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Author: Shruti Rao

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Leveraging Global Value Chains to Bridge the Gap Between Rural and Global Economies: Case of North Carolina's Appalachian Automotive Industry[1]

Shruti Rao
Duke University
Durham, North Carolina, USA
shruti.rajesh.rao@gmail.com

Abstract

Globalization has intensified challenges for rural regions. As countries have become increasingly aware of the need to increase innovation, resources are being allocated towards making cities and technology-intensive industries more competitive. While urban areas focus on knowledge and technology intensive areas, rural regions face distinct challenges in the push for greater economic prosperity. This article examines how the Global Value Chain (GVC) framework can be a key asset to policy makers interested in rural development by providing guidance on how to connect rural regions to globalized industries. GVC analysis has grown in popularity as a framework to facilitate economic prosperity, but has not yet been rigorously applied towards specific rural regions, only rural countries. This paper demonstrates the potential for the GVC framework to help rural areas leverage their strengths to become players in the global economy. The application of the GVC framework is focused on North Carolina's automotive industry, in which researchers studied employment and wage data, educational infrastructure, key firms, and broader industry trends. The results of the GVC analysis led to several recommendations for North Carolina to increase its global competitiveness in the automotive sector by continuing to strengthen the community college system, invest in light-weight technologies and capture more of the value in high-tech parts manufacturing. The implications of the case study in Appalachia reveal the strengths of the GVC framework to applications in rural regions and communities. The holistic nature of the framework allows for the successful use of the GVC framework to both understand the advantages of a rural region and identify key strategies that will allow the region to generate value in globalized industries. By using Appalachia's trucking industry as a case study, the findings of this study lay a foundation for the future application of GVC analysis to be used by rural regions seeking greater participation in globalized industries.

Keywords: global value chains (GVCs), Appalachia, economic development, automotive industry, manufacturing

[1] This research was conducted as part of a Duke University Bass Connections project led by Gary Gereffi and Lukas Brun during the 2015-2016 academic year. The author gratefully acknowledges funding made available for this research by the Bass Family to the Duke University Social Science Research Institute and the work of fellow Bass Connections team members Melissa Piano and Madeleine Roberts in completing this project.

1.0 Introduction

Marked by crushing poverty and breathtaking beauty, America's Appalachian region has evolved into an iconic and distinct territory. Stretching over 12 states and 205,000 square miles, the region is home to over 25 million Americans, with approximately 42% estimated to be living in rural areas (Appalachian Regional Commission, 2015). Policy experts and economists have long struggled to address economic development in Appalachia, a region that evokes idyllic imagery of rolling mountains and small coal-mining towns. Much of the severe poverty in Appalachia has been attributed to the wave of industrial age manufacturing and technology that swept most of the United States along to prosperity, but left rural communities behind (Maggard, 1994). Rural regions like Appalachia desperately need innovative solutions in order to connect to the greater economy in an increasingly globalized world. As the country becomes increasingly aware of the need to push for greater innovation, resources and attention are shifted to making cities and technology-intensive industries competitive. Thus, if rural regions do not advocate for themselves or focus on generating their own economic success, there is a greater risk of being left behind. The challenge for rural regions is to understand how to leverage their assets to compete in the global economy. Rural regions must successfully orchestrate collaboration between local actors, educational institutions, higher-level government actors, businesses, unions, professional leaders and community groups. The collaboration of all these players and the leveraging of their particular strengths is the key to rural economic success (Leigh & Blakely, 2013).

