Enabling Sustainable Global Manufacturing
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A proposed Advanced Manufacturing Framework for policy-makers, the private sector and society

On behalf of the Members of the Council on Advanced Manufacturing

1. Manufacturing Matters

The Great Recession of 2008/2009 once again triggered the debate about the importance of manufacturing as a foundation of economic development, employment, social stability and national security. All developed economies – the United States, Germany and Japan among them – have emerged over strong manufacturing bases. Emerging economies such as China, Brazil and India also rely on manufacturing to drive their economic development, expand export markets and trigger economic and social inclusion. According to the National Association of Manufacturers, manufacturing has the highest economic multiplier effect of all sectors, while the wholesale and finance sectors have the lowest multipliers. Manufacturing not only provides gainful employment, but also brings about capabilities for capital accumulation and innovation.

Manufacturing is a core element of wealth creation and has traditionally been the foundation for economic development in advanced nations. However, the share of GDP accounted for by the manufacturing sector in most developed economies has declined over the last several decades. For instance, the contribution of manufacturing activities to the United States national GDP stayed at a level of 20 to 25% from 1945 through the middle 1990s and then declined in the last two decades to the current level of 13%. Such a trend was experienced across other developed countries. At global level this share dropped from about 27% in 1970 to 17% in 2010. This is partly due to the fact that the manufacturing sector became increasingly productive with growing levels of output and lower levels of labour. The practice of outsourcing and offshoring has also contributed to the decline of the manufacturing contribution to GDP in many developed countries and has been a factor of industrialization in a number of developing countries. Additionally, the setting of global supply chains relies on a variety of activities, many of them services such as transportation or product design, which provide added value but do not count as manufacturing. This shift in the balance of contribution of economic sectors questions the current size of the service sector, particularly the Finance, Insurance and Real Estate (FIRE) “industry”, where the bulk of job creation has been taking place, notably in developed economies.

Globalization has had a profound impact on the manufacturing landscape. Traditional region-centric manufacturing strategies have been changed in response to the opportunities to compete on global markets. Access to emerging consumer centres around the world as well as to low cost labour, the development of global sourcing and supply networks, and foreign direct investments (FDI) have contributed to the transformation of global manufacturing in global economic systems. Corporate decision-makers are driven by the need to provide best shareholder value in their manufacturing and business strategies. Wherever parts and final goods can be produced and distributed in the most cost effective ways, manufacturing plants are likely to be established. Governments and policy-makers are increasingly challenged to foster the creation of high-paying jobs and the generation of economic growth. Beyond traditional policy and institutional levers, governments around the world are being compelled to use stimulus packages, job creation programmes, financial incentives and regulatory regimes to promote economic growth. New studies on “economic complexity” also suggest focusing much more on reducing capability, skills and innovation gaps to improve productivity, economic growth and prosperity. At the same time, environmental sustainability has become a matter of concern to societies, a priority for private and public policy-makers and an emerging source of economic opportunities.

All these issues bring salient questions that are reflected upon by public and private interests: How can incentives and the interests of stakeholders in manufacturing be better aligned? Which factors could further incite the convergence towards sustainable advanced manufacturing and which factors would be the most disruptive for such an endeavour? Based on those factors, what are potential scenarios about how manufacturing developments could unfold for different types of economies? Who is likely to benefit the most?

This paper is a collective effort of the Global Agenda Council on Advanced Manufacturing of the World Economic Forum, a group of policy-makers, business leaders and academics who are involved in various aspects of developing public policies, business models and technologies that impact the future development of global manufacturing.

Based on a common framework, it examines the key factors and drivers affecting the future development of manufacturing industries. These discussions will be carried out from the viewpoints of government, business and sustainability. As a result, potential future scenarios are outlined for four types of economies: developed, emerging, energy-based and least developed. Finally, based on a proposed framework, some key recommendations will be presented for policy-makers, corporate decision-makers and NGOs.

2. The Need for an Advanced Manufacturing Framework

Manufacturing is a highly complex activity, which is affected by many key factors including – but not limited to – government policies, trade agreements, infrastructure, FDI, workforce and talent development, wage growth, energy supply, access to resources, innovation ecosystem and currency exchange. Advanced manufacturing is defined in this paper as the technological, organizational, social and environmental strategies that improve manufacturing so that it can meet the goals of enterprises, society and governments and adapt to change. This definition reflects the growing level of embeddedness to the functions of production, distribution and consumption.

