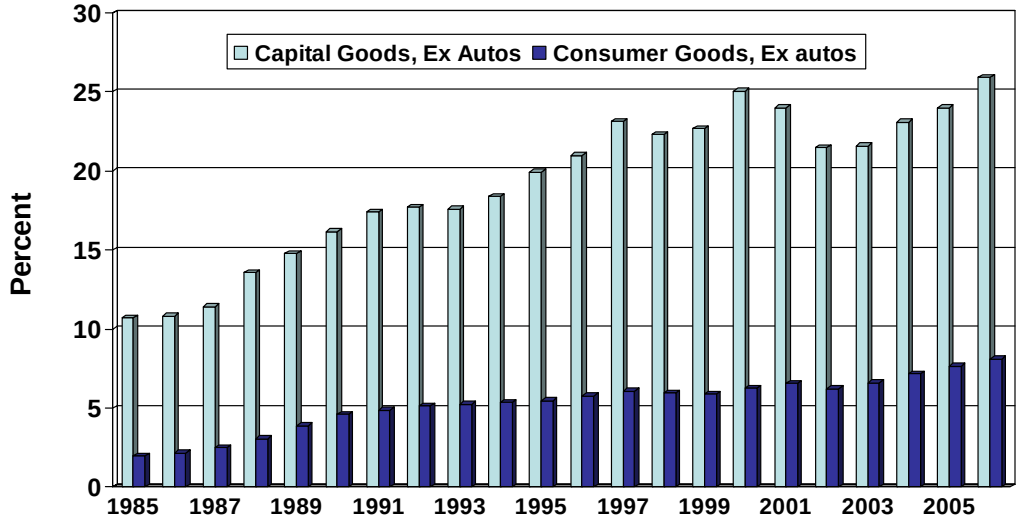
Testimony of
Thomas J. Duesterberg, Ph.D.
President and Chief Executive Officer
Manufacturers Alliance/MAPI
on
"The Globalization of R&D and Innovation"
Before the
Committee on Science and Technology
United States House of Representatives
June 12, 2007

Mr. Chairman and Members of the Committee, I want to thank you for holding this hearing on a subject of vital and timely importance to U.S. manufacturers. My organization represents over 500 leading manufacturing firms whose products range from basic materials to advanced manufacturing and leading-edge technology and associated services. The Alliance itself is primarily a research and executive education provider, but we do advocate public policies benefiting our member companies. Notwithstanding the support of our member companies, the views I will present today are mine alone and do not necessarily represent the unanimous opinion of our members.

I. The U.S. Manufacturing Sector: Evolution and Adaptation

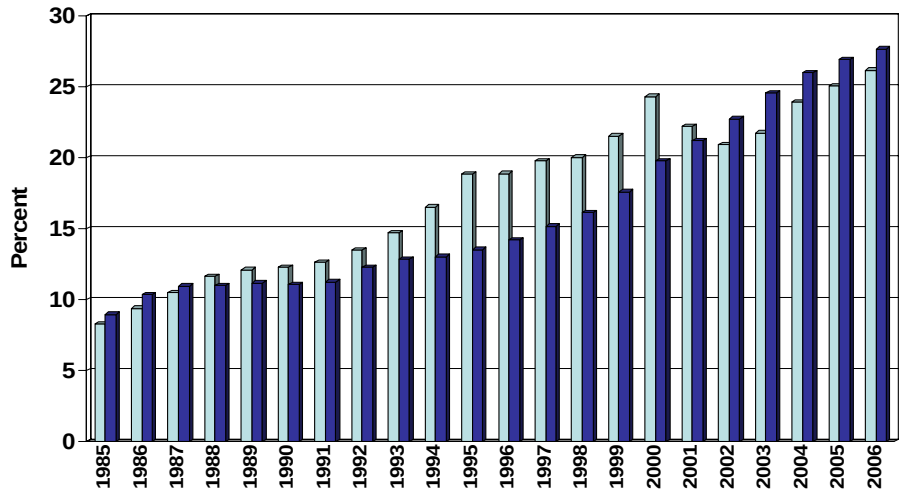
The subject of the hearing today is of vital importance to manufacturers for the simple reason that this sector has been much more engaged in the global economy than the much larger services sector. It is also a leader in innovation, accounting for over 60 percent of private sector research and development (R&D) in the United States and more than three-quarters of patents granted in the United States. For this reason, it is necessary to understand the manufacturing sector's response to globalization in order to fully appreciate the many issues surrounding the globalization of innovative activity. Figures 1 and 2 illustrate the strong pattern of manufacturing globalization of the past two decades. As shown in Figure 1, capital goods exports as a share of U.S. manufacturing output grew from 11 percent in 1985 to 26 percent by 2006, while the share of consumer goods exports quadrupled from 2 percent to 8 percent during the same time frame. Both innovation and constant research and development efforts are required to stay competitive. For capital goods, the path of import growth has been somewhat similar to the path of export growth. As shown in Figure 2, capital goods imports as a share of manufacturing output grew from 8 percent in 1985 to 26 percent by 2006, while consumer goods exports skyrocketed from 9 percent to 27 percent. As a result, the trade deficit, which is 75 percent or more in manufactured goods, is largely a function of our imbalance in consumer goods and raw materials such as oil. We are roughly in balance—and fairly competitive in capital goods—particularly those which embed high technology and require substantial scientific and engineering resources.

Figure 1
Capital and Consumer Goods Exports
Share of U.S. Manufacturing Output
1985-2006



Source: Bureau of Economic Analysis

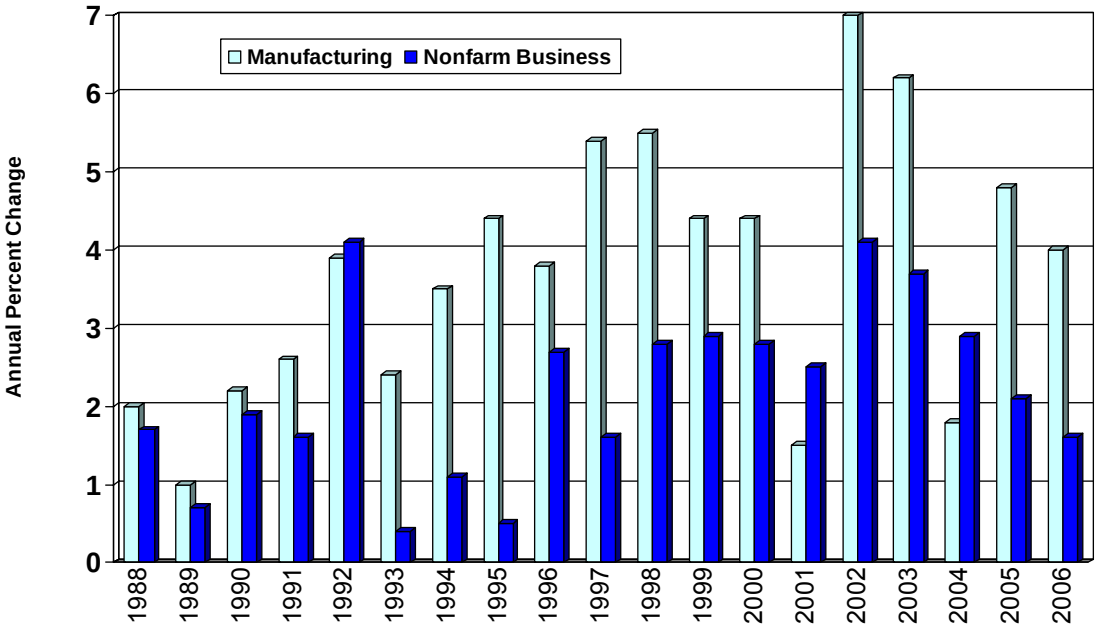
Figure 2
Capital and Consumer Goods Imports
Share of U.S. Manufacturing Output
1985-2006