The Global Value Chain (GVC) framework, which includes a comprehensive set of actors to understand the development opportunities for a region, is uniquely suited to address the challenges of rural regions in a globalized economy. The GVC framework takes into account government actors, political actors, educational institutions, and most importantly, firms. Specifically, GVC analysis is comprised of mapping the value chain, examining the geographic distribution of the industry—especially global demand and supply—, identifying global lead firms and supply chain governance, studying human capital and industry standards, and classifying upgrading trajectories. The application of GVCs towards economic development and policy for rural regions in developed countries has the potential to be immensely effective because it provides specific insights into how rural regions can 'link up' into the global economy (Gereffi & Fernandez-Stark, 2011). However, GVC analysis has been underutilized for understanding the development opportunities of rural subnational regions. Previous GVC research has focused on national-level agrarian economies in the developing world, but not on rural regions within a developed country. The key contribution of this article to the rural economic development and GVC literatures is to illustrate how GVC analysis can be used to understand the upgrading trajectories of rural regions within an advanced industrialized nation.

The successful application of GVCs in Appalachia's heavy-duty trucking industry reveals a new framework that could be further applied to other rural regions. The application of this framework is uniquely powerful because key stakeholders of all varieties ranging from the public to the private sector are considered. The research conducted using the GVC framework in Appalachia's automotive industry serves as an excellent case study to further this argument. The GVC framework leverages both an industry-level understanding of firms, but also an analysis of local third-party players—community college, local government policy, non-profit groups—

in order to provide innovative solutions for rural areas to reap the benefits of globalization.

The GVC analysis of the automotive sector in North Carolina's Appalachia region revealed the unusual strength of the heavy-duty parts manufacturing industry and opportunities for future growth. Value chain mapping, conducted as a part of the research, demonstrated particular strengths in the 'Sub Components and Assembly' segment of the industry value chain. Further value chain research revealed remarkable industry support through the robust community college system and changes in the overall industry trends that suggest a new focus for Appalachia. Appalachia has already engaged in technology intensive manufacturing and should expand by pushing to manufacture engines and high-tech lighting and electrical systems. Additionally, the heavy-duty automotive industry is a strategic industry for North Carolina to invest in due to the logistical challenges in manufacturing abroad. Research found that the rise of automation is decreasing the number of available jobs, although workforce development opportunities are thriving. While skill-intensive jobs are available, they require thorough engagement with the workforce development opportunities in Appalachia. An interesting finding in the research is that Appalachia's strength as a furniture producer makes it an increasingly competitive region for the automotive industry, which seeks workers with similar skill sets. These findings for North Carolina's automotive industry can be used to foster growth and innovation. The successful application of GVCs in Appalachia stands as a successful testimony for GVCs to continue to be used in various rural regions.

To make this argument, the article is organized as follows. In the next section (section 2.0), the case selection methodology and data used to conduct the research is explained. Section 3.0 summarizes relevant portions of the GVC theoretical and analytical framework, followed by a presentation of results in section 4.0. Section 5.0 discusses the implications to Appalachia and how GVC analysis can be applied to other rural regions. Section 6.0 concludes with a summary of the article and its key findings.

2.0 Methodology

The context of the research is the geographic area outlined by the Appalachian Regional Commission (ARC), comprised of 29 counties making up the North Carolina Appalachian region.[2] The phrase 'ARC region' used throughout this article describes the counties in the North Carolina Appalachian region. The automotive industry was chosen for GVC research in collaboration with the North Carolina Economic Development Partnership, who provided data identifying the automotive industry as one of the largest employers based on ten years of data, net gain in employment and a Location Quotient at least greater than 1. Other industries considered for research were the beverages industry and the furniture industry. However, because the automotive industry is characterized by global production, high levels of technology content, and important workforce implications, the automotive industry was chosen to examine the role of rural regions in a globalized industry.

[2] North Carolina's ARC counties are: Alexander, Alleghany, Ashe, Avery, Buncombe, Burke, Caldwell, Cherokee, Clay, Davie, Forsyth, Graham, Haywood, Henderson, Jackson, McDowell, Macon, Madison, Mitchell, Polk, Rutherford, Stokes, Surry, Swain, Transylvania, Watauga, Wilkes, Yadkin, and Yancey (https://www.arc.gov/counties).

