SGA Southern Governors' Association

# Advanced Manufacturing in the American South:

## An Economic Analysis Supporting Regional Development

MAPI
Manufacturers Alliance for Productivity and Innovation

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## EXECUTIVE SUMMARY

### The Value of Advanced Manufacturing Clusters

1. Nearly two decades of economic research has demonstrated the value of clusters in general. They provide cost-effective, value-adding synergies among key public and private economic units within a region. Such synergies allow for the agglomeration economies that make regions competitive. Strong clusters have been statistically shown to be positives for patenting activity and entrepreneurship. New industries can be created from strong clusters.

2. The cluster strategy of regional development is almost perfectly tailored for advanced manufacturing given the complexity of advanced manufacturing supply chains, the need for public investment in basic science to support innovation, and the need for close alliances between research and industry.

### Advanced Manufacturing Potential

1. Manufacturing output and employment shares in the American South (based on the findings of seven Southern states that were used as a sample for the study), while falling, remain above those of the U.S. and are roughly suggestive of labor productivity gains, given the steeper fall in employment shares than output shares.

2. The nation is in the midst of a short-term manufacturing renaissance that includes the advanced manufacturing sector.

3. Such evidence creates legitimate optimism that an advanced manufacturing development strategy has some potential to reap wide economic benefits in the American South.

## Regional Challenges That Must Be Addressed

1. The American South does have a large pool of workers who have experience working in industry but may now be either unemployed or underemployed. But this region's lag in college-level attainment and in the share of the workforce in science and engineering employment relative to the U.S. average has multiple implications. Most importantly, these labor force gaps have contributed to a sizable regional deficit in innovation activity.

2. Innovation deficits are negatives for the quality of both labor and non-labor inputs into the production process and for the advancement of the production process itself, holding back the total factor productivity gains needed for strong advanced manufacturing clusters.

3. Labor force deficits are also, as research shows, a negative for entrepreneurship and particularly manufacturing entrepreneurship.

4. Fortunately, the American South's labor force gaps with the U.S. average are not so sizable as to be insurmountable. As illustrated by the structure of our project framework, well-placed investments in the development and buttressing of science and technical education will likely yield measurable returns. Given the fact that U.S. workforce development continues to advance, however, regional investments need to be strong, focused, and persistent.

5. This region also has challenges that negatively impact the strength of demand. Many parts of the American South experience high poverty with lagging household incomes and deficits relative to the U.S. in per capita disposable income, a key determinant of the strength of consumer demand.

6. The strength and diversification of export demand is remarkably mixed among the seven states that are the focus of our paper. Broader regional export diversification should be a policy goal especially in light of the challenges with consumer incomes and spending.

## Hints of a Path Forward

1. The American South can generally boast of being competitive in total business costs. But cost minimization by itself is not a development strategy and low wage costs are a mixed blessing. While low wages relative to the U.S. have certainly played a role in attracting foreign direct investment, particularly in the auto sector, they have obviously contributed to weak incomes and have likely been a negative for attracting much-needed high-skilled labor and manufacturing production processes.
2. There are hints of promising industry clusters for this region. Civilian aircraft is a widely shared top export among the seven study states and is closely linked via the supply chain to the broader transportation equipment sector, which is important in many places in the region.
3. Further, a number of these states have notable relative strength in patenting activity in the analytical instruments cluster—in a region that broadly lacks innovation dynamism. These data suggest cluster potential if macro problems, particularly in the labor force, are confronted.

## Policy Players

1. States have a long-established role in using public policies to promote economic development. Support functions, such as education and infrastructure provision, are key components of the foundation that enables private sector expansion, giving rise to job and income creation as well as tax base enhancement.
2. There are a number of public and private sector players, aside from the state governments, that facilitate industrial development. These include local governments, industrial development boards, the federal government (through the presence of facilities such as national laboratories and programs like those of the Small Business Administration), and public utilities. Collectively, these constitute a support network that can be used to facilitate growth of the region's advanced manufacturing sector.

## Principles and Strategies

1. Southern states have been effective in promoting a low-cost strategy of development through the recruitment of industry, especially branch manufacturing plants from outside the region. This strategy should be re-evaluated in light of the globalization of the economy and the loss of manufacturing jobs to offshore producers. Low costs will remain essential to manufacturing firms, but increased emphasis should be placed on ensuring that regional economies can support value-added in the production process.
2. The starting point for an acceleration of advanced manufacturing development should be a strategic plan that places advanced manufacturing within the state's broader context of economic development. Regionalism, high-level policy coordination across economic development facilitators, and accountability in resource use are among the important principles that should guide policy.
3. There should be a focus on policy touch points (i.e., targets) that are included in the framework of our study. These include target industries, infrastructure development, technology adoption and R&D, and the use of incentives as an investment in the state's future.
4. Entrepreneurship and human capital development warrant special attention because of the innovation deficits that characterize this region.



# PART 1 — ECONOMIC ANALYSIS

## Introduction

In late 2012, the Southern Governors' Association (SGA), the oldest and historically largest of the U.S. regional governors' organizations, approached the Manufacturers Alliance for Productivity and Innovation (MAPI) with a considerable challenge. SGA was seeking to develop an intellectual blueprint for an advanced manufacturing development strategy for the American South. The economic and policy context for such an undertaking had been building for many years, even before the deep recession of 2007-2009, and subsequent anemic recovery made it abundantly clear that the U.S. needed new ideas to achieve strong and widely beneficial economic growth.

The intellectual aftermath of the recession, however, certainly strengthened the context for the SGA/MAPI project alliance. An increasing share of the "new ideas" discussion, both inside and outside of Washington, has focused on ways to restore U.S. manufacturing competitiveness as a vehicle for a stronger, more durable, and less crisis-prone national economy. Add to this the growing academic understanding of regional economies as distinct economic units, and it seems that the time is right for regional manufacturing strategies, both as an idea and as a policy goal.

As shown by this research report, which is our response to SGA's request, the American South does have promise as a region whose economy might be led by a modern industrial architecture. But the obstacles for such a challenge, while by no means insurmountable, are certainly formidable. They include labor force deficits, entrenched poverty, and the need for export diversification.

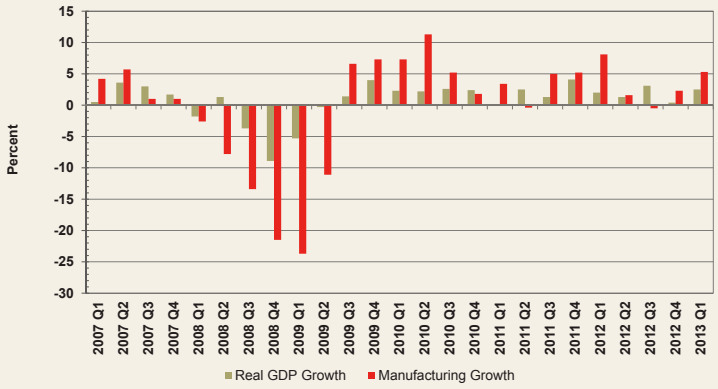
We have nonetheless come to believe that the required investments for Southern advanced manufacturing dynamism will yield a satisfactory return. If fundamental issues are confronted, this region could realize its full economic potential and make a vital contribution to an industry-led strategy for a revival in U.S. economic fortunes.

## Economic Backdrop for an Advanced Manufacturing Development Strategy in the American South

The 2007-2009 recession was the deepest business cycle downturn of the post–World War II era, both for the U.S. economy and for U.S. manufacturing. It also was the longest, lasting 18 months. Only the 1973-1975 and 1981-1982 recessions came close, both spanning 16 months. From the fourth quarter of 2007 to the trough seen in the second quarter of 2009, U.S. gross domestic product (GDP) contracted by 4.7 percent. From December 2007 to June 2009, U.S. manufacturing output contracted by a massive 20.8 percent.

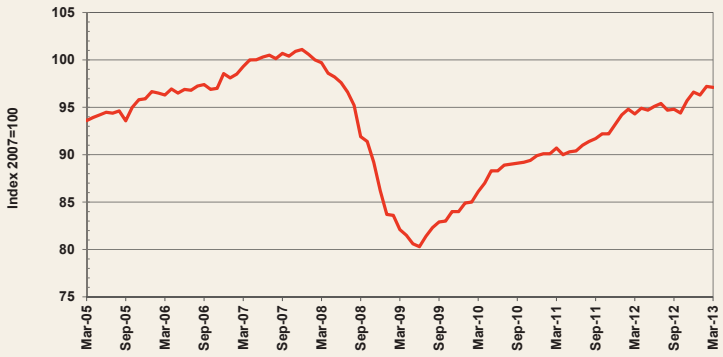
As shown in Figure 1, from the mid-2009 trough for GDP and manufacturing output until the first quarter of 2012, the U.S. manufacturing sector served as an important catalyst for a slow rebound in GDP. Average growth for the 11 quarters between the third quarter of 2009 and the first quarter of 2012 was a tepid 2.3 percent for GDP, versus 5.5 percent for manufacturing output. Unfortunately, manufacturing growth slowed significantly after the early months of 2012 as a result of a global economic slowdown and the impact of growing fiscal uncertainty on business investment. Capital spending, along with export demand, is a key driver for U.S. manufacturing production. Remarkably, the U.S. manufacturing sector, as of the writing of this report, has not yet made a full recovery (Figure 2). Output remains shy of the December 2007 peak.

**Figure 1 – U.S. Manufacturing and GDP Growth, Seasonally Adjusted Annual Rate**




Source(s): U.S. Bureau of Economic Analysis and Federal Reserve Board

**Figure 2 – U.S. Manufacturing Output**

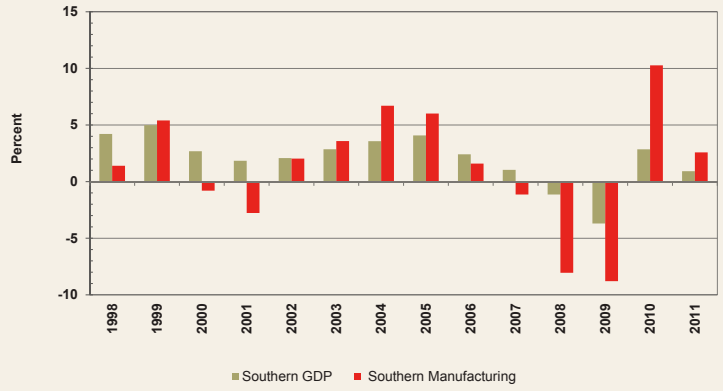



Source(s): Federal Reserve Board

The South has certainly felt all of the post-2007 economic pain of the nation. Figure 3 (on the following page) shows the path of GDP and manufacturing output growth for this region, using indices constructed and maintained by the U.S. Bureau of Economic Analysis.[1]

[1] The Southern index (referred to by the Bureau of Economic Analysis as the "Southeastern" index) encompasses a broad range of states that includes Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia.

**Figure 3 – Southern Real GDP and Manufacturing Output Growth**

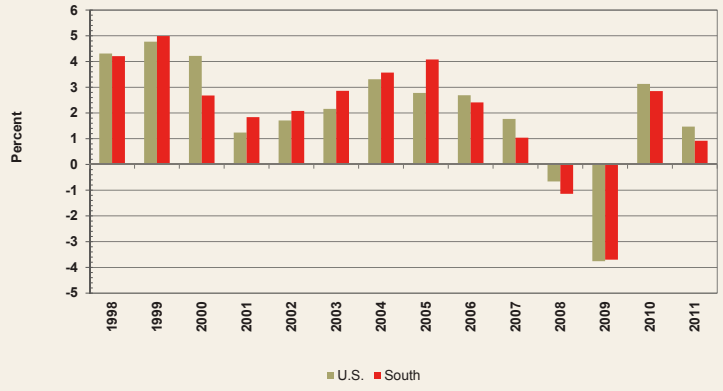



Source(s): U.S. Bureau of Economic Analysis

Unfortunately, quarterly regional data are not available. The figure nonetheless reveals the steep 8.1 percent contraction in Southern manufacturing output during 2008 and 8.8 percent contraction during 2009. The strong 10.3 percent rebound during 2010 slowed dramatically to 2.6 percent during 2011.

As with the U.S., the GDP rebound in the South has been tepid. The region's economic growth was somewhat stronger than for the U.S. between 2001 and 2005 (Figure 4). Subsequently, the South trailed U.S. GDP growth during 2006 and 2007. The region had a modestly sharper output loss than the U.S. during 2008 but a modestly shallower output loss during 2009. The pace of GDP recovery in the U.S. has been slightly faster than for the South through the latest data for 2011.[2] Following the same pattern as for GDP, the manufacturing output contraction was somewhat deeper in the South than in the U.S. during 2008, while being slightly shallower during 2009 (Figure 5, on the following page). The manufacturing recovery in the U.S. has been somewhat stronger than in the South.

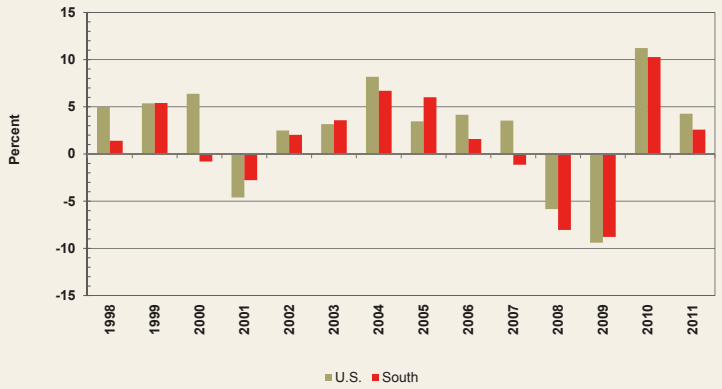
**Figure 4 – U.S. and Southern Real GDP Growth**




Source(s): U.S. Bureau of Economic Analysis

2 The reader should note a number of method differences that make these U.S. GDP data slightly different from those that appear in the quarterly national GDP report.

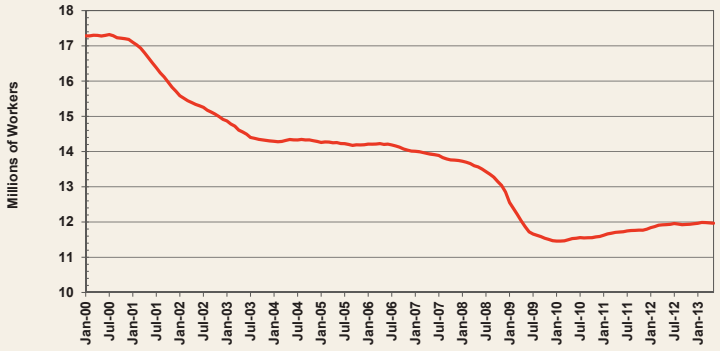
**Figure 5 – U.S. and Southern Manufacturing Output Growth**




Source(s): U.S. Bureau of Economic Analysis

Figure 6 shows the path of U.S. manufacturing employment. Between the December 2007 peak and the June 2009 trough, U.S. manufacturing lost 2 million jobs, approximately 14.7 percent of the factory sector workforce. In sharp contrast, the U.S. economy as a whole shed 5.4 percent of its workforce. Fortunately, in February 2010, the national manufacturing jobs picture took a modestly positive turn. In spite of a 2012 slowdown in a still troubled global economy, the U.S. manufacturing sector added 524,000 jobs between February 2010 and February 2013. While this is welcome news, there is a long way to go before the full extent of the damage to factory payrolls is fully repaired, not just from the deep 2007-2009 downturn, but more broadly from the difficult post-2000 period for U.S. manufacturing.