Source: Bureau of Economic Analysis

The pressures of globalization have forced manufacturers to become leaders in finding ways to adapt to international competition. They have quickly realized that cost containment and the relentless pursuit of both process and product innovation are the keys to survival. Constant improvement programs such as lean manufacturing and six sigma have rapidly become the norm in multinational manufacturing enterprises. Partially as a result, the manufacturing sector as a whole has realized the benefits of strong productivity gains, although some argue that these gains are limited to R&D intensive, high-technology industries. Figure 3 illustrates the strong acceleration of manufacturing labor productivity growth since the late 1980s. And while the data aren't strictly comparable, it is quite evident that manufacturing productivity growth has far exceeded productivity gains for the economy as a whole. There is anecdotal evidence that service-sector firms are beginning to mimic manufacturing productivity improvement practices. In fact, some studies show that those service industries most closely tied to manufacturing, such as wholesale trade, are the leaders in productivity enhancement.

Figure 3
Manufacturing and Non-Farm Business
Labor Productivity Growth

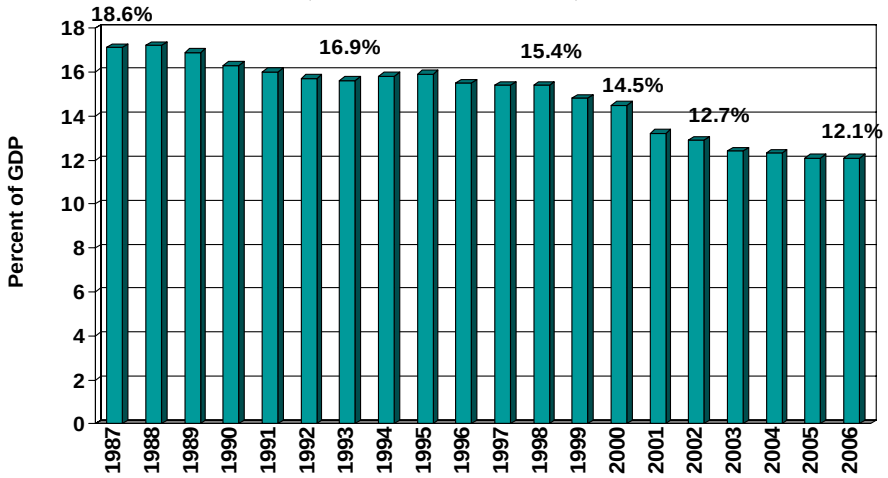


Source: Bureau of Labor Statistics

Productivity gains have created what is often referred to as the "paradox of manufacturing." The sector is smaller in some very visible respects but more global. Figure 4 shows that the manufacturing share of the U.S. economy has declined from 18.6 percent in 1987 to 12.1 percent by 2006. Part of this decline, but by no means all, is explained by the productivity induced price effect engendered, in turn, by global competition. Additionally, global competition has restrained pricing power in manufacturing to a much greater extent than in services, so that manufacturing's nominal share of GDP declines despite continued growth in physical output at about the same pace as the overall economy. Figure 5 shows the even more dramatic employment decline. As shown, the manufacturing workforce has declined from 20.7 percent of the U.S. workforce in 1980 to 10.4 percent by 2006. And in fact data show that manufacturing employment has been declining as a

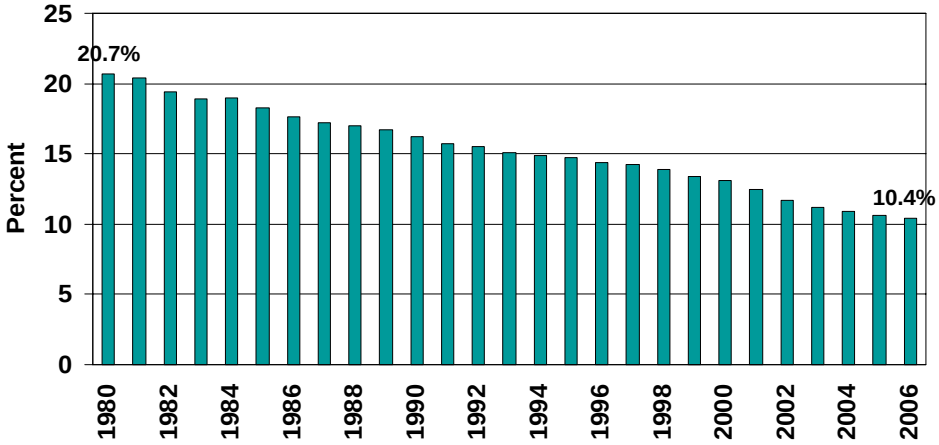
share of the U.S. workforce since the early 1950s, suggesting that the reasons for the employment decline are fundamental to the factory sector's evolution and are not simply a result of the current challenges presented by emerging markets. But while smaller, manufacturing has maintained its global position. Figure 6 shows that the U.S. share of global manufacturing output has actually increased slightly from 22.9 percent in 1980 to 23.8 percent in 2003. And more impressively, Figure 7 shows that the U.S. manufacturers' share of global high-tech output increased from approximately 25 percent in 1980 to 42.5 percent by 2003 (the latest year for which data are available). Clearly, the sometimes painful domestic adaptations have allowed the U.S. manufacturing sector to survive and compete in the global business environment in which it now operates.