Following established GVC analysis procedures, secondary sources were used to create a literature review on the automotive industry to orient the research and to identify key industry trends. After creating the literature review, an input-output structure of the industry was created, followed by an analysis of imports and exports, global lead firms, supply chain governance, workforce needs and industry standards. After understanding the global automotive industry and the participation of the NC ARC region within the industry, key informant interviews with global lead firms, local suppliers, and community colleges were conducted.

The mapping of the automotive supply chain relied heavily on data from the Bureau of Labor Statistics Census of Employment and Wages (BLS CEW). The construction of the supply chain was closely followed by analysis of the data to see how successful the industry is in the US, North Carolina, and the Appalachian Regional Commission region. Quantitative data for the study was retrieved from BLS CEW, a data collection program utilizing US census data and 'quarterly contribution reports' filed by employers.

While US census data is a standard data source in research, there are some limitations to consider. BLS employment data only counts filled jobs—full-time and part-time—by place of work, which increases the likelihood that an individual holding multiple jobs could be overcounted in the data. Additionally, there are some exclusions in the data coverage such as, "self-employed workers, agricultural workers on small farms, all members of the Armed Forces, elected officials in most states, most employees of railroads, some domestic workers, most student workers at schools, and employees of certain small nonprofit organizations" (Bureau of Labor Statistics, 2016).

The data were critical in understanding the makeup of establishment, employment and wage trends for the automotive industry in Appalachia. For the analysis of third-party players such as community colleges and companies, researchers used qualitative informational interviews. Through interviews, information was collected regarding trends in the industry and the current state of manufacturing in the region. Researchers also directly contacted community colleges and used the colleges' websites to learn about workforce development in the area and how the colleges connect students to employers in the region. To further develop an understanding of industry wide trends, researchers used existing academic and business research on the state of the automotive industry.

3.0 Theoretical Framework

3.1 GVCs: An Introduction

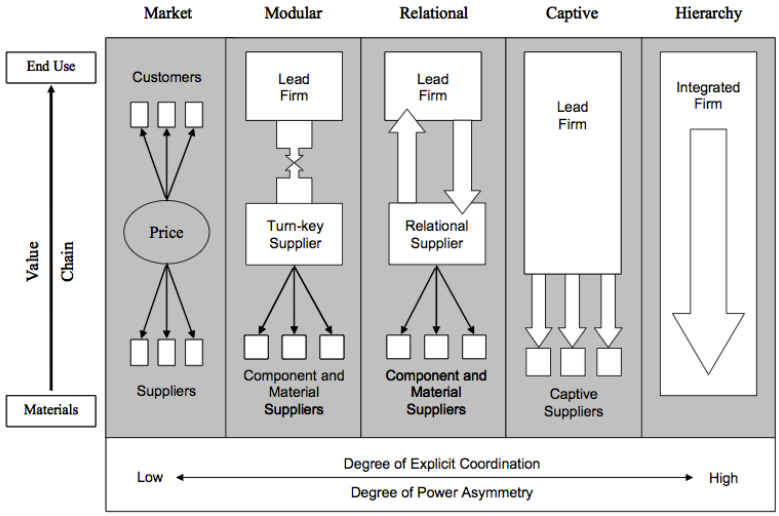
The research conducted for this case study closely followed the Global Value Chain framework. Value chains are defined as the, "full range of activities that firms and workers perform to bring a product from its conception to end use and beyond" (Gereffi & Stark, 2011, p. 7). Global value chains thus refer to the expansion of value chains internationally, which often include multiple firms of various sizes. Global value chain analysis is useful for economic actors at every scale, from a single firm that wants to gain a better understanding of the industry or a country looking for ways to bolster their economic sector and compete with other businesses in different regions.

Globalization has created a network of economic and social relationships at an unprecedented rate and scope (Castells, 2010). The ramifications of globalization have resulted in a complex overlay of relationships that have been difficult to fully interpret and understand. The Global Value Chain (GVC) framework has become increasingly adopted by various economic actors around the world such as the World Bank, World Trade Organization and International Labor Organization. The GVC framework, developed by Gary Gereffi and other social scientists, has been a key analytical tool for corporations, governments and international organizations like the World Bank (Elms & Low, 2013).