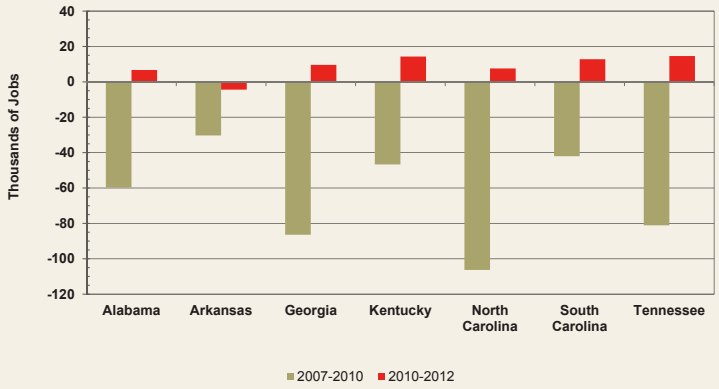
**Figure 6 – U.S. Manufacturing Employment (Seasonally Adjusted)**




Source(s): U.S. Bureau of Labor Statistics

Against this challenging national perspective, Figure 7 (on the following page) shows the weak rebound from the sharp job losses suffered by key Southern states. Between 2007 and 2010, the average manufacturing job loss for the seven states used for analysis in this report was approximately 64,600, with an average rebound of about 8,700 from 2010 to 2012.

**Figure 7 – Manufacturing Employment Changes, Southern States**

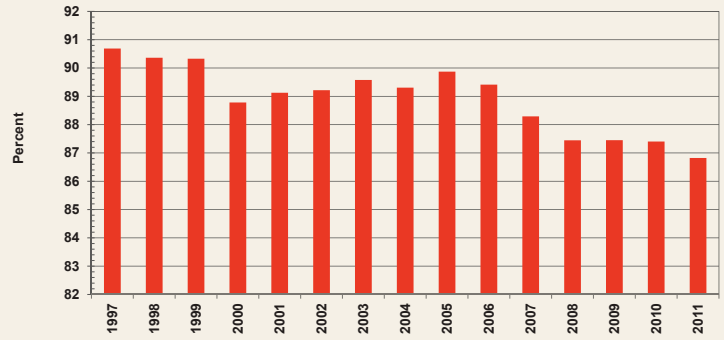



Source(s): U.S. Bureau of Labor Statistics

A restoration of at least moderately strong manufacturing job growth would be effective economic medicine for an income-challenged area. Figure 8 shows that the South's per capita real (inflation-adjusted) GDP, an indicator of the impact of economic growth on regional living standards, lags behind that of the U.S., with an ever-widening gap. In 1997, Southern per capita GDP was 90.7 percent of U.S. per capita GDP. With some volatility, it fell relatively steadily to 86.8 percent by 2011. Partially as a result, Southern disposable personal income, an important driver of consumer demand, has been consistently less than 100 percent of U.S. disposable personal income (Figure 9, on the following page).

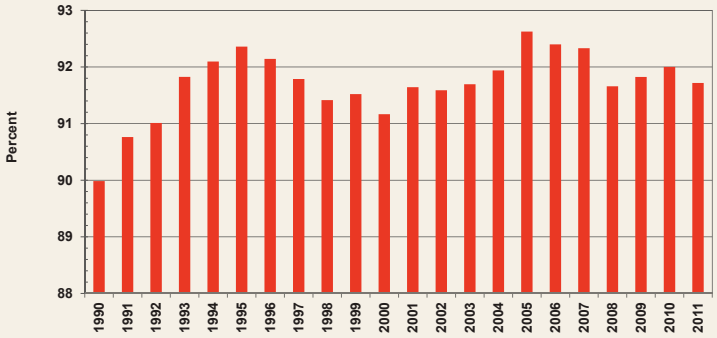
The income challenge is particularly difficult when considered from a structural vantage point. Relative weakness in per capita GDP growth and disposable personal income has contributed to a difficult picture with respect to poverty. Figure 10 (on the following page) shows that the poverty rate in seven Southern states is well above the U.S. average. At a fiscally challenged time, high poverty rates are a burden on already stretched state

**Figure 8 – Southern Per Capita GDP as a Percent of U.S. Per Capita GDP**




Source(s): U.S. Bureau of Economic Analysis

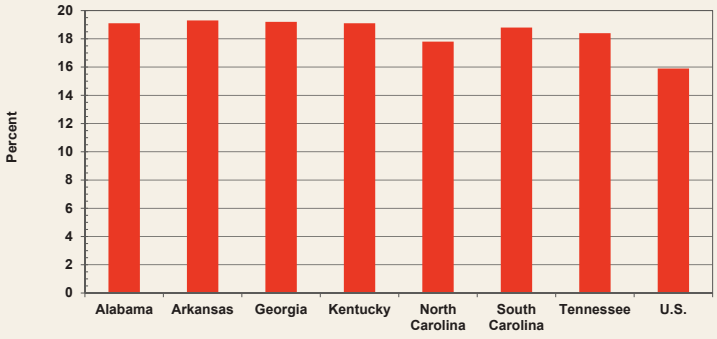
**Figure 9 – Southern Disposable Personal Income as a Percent of U.S. Disposable Personal Income**




Source(s): U.S. Bureau of Economic Analysis

budgets. This creates something of a vicious circle, whereby the public sector burdens of very low incomes make it more difficult for states to fund and implement much-needed economic development initiatives.

**Figure 10 – Percent in Poverty, All Ages, U.S. and Southern States 2011**




Source(s): U.S. Census Bureau, Small Area Income and Poverty Estimates, December 2012

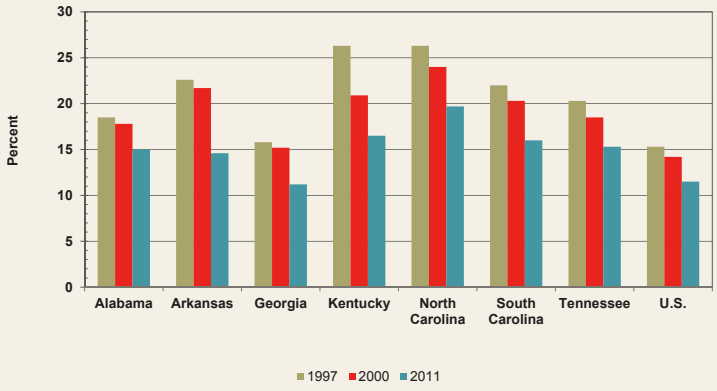
Manufacturing has some potential as a development vehicle for the South. With its strength relative to the national economy, as well as some evidence of increased stability, the factory sector is certainly being targeted nationally as a vehicle to achieve a faster-growing, more globally competitive U.S. economy. A growing number of prominent think tanks, including the prestigious Brookings Institution, have made manufacturing research a regular part of their work output. The South could very well be a beneficiary of, as well as an interesting laboratory for, planned manufacturing development. A recent article from the Federal Reserve Bank of Atlanta[3] highlights the dramatic change in the South-

3 Charles Davidson, "Made in the South: A Bad News, Good News Story," *EconSouth,* Federal Reserve Bank of Atlanta, Third Quarter 2011, www.frbatlanta.org/documents/pubs/econsouth/11q3_manufacturing.pdf.

ern factory sector, where foreign automakers are replacing a declining textile and apparel economy. As the author notes, "foreign automakers have come to be viewed as something akin to manufacturing saviors in the Southeast." He explains that states compete for foreign auto plants with generous tax breaks, publicly funded training programs, and other financial incentives. The presence of foreign auto producers appears to be the main reason that transportation equipment has remained one of the region's biggest manufacturing employers. The article cites a report from the Congressional Research Service that states that foreign investors are drawn to the South by low-cost land and labor, flexible labor regulations, and the lack of strong pro-union sentiment.

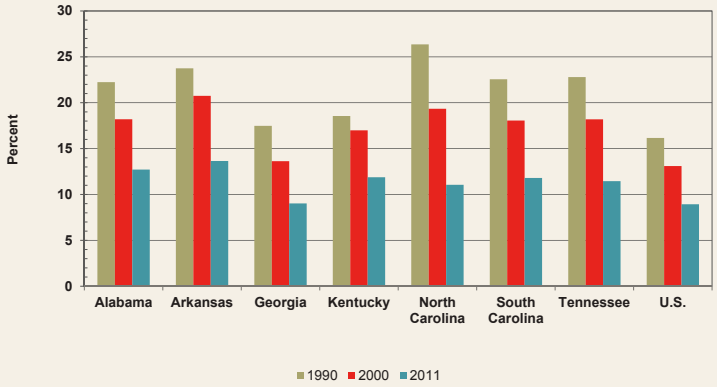
But auto plants do not open often, and the shift toward a more innovation-driven, technologically sophisticated manufacturing sector on the national level continues. A fundamental question for Southern policymakers is whether the region can capitalize on such manufacturing advancement. Data that suggest productivity growth at least on par with the U.S. average are encouraging. As shown in Figure 11, the share of total state output accounted for by the manufacturing sector has fallen in key Southern states. But with the exception of Georgia, it remains above that of the U.S. level. Figure 12 shows that the same is true of the share of total state payroll employment accounted for by the manufacturing sector. Georgia and the U.S. are at the 9 percent level, and high employment shares are seen in Alabama and Arkansas.

**Figure 11 – Manufacturing Output Share in Southern States and the U.S.**




Source(s): U.S. Bureau of Economic Analysis and MAPI

**Figure 12 – Manufacturing Employment Share in Southern States and the U.S.**




Source(s): U.S. Bureau of Labor Statistics and MAPI

Table 1 summarizes the output and employment dynamic by showing the 2000 to 2011 percentage point shift in the output share and in the employment share of manufacturing for each of the seven Southern states that, as we explain in the next section, constitute the analytical sample for this report, and for the United States. The numbers are fairly encouraging of at least a competitive regional labor productivity picture. With the exception of Arkansas, where the percentage point change in output share matches the percentage point change in employment share, the employment share decline exceeds the output share decline, suggesting that manufacturing labor productivity in this region is advancing, as we know it to be for the nation.

**Table 1 – Change in Employment and Output Share of Manufacturing, 2000-2011**

| | Change in Output Share | Change in Employment Share |
|---|---|---|
| | 2000-2011 (Percentage Point Change) | 2000-2011 (Percentage Point Change) |
| Alabama | -2.8 | -5.5 |
| Arkansas | -7.1 | -7.1 |
| Georgia | -4.0 | -4.6 |
| Kentucky | -4.4 | -5.1 |
| North Carolina | -4.3 | -8.3 |
| South Carolina | -4.3 | -6.3 |
| Tennessee | -3.2 | -6.7 |
| U.S. | -2.7 | -4.2 |

Source(s): U.S. Bureau of Economic Analysis and U.S. Bureau of Labor Statistics and MAPI

But in an income-constrained region with poverty rates that are high by U.S. standards, no one can argue that such productivity potential has amounted to much in a broad economic sense. If the South is to capitalize on its productivity promise, it needs to ignite sources of economic dynamism beyond just the foreign investment that appears to be driven by a low-cost structure. If it is to become a competitive region with increasing incomes and advancing living standards, it needs a broader base of high R&D-intensive manufacturing.

Given the well-understood spillover impacts of innovation, an advanced manufacturing base for this region can yield wide economic benefits. Our strategy for developing an intellectual blueprint for such a regional advancement challenge is discussed in the next section.

## Project Structure

Region-focused strategies for economic development have blossomed in recent years, influenced by growing evidence of regions as distinct economic entities. In a much-cited paper, Michael Porter of the Harvard Business School observes substantial differences in economic performance across regions.[4] This 2003 study reveals that the performance of regional economies varies markedly in terms of wage levels, wage growth, employment growth, and patenting.

Porter asserts that his results reveal the need for much of economic policy to be decentralized to the regional level, an argument supported by a 2004 collection of comments from the Kansas City Federal Reserve.[5] The authors argue that the era of one-size-fits-all economic development policy has passed. Further, they observe that globalization has dramatically redrawn the map of regional economies and note that some regions have prospered by finding niches to capture gains from global trade while others have struggled. The authors conclude that in today's global economy, rural America can no longer rely on producing even more farm and industrial products. Rural America must build new economic engines. To do so, communities need to build critical mass, develop skills for their workforce, and provide access to the capital needed to generate growth and innovation. But an individual rural community can seldom do this by itself. Such communities in isolation are normally unattractive to industry because of workforces that are too small and too limited to very specific occupational areas. They need to partner with other communities to reap the benefits of broader region-based growth. Regions, as the Kansas City Fed authors argue, increasingly need new maps to navigate today's innovation-oriented economy.

We endeavor in this paper to provide such a map for the South. We begin by defining "advanced manufacturing," a phrase that while in widespread use remains contentious as to its precise meaning. We propose and defend a process-based definition as the optimum focus for analysis and policy. Next, we develop a theoretical framework for understanding the dynamics of advanced manufacturing on a regional level. Our new model is an amalgam of three existing models—a simple regional production function; the cluster paradigm of regional economic activity, which has evolved into the basic tool for studying regional economic dynamics; and a simple model of manufacturing innovation taken from a research paper published by MAPI economists. We comment upon the economic implications and policy touch points suggested by our hybrid framework.

4 Michael E. Porter, "The Economic Performance of Regions," *Regional Studies* 37, no. 6&7 (2003): 549-578.

5 *The Main Street Economist,* Center for the Study of Rural America, 2004 Annual Report, Federal Reserve Bank of Kansas City, www.kansascityfed.org/publicat/mse/MSE_1204.pdf.

Subsequently, we gather and analyze data to empirically apply our new analytical framework to the region. This analysis includes the use of cluster mapping data from the Harvard Cluster Mapping Project. Insights from this analysis are then presented, both in terms of regional deficits and promising touch points for strong advanced manufacturing cluster development.

For the purposes of both parsimony and analytical tractability, 7 states were chosen from the diverse SGA membership of 18 states and regions as the subjects of study for this report. They are **Alabama, Arkansas, Georgia, Kentucky, North Carolina, South Carolina,** and **Tennessee**. The focus is on the region, and the authors doubt that the fundamental insights of the research would change with a sample of different size or composition.

The second part of this paper puts forth a detailed regional policy analysis, with a discussion of the roles of states and other actors in regional development, the emerging state policy landscape in the South, principles to guide state policymaking, and specific recommendations for advanced manufacturing development in the South.