Figure 4
Manufacturing Share of the Economy:
1987-2006
(measured in nominal dollars)



Source: U.S. Department of Commerce, Bureau of Economic Analysis

Figure 5
Manufacturing Share of the U.S.
Non-Farm Workforce
1980-2006



Source: U.S. Department of Labor, Bureau of Labor Statistics

Figure 6
U.S. Share of Global Manufacturing Ouput,
1980-2003

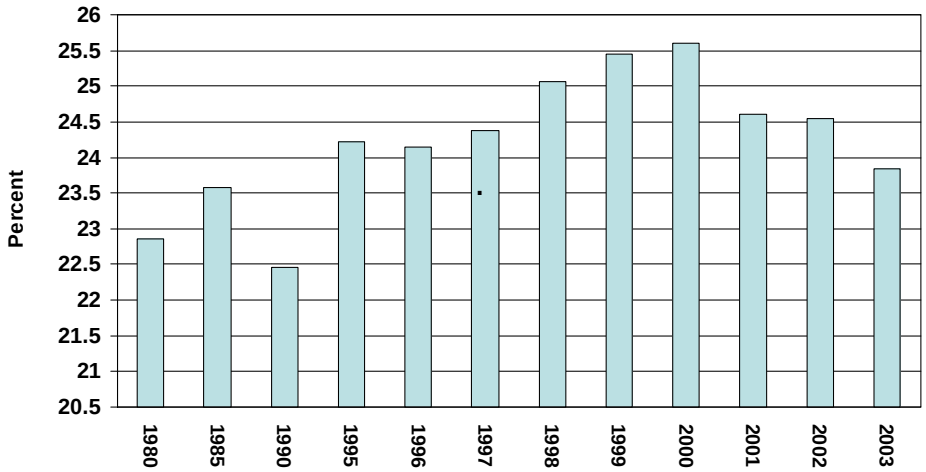
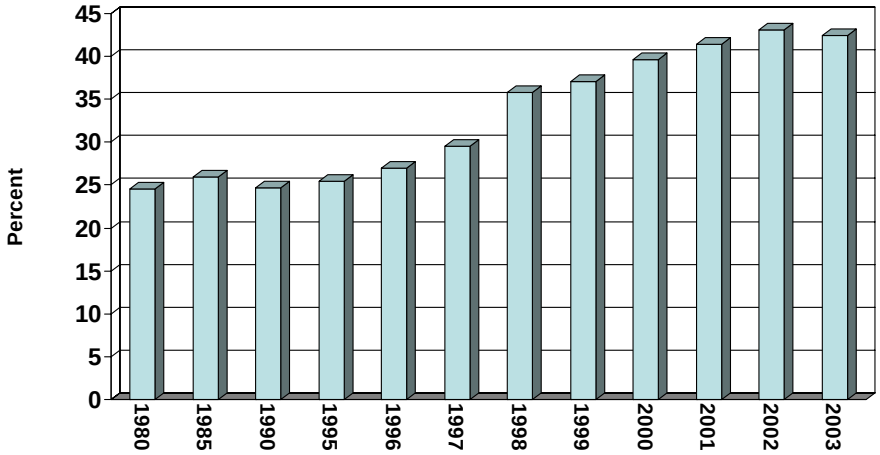


Figure 7
U.S. Share of Global High-Tech Manufacturing,
1980-2003



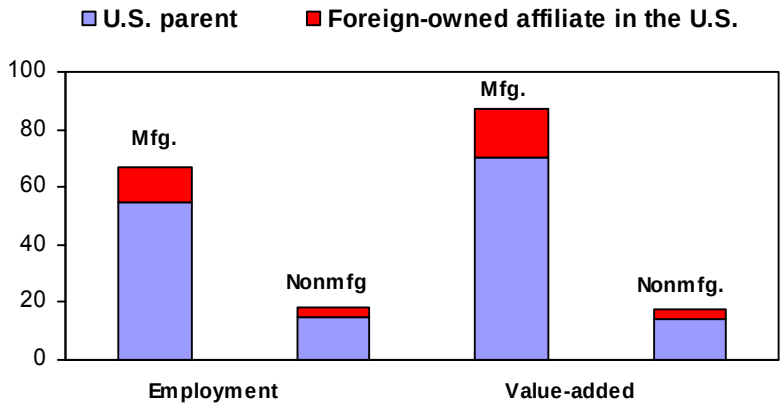
Source: National Science Foundation

II. U.S. Multinational Foreign Direct Investment: Myths and Benefits

While the macro data presented above illuminate the broad sectoral response to globalization, a fuller understanding of the key issues related to jobs, capital investment, and innovation requires a more focused study of the multinational firms that dominate the U.S. manufacturing sector. Along

these lines, MAPI's Chief Economist, Dan Meckstroth, recently published a comprehensive essay on the role of multinationals and the benefits and costs of multinational activity.[1] Popular myth often creates the incorrect perception that multinational corporations (MNCs) are the agents of U.S. job and capital loss in a globally integrated world. But Dr. Meckstroth's paper provides a wealth of data and empirical research to show that the business dealings of U.S. multinationals with their affiliates abroad complements rather than substitutes for the domestic economic growth. Figure 8 illustrates the large footprint that multinationals (including foreign-owned MNCs operating in the United States) have in the manufacturing sector in spite of only accounting for less than 1 percent of all manufacturing firms. As shown, during 2004 multinationals accounted for about two-thirds of manufacturing employment and about 85 percent of U.S. manufacturing GDP.

Figure 8
Multinational Corporations' Share of U.S. Employment and Value-Added by Industrial Sector, 2004
Percentage of U.S. Nonbank Private Industry



Source: U.S. Department of Commerce, Bureau of Economic Analysis

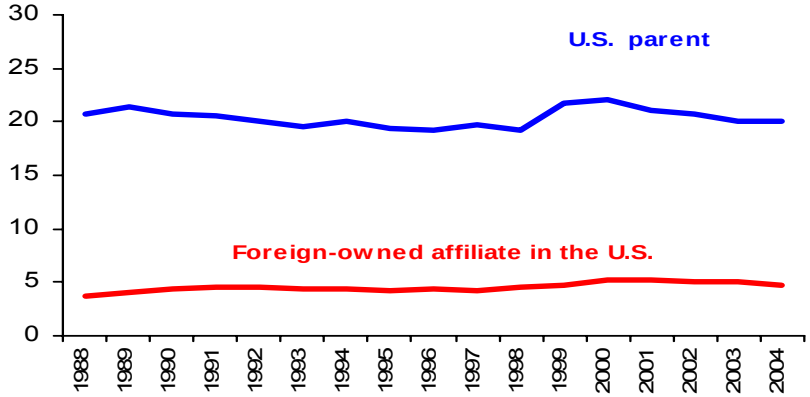
Contrary to common myth, multinationals aren't transferring jobs out of the United States, even as they increase production among their foreign affiliates. Figure 9 shows that the employment share of U.S. parent multinationals has remained relatively flat as a share of total non-bank private industry employment, while foreign-owned multinational employment in the United States actually increased slightly between 1988 and 2004. Domestic employment growth in both manufacturing and non-manufacturing MNCs generally equals or exceeds the growth of other companies in the same sector over the past 20 years. Finally, the data show that an increase in employment at foreign affiliates is positively correlated with growth in jobs at the domestic parent. While overall job losses do affect the domestic manufacturing sector, they are much less among MNCs.

