, 2009, p.21)

The structure of the US health care system creates a very large domestic market. The Council of Economic Advisors forecasts that health services will be one of two industries with significant employment growth in the coming decade (Executive Office of the President, 2009, p.5). The innovation plan aims to expand the use of health IT and slow the growth of health care costs. Will this plan shrink opportunities in this middle-wage job-generating sector? Does it create any opportunities for export? US medical equipment manufacturers are scarcely holding their own against German ones, and even these high-end manufacturing jobs are moving out of the country. Can health IT products fill some of the gap? The plan is silent on these crucial questions.

Another national priority area is energy – an excellent choice by any standards. The terminology is strong: 'Unleash a clean energy revolution'. Reflecting the overall goals of the innovation strategy, the objective is to create 'new jobs in cutting edge industries while tackling the threat posed by climate change'. Stimulus funding is creating immediate jobs in weather and conservation, and over the longer term the plan calls for innovation in clean energy technologies, but the plan is silent on the fact that many of the clean energy technologies being installed today are products of European economies, which have been developing them for decades. There is no acknowledgement of the need to catch up in this area or even to get into the alternative energy technology market. Without a solid strategy, the investment goal is a recipe for deepening the balance of payments deficit further.

Finally, and also related to energy and environment, the plan identifies advanced vehicle technologies as a priority area, with an emphasis on batteries for electric vehicles. Government will help the market along by testing the necessary infrastructure and educating consumers, but again, just as the cash for clunkers program benefited the Japanese car makers who already sold the efficient products US consumers wanted, the investment in electric car infrastructure could end up increasing US debt to the benefit of production jobs in other countries. The plan's emphasis on innovation in the next generation of biofuels (cellulosic and algae-based) is more suited to US strengths, although the global shape of the biofuels business is still dependent on the highly volatile cost of oil. In short, while unfurling the innovation banner and exhorting new ideas, the plan does not acknowledge the realities of world competition in the areas where the US needs new technologies the most. Conversely, it does not identify technologies where the US has something to offer to solve problems in the rest of the world.

A world class workforce In order to implement any innovation-based strategy for prosperity, a high-skill workforce is needed. The plan acknowledges this reality, and pledges to take it up – just as its Bush-era predecessors did. The elements of the plan are unsurprising, but sensible: reform public schools, increase the percentage of college graduates, improve science and math education, develop career pathways through community colleges, and design good online courses for continuing education (Executive Office of the President, 2009, p.12). Making progress on these goals would improve the chances of all Americans being able to take up the high-end jobs that the rest of the strategy promises.

The last element jars, however: 'Improve the processing of high-tech visas'. The text here points to visas for scientific conferences, a positive step towards protecting the ability of US scientists and engineers to learn from the rest of the world, but is the subtext that work visas will also be more plentiful? The US economy under the old world order benefited enormously from immigrant scientists and engineers, and certainly wants to keep the doors open; but the new reality is that these contributors will be more and more likely to go home rather than stay after graduate training. A realistic assessment of this situation would articulate the importance of developing domestic talent. The plan is silent on this key point.

Public sector and community innovation The Obama plan moves into the new reality of innovation in its emphasis on public sector and community innovation. High-technology developments are not the only route to improving quality of life; improvements in organization and communication can also contribute. The emphasis in the Obama administration on open government – 'more transparent, participatory, and collaborative' – is certainly a step in this direction. The creation of a White House Office of Social Innovation is also interesting. The office will 'help tackle our nation's toughest problems' by identifying promising and results-oriented non-profit programs (Executive Office of the President, 2009, p.17). It would certainly be to the benefit of the US to apply some of these principles to international partnerships as well as to domestic issues.

Missing the global context There are many other elements of the plan, each of which constitutes a good thing in its own right, but none of which specifically addresses challenges that arise in the new world order. The key question is: what kind of partner will the US be if it follows this plan? In contrast to the

Council on Competitiveness (2004) document, the Obama innovation strategy does not address global partnerships directly. Like the Bush administration visions, it is strongly domestically oriented, with international relations seen as relevant only in opening markets, exports, trade agreements, and protecting intellectual property rights.

Thus, the plan misses a key structural element of the new world order: if the US economy is going to grow, if it is going to maintain its chosen high-technology position, if there are going to be markets for new industries, the world economy must be growing even faster. Surely US innovative capacity does not need to be confined to maintaining a competitive position; surely it could also help in that larger growth. The Obama innovation plan fails to recognize and embrace these potentials.