The fundamentals behind a successful advanced manufacturing strategy include focusing on identifying and addressing capability and innovation gaps through manufacturing, effective FDI strategies, strong talent and infrastructure developments, and also access to finance. Putting manufacturing back at the centre of country competitiveness can help address, in the longer term, both job creation and higher productivity challenges.
There are, however, a number of trade-offs and conflicting requirements when establishing a more comprehensive and sustainable manufacturing strategy. Those include trade-offs between local jobs vs global outsourcing, job creation vs productivity, protectionism vs free trade, national technology development vs technology transfers, technology enabling vs standalone manufacturing, short-term vs long-term strategies.

The framework below highlights the need to align public and private sectors incentives far more extensively to develop an effective advanced manufacturing strategy. Institutions and public-private dialogue play a significant part in aligning these incentives.

Aligning incentives to improve manufacturing capabilities is the main objective of this proposed framework. There is, however, little evidence to indicate what the optimal share of GDP manufacturing should be, implying that a high share is not necessarily associated with high development levels. Also, issues related to definition are arising at the boundaries of manufacturing and services, as traditional manufacturing processes are becoming digitized (which also enables them to be performed remotely). Consequently, they are now often classified within service industries rather than manufacturing. While the share of manufacturing in global economic output has diminished, the level of manufacturing output has increased substantially, as has the level of economic development.
It has also been recognized that the competitive model based on traditional economic theory needs to be challenged - it has focused on how one nation can gain advantage and dominance over others. Indeed, countries are not the only unit of analysis: the nation-state is only one part of global society. What works for part does not necessarily work for the world economy as a whole, e.g. the export-driven strategy of East Asian economies and now China cannot be replicated by all nations globally.\(^7\)

3. Convergence and Disruptive Factors Determining the Future of Advanced Manufacturing

Based on the proposed framework, four key factors supporting the convergence of interests were identified, as were five factors that may disrupt them.

**Convergence factors: How best to aim for longer term sustainable capabilities?**

Skills and talent improvement, innovation development, soft industrial policy and resource efficiency seem to be factors in the common interest of government, the private sector and society. These four areas will be critical to further addressing convergence of interests and thus achieving greater coherence and comprehensive advanced manufacturing approaches and capabilities.

1. **Skills and Talent Development.** A skilled and adequately educated workforce is always in demand. As future manufacturing demands more advanced skills, the competition for highly skilled and well-educated talents will intensify\(^8\). This underlines a paradox between ongoing global demographic growth and the capabilities of education systems to provide relevant skills. The key to filling the anticipated skills gap is through collaboration in public and private partnerships, where the public education system is able to provide knowledge and skills that the private sector can expand through their own programmes. The interest of all parties is here aligned to aim in the same direction.

2. **Capability Development and Innovation Ecosystems.** With today’s global connectivity, the amount of time for companies to maintain competitive advantage has been greatly compressed. Therefore, countries need to support a sustainable ecosystem for innovations if they are to continue to lead competition. The stakes can be high as early innovators are often able to capture (or create) a dominant market share, secure appropriateness and extract substantial value before competition can effectively position itself with comparable products. Interests of the private sector, society and government are here aligned to create such systems. It must be noted that there is increasing concern that prevalent trends in Intellectual Property (IP) regimes may be going too far to protect patents and could be throttling the diffusion and application of knowledge, as well as distorting competition.
While these concerns are more acutely expressed in some industries today, such as the pharmaceutical and the high-tech industries, they are raising questions about their generalization to other industries. Therefore, any projection of the factors that will advance manufacturing globally will also have to keep these issues in sight.

3. **Soft Industrial Policies, Institutions and Governance** can help align different stakeholder interests and boost advanced manufacturing. It is critical for states to recognize and understand the relationship between economic prosperity and the advancement of manufacturing capabilities. When a nation progresses towards more advanced manufacturing capabilities, it enables the production of more diverse and sophisticated products by using more advanced equipment and processing technologies. Thus, it opens the door for growth of jobs that demand higher skill levels at higher wages. This will in turn enable the nation to establish its own capabilities to innovate and set new economic development opportunities. This calls for the implementation of industrial policy. A number of governments adopt various industrial policies to influence the competitiveness of their manufacturing sector. These policies may include tax credit for innovation and R&D, access to credit and grants, public-and-private partnerships for workforce and infrastructure developments, and assistance or incentives for exports. Regulations also play an important role since they impact many elements of input costs, including working conditions, critical infrastructure availability and ownership of land. The creation and use of government policies has been intensified in recent years among both advanced and emerging economies. Even in the United States, where the term “industrial policy” is politically contentious, federal and state policies are being developed to promote manufacturing.