As the Meckstroth paper explains, expansion abroad through foreign direct investment is the only way to accelerate the pace of growth beyond what is possible in the domestic marketplace. Demand is growing rapidly around the world in such places as China, India, and Southeast Asia at a faster pace than in the United States. The data of the past three decades show clearly that multinationals invest abroad primarily to gain access to fast-growing markets for their products and services. Table 1 shows considerable growth in affiliate sales as a share of total global sales for MNCs, from 1999 to 2004 foreign affiliate sales grew at a 10 percent rate, faster than the 3.5 percent rate of domestic

[1] Daniel J. Meckstroth, "Globalization Complements Business Activity in the United States," Manufacturers Alliance/MAPI, ER-624e, January 2007. I wish to thank Dr. Meckstroth, Cliff Waldman, and Ernest Preeg for their assistance in preparing this testimony.

parents. Figure 10 shows the destination for the sales of U.S. manufacturing affiliates since 1989. In 2004, only 10 percent of these affiliate sales were back to the U.S. parent corporation, and that share has declined modestly over the past 15 years. Although not shown separately in the figure, only 1 percent to 2 percent of U.S. foreign-affiliate sales are exported back to the United States to third parties. The vast majority of the sales of U.S. affiliates, about 90 percent are either to the country in which the affiliate is located or to the nearby region. This pattern dates back at least to the 1920s and 1930s when U.S. automakers began to produce in Europe and elsewhere to access local and regional markets. These problems apply to the sales of non-manufacturing affiliates as well.

Figure 9
Multinational Corporations' Share of U.S. Employment
By Corporate Nationality, 1988 to 2004
Percentage of U.S. Nonbank Private Industry



Source: U.S. Department of Commerce, Bureau of Economic Analysis

Table 1
U.S. Multinationals Sales and Exports, 1999-2004

	Manufacturing		Non-Manufacturing	
Year	MOFA sales % of global sales	Number of times MOFA sales larger than parent exports	MOFA sales % of global sales	Number of times MOFA sales larger than parent exports
1999	34.7	4.0	19.2	11.0
2000	35.4	4.4	18.7	12.5
2001	36.1	4.6	18.6	14.0
2002	37.8	5.1	18.2	14.1
2003	40.2	5.7	19.5	15.8
2004	41.7	6.2	19.9	16.6

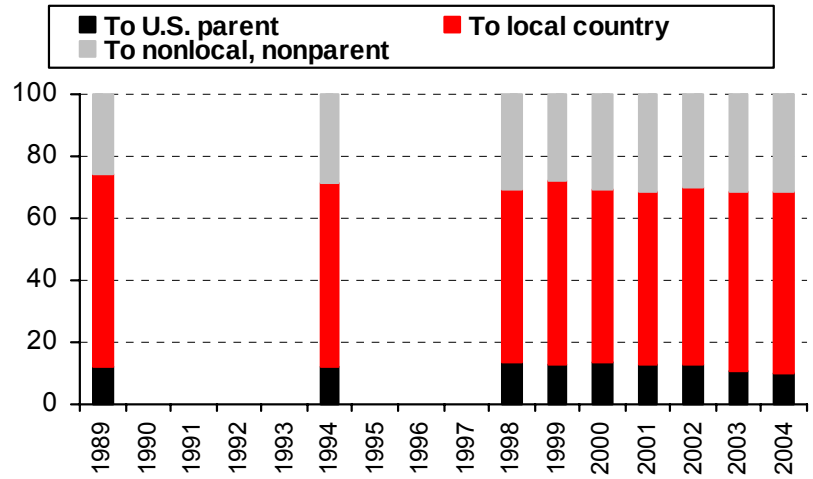
Source: U.S. Department of Commerce, Bureau of Economic Analysis

Note: MOFA is Majority-Owned Foreign Affiliate.

The issue of low-wage country arbitrage is perhaps the most contentious and difficult one in analyzing outsourcing. Figure 11 shows that the share of U.S. majority-owned foreign affiliate employment in high-income countries remained large in 2004 at 64 percent. But it nonetheless fell steadily from a peak of 75 percent in 1989. Further, Table 2 shows the considerable growth of

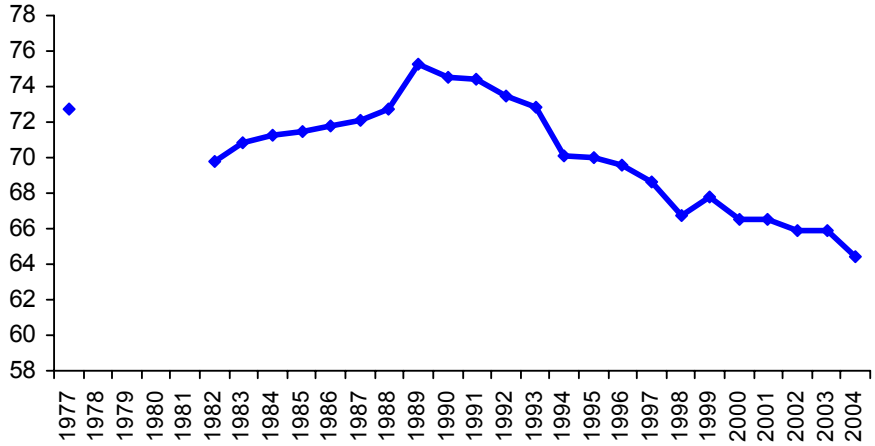
employment of U.S. majority-owned foreign affiliates in China, India, and to a lesser extent Mexico. If China and India are excluded, affiliate employment growth in the low and middle income countries is marginal, reinforcing the notion that foreign investment largely seeks fast-growing, large markets like China and India.

Figure 10
Destination of U.S. Majority-Owned Manufacturing Foreign-Affiliate Sales By Industry of Affiliate, 1989 to 2004
Percentage of total sales



Source: U.S. Department of Commerce, Bureau of Economic Analysis

Figure 11
High-Income[a] Country Share of Employment by U.S. Majority-Owned Foreign Affiliates, 1977 to 2004
Percentage of total employment



Source: U.S. Department of Commerce, Bureau of Economic Analysis
[a]The high-income classifications are determined by the World Bank.