## Defining "Advanced Manufacturing"

Given the dynamic and sometimes amorphous nature of technology and innovation, it is not surprising that it has been difficult to find a fully accepted definition of "advanced manufacturing." Fortunately, our model building effort does not require a definitive meaning of "advanced" but rather an acceptable working approximation. By its very nature, the adjective "advanced" is both relative and changing. What is currently considered advanced in one industry or sector is not in another. What is advanced at the moment will be obsolete in a decade. Further, in the manufacturing world, "advanced" can refer to research and development, production, and/or the skill set of the labor force.

We argue that there is a clear decision paradigm for defining "advanced," born out of recent literature. For the purposes of this report, we needed to consider whether our advanced manufacturing definition would be process-oriented or product-oriented. Unfortunately, it has become somewhat common to think of advanced manufacturing only in terms of product. Thus, electronics manufacturing is advanced, while steel manufacturing is not. We assert that there are challenges with a purely product view of advanced manufacturing. It limits analytical consideration to a small segment of industries and it can be difficult to know where to place the dividing line between advanced and non-advanced—and when the line shifts. Further, excluding process ignores what has come to be recognized as an important component of manufacturing innovation. Process innovation is now reaching par with product innovation in the literature. A recent working paper from the National Bureau of Economic Research (NBER) found that the sharp increase in the productivity of the steel industry between 1963 and 2002 was linked to a new technology for producing steel—the minimill.[6]

6 Allan Collard-Wexler and Jan De Loecker, "Reallocation and Technology: Evidence from the U.S. Steel Industry," National Bureau of Economic Research, Working Paper 18739, January 2013.

The authors note that minimills displaced vertically integrated production and were responsible for one-third of the increase in the industry's productivity. They more generally state that the arrival of new technologies can have a major impact on productive efficiency through increased competition and a reallocation of resources.

By developing the analytical framework for the current study based on a process view of advanced manufacturing, we are positioned to consider policies for a wider swath of industries than would be the case with a product delineation. More importantly, we consider the meaningful drivers of change and advancement in the manufacturing sector as a whole. Consequently, for the current study, we define advanced manufacturing as "the application and integration of innovative technologies, materials, and processes to the production of manufactured products."

The use of "innovative technologies" in our chosen definition of advanced manufacturing provides a well-defined link to product innovation that should satisfy those who are biased to a product paradigm. Innovative technologies portend a host of new products that are often designed through an innovation ecosystem. They encompass the type of high R&D capital products for which the U.S. has some global competitive advantage.

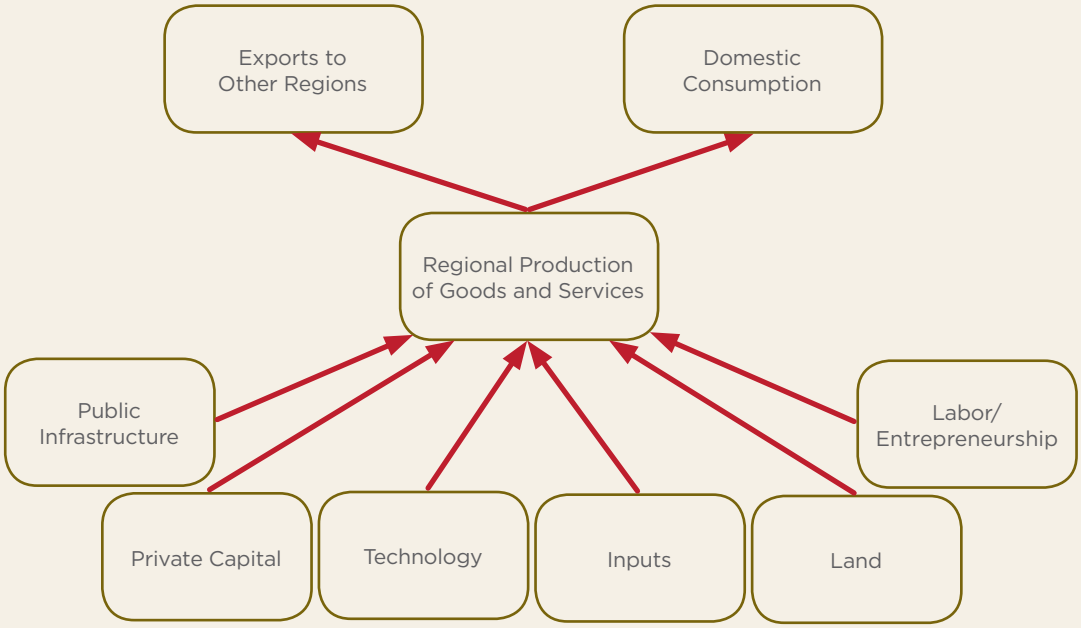
## Building Blocks of the Analytical Framework

With our working definition of advanced manufacturing in place, we developed a project framework that disciplines our analysis of the South and highlights touch points for regional policy. Such a framework is optimized as a unification of three well-accepted constructs: a basic regional production model; a cluster model of regional economic activity, which has become increasingly used by both regional planners and economists who study regions; and a published model developed by MAPI economists that creates a simple but holistic framework for understanding manufacturing innovation.

A simple regional production model is illustrated in Figure 13 (on the following page). As shown, wide-ranging public and private, labor and non-labor inputs feed into the regional production of goods and services, satisfying domestic consumption as well as exports to other regions in the U.S. and abroad.

This is only the starting point. While the regional production model is useful for illustrating policy touch points, it does not explicitly show supply chains and inter-industry linkages. It is important for our project framework to capture—at least in a general sense—the nuances of manufacturing processes in order to gain a full understanding of the impact of policy on process evolution.

**Figure 13 – The Regional Production Function**




Further, research has raised questions about the value of production functions for regional analysis. A recent paper from the Levy Economics Institute at Bard College cautioned against the use of aggregate production functions for analytical tasks that include measuring the rate of regional technical progress to model regional economic growth.[7] The authors note that regional production functions have been used to estimate the impact of regional capital and/or labor subsidies. They assert that such calculations are fatally flawed and warn against the continued uncritical use of aggregate production models in economic geography.

Clearly, the simple regional production function needs to be wedded to a more sophisticated and accepted paradigm that will capture the supply chain, inter-industry, public-private, and cross-region linkages that exist for manufacturers on a subnational level. While burdened by the flaws of incomplete development, the cluster model should at least be an important input into the development of a theoretical framework for thinking about regional advanced manufacturing.

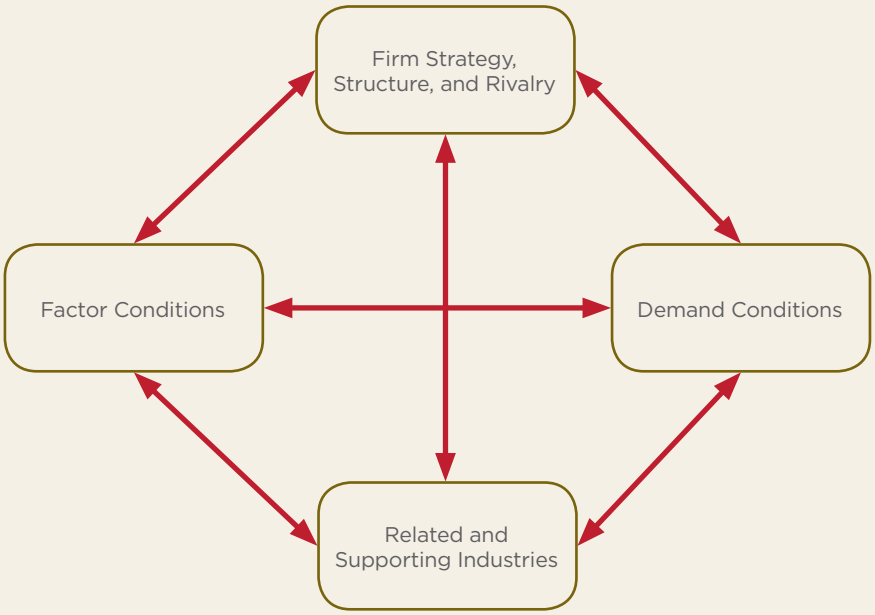
Given that clusters are now considered building blocks of regional economies as well as goals for regional competitiveness, it is not entirely surprising that the fundamental thinking on clusters, at least in large part, comes from Michael Porter. Porter observes that a striking feature of regional economies is the presence of such clusters, which he defines as a "geographically proximate group of inter-

7 Jesus Felipe and John McCombie, "Problems with Regional Production Functions and Estimates of Agglomeration Economies: A Caveat Emptor for Regional Scientists," Levy Economics Institute of Bard College, Working Paper 725, May 2012.

connected companies, suppliers, service providers, and associated institutions in a particular field, linked by externalities of various types."[8] The externalities, often referred to as "agglomeration economies," include common technologies, skills, knowledge, and purchased inputs. On a gut level, manufacturers should understand and appreciate the wording of the cluster definition given their world of suppliers, customers, competitors, R&D laboratories, public institutions of various kinds, and universities.

Figure 14 shows the diamond model that Porter uses to illustrate his cluster concept. In a 2000 article, he explains the corners of the diamond.[9] "Factor conditions" refer to the regional supply of both tangible and intangible assets such as raw materials, physical infrastructure, information, the legal system, and the output of research institutions. "Firm strategy, structure, and rivalry" refer to the legal and institutional norms governing the type and intensity of local competition. The character of rivalry is influenced by many aspects of the business environment, both market-driven and policy-related. Macroeconomic and political stability, labor market policies, and intellectual property rules all contribute to the climate for local business strategies and competition.

**Figure 14 – Michael Porter's Diamond Depiction of the Cluster**




Source(s): www.themanager.org

8 The cluster definition, which has evolved, can be found in a number of papers. An important source is Michael E. Porter, "The Economic Performance of Regions," *Regional Studies* 37, no. 6&7 (2003): 562.
9 Michael E. Porter, "Location, Competition, and Economic Development: Local Clusters in a Global Economy," *Economic Development Quarterly* 14, no. 1 (2000): 15-34.

Porter's observations on the "demand conditions" corner of his diamond seem particularly relevant to manufacturing, and especially innovation-driven manufacturing. He notes that local demand conditions strongly influence product evolution, specifically whether firms move from low-innovation products and services to competing on differentiation. The advancement from low-productivity economies requires the emergence of sophisticated, smart local customers. Smart customers stimulate supply improvements. Local demand provides cues for firms to differentiate themselves around such improvements. Of interest for manufacturing supply chains, it should be noted that "demand" in the cluster context is not restricted to final demand. It could very well be—and often is—intermediate demand. The final corner, "related and supporting industries," which include local suppliers, respond in degree and kind as firms differentiate themselves with the stimulation of smart local demand. It should be noted for both analytical and policy purposes that clusters, while tightly knit ecosystems, more often than not cross jurisdictional and specifically state lines.

Porter notes three different types of industries that make up a regional economy, serving as one convenient taxonomy for clusters. "Local industries" provide goods and services primarily to the local market or the region in which the employment is located; they compete in only a limited way with other regions. Most local industries are services, including health services, utilities, and retail. Construction is also considered to be a local industry. "Resource-dependent industries" have employment that is located primarily where the needed natural resources are found, e.g., freight transportation and logging. These industries can compete with other domestic and international locations. "Traded industries" that are not resource-dependent sell products and services across regions and often to other countries. Their location decisions aren't just based on resource availability but on broad competitive considerations.

The cluster concept has spawned an entire research program, whose results are often of practical interest to state and local policymakers. The authors of a July 2012 paper note that empirical analysis of regional performance must account for two potentially competing economic forces: convergence and agglomeration.[10] Convergence arises when the potential for growth is declining in the level of economic activity because of diminishing economic returns driven by the increasing scarcity of inputs from the succession of firms that enter the market. Agglomeration is essentially the opposite; in the presence of agglomeration economies, growth is increasing in the level of economic activity. The key insight of this paper is that while convergence is likely to take place at the industry level, agglomeration operates across industries within a cluster. By sharing common technologies, inputs, and cluster-specific institutions, industries within a cluster benefit from complementarities, even if they do not engage in trade with one another. Specifically, the authors find that industries participating within a strong cluster (i.e., a large presence of other related industries) enjoy higher employment growth, accelerated wage growth, and stronger patenting and entrepreneurship than would otherwise be the case.

10 Mercedes Delgado, Michael E. Porter, and Scott Stern, "Clusters, Convergence, and Economic Performance," National Bureau of Economic Research, Working Paper 18250, July 2012.

Research has revealed that new industries can actually be spawned by clusters. An earlier paper by the same three authors specifically considers the role of regional clusters in regional entrepreneurship.[11] The authors postulate that the presence of a cluster of related industries in a given location lowers the cost of starting a business, enhances opportunities for innovation, and creates optimal access to a range of inputs and complementary products. They find that industries located within a strong cluster or that can access strong related clusters are associated with higher growth rates in the formation of new firms and startup employment.

The authors also find that clusters can contribute to the formation of new establishments of existing firms. Apparently, these new establishments often belong to firms that participate in like clusters in other locations. One interpretation of such a result suggests that firms seek complementarity across regional clusters, benefiting from the comparative advantage of each location.

The authors of a 2008 paper focused specifically on manufacturing entrepreneurship on a local level, noting that new manufacturing startups are particularly stimulated by the presence of other industries that utilize the same type of labor.[12] Remarkably, the composition of the local labor force matters more for manufacturing entrepreneurship than input supplier and customer linkages.

## Challenges to the Cluster Paradigm and Adaptation to an Advanced Manufacturing Framework

As with any paradigm that attempts to model complex interrelationships, it is important to be aware of the shortcomings as well as the strengths of the cluster literature. A number of articles, in the spirit of advancing the cluster framework, have identified challenges with the existing model.[13]

Analyzing interconnections within a cluster is problematic with the current state of the theory. Input-output (IO) analysis is one of the few useful tools for such a task but determining the standard for "substantial" connections among the components of a cluster remains difficult and not well defined. Further, IO analysis captures only monetary transactions, not such factors as rivalry, collaboration, and knowledge spillovers—critical to the heartbeat of a strong cluster.

Other critiques discuss the need to more systematically account for industry variation. It is important, for example, to consider the relatively greater dependence of high-technology clusters on strong links with research-generating institutions. Further, of particular relevance to advanced manufacturing, many have noted the need for a more dynamic cluster paradigm to spawn much-needed understanding

11 Mercedes Delgado, Michael E. Porter, and Scott Stern, "Clusters and Entrepreneurship," Center for Economic Studies, Paper #10-31, September 2010.
12 Edward L. Glaeser and William R. Kerr, "Local Industrial Conditions and Entrepreneurship: How Much of the Spatial Distribution Can We Explain?" National Bureau of Economic Research, Working Paper 14407, October 2008.
13 See, for example, Yasuyuki Motoyama, "What Was New About the Cluster Theory? What Could It Answer and What Could It Not Answer?" *Economic Development Quarterly* 22, no. 4 (2008): 353-363.

of how clusters appear, evolve, and change. Dynamism in the cluster model would be useful for capturing the impact of innovation—by definition a change-stimulating process—on regional economies and regional competitiveness.