As part of such policies, an increasing number of trade agreements (global, regional, multilateral and bilateral) have promoted the development of manufacturing worldwide. These agreements allow developed nations to access to production hubs and overseas markets in developing nations. At the same time, developing nations also benefit from the access to advanced production technologies and expanded markets. But, these trade agreements may intensify in recent years among both advanced and emerging nations in the United States, where the term “industrial policy” is politically contentious, federal and state policies are being developed to promote manufacturing.

3. **Access to material resources and investment in infrastructure**. As global manufacturing consumes more and more material resources, particularly those rare earth elements or materials with limited supply, the volatility of resource prices and availability will force companies to rethink alternative material supplies and improve the efficiency of material use. It is essential for manufacturing firms to establish a robust strategy for reliable access to material resources. Future growth in manufacturing will also depend on efficient infrastructure support, including IT, transportation, energy and utility supply, import/export procedures, etc. In many developed nations, infrastructure is nearing or has reached the end of its life cycle and needs to be upgraded, while early developing nations lack investment to build adequate infrastructure to setting up manufacturing operations. A few emerging economies, particularly China, have invested heavily in modernizing their infrastructure to support the growth of manufacturing. The global infrastructure landscape thus remains highly diversified in terms of its capability to support manufacturing.

4. **Currency Exchange.** Increasing currency volatility, particularly in relation to the US dollar, affects competitiveness and supply chain strategies. Operating within the jurisdiction of a strong currency, imported raw materials become less expensive while exported goods will be more expensive on global markets and therefore less competitive. Many companies start to strategically locate production closer to the intended markets. For instance, a strong Japanese Yen drives many Japanese manufacturing companies to re-locate their manufacturing activities outside Japan. Similarly, strong Australian dollars significantly affected Australian ore and coal resources. On the contrary, a low currency may be seen as a boost in the competitiveness of exports on global markets, it is also linked with higher input costs and inflationary pressures on wages and the cost of living.
5. The short and long terms. The trade-off between long-term capabilities and short-term returns remains a key challenge to align stakeholder interests. Countries trying to align both public and private sector incentives – whether through soft industrial policy or not – tend to have better long-term capabilities. However, alignment between the public and private sectors takes time because of the complexity in identifying and addressing capability gaps. Beyond quarterly corporate result imperatives and elections, consistent, longer-term alignment on the direction to take is essential. A typical example is manufacturing outsourcing that can trigger short-term profits for the firms but can ultimately deprive a country of some of its core capabilities. Simply put, the path towards advanced manufacturing should be a marathon (consistent in the long term), not a sprint (volatility of goals and strategies).

4. Scenarios for Future Advanced Manufacturing

A suitable scenario for future advanced manufacturing must align the goals of business, government and society to achieve sustainable global manufacturing, whereby all nations, all citizens and the environment in general can benefit from these developments. However, each country has its own economic strengths and weaknesses and may opt for specific strategies to achieve their goals. Therefore, it is difficult to provide a general scenario for future manufacturing. Instead, to illustrate representative scenarios for future development, four groups of economies are depicted.

1. Developed economies and the need to align incentives

Contrary to general perception, manufacturing in developed economies remains highly significant, competitive and innovative. However, the industrial pre-eminence of developed economies, along with their manufacturing models, has been challenged by the industrialization, outsourcing and offshoring in emerging economies. Yet, these forces are implemented by their own manufacturing firms that have been successful at capturing a large share of the resulting added value (e.g. repatriation of profits by multinationals). The challenge for the manufacturing sector of developed economies involves keeping a balance between the forces of offshoring, their disruptive impacts on national labour markets and the development of new value-added manufacturing activities.

A significant gap has been recognized between technology innovations and commercialization of products. For instance, the United States innovated much of the flat-panel displays, flexible electronics, smart phone and tablet computer technologies, but did not establish a commercially viable production base for these products. As these products became mass market items, input costs, particularly labour, became a determining competitiveness factor, which incited the offshoring of their manufacturing. Although the United States is still a world leader in R&D and technology innovations, there is a sense of urgency among stakeholders that its innovative capabilities may recede. Many of the large OEMs (Original Equipment Manufacturers) push their first- and even second-tier suppliers to develop next generation technologies while these suppliers rely on their own suppliers to do the same. As a result, the innovation burden tends to fall on the shoulders of small and medium enterprises (SMEs), which have limited resources to satisfy this demand. This outsourcing strategy greatly weakens the innovation capacities of the US manufacturing industry. Also, due to the negative media coverage of shrinking manufacturing jobs and the appeal of FIRE jobs as status symbols, many young students choose to avoid science and engineering programmes. The number of engineering graduates from US universities has declined steadily, which further threatens the future of US advanced manufacturing industries.