3.2 Typology of Global Value Chains

By simplifying a dense network of social connections, value chains allow researchers to understand who the key players in the supply chain are, where value is being created, and how to understand the scope of players in the chain. One major form of typology when studying value chains is governance structures. Value chain governance theory sets up five different types of value chain governance structures: Market, Modular, Relational, Captive, and Hierarchy as demonstrated in Figure 1 below (Gereffi, Humphrey, & Sturgeon, 2005).

Figure 1. Five global value chain governance types.



Source: (Gereffi et al., 2005)

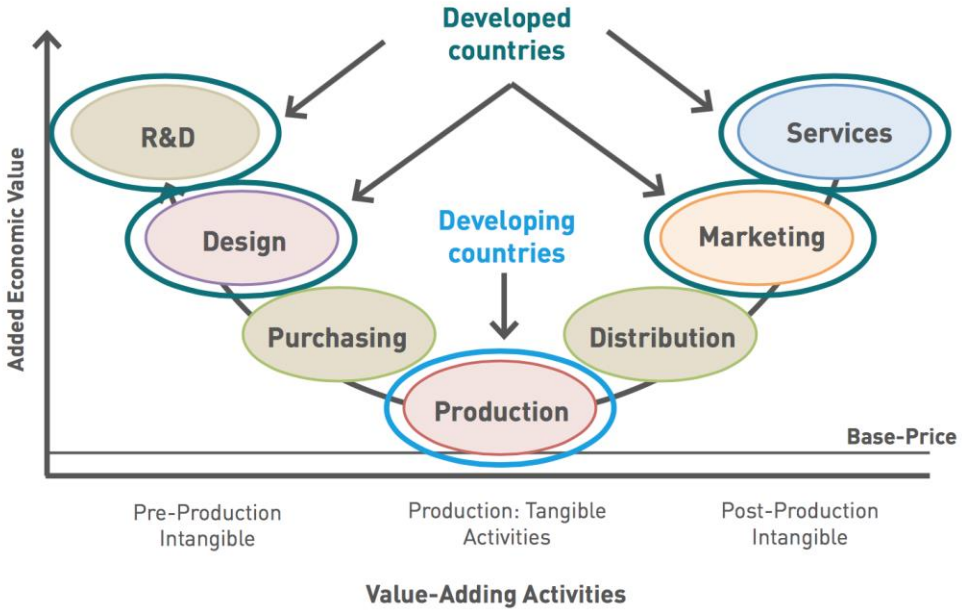
These governance structures illustrate models for how various industries operate. It is important to understand that value chains are constantly evolving. In "The Governance of Global Value Chains", Gereffi and others describe the shifts in governance for specific industries. For example, the bicycle industry in the 1890's fit the 'hierarchy' model due to the high level of integration in bicycle manufacturing. Over time, the various aspects of the bicycle were manufactured by different entities and the industry as a whole became more fragmented thus changing the governance structure to more closely model the 'market governance structure'.

3.3 Social Implications of Upgrading

Global value chains have also become an important tool for socio-economic growth. A concept known as *upgrading* refers to the process of countries and companies

trying to change the economic activities they engage in to move 'higher up' on the value chain. Upgrading is a key area of focus for rural areas, which often faces economic stagnation because they specialize in low value-added activities. Rural areas can use upgrading to shift into higher value-added activities and should work towards economic upgrading. A similar concept is seen in the 'Smiley Curve' first created by Stan Shih. Several researchers have published their own versions of the curve to reflect how the concept can be used in a global setting. Below(see Figure 2) is an excellent example (Gereffi and Stark, 2011).

Figure 2. Smile curve



Source: Gereffi & Stark, 2011; Shih, n.d.