Some find the relatively non-specific nature of clusters to be a weakness of the model, while others find it to be a strong point. Either way, non-specificity requires that the cluster paradigm be adapted to the type of industry being studied. Given the innovative bent in our working definition of advanced manufacturing, such an adaptation for the development of our project framework requires that we consider the drivers of U.S. manufacturing innovation. Two MAPI economists, including the director of this study, published such a paper in 2007.[14]

The authors estimated a simple model and then derived summary indicators for both product and process innovation in the U.S. manufacturing sector. Patents were used as an empirical proxy for product innovation, while the growth rate of multifactor productivity in U.S. manufacturing was used as an empirical proxy for process innovation. Explanatory variables in the product innovation equation include a two-year lag on the growth rate of scientists and engineers in R&D-performing companies, a six-year lag on the growth rate of dollar expenditures on university- and college-performed basic research, and R&D expenditures as a percent of sales in the U.S. manufacturing sector. While business R&D clearly plays a role in manufacturing product innovation output, the equation shows it to be part of a broader ecosystem that includes a critical link to academic research—the type of link that squares nicely with the cluster paradigm.

The six-year lag on expenditures for basic university R&D should not be surprising given the time requirement of research, publication, dissemination, and absorption by the private sector. But the investment does pay off. The authors found that a 10 percent increase in nominal dollar expenditures on basic science research at universities and colleges is associated with a 3.6 percent increase in a four-year moving average of utility patent approvals after six years.

14 Jeremy A. Leonard and Cliff Waldman, "An Empirical Model of the Sources of Innovation in the U.S. Manufacturing Sector," *Business Economics* 42, no. 4 (October 2007): 33-45.

The process innovation equation also had growth of the science and engineering workforce (lagged two years) and the growth rate of dollar expenditures on university- and college-performed basic research (lagged five years in contrast to six in the product innovation equation) as explanatory variables. But the process equation also includes the growth rate of investment in equipment and software in the entire economy, both in current form and lagged three years. The authors surmise that while investment provides a degree of immediate payoff in terms of process improvement, there is a learning curve that companies must climb before reaping the full efficiency benefits of capital spending.

The close link between investment and process innovation validates the embodiment hypothesis first postulated by the Nobel Prize–winning economist Robert Solow. The hypothesis can be stated in a simple manner: as old machinery is replaced by newer, more technically capable equipment, productivity can increase without an increase in the ratio of capital to labor.

In a broad sense, the authors conclude that the drivers of manufacturing innovation extend well beyond business R&D spending. Capital investment, academic science, and the growth of the science and engineering workforce all matter a great deal.

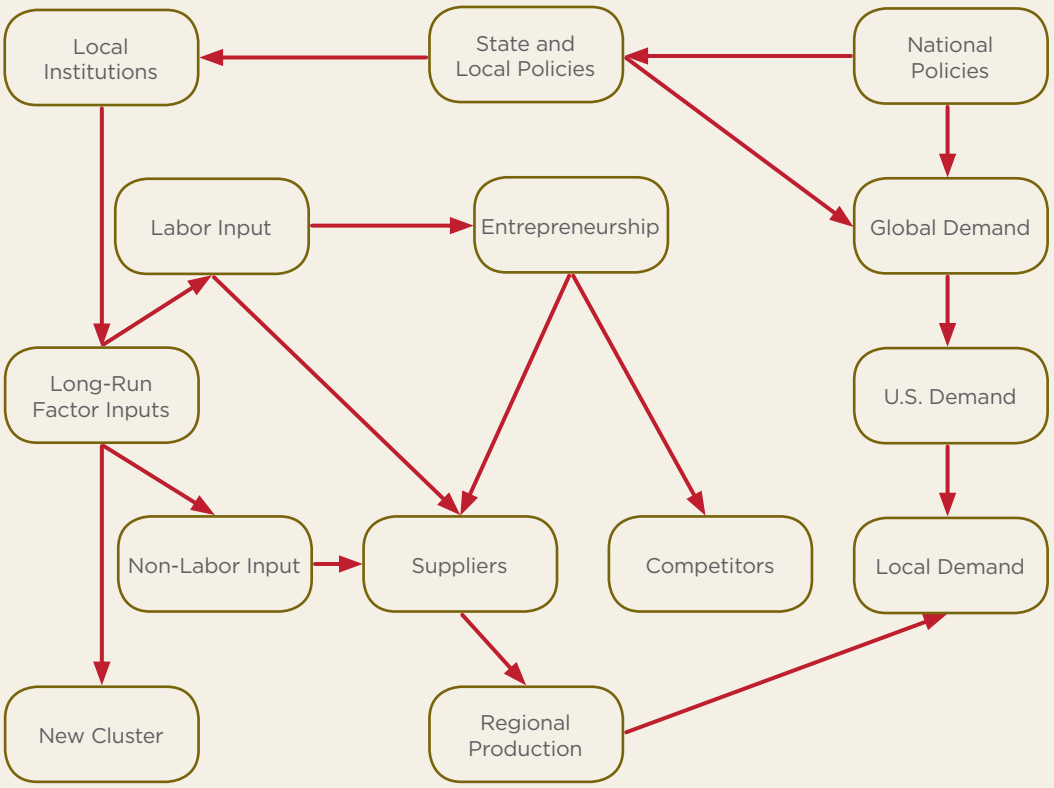
## Advanced Manufacturing Cluster Schematic: Links and Implications

Mindful of the policy touch points revealed by a simple regional production model, the advances in regional economic understanding brought about by cluster theory, and the drivers of manufacturing innovation, we reveal, in Figure 15 (on the following page), the schematic that serves as the optimal framework for considering advanced manufacturing on a regional level.

At two points this is an "open" cluster. In the upper right, national policies are "allowed in." It is simply unrealistic to ignore the influence of federal policies on state and local policies as well as on state and local economies. In the bottom left, we allow for the evolution of a new cluster, which is spawned either as a second cluster from the existing one or as a result of an evolutionary change in the existing cluster. This new cluster "opening" is one of several ways that the basic demand structure of the standard cluster model is adapted to the dynamic realities of an advanced manufacturing framework. The innovation-driven nature of advanced manufacturing, in which new processes and new products catalyze one another, can and should create new industries and new supply chains, and thus new clusters.

We also adapted the factor conditions corner of Porter's diamond to account for the impact of innovation on advanced manufacturing inputs. We did so by adding a long-run factor inputs box. Such inputs include what many would consider the essentials of national and regional competitiveness—education and training, research and development, and infrastructure. These are not direct inputs into any current regional production process, but they do have a critical influence on the evolution of future inputs, both labor and non-labor.

**Figure 15 – A Model for the SGA-MAPI Project**




Source(s): MAPI

Labor and non-labor inputs, as per the structure of the basic regional production framework, all feed to suppliers, who produce the regional output to satisfy regional demand, U.S. demand outside of the region, and global demand. The labor input is also the source of entrepreneurship, both by being one source of entrepreneurs and, as referenced earlier, by being critical for stimulating manufacturing entrepreneurship in certain industries that integrate into the local cluster. Entrepreneurship in turn feeds the population of suppliers and competitors.

The connections revealed by our regional advanced manufacturing schematic have clear implications for state and local policymaking. As mentioned, state and local policies are framed, to some extent, by national policies. National tax and regulatory policies, national minimum wages, federal investment in R&D, and federally developed foreign trade relationships are examples of the many federal economic policies that impact policy development on the regional level. Together, as the schematic shows, national and regional policies impact global demand, U.S. demand, and local demand for goods produced by any given advanced manufacturing cluster in any given region.

Nonetheless, beyond the federal-state policy mix, state and local policymakers—as our schematic shows—can have a unique impact on current and future cluster conditions by either creating or impacting local institutions. But even this avenue

of impact is to some degree affected by the federal policy setting. Such institutions can include workforce training centers, small business incubators, federally funded research and development centers, or just an investment in stimulating the effectiveness of locally based educational institutions, such as community colleges. The framework for local institutions can also be broadened to infrastructure development. The development, not only of investment funds, but also of local institutions for the renewal of everything from airports and roads to parks and downtown areas, has the capacity to generate the kind of public capital investment that attracts valuable, cluster-enhancing private capital. These local institutional investments, as we show in the schematic, feed into the long-run factor inputs that allow for the persistent upgrading and innovation of both labor and non-labor inputs into advanced manufacturing processes.

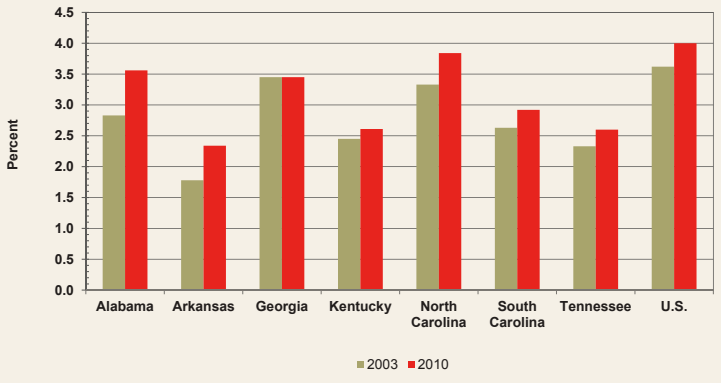
With perfect federal, state, and local investment foresight, the advanced manufacturing cluster will be unstable. The innovation drivers will be so dynamic that either the existing cluster will morph into something new or a new cluster will be spawned. It is this evolving and spreading effect that can make advanced manufacturing clusters such powerful drivers of regional development and competitiveness.

Such clusters are not necessarily restricted to state borders. Thus, as we discuss in subsequent sections, a coordinated and shared effort among state and local governments is often needed for the far-sighted and optimal local institutional investments that will support dynamic advanced manufacturing clusters and allow for their full benefit.

## Empirical Application of the Cluster Schematic to the American South

The growing and increasingly accessible supply of state and regional economic data allow us to empirically specify our project framework for the South. While our regional advanced manufacturing schematic gives general direction to state and local policymakers, an empirical specification reveals the challenging deficits as well as the promise in this region.

**Figure 16 – Full-Time Equivalent Science and Engineering Employment as a Percent of the Labor Force**




Source(s): National Science Foundation

Economic research uniformly supports the importance of a strong R&D workforce for innovation output. Science and engineering employment thus matters a great deal to the quality of the labor input for an advanced manufacturing cluster. Figure 16 shows full-time equivalent science and engineering employment as a

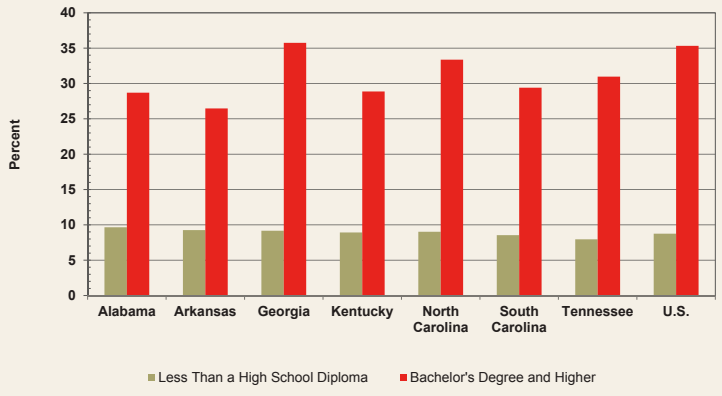
percent of the labor force for our seven study states and for the nation. Data are shown for 2003 and 2010. With the exception of Georgia, it is encouraging to see growth in our study states and in the country.

Nonetheless, the region is lagging the nation in science and engineering employment. With a U.S. average of 4 percent of the labor force, policymakers should be somewhat concerned about North Carolina at 3.8 percent and Alabama at 3.6 percent. State governments should be more than a little concerned about Kentucky at 2.6 percent and South Carolina at 2.9 percent. For the region as a whole, the gap with the U.S. is not insurmountable. Nonetheless, policymakers need to consider the "footrace" effect, whereby the efforts of the South to move ahead are concomitant with U.S. efforts to increase the national science and engineering workforce. Local institutional development in the training of scientists and in the kind of cutting-edge basic R&D that might attract scientists from other U.S. regions (and other countries) could very well put the South at least on par with the United States. But such investments need to be strong, focused, and persistent.

Figure 17 shows the broader regional education picture. For each of the seven states and the U.S., we show the share of the 2011 labor force with less than a high school diploma and the share with a bachelor's degree and higher. Somewhat encouragingly, the share with less than a high school diploma in the seven states is not too out of line with the U.S. average of 8.7 percent. Kentucky is just slightly above at 8.9 percent, while Georgia and Alabama are at 9.2 percent and 9.7 percent, respectively. South Carolina and Tennessee are slightly below at 8.5 percent and 8.0 percent, respectively.

The region, however, is lagging in college attainment. Here, too, the gap is modest. On average, 35 percent of the U.S. workforce has a bachelor's degree or higher, while the average for the seven states is just under 31 percent. The college attainment shares range from 26 percent in Arkansas to Georgia's rate of 36 percent, slightly above the national average. But as with science and engineering employment, there is the challenge of a regional/national footrace and thus it bears repeating: southern investments in broad educational attainment, as with the more specific challenge of developing a science and engineering workforce, need to be strong, focused, and persistent.

**Figure 17 – Educational Attainment, Percent of Civilian Labor Force, 2011**

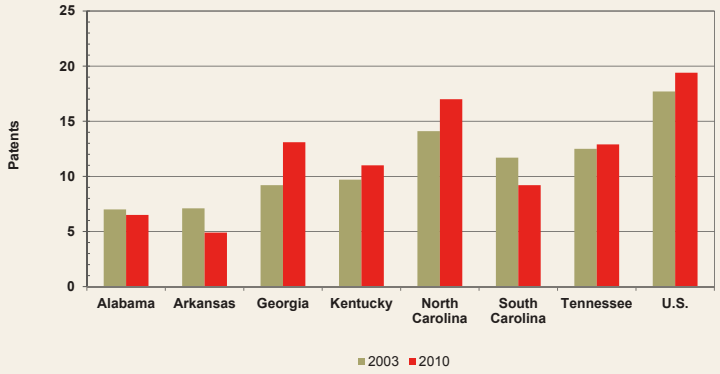



Source(s): U.S. Bureau of Labor Statistics and MAPI

## Workforce and Educational Challenges Impact Patent Activity

Figure 18 illustrates a regional lag in innovative activity. While patents are not a perfect measure of innovation in that not all innovations result in a patent, the economics literature nonetheless recognizes patents as being the best proxy for product innovation output. For the seven states and the U.S., Figure 18 shows patents per 1,000 individuals in science and engineering occupations for 2003 and 2010. In contrast to the case for science and engineering employment, not all of the states have seen an increase in what is essentially a measure of the productivity of the science and engineering workforce. Alabama, Arkansas, and South Carolina have experienced declines in patent output. While North Carolina is bridging its gap with the U.S., the difference remains sizable.