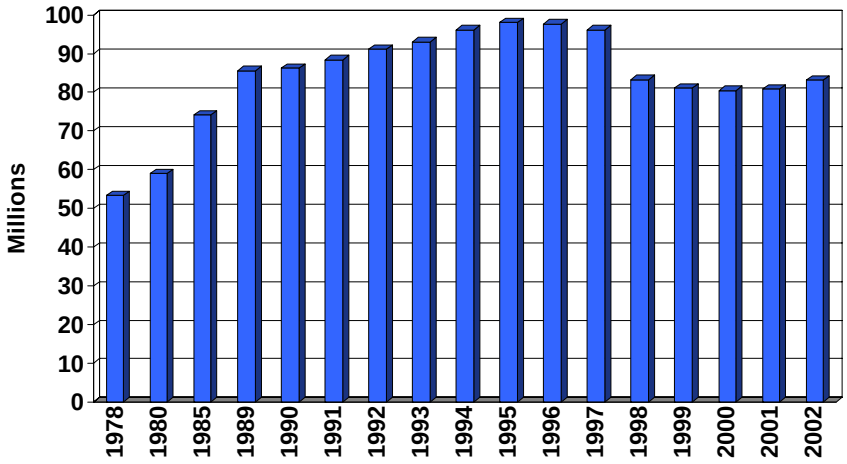
Table 2
Employment Growth
Majority-Owned Foreign Affiliates of U.S. Multinationals
By Income Classification/Country, 1997-2004

Income Classification/Country	Number of Countries	Employment Annual Percent Growth
Low-Income	**20**	**12**
India	1	19
Excluding India	19	0
Low-Middle Income	**33**	**5**
China	1	13
Excluding China	32	3
High-Middle Income	**30**	**3**
Mexico	1	4
Excluding Mexico	29	2
High-Income	**37**	**3**

Source: U.S. Department of Commerce, Bureau of Economic Analysis

While the trend toward low-wage country foreign direct investment is growing, Dr. Meckstroth's paper notes that anecdotal evidence suggests that market expansion, not costs, is the primary driver of U.S. entry into these high-potential emerging market countries. The absence of understanding of this simple fact has created misguided perceptions about job exporting that are often belied by actual data. For example, the fear that manufacturing jobs are "being lost to China" is somewhat undermined by the weakness in manufacturing employment growth in China during the late 1990s and early 2000s, shown in Figure 12.

Figure 12
Manufacturing Employment in China



Source: China Statistical Yearbook, 2006

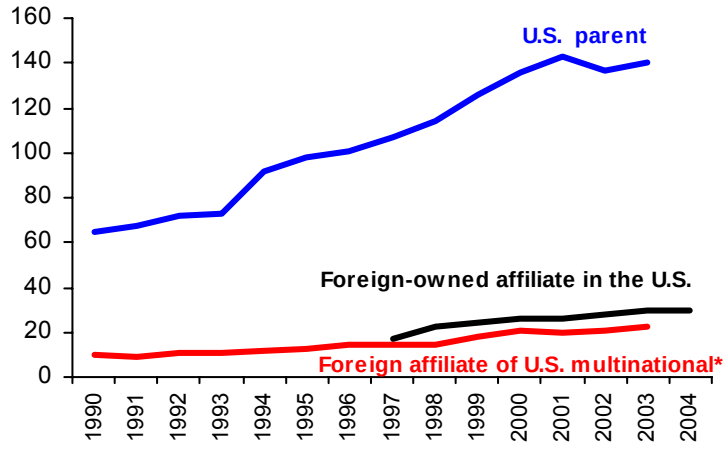
The MAPI study also highlights the indirect benefits to the domestic U.S. economy from multinational global profit-seeking behavior. U.S. businesses and consumers gain from lower cost products, improved services, higher quality goods and services, longer product life cycles, higher

profits, and higher quality jobs. U.S. firms are motivated to produce abroad to avoid tariffs and other barriers to adapt products to those markets, and—as I will discuss later—tap local talent and other resources. And far from being substitutes for domestic activity, the paper points to credible research which shows that when foreign affiliates expand, their U.S. parents also expand domestic operations. Finally, many studies show that low wages and fast growth in foreign countries do not in and of themselves attract foreign investment. That is why foreign investment is still high in developed countries, including increased investment into the United States. Ninety percent of the employees of U.S. MNCs are in high wage countries, including employment at the domestic parent plants.

III. The Next Wave: The Globalization of Innovation

While much public debate has been centered on the consequences of globalization for U.S. job and investment growth, the potential globalization of innovation supply chains has received far less attention. The reason is quite clear. At the moment, as pointed out by the Meckstroth paper, R&D is the least globalized activity within multinationals. Foreign affiliates represent 31 percent of all sales and 28 percent of employment among U.S. multinationals. These firms have, however, been reluctant to globalize research activity for fear of losing intellectual property protection for what are often their core competences. Consequently, foreign affiliates' share of multinational R&D spending has not changed appreciably during the 13 years from 1990 when it was 11.4 percent to 2003 (the latest data available) when it was 13.7 percent. Figure 13 shows the total R&D spending by U.S. MNCs at the parent and among foreign affiliates. It is also worth noting that more R&D by non-U.S. firms is insourced than is outsourced by U.S. firms; the United States remains an outstanding destination for R&D by European, Japanese, and other Pacific Rim developed countries.

Figure 13
Multinational Corporations' Research and Development Spending
By Corporate Nationality, 1990 to 2004
Billions of dollars



Source: U.S. Department of Commerce, Bureau of Economic Analysis
*Majority-owned
R&D spending for foreign-owned affiliates in the United States was not available prior to 1997.

To understand the motivation for and the benefits of expanding production and the limited offshoring of R&D networks around the world, some extended discussion is warranted. Global production and sourcing can, first, improve the rate of return on product innovation by extending the life cycle of products. New products (such as computers or medical diagnostic devices) introduced in the United States, Western Europe, and Japan tend to have high value propositions. Early in the product life cycle, production costs are relatively high because firms are producing first-generation products on a small scale, using relatively high-skilled workers and employing specialized capital equipment. The relatively high price of products at the early stage of a product's life, however, com-

pensates for the start-up costs and risk. Over time, newer product generations are introduced, and the market for the older generation matures. The longer the products embodying old technology stay on the market, the more likely competitors will be to commoditize them. Intense competition may lead to falling prices, and eventually products in the mature stage of the product cycle do not have a large enough market and revenue stream to support U.S. production costs. Globalization, however, can preempt discontinuation of such mature product lines and provide them with a new life. An old-technology product or a significant portion of the product can be manufactured using less expensive capital and low-wage labor in developing countries.[2] Otherwise the product would simply be supplanted by foreign competitors. The ability to generate profits on a product over a longer life cycle increases the rate of return on innovation and promotes more new product development in industrialized countries.

Research evidence also finds that multinationals benefit from global research and development and from an expanded international knowledge network. Economists Chiara Crascuolo, Jonathan E. Haskel, and Matthew J. Slaughter[3] examined data on several thousand firms in the United Kingdom and found that globally engaged firms generate more innovation outputs than firms not globally engaged. In the 1998 to 2000 time frame, only 18 percent of firms with domestic-only operations had made some significant product or process innovation. The average number of patents applied for among the non-multinationals was just 0.1 per firm. Among firms that were multinational parents, however, 45 percent reported either product or process innovation during the time period, and they averaged ten patent applications each.