The horizontal axis of the curve shows the evolution of a product from conception to distribution while the vertical axis shows that amount of value added at that moment of production. Under the GVC framework, industries that want to 'upgrade' should try to move away from low value creating activities like manufacturing and instead shift to innovation, design, and marketing. The 'smiley curve' demonstrates why companies like Apple and Nike can develop such a strong global presence and power without actually manufacturing their own products and instead leverage contract manufacturers (Yan & Islam, 2011). Rural areas often look to manufacturing jobs as a source of economic opportunity (Haggblade, Hazell, & Reardon, 2007). Upgrading suggests that rural areas should aim to manufacture in technology and knowledge intensive industries, such as the automotive industry, or push to expand into higher value activities outside of the manufacturing segment.

The automotive industry is a particularly interesting case study for rural upgrading analysis due to the relational governance structure of the industry. In a relational governance structure, clusters and suppliers must be able to maintain close ties to lead firms, which are typically powerful and agile. The relational governance structure provides opening for lower cost regions to participate, but also presents

challenges due to the over-reliance on lead firms and regional consequences in the case of lead firm mobility to another region.

Global Value Chains have been used to analyze everything from electronics and tire industries to the sugar and cocoa industries. The complex relationships between retailers, raw material exporters, manufacturers and consumers are clearer under the GVC framework and are valuable for rural areas to understand. By understanding these relationships, rural regions can make strategic decisions about how to best leverage their resources to maximize their position in the global economy.

3.4 GVCs, Clusters and the Automotive Industry

There has been extensive GVC research conducted on the global automotive industry. Experts claim that the "automotive industry is neither fully global, consisting of a set of linked, specialized clusters, nor tied to the narrow geography of nation states or specific localities, as is the case for some cultural or service industries" (Sturgeon, Van Biesebroeck, & Gereffi, 2008, p. 303). As global firms expand, suppliers have aggressively moved towards taking on more design efforts while production has become increasingly domestically clustered (De Marchi, Di Maria, & Gereffi, 2017). This push for domestic clustering has increased for political and economic reasons, with areas like the Southern United States and Mexico becoming prominent within North American productions hubs. Industrial cluster research (Porter, 2003) and focus on cluster-based performance has been linked with improved regional competitiveness (Mongkhonvanit, 2014). As academic research emphasizes the competitiveness of individual regions within global economies (Kitson, Martin, & Tyler, 2004), cluster and regional analysis have become increasingly relevant (Porter, 2008). Global value chain analysis acknowledges that while industries are typically global in their reach, activity is rarely distributed evenly around the world. Thus, cluster analysis provides insight on how global industries touch down in specific regions.

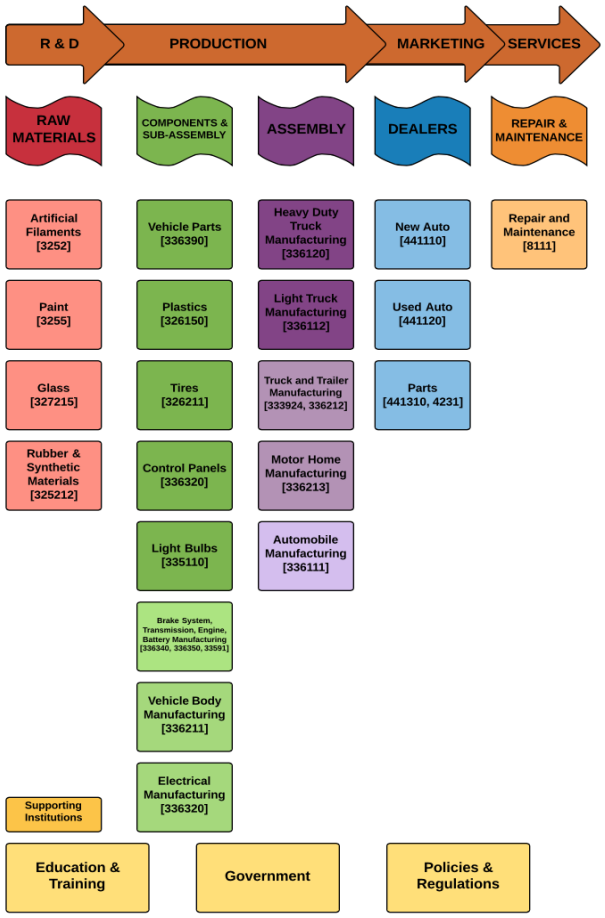
The automotive industry is both globally integrated and locally concentrated. Manufacturing is organized regionally across countries and in particular regions within countries, with a strong tendency to remain in these regions due to the deep investments that must be created to build initial capacity and maintain competitiveness. Due to the unique characteristics of the industry, buyer-supplier relationships rely not only on price based competition, but on "relational linkages to support the exchange of complex uncodified information and tacit knowledge" (Sturgeon et al., 2008, p. 297). Thus, "local, national, and regional value chains in the automotive industry are 'nested' within the global organizational structures and business relationships of the largest firms" (Sturgeon & Van Biesebroeck, 2010, p. 4). Given the governance structure of the industry, the greatest opportunity for regional upgrading lies in the manufacture of products that are both technology-intensive and high value. As the industry moves toward the adoption of newer technologies, such as light-weight metals, Appalachian firms should strive to develop the capabilities to manufacturing these products.