**Figure 18 – Patents Per 1,000 Individuals in Science and Engineering Occupations**




Source(s): National Science Foundation

Table 2 presents an industry analysis of the regional patenting challenge. These data are sourced from the U.S. Cluster Mapping Project, which is a cooperative

**Table 2 – Ranking of Southern States in Patents Per 10,000 Employees By Traded Cluster**

| Cluster | State Rank | | | | | | |
|---|---|---|---|---|---|---|---|
| | AL | AR | GA | KY | NC | SC | TN |
| Production Technology | 43 | 44 | 25 | 40 | 29 | 41 | 35 |
| Plastics | 35 | 40 | 20 | 39 | 32 | 30 | 27 |
| Motor Driven Products | 42 | 47 | 40 | 26 | 36 | 44 | 43 |
| Metal Manufacturing | 38 | 39 | 19 | 34 | 24 | 27 | 29 |
| Information Technology | 41 | 47 | 31 | 15 | 10 | 48 | 38 |
| Heavy Machinery | 35 | 39 | 29 | 35 | 28 | 26 | 32 |
| Chemical Products | 37 | 47 | 34 | 37 | 31 | 36 | 45 |
| Aerospace Vehicles and Defense | 33 | 34 | 35 | 19 | 12 | 24 | 21 |
| Analytical Instruments | 31 | 37 | 4 | 5 | 7 | 18 | 8 |
| Power Generation and Transmission | 32 | 38 | 34 | 33 | 21 | 29 | 10 |

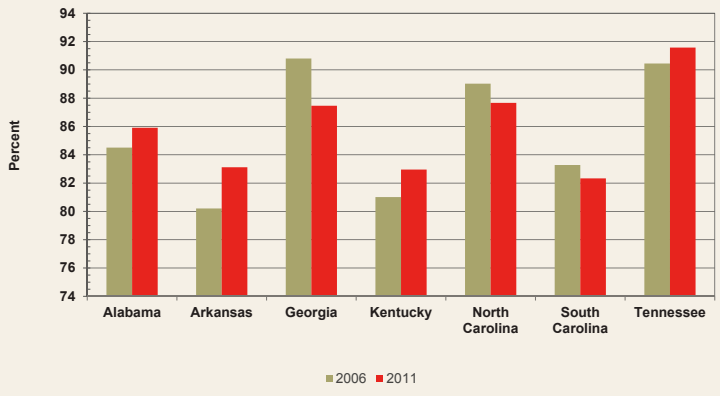
Source(s): U.S. Cluster Mapping Project and MAPI

effort between the U.S. Commerce Department and the Institute for Strategy and Competitiveness at the Harvard Business School. Their aim is to provide data for understanding industry clusters by U.S. region; the grouping of industries into clusters is based on linkages that are partially revealed by geographic patterns of employment. For the presentation in Table 2, 10 clusters were chosen that bear a direct or indirect relationship to advanced manufacturing in the context of our process-oriented definition. For each of the seven study states in each of the chosen clusters, we show the ranking of patents per 10,000 employees, with larger numbers indicating a lower rank. These cluster data appear to corroborate the comparatively weak showing of the aggregate state data in Figure 18. Nonetheless, the data allow for industry-level insight; along those lines, it is interesting to see a strong showing for the analytical instruments cluster in Georgia, Kentucky, North Carolina, and Tennessee, very much a standout from almost all other data in the table. The relatively high rankings for patenting activity in the information technology cluster in Kentucky and North Carolina are also noteworthy.

## Demand Weakness

Figure 19 focuses, at least indirectly, on the demand side of advanced manufacturing cluster strength, specifically on local demand. Per capita disposable income is an accepted predictor of the strength of consumer demand in the region.[15] As shown, disposable income in the South was lagging the U.S. just before the U.S. and global economic crises in 2006 and continued to lag in 2011, the latest year for which data are available. The trend has been mixed among the seven study states, increasing in Alabama, Arkansas, Kentucky, and Tennessee, while falling in Georgia, North Carolina, and South Carolina.

**Figure 19 – Per Capita Disposable Personal Income in Southern States as a Percent of U.S. Per Capita Disposable Personal Income**

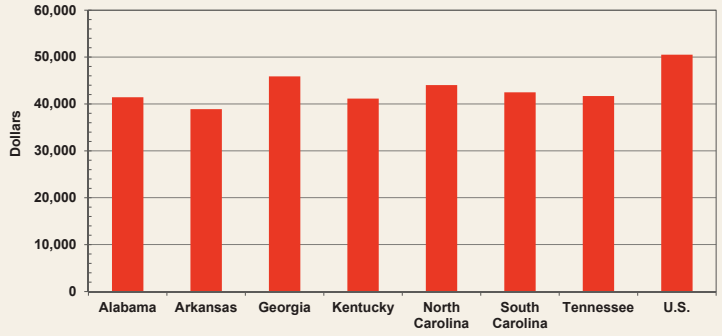



Source(s): U.S. Bureau of Economic Analysis and MAPI

15 Harmonized data on consumer demand by region are not available.

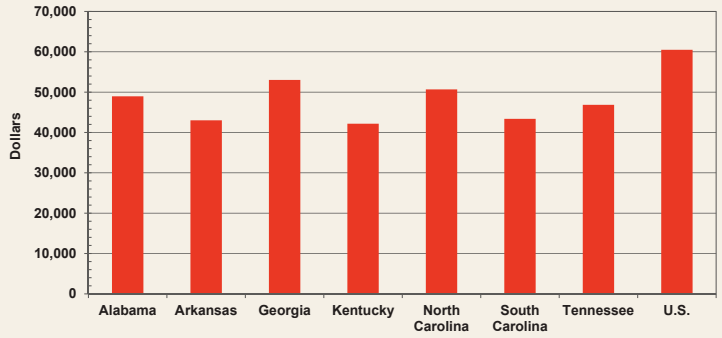
The regional lag in the median household income, shown in Figure 20, might suggest that demand weakness in this high-poverty region is fairly structurally rooted and won't necessarily be completely overcome by stronger national economic growth. The core issue is wages, which is a double-edged sword for the South. Figure 21 shows the average wage in traded clusters for the seven study states and for the nation. These data corroborate, in a general sense, the lag in regional disposable income; they also highlight that lagging wages in manufacturing and advanced manufacturing, likely a reflection of lags in education, are playing a role in the region's broad income weakness.

**Figure 20 – Median Household Income, 2011**




Source(s): U.S. Census Bureau, Small Area Income and Poverty Estimates, December 2012

**Figure 21 – Average Wage in Traded Clusters, 2010**




Source(s): U.S. Cluster Mapping Project

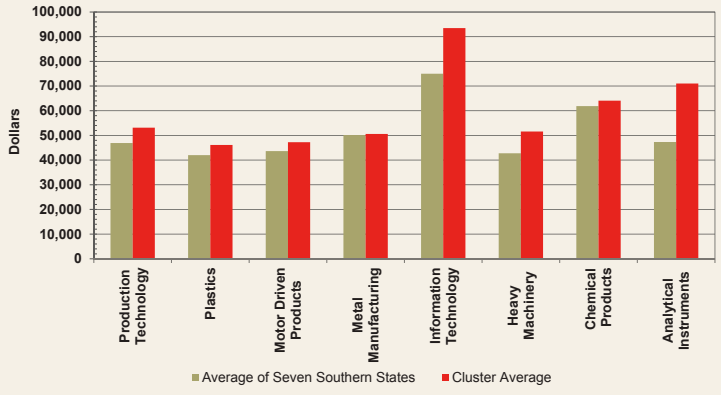
**Table 3 – National Ranking of Southern States in Wages by Traded Cluster**

| Cluster | State Rank | | | | | | |
|---|---|---|---|---|---|---|---|
| | AL | AR | GA | KY | NC | SC | TN |
| Production Technology | 30 | 44 | 31 | 34 | 33 | 26 | 41 |
| Plastics | 19 | 42 | 30 | 27 | 24 | 16 | 32 |
| Motor Driven Products | 15 | 34 | 17 | 33 | 14 | 25 | 35 |
| Metal Manufacturing | 2 | 1 | 32 | 15 | 29 | 16 | 26 |
| Information Technology | 36 | 41 | 13 | 37 | 17 | 25 | 31 |
| Heavy Machinery | 42 | 44 | 29 | 37 | 35 | 39 | 33 |
| Chemical Products | 12 | 27 | 26 | 10 | 11 | 13 | 24 |
| Analytical Instruments | 40 | 43 | 37 | 38 | 32 | 9 | 25 |

Source(s): U.S. Cluster Mapping Project and MAPI

Table 3 allows for a more detailed view by showing the national ranking of wages in the seven study states in a selection of clusters that matter to advanced manufacturing, as defined by our process framework. While the high numbers throughout this chart corroborate general income weakness, there are a few bright spots, most notably the high ranking of metal manufacturing wages in Alabama and Arkansas as well as the relatively high ranking of chemical products wages in Kentucky, North Carolina, South Carolina, and Alabama. The high ranking for analytical instruments wages in South Carolina is also interesting in light of some degree of regional innovation dynamism in the analytical instruments cluster.

**Figure 22 – Average Wages of Southern States in Key Clusters Compared to Cluster Average, 2010**




Source(s): U.S. Cluster Mapping Project and MAPI

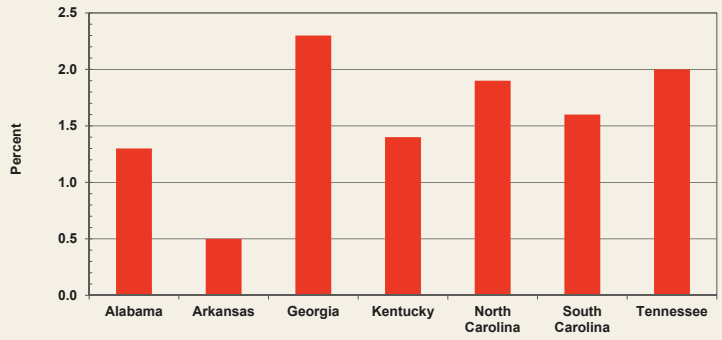
Figure 22 completes the wage picture by showing the average wage of the seven study states within key manufacturing clusters compared to the national cluster average. In the metal manufacturing cluster, the average wage of the seven states is nearly even with the national cluster average. In all other featured clusters, the seven-state average lags the national average. The largest gaps are in the analytical instruments and information technology clusters, two R&D-intensive areas. A policy focus on analytical instruments, with its bright spots for regional innovation activity, is certainly a good investment in a better regional income picture.

It can be legitimately argued that low wages were part of an advantageous cost structure that created incentives for foreign automakers to locate production and other facilities in the American South. But moving forward, low nominal wages are now more likely to do harm than good, keeping incomes and demand weak. Regional wage growth will benefit from the emergence of advanced manufacturing processes in the region. Such processes create demand for high-skilled labor and thus incentivize regional human capital development.

## Global Demand and Exports

With structural regional weakness in consumer incomes and a still sluggish U.S. economy, global demand becomes all the more important for the South. Figure 23 shows each of the seven study states' export share of total U.S. exports. There is wide variation, with strength in Georgia and Tennessee and weakness in Alabama and Arkansas. Many will argue, with some validity, that the relative size of the state matters to export activity; exporting, however, is a relatively rare activity. For any state, the presence of one or two large exporting companies can sway its relative ranking dramatically.

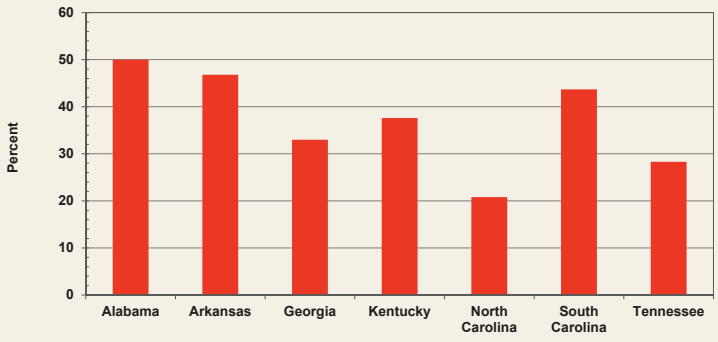
**Figure 23 – State Exports as a Share of U.S. Exports, 2012**




Source(s): U.S. Census Bureau

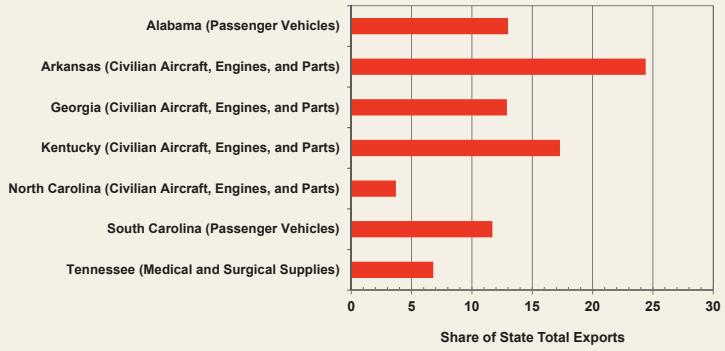
Figure 24 displays the top 10 commodities' share of total state exports, a rough measure of export diversification. Unsurprisingly, the states that make the weaker contribution to total U.S. exports—Alabama and Arkansas—appear less diversified in their export base (and thus are more reliant on the top 10 commodities).

**Figure 24 – Top 10 Commodities as a Share of Total State Exports, 2012**



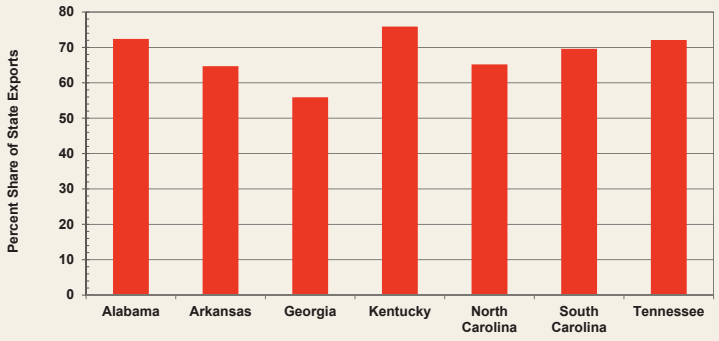

Source(s): U.S. Census Bureau and MAPI

**Figure 25 – Top State Export as a Share of the State's Total Exports, 2012**



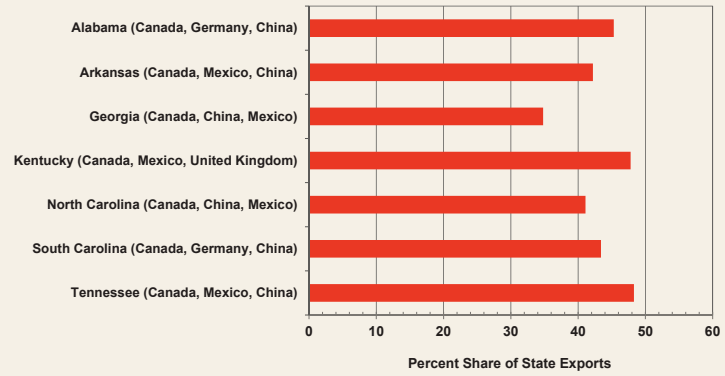

Source(s): U.S. Census Bureau

**Figure 26 – Share of State Exports Sent to Top 10 Countries**




Source(s): U.S. Census Bureau and MAPI

**Figure 27 – Share of State Exports Sent to Top 3 Countries**




Source(s): U.S. Census Bureau and MAPI

Figure 25 drills down further by showing the top state export and its share of the total for each of the seven study states. Clearly, civilian aircraft, engines, and parts is a critical export industry for this region.