An important finding from the research on how globalization improves innovation concerns the way multinationals achieved superior knowledge generation. MNCs are more innovative than non-multinationals not just because they have more researchers, but because they have an expanded global knowledge network. In the case of patents, increased innovation is derived from collaboration and networking with other researchers in universities around the world. When it comes to production process and product innovation, multinationals are able to learn more than non-multinationals from both domestic sources of applied knowledge and a wide network of international sources, such as suppliers, customers, and their foreign affiliates.[4] The resulting productivity gains from multinationals' innovation directly benefit Americans' standard of living, and the knowledge spillover indirectly benefits domestic firms that supply and/or are customers of multinationals.

The availability of technical talent overseas and the rapid growth of foreign markets provide further incentives for U.S. multinationals to expand international research centers. The reason that foreign-affiliate R&D shown in Figure 13 is such a small proportion of the total is that R&D is a core value generator for U.S. multinationals. U.S. multinationals are reluctant to globalize the activity and risk losing protection for their intellectual property.

Another way to illustrate the point that the United States is not rapidly offshoring R&D activity to foreign affiliates is to look at R&D spending growth. From 1990 to 2003, R&D spending by U.S. parent companies increased at a 6.1 percent annual rate of growth, and majority-owned foreign-affiliate R&D spending grew at a 6.2 percent annual rate of growth—expanding essentially at the same pace.

Although R&D spending by U.S. parent companies kept pace with R&D spending by foreign affiliates from 1990 to 2003, there is some evidence that the future pace of R&D globalization may be accelerating. The United Nations Conference on Trade and Development (UNCTAD) found in a 2006 survey that developing countries are likely to grow in importance as R&D locations for

---

[2] Craig K. Elwell, *Foreign Outsourcing: Economic Implications and Policy Responses*, Congressional Research Service Report for Congress, Order Code RL32484, June 21, 2005, p. 15.

[3] Chiara Crascuolo, Jonathan E. Haskel, Matthew J. Slaughter, "Global Engagement and the Innovation Activities of Firms," National Bureau of Economic Research, Working Paper 11479, June 2005, pp. 1-46.

[4] *Ibid*, p. 5.

multinational firms. Fifty-seven percent of multinational firms surveyed already have an R&D presence in China, India, or Singapore,[5] and 67 percent of U.S. firms indicate that their foreign R&D is set to increase over the next five years.[6] While the lion's share of global R&D clearly remains with industrialized countries, emerging economies, most notably China and India, are becoming more important innovation centers. A recent survey of 186 of the world's largest firms found that 77 percent of R&D centers over the next three years are likely to be in China and India.[7] My colleague Ernie Preeg has shown that China is expanding R&D expenditures at the rate of 22 percent per year, far above the 6 percent in the United States and 5 percent in the European Union and Japan.[8] Of course some of the attraction to perform R&D in China is due to the tax breaks and other subsidies provided by both Beijing and regional governments. Additionally, China frequently tries to leverage research and knowledge transfer in return for access to its huge and fast-growing market.[9]

Despite the enthusiasm for developing country R&D, the United States remains a commanding R&D presence in the world, although China especially is becoming more attractive when future investments are considered. When UNCTAD asked non-U.S. multinationals from around the world what their preferred location was for new R&D projects abroad, the United States was listed second most often. China was mentioned most often, and India was listed third most often, followed by Japan and the United Kingdom.[10] The survey demonstrates that the United States is a preferred location for R&D among multinationals headquartered in other developed and emerging countries.

In sum, while R&D activity and technological excellence is being globalized, the United States maintains a commanding presence at this time. An often overlooked fact is that the United States has a surplus in R&D and service payments among multinationals. Figure 13 shows that foreign-owned firms spend more on R&D in the U.S. than foreign affiliates of U.S. multinationals spend abroad. As noted earlier, R&D insourcing thus exceeds outsourcing among multinationals in the United States. Furthermore, the United States has a trade surplus in royalties and licensing fees ($62 billion in receipts versus $26 billion in payments in 2006) and a trade surplus in business, professional, and technical services ($41.3 billion in receipts versus $33.2 billion in payments in 2005). At the same time that U.S. multinationals are looking abroad for technology, research, and collaboration, the rest of the world is coming to the United States for the same services. Globalization thus clearly complements innovation in the United States.

While R&D activity is certainly of interest, it is only one component of a complex ecosystem that produces what has come to be known as innovation. Whether R&D offshoring, if it accelerates, is indicative of the true globalization of the broad class of activities that enter into the innovation process is, at the moment, an open question. Many other factors, technical workforce, legal protection for intellectual property, financial innovation, and more qualitative factors such as propensity for risk taking all figure into the generation of innovation. The potential emergence of innovation supply chains that originate in the U.S. and other major manufacturing centers raises a number of questions for U.S. policy makers. Research is needed to expand understanding of the globalization of innovation and to provide needed insights to inform the domestic U.S. policy response. Unfortunately, a paucity of data has left many crucial questions about the globalization of U.S.-based innovation activity unanswerable.

---

[5] United Nations Conference on Trade and Development, *UNCTAD Survey on the Internationalization of R&D, Current Patterns and Prospects on the Internationalization of R&D*, UNCTAD/WEB/ITE/IIA/2005/12, December 12, 2005, p. 1.

[6] *Ibid*, p. 11.

[7] See "R&D Outsourcing," *Business Week*, May 10, 2006.

[8] Ernest H. Preeg, *The Emerging Advanced Technology Superstate*, Manufacturers Alliance/MAPI, June 2005.

[9] *Ibid*, pp. 46-50, for a discussion of Chinese tax and other incentives to attract investment in the semiconductor industry.

[10] UNCTAD, *op. cit.*, p. 13.

The existing literature on the globalization of innovation suffers from a number of crucial shortcomings. First, the myopic focus on R&D as the sole indicator of innovative activity has distorted results and hidden key policy implications. The absence of a coherent framework and statistical robustness has also plagued these studies. For the moment, it is reasonable to conclude that we fall far short of a full understanding of the innovation globalization dynamic as well as the forces that are driving innovation offshoring decisions.

IV. MAPI Innovation Research Program: Conclusions and Implications

To contribute to understanding of the forces that impact innovation in the manufacturing sector, both domestic and international, two of my MAPI colleagues, Cliff Waldman and Jeremy Leonard began collaborating on a significant innovation research program in the early part of 2006. The purpose of the initial work was to specify and estimate a simple, yet utilitarian model of innovation in the U.S. manufacturing sector and to derive comprehensive indicators of product and process innovation.

Their research provided robust statistical evidence that the drivers of innovation extend well beyond the business R&D spending that is typically thought to be the principal source of innovation.[11] Our results show that variables such as capital investment, university-industry linkages, and the employment of science and engineering personnel are also important ingredients for innovation. The results were particularly interesting with regard to basic R&D expenditures in universities and colleges. Our equations indicate that a 10 percent increase in nominal dollar expenditures on basic science research at universities and colleges generates a 4.16 percent increase in a 4-year moving average of U.S. utility patent approvals after a lag of six years and a nearly two percent increase in multi-factory productivity growth in manufacturing five years hence. Basic R&D in universities and colleges as well as the employment of science and engineering personnel proved to be important ingredients for both process and product innovation.