For example, the plan calls for building a leading physical infrastructure by investing in roads, bridges, mass transit, the electricity grid, and high-speed rail; but these are not just America's needs. Much of the developing world is looking to improve in these areas. If the US partnered with other countries in their projects, the resulting improvements could increase world trade and open US markets. Could innovation be applied to the two problems together, US and international? Could US firms take the lead in developing and installing new materials and processes in these crucial civil infrastructure areas? As with the energy area, unless US firms assertively take the lead, this set of investments will end up building the business and capabilities of European or Asian firms, which will also then be poised to sell to the rest of the world.

What if US businesses, rather than seeing the rest of the world as passive export markets where intellectual property rights must be maintained, saw firms in other countries as potential business partners? What if they grew markets by creating two mid-skill jobs abroad for every high-skill job in the US? What if US firms listened to their international partners about incremental or radical innovations that would transform their standards of living? Nothing in world economic development needs to be a zero sum game, unless we make it that way.

The rightful place of military R&D The Obama plan says nothing explicitly about military research and development, although several examples mentioned in the report reflect military needs. Is the assumption that military R&D will continue to constitute over half of US federal R&D investment? Does this assumption address twenty-first century realities? Examination of past cases shows that the relationship between military technology development and civilian technology success is variable, both across industries and over time (Mowery, 2009). The focus on military technologies has sapped resources from more productive civilian technology sectors, such as clean energy (Markusen and Yudken, 1992). The emphasis on short-term results in the current homeland security R&D portfolio, in contrast to more basic and applied research investments in the past, may undermine the potential for civilian spinoffs (Mowery, 2009).

The dominance of military R&D in the US, then, is probably one of the factors undermining US economic performance. As the world becomes more peaceful – a dominant goal of the Obama administration – trading in arms becomes less and less viable as an economic strategy. As it succeeds in its diplomatic efforts, this new administration is likely to begin to shift resources into other areas that are more crucial to long-term US prosperity.

End of empire

There is, then, a rosy scenario for the future of the US economy, but it is not the one that the Obama innovation strategy portrays. This strategy suggests a nation going it alone, building internally while ignoring realities in the rest of the world economy, particularly competition from other affluent nations and from such rising stars as India and China, and the opportunities created by past under-development. The rosy scenario does not have a place for any emphasis on military technology, which has demonstrated lower rates of return to the civilian economy and contributes to violence and instability in the environment. If the US wants to look towards a prosperous future, it needs to begin to wean itself from military technology dependence. This will surely be a slow process, but it must be a steady one.

The alternatives? The United States, as a formerly dominant economy, has no role models to look to for paths forward. Perhaps empires do not need role models; perhaps they just fall. The matter has stirred the thinking of others:

> Historians will look back on the last twenty five years as an era of decadence and decline. Our economy is left tottering, our enemies are plotting our destruction, and we are left with an inevitable sense of fatalism about the future. (www.populistamerica.com, accessed October 2009)

> . . . one of the reasons for Ottoman economic decline was the inability of the ruling class to make a clear choice between war and the more conventional types of capital formation. (http://en.wikipedia.org/wiki/Fall_of_the_Ottoman_Empire, accessed October 2009)

> Many say the Fall of Rome was an ongoing process, lasting more than a century. Since Rome still exists, it is argued that it never *fell*. Some prefer to say that Rome *adapted* rather than fell. (http://ancienthistory.about.com/, accessed October 2009)

If US leadership can develop a strategy that reduces dependence on the military economy gradually and takes world competitive and cooperative realities into account, then perhaps we can adapt after all.

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Notes

1. http://www.census.gov/foreign-trade/statistics/historical/gands.pdf [accessed October 2009]. The balance is negative in goods, not services.
2. http://www.census.gov/foreign-trade/balance/c5700.html, http://www.census.gov/foreign-trade/statistics/highlights/top/top0812yr.html [accessed October 2009].
3. http://www.census.gov/foreign-trade/balance/c0007.html#2004 [accessed October 2009].
4. http://www.nsf.gov/statistics/seind08/c5/c5s3.htm#c5s32 [accessed October 2009].
5. http://www.nsf.gov/statistics/seind08/c5/c5s3.htm#c5s32, Table 5–23 [accessed October 2009].

6. The Asia-10 includes China (with Hong Kong), Japan, India, Indonesia, Malaysia, the Philippines, Singapore, South Korea, Thailand, and Taiwan.
7. The National Science Foundation, however, uses exactly that word in the text accompanying *Science and Engineering Indicators* (2008).

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National Science Foundation (2008) *Science and Engineering Indicators*, Figure 6, Washington, DC, September.