Figures 26 and 27 offer a geographic view of export activity for the South. Figure 26 shows the almost uniformly high dependence on the top 10 countries goods are exported to, while Figure 27 corroborates these data by showing the relatively high export dependence on the top three countries in particular. There is no denying that trade with Canada is an economic driver for the South—it is the top export destination for all seven study states. Export business with China is also critical, while exports to Germany, Mexico, and the United Kingdom are of clear import to regional strength.

## Summary of Findings: Southern Challenges and Promise

Evidence of manufacturing labor productivity gains in Southern states and the fact that manufacturing output and employment shares remain generally above that of the U.S. both hint at the potential for a regionally beneficial advanced manufacturing development strategy. The obstacles, however, are at least as sizable as the promise. This region's lags in college-level attainment and in the share of the workforce in science and engineering relative to the U.S. have multiple implications. Most importantly, these labor force gaps have likely contributed to a sizable deficit in innovation activity.

Regional innovation deficits are negatives for the quality of both labor and non-labor inputs into the production process and for the advancement of the production process itself, holding back the total factor productivity gains needed for strong advanced manufacturing clusters. Labor force deficits are also—as research shows—a negative for entrepreneurship, particularly manufacturing entrepreneurship.

Fortunately, the Southern labor force gaps with the U.S. are not so sizable as to be insurmountable. As illustrated by the structure of our project framework, well-placed investments by state and local policymakers in the development and buttressing of higher education in general, and in science and technical education in particular, will likely yield measurable returns, although they need to be strong, focused, and persistent given the continued progress in the nation.

The region also has difficulties that negatively impact the strength of demand. The South is a high-poverty area with lagging household incomes and lags relative to the U.S. in per capita disposable income, a driver of the strength of consumer spending. This pattern is largely a reflection of relatively weak education within the population. Structurally weak regional domestic demand means that export strength has disproportionate importance. The strength and diversification of export demand is remarkably mixed among the seven study states. Broader regional export diversification should be a policy goal.

The development experience of this region shows that while cost minimization is certainly an element of regional competitiveness, it does not—by itself—constitute an entire development strategy. Low wages in the South relative to the U.S. have certainly played a role in attracting foreign direct investment, particularly in the auto sector, but low wages have also contributed to structurally weak regional incomes and have likely been a negative for attracting much-needed high-skilled labor.

Our analysis hints at promising industry clusters for the South. Civilian aircraft is a widely shared top export among the seven study states and is closely linked via the supply chain to the broader transportation equipment sector, which is important in many places in the region. Further, a number of the study states have notable relative strength in patenting activity in the analytical instruments cluster, an interesting standout given the region's broad weakness in innovation dynamism. If macro problems, particularly in the labor force, are addressed, we might see the beginnings of a cluster development framework for this area of the country.

In the subsequent sections of this report, we consider the policy framework for addressing these challenges in the South. We first consider the role of state governments as well as non-state actors in industrial development. We next provide an overview of the history of industrial development policy in the South as well as the emerging policy landscape. Broad principles to guide state policymakers are then offered along with specific policy recommendations for regional advanced manufacturing development.

# PART 2 — POLICY ANALYSIS

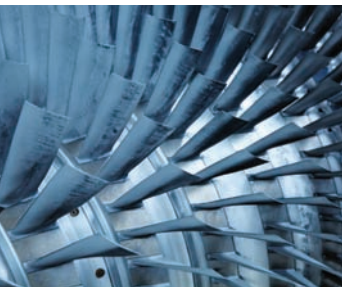
## States as Facilitators of Economic Development

The states in the SGA region, like states around the country, have long played a central and active role in promoting economic development. Government is generally seen as a facilitator and catalyst of market-based economic growth, although the Southern states have sought to limit public sector interference with market forces. Despite the region's economic and governmental diversities, there is a clear recognition that state action is an essential piece of the economic development puzzle. The nature of this action varies based on each state's unique history, endowment of productive resources, labor force, location, and so on.

The targets of state policy can be seen through the lens of our project framework. A primary policy target is education, which represents one of the largest state expenditure categories; it is arguably the most important foundational component of economic growth through its impact on labor inputs and entrepreneurship, and thus the competitiveness of private industry in the supplier network. The scope of essential human capital investments has expanded as the economy has grown in size and sophistication. The K-12 pipeline has expanded to a PK-20 pipeline that includes early childhood (i.e., pre-K) education and college, with recognition that there is an ongoing longer-term role for states in supporting worker training and retraining for adults. Support for entrepreneurs often includes various types of training and education to help foster the viability of small enterprises that offer the promise of job creation.

Another core economic development function of the states is the provision of infrastructure, which is an important non-labor input to production. The most visible and costly component is the transportation network that serves as a critical facilitator of commerce both within and across regions and states. Water, sewer, electricity, natural gas, and telecommunications are also fundamental forms of infrastructure, typically regulated in some way by the states but provided locally.

Business incubators and industrial parks are examples of infrastructure that is intended to more directly facilitate specific forms of business activity. Business incubators provide common services and office/production capacity to firms that could otherwise not purchase these same services. Georgia Tech's Advanced Technology Development Center, for example, places emphasis on technology startups through incubation and technology acceleration. Industrial parks, on the other hand, serve to concentrate industry in specific locations, yielding cost savings in infrastructure provision and mitigating the negative consequences of industrial growth (e.g., noise and traffic congestion). Business tenants benefit from supply chain opportunities, reliable utilities, and infrastructure access.



Urban growth and sprawl in many Southern cities has crowded out space for industrial activity, making these parks increasingly more important to both industry and communities. Thus the land component of economic development has also become more central with the passage of time. Land remains an abundant resource in the states, but there is a growing scarcity of large tracts amenable to development near many large population centers. Megasites, banked land, and development-ready land (i.e., graded sites with existing infrastructure) are now common throughout the region.

The states have sought to encourage technology development and thus the competitiveness of the supply chain through special provisions of the corporate income tax code, through universities, and through the recruitment of targeted industries that are thought to offer the promise of R&D and significant capital investments. But, as we have noted, the region continues to trail the nation as a whole on indicators reflecting innovation potential and activity. Early industrial development was characterized by mass production processes that relied on labor-intensive production and unskilled labor—regional production was at the bottom of the product cycle, not at the top where innovation takes place. Regional education spending continues to lag the nation and has limited the capacity to invest in human capital throughout the education pipeline.

The industrial recruitment practices of the states, along with market forces, determine the supply chain and inputs available to support in-state production activity. Together, the set of industry clusters and other forms of business activity constitute the regional production function from which intermediate and final goods and services flow. The policy targets noted above, along with other policies such as the state's regulatory structure, can have a bearing on the nature of the firms engaged in regional production and thus the vitality of job and income creation and tax base expansion for the states.

As we discussed in our overview of the cluster literature, some firms may produce solely for local markets, as with businesses that provide many personal services. Some firms sell their output within the region as well as elsewhere. An engineering firm, for example, may provide services to local regional construction firms or to firms located anywhere in the world. Similarly, a firm engaged in the production of electrical components may supply its output to the aerospace, automotive, and marine industries, with final products being shipped globally.

Firms producing for external markets are most critical to regional development and represent the primary engine of economic growth for the states. These firms draw in purchasing power from outside the economy and are responsible for jobs, income, and tax receipts that would not otherwise accrue. But these same firms are subject to the intense competitive pressures of the national and global economies. If firms can prosper and thrive in the face of these pressures, economic and fiscal benefits will continue to flow to the state.

This broad perspective applies to economic development generally, as well as to the narrower advanced manufacturing component of industrial development. The difference is that advanced manufacturing may have more nuanced needs than business and industry as a whole. Access to innovation assets such as the science and engineering workforce and university research capacity are much more important to firms engaged in advanced manufacturing compared with most firms. While other firms and industries may rely on these same innovation assets, as our project framework shows, they are essential core needs for many advanced manufacturers.

## Non-State Facilitators of Industrial Development

While the states have served as the center of industrial development policy formulation, they have been supported by a large cast of other actors who have pursued complementary policies and initiatives. Engaging these other facilitators of industrial development will matter for the effectiveness of policies targeted to advanced manufacturing. The states and their primary economic development agencies will need to play a central role in developing strategic plans, defining target industry clusters, coordinating policy, and promoting accountability, while at the same time allowing other facilitators the flexibility and discretion to pursue best practices. Some critical non-state facilitators are as follows:

- Local governments must continue to be a major partner as the states seek to foster the development of advanced manufacturing. Localities are important service providers when it comes to key development inputs such as elementary and secondary education and more specific inputs such as STEM (science, technology, engineering, and math) education. Even if there is no formal statewide STEM initiative, it is quite possible that there are independent STEM initiatives being pursued at the local level. Local governments also provide support for some forms of infrastructure, including transportation networks. Parks, libraries, and recreation assets are dimensions of quality of life that can influence industrial development; local governments are on the front line of delivering these services.

- Industrial development boards serve a vital role in the process of business recruitment and, through their support, for industrial parks. These boards are generally funded by local cities and/or counties and are thus accountable to the communities that they are intended to serve. They work in tandem with others involved in industrial recruitment, especially the state and entities such as major public utilities. They are an interface to the federal government and often serve as a conduit for federal funding from agencies such as the U.S. Economic Development Administration. Industrial develop-

ment boards are generally staffed by trained economic development specialists and have oversight boards that should be representative of community interests.

- The federal government plays a variety of roles in promoting state and substate economic development. Small Business Administration programs and small business innovation research grants help support smaller enterprises, including manufacturers. Major federal agencies, including the Department of Defense and Department of Energy, often have facilities and employees that can promote economic development. National laboratories such as the Savannah River and Oak Ridge sites offer an advanced science and engineering workforce, clusters of related economic activity, and various types of support for private industry, including R&D.
- Major public utilities such as Duke Energy and the Tennessee Valley Authority provide site location assistance, startup support, and incentives to encourage economic development. These utilities have become increasingly aware of the importance of advanced manufacturing as traditional industry wanes.

Many others play key roles in supporting economic development, ranging from departments of transportation to local community groups. These entities have assets and are stakeholders with something to contribute and something to gain from successful efforts to create jobs, incomes, and economic health for states and communities.

## The Evolution of Industrial Development Policy in the American South

The approach to economic development has changed markedly in the Southern states over time. In the era that followed World War II, the region was characterized by a lack of infrastructure, abundant land, a poorly educated workforce, and surplus labor. At the same time, the South established a reputation as a low-cost place to do business. By the 1960s and 1970s, the states had become quite effective in drawing in branch manufacturing plants from other parts of the country. These plants, notably in the areas of textiles and apparel in several states, created large numbers of jobs for unemployed and underemployed workers. These benefits were important at the time given the nature of regional production practices and labor markets.

By the 1980s and 1990s, the states were increasingly using economic development incentives to further extend the low-cost strategy of industrial recruitment. These incentives included generous long-term tax abatements that helped recruit industry but hampered the capacity of state and local governments to support the fundamentals of economic development, especially human capital development. The utilization of incentives accelerated and it became common for the states to forego corporate and personal income tax revenues for decades in exchange for the siting of industrial facilities and jobs; local governments continued to provide generous long-term abatements under the local property tax. Eventually, it became easy to find examples of concessions that exceeded $100,000 per job.

Globalization has unraveled the low-cost strategy of industrial development. When states pursued the domestic zero-sum game of development using low costs and incentives, they could count on being winners at least some of the time since their competitors were just next door. But when competing against the rest of the world and low-cost countries, it becomes increasingly hard to win the low-cost competition game, and thus the region has seen its industrial job base contract. Part of this is an overall trend of technology adoption, outsourcing, and productivity gains that have reduced the need for workers in manufacturing. It is also attributable to the fact that the Southern states have not always prioritized putting resources toward innovation assets that may have better positioned them in this new global marketplace.

While low costs continue to be important to business vitality and success, a state economy needs to support the creation of value-added for business. Low taxes can make a state an attractive place to do business, but the state must have the capacity to support investments in people, infrastructure, and other assets that are critical to economic development. Low labor costs certainly matter, but these low costs may simply reflect workers who do not hold the requisite skills to ensure gainful and productive employment. Of course, employers bear part of the consequences of an inadequately skilled workforce.

Manufacturing is going through a modest renaissance throughout the country and the states of the SGA region. There are a number of big stories that underlie this trend. One is the narrowing of cost differentials around the world. For example, labor costs in places such as China are rising while supply chain and bureaucratic costs are revealing themselves to be higher than expected, reducing such locations' attractiveness as low-cost sites for production. Labor costs are certainly important, but labor productivity relative to labor costs is more important still.

Further enhancing the modest U.S. manufacturing revival is the growing desire for manufacturing firms, including their R&D and commercialization arms, to be closer to domestic markets where they can be more nimble in their response to changing market forces and technology development. The growth of advanced manufacturing processes such as applied printing and robotics further adds to U.S. attractiveness. Because of the nation's superior infrastructure, innovation assets, and ability to protect intellectual property rights, domestic U.S. markets are proving to be a hotbed for the growth of advanced manufacturing.

This manufacturing renaissance is expected to be short-lived in terms of net employment gains in manufacturing. For example, IHS Global Insight, a leading economic forecasting firm, projects net gains in U.S. manufacturing employment through 2019, after which employment returns to its long-term path of contraction. Jobs in manufacturing will still arise as the spatial pattern of employment changes, and more fundamentally as workers quit or retire, but the job creation process will be leaner, much like industry itself. Through these evolutions, there will be an opportunity for the states to increase their investment in innovation assets to garner more manufacturing activity, especially activity related to advanced manufacturing.

## The Emerging State Policy Landscape

Given advanced manufacturing's recent emergence as a sector of prominence, targeted policy is only now being developed and implemented to foster its growth. Some Southern states have taken significant steps to better understand advanced manufacturing and its implications. For example, the Kentucky Cabinet for Economic Development issued a scoping report in 2009 that looked at the advanced manufacturing sector and its contributions to the state economy.[16] One now finds the keywords "advanced manufacturing" on economic development websites and as part of the regular parlance of those in the economic development field.