All these challenges may underscore the need to articulate a national manufacturing policy that promotes investment in R&D and innovations, and also science and engineering education to produce future workforce and talent, as well as assistance to SMEs to maintain their technological and innovative capabilities. However, the nature of this policy must be carefully crafted as developed economies show ample evidence of misallocation of government resources in terms of picking favourite sectors that fail to meet expectations and providing subsidies that artificially support uncompetitive manufacturing segments into remaining uncompetitive. When given the opportunity, the reflex of the private sector is to switch the risks to the public sector and an ill-designed industrial policy may present yet another opportunity to do so. Possible strategies should thus focus on a support structure for manufacturing and not the sector itself, at least not without an effective public/private dialogue mechanism where a clear consensus is reached. The sectors where public actors have conventionally been proactive remain as important for the global production networks of the 21st century as they were for the manufacturing belts of the 20th century. Transport and telecommunication infrastructures, (alternative) energy supply systems, professional and vocational education are among ventures providing a support system over which added value manufacturing can thrive in developed economies.

2. Developing economies gradually building sustainable capabilities

Some developing economies were able to benefit substantially from the convergence of trade liberalization and offshoring by becoming the recipients of investment in manufacturing from foreign firms and emerging domestic firms. They have experienced significant gains in their manufacturing output, with China accounting for the world’s largest net gain between 2005 and 2010 (US$ 967 billion).

The model adopted generally follows the export-oriented paradigm, often leading to distortions in national allocation of infrastructure and labour as well as the value of the national currency. This created pressures to mobilize labour and provide infrastructure investment to accommodate a growing level of integration to global supply chains. China is a good representative of this group of developing economies. It has attracted significant FDI and established substantial physical infrastructures (e.g. ports, railways and highways) through the use of government policies and infrastructure investments. Chinese manufactured products have dominated all major export markets with the “China Price” de facto becoming the frame of reference in manufacturing costs. As an additional incentive, the Chinese currency, which has been pegged to the US dollar since 1994, started to be re-valued in 2005 (about 20% re-valuation between 2005 and 2011) and the labour wage has significantly increased (e.g. more than doubled in the last five years). However, typical to many export-led developing economies, manufacturing sectors are commonly energy inefficient and environmentally unfriendly. Worker safety is also sub-standard.

The challenge for the manufacturing sector concerns the extent to which emerging economies effectively capture added value and develop capabilities fulfilling a growing domestic demand as labour costs increase and social contracts become more complex. These economies need to transform their industrial structure and change investment patterns for more energy efficiency, tighter environmental conservation and better work safety. They also need to promote innovations and establish transparent legal and regulatory procedures and policies. Given the current global economic downturn, especially the difficulties in EU and US markets as drivers of additional demand, these developing economies need to expand internal consumption markets to offset the reliance on export markets.
3. Energy-based economies risk being overly dependent on natural resources

Energy-based economies such as Saudi Arabia, Kazakhstan, Qatar or Azerbaijan have experienced unparalleled rates of growth over the past ten years. The exploitation of these resources and the investments that have been made, often with the help of foreign capital, provide the basis for this paradigm of growth and productivity. However, many challenges, including economic diversification and lack of manufacturing development, hamper future growth prospects. Indeed, the share of manufacturing in these economies remains relatively low (commonly less than 10%) and concerns punctual developments linked to specific local resources (e.g. energy and mining).

Two scenarios can be envisaged for these types of economies: (1) development of capabilities related to infrastructure, education, and science and technology. Such policies will help to reduce the capability gap of the countries over the longer term. (2) Industrial policy and FDI attractiveness: countries from the Community of Independent States like Kazakhstan have been focusing on “industrialization” programmes proactively, attracting FDI and supporting state-owned enterprises in specific manufacturing areas. Although the results of the overall effort remain to be assessed, prioritization of sectors and industries for investment promotion has already proven beneficial. Kazakhstan currently attracts more than 75% of the FDI in the Central Asian region.