4.0 Results

4.1 Mapping the Value Chain

The study mapped the footprint of North Carolina's Appalachian region in the automotive value chain. To construct the value chain, the North American Industry Classification System (NAICS) codes most relevant for each segment, from raw materials to manufacturing and final sale, were identified. Figure 3 illustrates the value chain map of the automotive industry with its corresponding NAICS codes.

Figure 3. Value chain map of the automotive industry.



Source: Author.

Our research showed that the 'Components and Sub-Assembly' section of the value chain was an area of strength for North Carolina. The Components and Sub-Assembly segment refers to the small-scale assembly of automotive parts that will eventually go into the completed vehicle. North Carolina's employment in the components and sub-assembly segment relative to other states is ranked fifth in the nation behind Michigan, Ohio, Indiana and Tennessee, respectively.

North Carolina's Appalachian region is also particularly strong in the components and sub-assembly area. The heavy-duty trucking industry is moving towards geographic consolidation due to transportation costs (Sturgeon & Van Biesebroeck,

2010). The relative success of the sub assembly segment in North Carolina suggests a potential for the state to attract other areas of the value chain to the region and expand their presence in the Appalachian region.

Another key aspect of value chain analysis is to understand how the industry operates and how it is changing. The automobile industry is a critical driver of economic activity in the United States accounting for nearly 3% of (GDP) Gross Domestic Product. The industry is also prevalent in North Carolina, contributing over 200,000 jobs. Understanding market trends can help us better understand if the industry is moving towards consolidation or fragmentation, which allows us to understand manufacturing trends in rural American regions such as Appalachia. Industry trends point to the future of the automotive industry and can provide insight when considering how firms in the Appalachia region will participate in the industry.

4.2 Industry Trends

There are four main trends in the heavy-duty parts manufacturing industry. The first is downstream demand. As the truck industry continues to expand and distribute goods throughout the United States, truck manufacturers continue to profit. Heavy-duty trucks are high in demand, both for construction, large-scale transportation and distribution of consumer goods. Truck-parts manufacturing has thrived due to the overall success of dealers and post-production areas of the heavy-duty value chain.

The second major trend is regulation. Environmental regulations, while threatening to companies that operate trucks, are surprisingly beneficial to truck parts manufacturers. Due to the mandate of stringent environmental regulations, truck parts need to be changed more often to decrease fuel emissions of fleets. In 2007, the United States Environmental Protection Agency introduced legislation that aimed to cut emissions by 95%. Due to the stringent requirements, the technology used in filters was rushed and initially imperfect. This caused several issues for truck engines, which actually increased overall demand. However, redesigned products with low-emissions technology have increased lifetimes, which will decrease demand for these products in the future. The impact of regulation is hotly contested within the industry. A member of the Heavy Duty Manufacturer's Association claims that the industry "is under assault from state and in some cases, federal regulators"(T. Kraus, personal communication, November, 9, 2015) with regards to environmental policy being too restrictive.