16 Rick Hall, *A Profile of the Advanced Manufacturing Industry in Kentucky,* Kentucky Cabinet for Economic Development, April 2009. The report provides a detailed listing of industry support and workforce training programs.

Others, notably educators, have shown some awareness of the rise of advanced manufacturing, especially in the context of community college and technical center training programs. Popular technologies such as 3-D printing have caught the attention of the media and the public at large. This growing awareness among a broader constituency will help support new policy development.

The policy approach of the states shows substantial variation consistent with the traditional experimentalist approach of the American states. There are philosophical differences that help shape how the states approach public policy toward economic development generally, with implications for the advanced manufacturing sector specifically. Some states, for example, take a more activist economic development role that entails picking winners. This includes not only the targeting of broad industries but also support for narrow industrial niches. Other states lean toward a "build it and they will come" model. This is a more foundational approach to economic development that in principle focuses on key ingredients to growth, especially education. Each state should evaluate its own approach relative to that of other states to see what practical lessons might be learned.

Most advanced manufacturing policy that is in place is an extension of current programs and policies targeted more generally to the overall manufacturing sector. For example, targeted industry recruitment programs commonly reference advanced manufacturing as an important piece of the recruitment portfolio. Training programs long targeted to workers and firms in the industrial sector frequently have components that are linked to advanced manufacturing. For example, Georgia provides advanced manufacturing training incentives and technical centers; Small Business Innovation Research (SBIR) grants are commonly tilted to advanced technologies and manufacturing and are allocated on a competitive basis. Policy appears to be more robust in state clusters that are already characterized by a significant presence of advanced manufacturing processes and/or products. North Carolina serves as a good example, with its strength in and ongoing focus on aerospace, biotechnology, composites, and nanotechnology.

This incremental and experimental approach to policy is not a bad thing. Existing policy initiatives offer many strengths and are therefore a good foundation for extension to what many view as a small or modest subset of a much larger industrial cluster. As advanced manufacturing develops further, there will be the opportunity to refine existing policies and introduce new policies that can support the needs of industry, workers, and communities.



# Principles to Guide State Policymaking

This section addresses future economic development policy. It is divided into two subsections. The focus falls first on principles and guidelines that should be considered in designing, implementing, and evaluating state policy toward the advanced manufacturing sector. While most of these principles could be applied more generally to economic development policy, there is an effort here to amplify their role in the context of modern clusters of firms engaged in advanced production processes and the production of sophisticated products across broad regions, including states. The second section focuses more specifically on a set of policy recommendations that states might consider, built around the modeling framework presented in the first part of this report. These recommendations are based on a variety of thought inputs, including a policy scan of the states, prevailing research, and conversations with professionals in the economic development and education arenas across the SGA study region.

In the end, the states will find their own way as they have in the past. Hopefully there will be a growing awareness that economic development spans borders and that the gains from cooperation can exceed the gains from competition over industry.

## Overarching Principles to Guide State Policy

In practice there are a number of important ingredients to effective public policy. The principles presented below are intended to highlight some of the ways to make policy more inclusive and cost-effective regardless of the specific target. Throughout the discussion there is recognition that policy encompasses a broad geographic area, requires the use of scarce tax dollars, demands accountability to the public, and engages multiple constituencies and stakeholders.

- **Utilize Strategic Planning**

  A strategic approach to the promotion of advanced manufacturing is essential to the proper allocation of resources and coordinated policy actions. At a bare minimum, such a plan requires measurable goals and objectives and a high-level policy champion to help secure results. Clusters should be identified and included as a core component of the strategic plan. Alabama and Arkansas are among the states that have formal strategic plans that include an explicit focus on advanced manufacturing.

  The targeted recruitment and retention program of the strategic plan should seek to identify industries—and potentially firms—that have the promise of yielding process and product innovations within advanced manufacturing. This would include industries/firms with a record of or realistic desire for making substantial capital investments in productive capacity and R&D and firms that pay high wages and salaries that reflect the advanced skills of workers.

- **Focus on Regionalism and Region-Based Economic Growth**

  It is critical to approach the promotion of advanced manufacturing through the lens of regionalism. Clusters, as we have noted, include firms and workers who have a spatial distribution that crosses the traditional jurisdictional boundaries of cities, counties, and states. Public services such as transportation infrastructure that support economic activity in one place also support economic activity elsewhere. This is why transportation planning has a regional component, sometimes so broad as to include the entire nation. Firms within an industrial cluster create important localized benefits through job creation and tax base expansion. Additional benefits of cluster-based development, elaborated in the first section of this report, include technology and production process spillovers, along with agglomeration economies that cross geographic and political boundaries. Regions are often stronger than their component areas and jurisdictions and include a wide array of stakeholders who can benefit from a common effort to promote industrial development.

  Regional approaches to economic development already take place to some extent within states, but to a much lesser extent across states. Substate regionalism could be further encouraged through state policy. For example, integrated inter-community planning could be fostered by state economic development agencies through resource allocation and community certification/preparedness programs. The U.S. Economic Development Administration encourages regional planning through its Comprehensive Economic Development Strategy (CEDS) program. Alabama is one state that utilizes this program.

  More challenging is the promotion of interstate regionalism to support advanced manufacturing and economic development. The absence of robust interstate cooperation is likely a reflection of political considerations and perceptions that economic development represents a zero-sum game. Cluster-based development can offer significant benefits across state borders as exemplified by the automotive and aerospace clusters that have a prominent place in the SGA region.

Local governments often cooperate in various ways to promote industrial growth and typically partner with their state government. Local cooperation might include industrial development boards that are jointly funded by city/county governments; communities may also partner and pool resources for marketing purposes. One noteworthy model of a deeper approach to sub-state regionalism is offered by the Pellissippi Place mixed-use research and development park located in Blount County, Tennessee, sited in proximity to Oak Ridge National Laboratory and the University of Tennessee. The park was planned and funded through a cooperative agreement between Blount County, two constituent cities (Alcoa and Maryville), and Knox County. Initial funding contributions of $5 million per partner helped secure land for the park, with additional funding support coming from the state and federal governments. The regional economy will benefit from economic growth in Pellissippi Place through commuting and business-to-business trade. The model will have the four local governments sharing equally in the incremental property tax revenues that follow from development, while the city of Alcoa will reap any local sales tax revenues arising from commercial activity in the park. The first business to locate in the park is an R&D and manufacturing firm that will produce the next generation of cancer treatment technologies.

- **Embrace Policy Coordination**

  High-level policy coordination is needed to address the horizontal and vertical structure of government units and agencies and facilitate interactions with other stakeholders, including private business and industry, public utilities, the federal government, and the public. Well-defined policy coordination in turn supports policy accountability. North Carolina's governor has proposed an Assistant Secretary of Manufacturing who could conceivably play such a coordination role and place accountability under the umbrella of the executive branch. Coordination assistance would be needed from other state agencies and with local governments. North Carolina's longstanding Office of Science & Technology is an example of a respected entity that could help administer and facilitate advanced manufacturing initiatives within the broader manufacturing sector.

- **Encourage Accountability**

  Accountability in the use of state tax resources is an essential component of a sound development strategy. There are always competing uses for funds across state agencies and within the context of economic development initiatives. Quantifiable metrics included in a strategic plan will help facilitate cost-benefit analysis and the identification of effective programs and policies. Accountability should extend to the beneficiaries of state resources, including firms, workers, nonprofits, and public sector entities that receive state funds or programmatic support.

Program evaluation is an invaluable tool for assessing the effectiveness of public policy toward economic development. Rigorous evaluation is not possible for all programs because of cost considerations, but even qualitative assessments can be informative. Such assessments may be especially appropriate for niche programs intended to support advanced manufacturing. Larger programs may better lend themselves to hard quantitative analysis, including cost-benefit analysis. These assessments are important to justify policy effectiveness in the eyes of taxpayers and to identify strong versus weak programs.

- **Pursue Partnerships and Collaboration**

  Region-based economic development requires cooperation. Partnering to promote economic development can conserve resources, exploit comparative advantages, and create synergies that might not otherwise be possible. There is a wide variety of stakeholders who can bring strengths to the table to foster the advanced manufacturing sector, as noted earlier in this report. Many examples of partnering already exist within state governments, between states and local governments, and between the public, private, and not-for-profit sectors. All of these actors have something to contribute to the development process and something to gain from successful economic development efforts. The Upstate South Carolina Alliance, for example, provides marketing through a public-private partnership encompassing 10 counties with a focus on advanced manufacturing.

  Another good example is the advanced manufacturing training partnership, which appears to be both popular and effective in meeting the workforce development needs of industry and the labor force. While the specific models differ, a common element of training partnerships is the inclusion of institutions of higher education (particularly community colleges and technical centers), private industry, business, and workers on oversight boards. Together these contributors are able to design and implement training programs that meet employer and worker needs.

  While partnering and collaboration is common within states, it is far less common across state borders. States can tend to view one another as competitors—as they often are. Since states also share in the benefits of cluster-based and regional economic growth, however, they should seek to work together to foster gains in the advanced manufacturing sector. Worker training programs and R&D assistance provided to industry by institutions of higher education are some examples of areas where partnering might prove possible and fruitful. For example, inter-university consortiums that cross state boundaries could be developed to support industrial clusters such as automobiles or aerospace that also cross state borders.

- **Encourage Competition**

  Competition is important to the realization of efficiency gains in resource allocation—this is a primary reason for reliance on the mechanism of private markets. Competition should be encouraged in the allocation of state resources supporting economic development. For example, programs supporting entrepreneurs may offer access to financial capital; this capital should be allocated on a competitive basis. Economic development incentives often become entitlements in the sense that once a firm satisfies basic criteria for their receipt, they can make use of the incentive. In principle, incentives could be allocated on a competitive basis to those firms offering the greatest potential to produce economic and fiscal gains.

- **Promote Value-Added, Not Simply Low Costs**

  Many states in the SGA region have benefited greatly from an economic development strategy predicated on low costs of production—low labor costs, low taxes, and cheap land. This strategy was highly successful during the branch plant boom era that drew manufacturing firms from the upper Midwest and Northeast and absorbed unemployed and underemployed individuals into the workforce. Businesses today still look for low costs, but more important is value-added in the production process. Unfortunately, low-cost labor typically translates to low-skilled labor. There are abundant sites around the world that offer low labor costs, and the Southern states cannot reasonably compete solely on the basis of these costs. While there is little hard data, anecdotes suggest that some of the reshoring of industrial activity to the U.S. is taking place because worker productivity, especially in developing countries, is inadequate and negates the benefits of low wages.

  Economic development policy should emphasize the creation of value for businesses and income and wealth for state residents. Beggar-thy-neighbor incentive strategies can yield short-term gains but do little to alter the fundamental foundation that supports economic development. Businesses engaged in advanced manufacturing are especially interested in value-added in production and typically rely heavily on a highly skilled workforce. The keys to promoting value-added are to invest in productivity-enhancing assets, including workers and infrastructure, and to recruit firms that offer the promise of high earnings, high levels of capital investment, and an active R&D agenda.



- **Build on Existing Strengths**

  The states and their constituent localities already have a wide variety of programs and networks in place to recruit, retain, and nurture the manufacturing sector. As a result, there is a potentially strong foundation for supporting growth in advanced manufacturing. New programs can be costly to implement, and once created, they can be hard to eliminate. Traditional SWOT (strengths, weaknesses, opportunities, and threats) analysis can help states identify existing programs that might be tweaked to offer enhanced benefits to advanced manufacturing clusters as well as to fill in gaps in the industry support network.

- **Support Autonomy and Decentralization**

  While clusters can cover a broad geography, the needs of specific industries and firms can demonstrate substantial variation. STEM education is one part of a broad education strategy to support the overall economy that will also impart valuable benefits to advanced manufacturing. Specific occupational and skill needs of workers and employers, on the other hand, can be much more regionalized or localized. State policy should encourage a decentralized approach to meeting the needs of industry, workers, and communities, while being consistent with statewide economic development goals and objectives. Experimentation should be encouraged to help identify best practices.

- **Ensure a Culture of Adaptability and Flexibility**

  Once policy is implemented, it can be difficult to change, even when the needs of the market evolve. For example, there is ample anecdotal evidence of well-intentioned training programs that gave workers skills that were obsolete or of little value to business and industry. As technology, production processes, and products change in the advanced manufacturing sector, policy must be poised to change as well, sometimes very quickly. Advanced manufacturing, by its very nature, is potentially subject to rapid if not abrupt change as new technologies are created, products die, and new products are created. This expedited lifecycle mandates a culture of policy adaptability and flexibility that can ensure viable ongoing support for the industry.

## Policy Recommendations for Advanced Manufacturing Development

State policy touches the advanced manufacturing sector in a host of different ways, including via taxes, regulation, worker training, and so on. The focus here falls on major policy targets motivated by the production function framework and embedded in the synthesized modeling framework of this report. Our simple but powerful framework allows policymakers to easily inventory and categorize potentially disparate policies that support economic development. The discussion that follows places emphasis on policy targets that appear to offer the greatest promise of fostering the growth of advanced manufacturing.

- **Targeted Industrial Recruitment and Retention**

  The seven SGA states in this study all rely on some form of targeted industry programs to help guide economic development policy and supplement regional production. These broad strategies should be tailored to embrace advanced manufacturing based on a careful assessment of state assets and opportunities. The cluster of firms centered on advanced manufacturing should be considered for inclusion in the overall state economic development strategy.

  Policy should focus on industries and firms that offer the promise of process and product innovation through their ongoing adoption of technology, R&D, capital investment, and utilization of a skilled workforce. New firms, especially firms with foreign ownership, often bring new business and production practices that can create spillovers within a regional economy. This was the case when Japanese automotive manufacturers migrated to the U.S.; they contributed team production processes and helped spread just-in-time inventory systems. These benefits can in turn enhance regional competitiveness.

- **Public Infrastructure**

  Public infrastructure, including roads, public utilities, ports and waterways, and industrial parks, generally facilitates private sector economic activity. Because infrastructure is often very costly, high levels of utilization are commonly required to make infrastructure investments cost-effective. Infrastructure investments must be weighed carefully against anticipated returns and not all seemingly viable investments will be truly viable in practice.

  Advanced manufacturing may benefit from dedicated R&D and technology parks that provide common support to establishments (e.g., highly reliable broadband services), create business-to-business and supply chain linkages, and foster agglomeration economies. By concentrating economic activity in a central location, the cost of supporting infrastructure—roads and public utilities in particular—can be minimized. Clusters have public cost as well as private cost-benefits. These same parks could provide incubator space tailored to the unique needs of small advanced manufacturers. Research Triangle Park

in North Carolina is one of the nation's best examples of an effective, synergistic facility that has nurtured advanced manufacturing for many years.

Dedicated parks offer good opportunities for partnering. Local governments, for example, may welcome such facilities and offer financial, planning, and management support. Institutions of higher education may provide access to research faculty in the science and engineering fields and offer a trained workforce; community colleges and technical centers may provide support services, including skills upgrading and training opportunities. Mixed-use parks that include residential and commercial space can provide broader benefits to the state and sub-state regions and thus garner additional support from stakeholders.