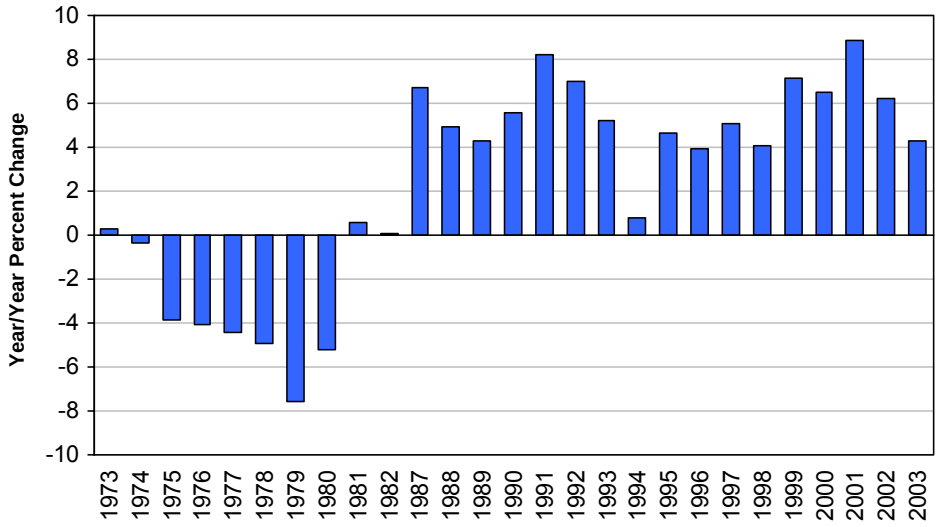
To aid those who need to track innovation growth we used these equations to develop composite indicators of both product and process innovation. These indicators show the fluctuation in productivity and patents (which we used to proxy process and product innovation) if those variables were only influenced by our postulated innovation drivers. The authors corrected for such things as changed patent laws, which impact patent activity, and the multitude of cyclical and institutional factors that impact multi-factor productivity. The two indicators are nothing more than the fitted values of their respective equations. For each year, it is the equation's prediction of either productivity or patents. By using the fitted value series as a measured index, we are allowing the user to view the fluctuation in productivity or patents as if they were ***only*** influenced by our postulated innovation indicators. Neither productivity or patents are pure measures of innovation output. Productivity is impacted by the business cycle and institutional factors. And patents are impacted by patent law. But by creating a fitted value series for our equations, we are coming as close as we can (both statistically and theoretically) to observing pure innovation output series.

Figures 14 and 15 present the results of our predictions for the innovation proxies. They show that our product and process indicators appear to map out a plausible history. Clearly the 1970s and early 1980s were troublesome times for U.S. manufacturing product innovation. As shown in Figure 14, sizable year/year declines in product innovation characterized numerous years of this period. The reasons are clear. Manufacturing R&D intensity fell below 3 percent during the 1977 to 1979 period. The growth of funding for basic university R&D decelerated from 11.3 percent during the 1965 to 1969 period to 5.9 percent during the 1970 to 1975 period. But the growth of the U.S. tradable goods sector and the resulting growth of international competition subsequently forced domestic changes.

[11] Jeremy A. Leonard and Clifford Waldman, *An Empirical Model of Innovation in the U.S. Manufacturing Sector*, Manufacturers Alliance/MAPI, ER-614e, August 2006, and Leonard and Waldman, *Innovation and Its Determinants: A Review of the Literature and Outline of a New Model*, Manufacturers Alliance/MAPI, ER-601e, February 2006.

Manufacturing R&D intensity grew from 3.0 percent in 1980 to 4.6 percent during 1987. And the growth of academic research expenditures accelerated from 5.9 percent during the 1970 to 1975 period to 10.5 percent by the 1980 to 1985 period. Consequently, product innovation growth, while it has been volatile, has averaged a solid 5 percent since 1987.

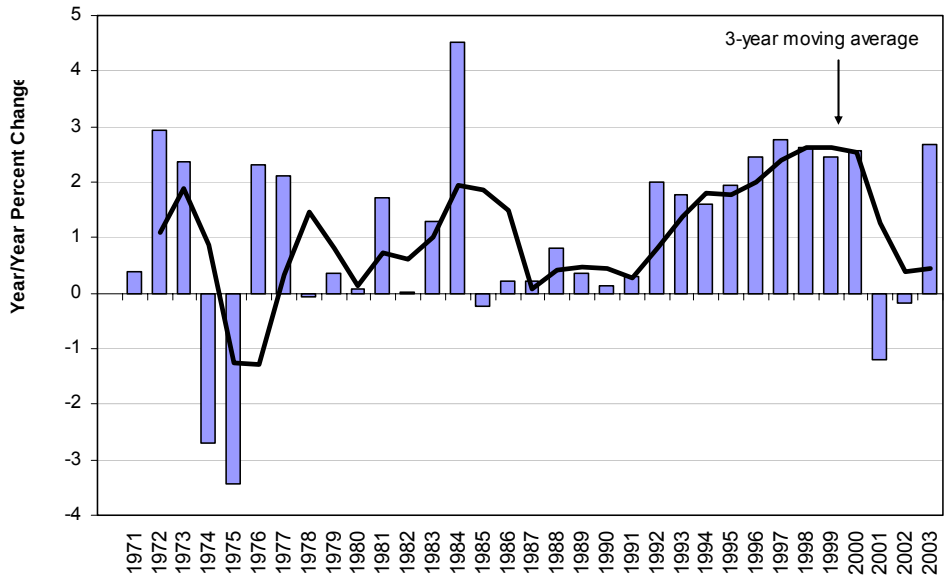
Figure 14
Composite Product Innovation Index, 1973-2003
(percent change from previous year)



Note: The jump from 1982 to 1987 is due to missing values of input variables.

Regarding process innovation growth, shown in Figure 15, the 1970s were characterized by wide annual swings in growth but the average over the decade was a paltry 0.5 percent. During this period, high inflation eroded the real value of investment and academic R&D, and international competitive pressures were much less severe than they are today (indeed the United States typically ran a trade surplus in manufactured goods). There were far fewer incentives for business process improvement. During the 1980s, manufacturing process innovation growth accelerated to an average of 1.0 percent, but much of this was in the early years of the decade. The particularly sharp accelerations in 1983 and 1984 were undoubtedly catalyzed in part by the dramatic tax cuts of 1981, which, among other things, accelerated depreciation of capital spending and boosted investment growth. Considerable concern about the future of the U.S. manufacturers at the beginning of the 1980s refocused attention on competitiveness, though little progress was made in the latter half of the decade. Finally, the rapid growth in unit labor costs, driven by double-digit inflation that occurred from mid-1979 to late-1981, forced manufacturers to reorganize production methods to remain profitable. The 1990s saw a further acceleration in process innovation growth, particularly in the latter half of the decade during which process innovation consistently grew in the 2 percent to 3 percent range. The 2001-2002 decline in process innovation growth was primarily due to a sharp decline in investment during the 2001 recession.