The third major trend is profit. Increased sales over the past few years have contributed to successful profit margins. In 2009, profit was low due to high operating costs, specifically energy and rent, and declining sales. Since 2009, stabilized operating costs and an increase in sales has led to increased profits for the trucking industry. Although concentration has been low, many of the powerful key firms have overtaken smaller-scale wholesalers allowing for greater capability.

The fourth trend is a shift to lightweight technology. This is seen as a transition in materials to new types of steel, aluminum, magnesium, composites and other lightweight options. While lightweight materials are stronger and less malleable than steel, they are significantly more expensive to manufacture due to their ability to re-bend into their original form. There are multiple benefits to lightweight technology that include, but are not limited to: (a) lighter bodies which mean that auto manufacturers can downsize other parts of vehicles, from batteries, engines and

transmissions to brakes and tires; (b) decreases in energy required to speed up or slow down trucks; and (c) reduced energy required to maintain a steady speed.

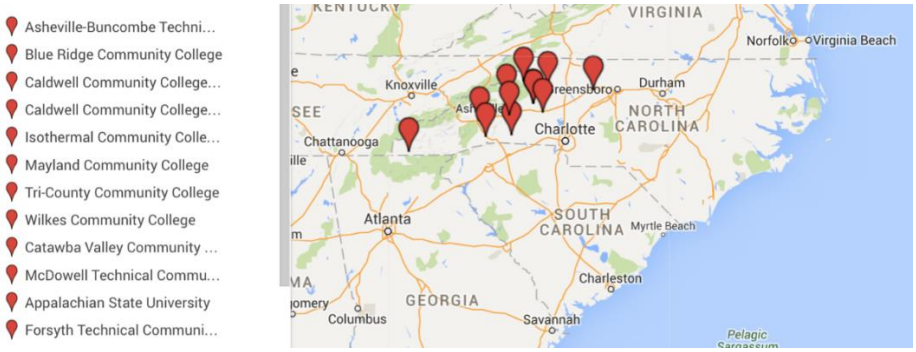
4.3 Appalachia's Workforce Development

Workforce Development in the Appalachian region is vital to the health of the automotive industry. The use of GVC analysis allows us to analyze the Appalachian work force from the perspective of value added to the industry value chain.

Currently, Appalachian North Carolina has 886,854 civilians ages 25–64 and 74.3% of them are in the labor force. Twenty-three percent of those 25 and over have a Bachelor's degree compared to the US average of 28.8%. Of those 25 and over, 8.8% have an Associate's degree compared to the US average of 7.8%. However, 16.3% of those 25 and over have less than a high school diploma while the US average is only 14%. In-state cost for a 16 credit-hour semester is $1,152 and out-of-state cost is $4,224. Popular programs of study that give the essential skills to work in the automotive industry include: (a) Industrial Systems Tech, (b) Welding, (c) Automotive Systems, (d) Electrical Systems, (e) Computer Tech Integration, (f) Collision Repair, and (g) Race Car Technology. North Carolina has seven of the institutions that make up the 54–college, 13–state Community Colleges of Appalachia (Pollard & Jacobsen, 2012).

Below, is a map of the North Carolina community colleges in the region including the Community Colleges of Appalachia among others. Research highlighted four community colleges that were models for successful programs in the area. Each of these community colleges offer comprehensive programs and collaborate with firms in the area to offer targeted learning opportunities that create a talented and thriving work force.

Figure 5. Map of community colleges in North Carolina Appalachian region



Source: Author.

4.4 Appalachia's Top Firms

Research highlighted several firms that were active employers and key players within heavy-duty automobile manufacturing in North Carolina's Appalachia region. Each firm had a different focus and operated in slightly different ways building various products.