- **Technology and R&D**

  The evidence presented in earlier sections of this report indicates that the South suffers from an innovation deficit. While markets are the primary driver of whether and where R&D takes place, there are policy tools that can tilt the orientation and trajectory of R&D. For example, state corporate income tax policy can be used to implement incentives that foster R&D and the adoption of new production technologies; sales tax exemptions on qualified equipment and technology purchases can achieve a similar objective. Universities and community colleges, as well as major federal players such as Savannah River National Laboratory and Oak Ridge National Laboratory, may be able to provide services, space, expertise, and partnerships to facilitate R&D and technology adoption.

  Universities commonly utilize centers of excellence to focus research activities on areas of interest and importance to the states. Centers of excellence in advanced manufacturing could be encouraged to support industry, foster product and process innovation, and engage university faculty and students in applied research. Research scientists, postdoctoral fellows, and students represent a critical asset for private industry in terms of research and staffing. Business schools can provide essential support services to help enable private sector firms to prosper in a competitive global marketplace. Program administration and governance of a center of excellence could include a partnership of educators, administrators, and private industry. Georgia Tech's Manufacturing Institute is one model that the states should evaluate. It provides people, training, R&D, and other support services that would be of value to many firms in the advanced manufacturing cluster.

- **Economic Development Incentives**

  Economic development incentives are embedded in the state and local policies component of the modeling framework and can be applied to any of a number of possible policy targets. Incentives should be used, as possible, to support value-added production and help create jobs, income, and wealth for state residents. In general, incentives should be viewed as investments that can yield a long-term flow of benefits to the state, not simply a means of lowering private sector costs. In the context of advanced manufacturing, incentives should target technology- and R&D-related business activity, investments in public capital, and investments in the human capital of workers. All of this targeted capital investment can provide a flow of benefits to firms, workers, and state and local tax bases and facilitate adaptation to a changing economic environment. Incentives should be performance-based and not become business entitlements.

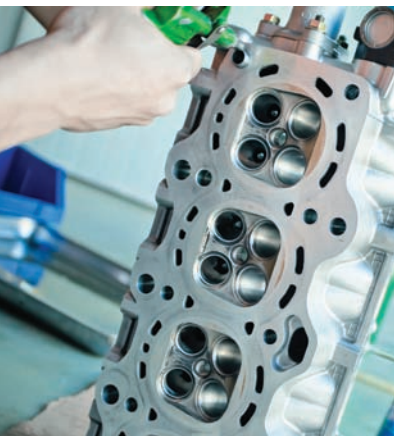
  The states make broad use of incentives to support manufacturing; these incentives could easily be altered to provide support for advanced manufacturing where this is not already the case. Special tax incentives could be developed that focus on innovation assets, especially investments in R&D, new technologies, advanced machinery, and worker skills. These incentives should be evaluated in terms of their return on the investment of state resources.

- **Entrepreneurship**

  Extensive support of various forms is already in place to support entrepreneurial success; these programs easily lend themselves to the support of firms engaged in advanced manufacturing. General support for entrepreneurship—including business plan development, basic accounting, and marketing services—would likely be of common value to firms in the advanced manufacturing supply chain and elsewhere. But some specialized services might be needed, e.g., support for product demand creation through exporting and prototype development.

  Innovate Arkansas supports entrepreneurs, including those engaged in advanced manufacturing. Many of the services are similar to what would be provided to entrepreneurs generally, including support for business plan development. The emphasis on technology yields more unique services, including support for protection of intellectual property rights. Applicants for services are screened and firms must pay wages and salaries that are 150 percent of the state average in order to receive assistance.

  Small manufacturers may not have the capacity to support prototype development and the early steps associated with commercialization. Facilities linked to universities, community colleges, or incubators could provide this type of support. One example is the Advanced Manufacturing and Prototyping Center of East Tennessee, which benefited from federal funding under the Advanced Manufacturing Jobs and Innovation Accelerator Challenge. The Prototyping Center is linked to the Manufacturing Demonstration Facil-



ity located at Oak Ridge National Laboratory, with training and certification provided by Pellissippi State Community College. The affiliated Council on Additive Manufacturing is intended to link firms in the additive manufacturing supply chain and cluster. This partnering utilizes resources and expertise from a number of different stakeholders to produce gains for the regional economy.

The Manufacturing Extension Partnership (MEP) is funded by the Commerce Department's National Institute of Standards and Technology (NIST) and provides support to small and medium-sized manufacturers. Technology acceleration and supply chain cultivation are two focal areas that would be of value to advanced manufacturers. The program operates as a public-private partnership and has linkages to other support services for manufacturers.

- **Education and Human Capital**

  The educational attainment deficit of the Southern states represents a major impediment to economic development and quality of life. The states have long lagged the nation in spending and educational outcomes, including college participation and completion. The science and engineering workforce is simply inadequate to fuel the advanced manufacturing goals of the region. Education and training are important to business vitality, worker and family well-being, and the fiscal health of the states and their local communities.

  As the states seek to improve their education pipelines, they are sowing seeds that will support the substance of future economic development and send signals to the rest of the world that the region is ready to embrace advanced manufacturing and other high-quality economic clusters.

  The current administration has established a goal to secure some form of college attainment for 60 percent of the adult population by the end of this decade. Other national champions for improving attainment include the Lumina Foundation, the College Board, and Complete College America. The Lumina Foundation, for example, has established its goal of 60 percent of the adult population holding a post-secondary degree by 2025, compared to 38.3 percent in 2010.[17]

17 *A Guide to Major U.S. College Completion Initiatives,* American Association of State Colleges and Universities, October 2011, www.aascu.org/policy/publications/policymatters/2011/collegecompletion.pdf.

All of the seven states covered in this report have adopted aspirational goals for college attainment consistent with this nationwide trend—some are extraordinarily ambitious.

- Alabama—Increase STEM graduates, promote college preparedness through the PK-12 pipeline, and find financial resources to support further investments in human capital.
- Arkansas—Double the number of college graduates by 2025 by increasing certificate/degree completion by 5 percent per year.
- Georgia—Increase the share of adults with a college degree or certificate to 60 percent by 2020.
- Kentucky—Close the higher education achievement gap relative to the national average.
- North Carolina—Increase the share of adults with a bachelor's degree or higher to 37 percent of the population by 2025.
- South Carolina—Increase the share of adults with at least a bachelor's degree to 29 percent by 2030.
- Tennessee—Increase the percentage of adults with a post-secondary award to 55 percent by 2025.

The goals are being followed up by different actions. Much of the work will have to take place at earlier stages of the education pipeline to help prepare students for college admission and success in the 2020s. Accountability standards and teacher evaluation systems in K-12 are an important piece of the puzzle. Some states, including Florida, North Carolina, and Tennessee, have created education data warehousing systems that can be used to support accountability and evaluate factors associated with successful student performance by tracking students from college into the labor force. Performance funding for higher education is being discussed in many of the Southern states, though only Tennessee has adopted a formal system as of the writing of this report.[18]

A broad problem that the manufacturing sector confronts is the stigma associated with industrial jobs that limits the career interests of young people. As noted in a 2012 report to the president, there is a compelling need to remove "false impressions" regarding a supposed unpleasant environment and lack of job security in the manufacturing sector.[19] A recent report regarding advanced manufacturing in Chicago reaches a similar conclusion, noting that there is the

18 *Performance Funding for Higher Education,* National Conference of State Legislatures, February 2013, www.ncsl.org/issues-research/educ/performance-funding.aspx.
19 *Report to the President on Capturing a Domestic Competitive Advantage in Advanced Manufacturing, Annex 3: Education and Workforce Development Workstream Report,* Executive Office of the President, President's Council of Advisors on Science and Technology, July 2012.

perception that jobs are "menial" or entail "dirty work."[20] A cursory walk-through of a modern manufacturing plant would reveal a very different work environment than that which characterized manufacturing establishments of the past. But the fact is that there is a stigma that discourages young people from pursuing gainful employment and productive careers in manufacturing.

One step toward a solution is image restoration, as discussed in the report to the president. Existing workforce development boards may be a springboard toward a solution by virtue of their existing public-private partnership that includes representatives from the business community and the education establishment. These entities could pursue deeper student (and parent) integration with educators and manufacturers, especially advanced manufacturers, who frequently offer good employment opportunities. Old-fashioned "lunch and learn" programs that bring businesspeople and educators together need to be enriched to help facilitate image restoration and engage the workforce of the future. Active student mentoring and co-op and internship opportunities could create a bridge between employers and fledgling workers. Businesses could be encouraged to sponsor scholarships on behalf of students interested in STEM and other much-needed fields of inquiry. Businesses could also sponsor open houses for parents, students, and educators to expose the new realities of modern manufacturing. Public relations and marketing programs could be localized, showing familiar faces from the local community working at attractive and visible local employers.

Foundational support of STEM education is critical to workforce development and economic competitiveness. The pursuit of these general goals can also meet the needs of workers and firms in the advanced manufacturing sector. There are abundant opportunities to partner across state agencies, between the states and local governments, and with the private sector to further encourage STEM education and related employment opportunities. It is becoming apparent that integrated approaches to problem solving, centered on STEM fields, offer considerable promise relative to the silo approach to fields of instruction.

Gaps often arise between worker skills and the needs of employers. Such gaps can be seen between the unemployed and employers, but they may also surface on an ongoing basis as technology and production processes change. These imbalances can prolong spells of unemployment and may induce firms to seek investment and production opportunities elsewhere.

20 *Metropolitan Chicago's Manufacturing Cluster: A Drill-Down Report on Innovation, Workforce, and Infrastructure,* Chicago Metropolitan Agency for Planning, February 2013.

Occupational supply and demand analysis offers one means of identifying where there are critical shortages of workers.[21] This information can be used to guide and encourage students and others to pursue career opportunities in growing and high-demand areas and can help educational institutions redirect course and reallocate instructional resources to high-demand fields of study and occupations. These applications generally look at the supply of college-educated individuals by instructional area (i.e., classification of instructional program) and then map this information to occupations (standard occupational classifications, or SOCs); the demand side of the labor market is captured by translating employment demands by industry (NAICS) to occupations (SOCs). The supply and demand sides of the market can then be brought together to determine where occupational shortages and surpluses exist. While there are many caveats associated with this type of education-labor market analysis, it is a potentially invaluable planning tool for addressing the needs of industry and workers.

Skills training and certification/credentialing are needed to ensure that workers are prepared for employment. All of the SGA states offer some form of training support for manufacturing and advanced manufacturing. Alabama, for example, provides training services centered in part on target industries such as automotive and aerospace manufacturing. The Southwest Alabama Workforce Development Council coordinates training for one of the state's 10 development regions. York Technical College in South Carolina has a Center for Advanced Manufacturing that provides technical training and certifications.

Standardized training that allows for the transferability of workers and their skills across firms, industries, and regions can be important to the smooth functioning of the labor market, the prosperity of workers, and the competitiveness of firms. National standards are already available for many skill sets through organizations such as ACT, which offers career readiness certificates. These programs can provide the hard training associated with specific fields of instruction and problem solving as well as the soft skills needed for workers to survive and thrive in the workplace. Because advanced manufacturing is subject to ongoing change and transformation, such programs need to be flexible and adaptable. There are some specialized skills that may be localized and not needed by the overall manufacturing sector or even the narrower advanced manufacturing sector. This is where decentralized and tailored training would be warranted.

21 Vickie C. Cunningham, LeAnn Luna, and Matthew N. Murray, *Academic Program Supply and Occupational Demand Projections: 2008-2018,* Center for Business and Economic Research, The University of Tennessee, April 2011, http://cber.bus.utk.edu/pubs/mnm118.pdf.

## Conclusions and Lessons for State Policy

Building on the economic profile of the first part of this report, as well as the policy discussion of the second part, the following key conclusions emerge regarding state policy and advanced manufacturing.

- States play a central role in promoting economic development and industrialization. They are facilitators that use policy to build on strengths and mitigate weaknesses of the market. Fundamental functions, including support for the education pipeline and investments in infrastructure, are intended to lay the foundation for private sector action.
- This is a new era of industrial development for the SGA states. For many years, the states were effective in recruiting industry and jobs through a strategy that emphasized low costs, particularly low labor costs. But the states cannot compete effectively on the basis of low costs alone, as evidenced by the migration of jobs to low-cost sites outside of the nation. Advanced manufacturers also need a business climate that nurtures value-added and productivity through the investment of state resources.
- State policy in support of the advanced manufacturing sector must be carefully coordinated with other public and private entities that seek to promote economic development in order to maximize returns for state residents and the business community. Local governments in particular are essential partners—they are on the front line of industrial recruitment and retention, and provide key services such as education. Effective coordination and partnering requires high-level policy coordination by the state.
- A strategy for fostering the growth of advanced manufacturing should be based on carefully developed strategic plans that build on SWOT (strengths, weaknesses, opportunities, and threats) assessments of state assets and needs and include quantifiable goals and objectives. Targeting industry clusters and promoting region-based approaches to strategic development offers the promise of significant returns on state investments.

- State policy should emphasize sound investments in human capital, entrepreneurship, infrastructure capital, and private capital (through industrial recruitment) in order to realize the tangible economic development goals of job creation, income growth, and tax base vitality. Other policies to promote R&D and technology adoption should be pursued to enhance the productivity and competitiveness of the economy. By investing in people and places, states will have prepared themselves for the dynamics of industry growth.
- Human capital development is one of government's primary responsibilities and it is arguably the single-most important foundational element of economic growth and development. All of the seven states that formed the basis for the analysis in this report are taking steps to improve their education pipelines, but some states have more aggressive goals and are more forward-looking with policy.



**About MAPI:**

The Manufacturers Alliance for Productivity and Innovation (MAPI) is a member organization focused on building strong leadership within manufacturing, and driving the growth, profitability, and stature of global manufacturers. MAPI contributes to the competitiveness of U.S. manufacturing in several ways:

- 25 councils that executives use to exchange best practices with peers
- Global forecasts, regulatory analysis, and industry surveys
- Independent, expert manufacturing data to promote U.S. and global manufacturing

MAPI provides the timely and unbiased information that business executives need to improve their strategies, boost productivity, and drive innovation.

**About Southern Governors' Association:**

Founded in 1934, Southern Governors' Association (SGA) is the oldest and historically the largest of the regional governors' associations. Since its inception, SGA has represented the common interests of Southern states' chief executives and provided a vehicle for promoting them. SGA supports the work of Southern Governors by providing a bipartisan, regional forum to help shape and implement national policy and solve regional problems.

In recent years, the South has become the dominant region in the country—a region characterized by innovation, growth, and opportunity. Southern Governors are at the forefront of key changes in the region, and through SGA, these leaders have a unique opportunity to exchange ideas, explore common issues, address pressing problems, coordinate regional collaborative initiatives, and promote regional accomplishments.

The association's membership is composed of the Governors of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, Missouri, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, Texas, U.S. Virgin Islands, Virginia and West Virginia.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