Figure 15
Composite Process Innovation Index, 1971-2003
(percent change from previous year)



While our statistical work adds considerably to understanding the manufacturing innovation process, we realize that the global dynamic must be studied much more extensively to complete our understanding. This is especially true given the anecdotal evidence of the potential globalization of R&D activities, and the fear that innovation will be outsourced in its wake. Thus, our next project addresses the void of data and understanding on innovation globalization through the use of a large-scale survey of manufacturers. We will design a survey to gather data on manufacturer's innovation offshoring activities (going well beyond simply measuring R&D location) as well as the factors driving those activities. We further intend to gauge the innovative capacity of key target countries for U.S. manufacturing innovation investment by reconstructing our U.S. product and process indices where data are available, or by performing innovation case studies for countries where the necessary data are not available. The results of this new proposed study will allow for an assessment of the implications of innovation offshoring for the domestic U.S. manufacturing base, particularly as to whether emerging markets post significant competitive threats.

V. Some Policy Implications

As globalization proceeds, many public officials, frustrated especially by the slow progress with China on such issues as currency and intellectual property protection, have begun to call for policies to protect markets via trade barriers and other means. Nothing could be worse for U.S. economic progress in a globalizing world. By closing markets, we negatively impact global economic growth, thus negatively impacting our own export opportunities. Export demand, in recent years, has been a key source of growth in the manufacturing sector, due partially to surprisingly muted domestic business investment demand. Further, by erecting protectionist barriers, we lose the growth, R&D, and productivity benefits that exposure to foreign markets has clearly afforded us. We might also lose the ability to access talent pools and new technology being developed around the world.

Our efforts should instead be directed to expanding the extent of free trade while working to end the many unfair trading practices that still plague our ability to access foreign markets. It is a poorly understood fact that only 5 percent of the trade deficit in manufactured goods is with countries where we have free trade agreements, while these same countries account for 30 percent of our imports and

44 percent of our exports. But an avoidance of blatantly protectionist policies does not, in any way, imply that U.S. policy makers should not be putting forth an aggressive set of policies for maximizing U.S. competitiveness in the ever-changing global environment.

To be globally competitive, we need first and foremost to keep our domestic economy strong with the sensible monetary policy that we have been blessed with for a number of decades and with a low-tax, spending constrained, low-deficit fiscal policy that nonetheless satisfies the needs of critical social goals. Over time we will need to increase national savings both to curb our trade deficit and fund needed capital and social investment. Moreover, we need to be increasingly mindful of the structural costs that our businesses face in a world where capital is increasingly mobile, an issue investigated in great depth in two MAPI studies.[12] In particular, we need to address the high differentials in corporate taxes, tort litigation costs, natural gas costs, health care costs born by employers, and regulatory burdens of U.S. firms, as compared to our leading global competitors. Finally, we need to combat the mercantilist policies, such as maintaining undervalued currencies, theft of intellectual property, and subsidizing export industries, practiced by competitors such as China and other Asian nations.

To put our own house in order, we need to ratchet up investment in the sciences and engineering disciplines so crucial to innovation and to attracting the domestic students to these fields. Our research shows a clear link of university research with innovation. The experience of the massive investment in sciences in the 1960s, when nearly 1 percent of GDP was devoted to federally funded, non-defense, scientific research, which led to many of the technological breakthroughs at the core of American manufacturing success in the 1980s and 1990s, should also guide our thinking. We also need to think seriously about creating a better career path for U.S. scientists and engineers.

The need for a globally competitive level of innovation to compete with both low-cost producers and technologically advanced competitors by expanding our product offerings and market opportunities is clear. But economists do not have a full understanding of the innovation process and there is a particular void as regards the globalization of innovation activity. Recent MAPI research supports the notion that an innovation policy extends well beyond a focus on R&D investment. While private sector R&D is clearly important, we have provided robust statistical evidence regarding the high returns that can be realized from investment in university and college R&D. Further, we have learned that the science workforce and capital spending matter to innovation output, as well. Anecdotal evidence that emerging market nations might grow as significant global innovation centers shows the critical need for data and analysis on the globalization of innovation. Only then can we understand the extent and nature of the dynamic, the factors that are driving location decisions, and the implications for the domestic U.S. economy.

[12] Jeremy A. Leonard, *The Escalating Cost Crisis: An Update on Structural Cost Pressures Facing U.S. Manufacturers*, Manufacturers Alliance/MAPI and The Manufacturing Institute of the National Association of Manufacturers, September 2006.

Biography

Thomas J. Duesterberg, Ph.D.
President and Chief Executive Officer
Manufacturers Alliance/MAPI

Dr. Thomas J. Duesterberg is President and Chief Executive Officer of the Manufacturers Alliance/MAPI. He also serves as President of The Institute for Technological Advancement, an affiliate of The Manufacturers Alliance; and is a member of the Board of Directors of The Manufacturing Institute, an affiliate of the National Association of Manufacturers. Prior to joining the Alliance, Dr. Duesterberg was Senior Fellow and Director of the Washington Office of the Hudson Institute. Former positions include serving as Chief of Staff to Congressman Chris Cox (1995-96); U.S. Assistant Secretary of Commerce for International Economic Policy (1989-93), where he was responsible for international trade and investment issues, trade promotion, and advocacy programs to assist U.S. exporters and investors; Administrative Assistant to U.S. Senator Dan Quayle (1981-89); Senior Research Analyst, International Business Services (1979-81); and Associate Instructor, Stanford University (1978-79). Dr. Duesterberg is co-author of two books and numerous magazine, journal, and op-ed articles on international trade, information technology, and global economics. He also edited and wrote chapters in two books: *Riding the Next Wave: How This Century Will Be a Golden Age for Workers, the Environment, and Developing Countries*, (Hudson Institute; 2001); and *U.S. Manufacturing: The Engine of Growth in a Global Economy* (Praeger; 2003). He writes a regular column for *Industry Week* called "The Competitive Edge." He graduated magna cum laude from Princeton University in 1972 and received an M.A. and a Ph.D. from Indiana University.

The Alliance is a policy research organization with approximately 500 member companies representing a broad spectrum of industries from machinery and components, primary metals, automotive, chemicals, oil and gas, electronics, telecommunications, computers, office systems, aerospace, and similar high-technology industries. The Alliance conducts original research in issues critical to the economic performance of the private sector and offers an executive development program with more than 2,000 senior executives participating