4. Least-developed economies still “excluded from the game”

The central question for this group of economies is how to get in the game. However, many countries remain excluded from the effective development of manufacturing capabilities and integration. A number of factors can influence the gap in manufacturing capabilities, e.g. the amount of capital required for production, technological sophistication or inputs and outputs in a product's value chain. To avoid focusing on one area or another, the “economic complexity” approach considers an outcome-based measure on the premise that if a pair of products is related because they require similar institutions, capital, infrastructure and technology, they are likely to be produced in tandem. As such, least-developed economies should aim first to identify and prioritize gaps in building fundamental capabilities and products. The challenge mostly focuses on the development of regulatory and infrastructure capabilities that are comparable to more advanced economies, which is often difficult to implement in a comprehensive manner.

5. Is there a Trade-off between National Manufacturing and Trade Liberalization?

The revival of the need for ‘industrial policy’ coincides, not surprisingly, with the need for governments in many parts of the world to respond to their citizens’ expectations that public actors should play a role in stimulating national job creation and, in some cases, balance national trade and balance of payments deficits. Thus the need for an industrial policy arises from demand for action by national governments to meet domestic requirements. This rising force is contending with another global force that had been ascending and that underlined the benefits of openness of national boundaries and global trade regimes rather than protection of domestic interests.

The principles of these two forces are in contention. The domestic governance system is set up to make governments directly accountable to citizens within their jurisdictional borders. The accountability of the global trade management system to citizens, if at all, is indirect and perceived to be tenuous at best. National governments, while supporting global trade liberalization in general, are also accountable to their constituents for the effects of global trade on national economies, which are far from being inconsiderable.

More open global trade can increase global economic production and efficiencies in manufacturing supply chains. Therefore businesses, and especially multinationals, will support trade liberalization. It was estimated that for every dollar increase in global output achieved by greater openness to trade, six or seven (and in some cases even more) dollars of income have to be shuffled around within societies, between those that cannot compete and stay in the same jobs and those that global trade provides with new opportunities. Such movements may be transitions only, but they disrupt the labour force. Those who lose expect some form of safety net from their governments: provisions for social security and assistance to acquire new skills to work through transitions. Governments must raise resources to provide for social security and rehabilitation, whereas the corporations and businesses that benefit from the openness to trade are often invited into countries by lower tax rates and other forms of subsidies that reduce the ability of national governments to mitigate the transition effects of globalization on their citizens.

Opportunities for and constraints to advances in manufacturing are related to at least three dimensions. The first is the development of well-adapted economic policies, by which advances towards greater international openness in trade should promote developments in manufacturing. The second is the development of technologies and concepts of manufacturing networks and organizations which will also improve manufacturing outputs. The third dimension is development of concepts and institutions of international and national governance, which will influence the direction in which and the pace at which the advances along the other two axes take place. Consequently, they are fundamental to the resurgent concept of industrial policy.

6. Recommendations

Global manufacturing based mostly on outsourcing, offshoring, trade liberalization and multinationals has produced significant progress in terms of total manufacturing output and wealth generation for many societies. However, the current model has also created many challenges, including growing inequality, high unemployment rates, chaotic competition, accelerated depletion of natural resources and negative environmental externalities. Clearly, global manufacturing as its stands is unsustainable on the long run. The consequences of doing nothing are high risk for all stakeholders.

The following recommendations can be put forward for public policy-makers:

- Future global manufacturing heavily depends on the competition for resources, capabilities and public policies. Governments should focus on identifying and addressing capability and innovation gaps, and support innovations by funding and creating tax incentives. At the same time, they need to avoid the risk of locking in their technology preferences as science tends to be more a public-sponsored endeavour while technologies are dominantly privately developed.
- It is crucial to establish permanent, consistent and transparent industrial policies using regulations and incentives aimed at creating a competitive environment for investment in manufacturing.
- Governments should leverage effective public-private partnerships to modernize manufacturing infrastructures, support education and workforce development and create long-term talent strategies. Yet, the risk remains that partnerships become rent seeking associations where innovation is commonly stifled.
Similarly, corporate decision-makers should take the following recommendations into consideration when developing future manufacturing strategies:

− Fierce global competition requires corporations to strengthen investment in R&D and innovation, particularly on technologies related to enhancing the efficient use of energy and materials, and environmental sustainability.
− It is critical for corporations to partner with governments on workforce and talent development. While it is commonly the state’s role to provide standard scientific and engineering education, the corporate sector must more effectively engage in the development of specialized skills that are specific to its activities.
− While pursuing shareholder values in global markets, corporations should also be concerned with local economic development and job creation, which will require a delicate balance between short-term gains and long-term goals.

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References

1. The views expressed are those of certain participants in the discussion and do not necessarily reflect the views of all participants, their respective organizations or of the World Economic Forum.
5. As defined by the World Bank.
9. Ibid.
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