4.5 Continental Automotive Systems

Continental Automotive Systems US, Inc. supplies electronics and mechatronic products for the automotive market. The company manufactures products relating to drive-train, engine management electronics, and fuel injection. The company also

provides performance instruments, replacement parts, power train products, safety products, interior products, chassis products, and car body products. In addition, it offers driver's workplace products, electronic network solutions, restraint systems and safety electronics, and tolling and telematics solutions. Further, the company provides original equipment manufacturer's solutions, such as audio and sound products, fuel measurement products, instrumentations, screen washer systems, and sensors, as well as audio systems and instruments for the marine industry, and chart plotters for sport and leisure boats. Furthermore, it offers vehicle fleet management and communication systems for public transit operations, such as products for information management, GPS-fleet workforce integration, mobile data communications, transit data organization, and traveler information systems. Continental Automotive Systems US, Inc. was formerly known as Siemens VDO Automotive Corporation. Located in Morganton, NC and headquartered in Auburn Hills, HI the firm has 600 total employees with the primary NAICS code designation of 336340 'Motor Vehicle Brake System Manufacturing'. The North Carolina location is a critical part of the firm evidenced by a statement saying:

> Continental Corporation in Morganton Site 1 manufactures systems that improve driver safety. In this facility, employees assemble Electronic Stability Control Systems. In the Morganton Site 2 facility, Electronic Suspension Systems are assembled. At Site 1, the plant has the capacity to produce 7 million EBS units per year. At Site 2, the plant has the capacity of 500K ESS systems per year (Herald, 2014).

The firm is acutely aware of the impacts of globalization saying,

> Over the long term, market development is being influenced by social trends in the major regions of the world. These trends include the rapid growth of the world's population, resulting in increasing urbanization; demographic change, and—in particular—globalization. In this context, people are striving to achieve a higher standard of living and the need for mobility is on the rise. Four megatrends can be derived from these global developments. They form the foundation of strategy and business activities (Continental, 2014).

Based on the four megatrends, the firm's strategy comprises seven dimensions that complement one another and are systematically geared toward sustainably creating value and ensuring the future viability of the company: "value creation, regional sales balance, top market position, in the market for the market, balanced customer portfolio, technological balance, and great people culture" ("Continental Teves, Inc.", n.d.).

Continental Teves Inc. is another division which manufactures automotive braking components. Its products include electronic air suspension systems, tire pressure loss detection products, electric and active parking brakes, hybrid braking systems, electro mechanical brakes, foundation brakes, electro-hydraulic brakes, traction control systems, antilock brake systems, electronic stability control products, and

active rollover protection products. The company sells its products to vehicle manufacturers in Europe, North America, and Asia. The primary NAICS code for the firm is 336390 or 'Other motor vehicle parts manufacturing'.

4.6 Sypris Technologies Inc.

Sypris Technologies, Inc. engages in forging, extruding, and machining parts for commercial vehicles, off-highway and farm equipment, heavy trucks, automotive, energy and transmission, mining, and energy industries. It offers axle shafts, trailer beams, I-beams, knuckles, carriers, differential cases, hubs, flanges and kingpins, and full float tubes. The company also provides forgings, such as side gears, pinion gears, helical gears, and transmission shafts. Sypris Technologies, Inc. was formerly known as Tube Turns Technologies, Inc. and changed its name to Sypris Technologies, Inc. in 2002. The company was founded in 1927 and is based in Louisville, Kentucky. The firm is headquartered in Louisville, KY with 300 employees and located in Morganton, NC. Their primary NAICS code is also 336390 'Other motor vehicle parts manufacturing'. The firm describes itself as:

> A world-class, integrated systems solutions provider. Our ruggedized electronic products, advanced engineering services and complete electronic manufacturing capabilities are aligned to provide our customers the best people, practices and technologies to continually exceed expectations. We consistently promote an agile, innovative culture by strategically partnering with leading-edge technology companies, agencies and universities. With over 45 years of experience, Sypris Electronics is proud to develop, manufacture and integrate leading technologies into mission critical electronics systems that secure America's interest (Business Wire, 2009).

The firm is incredibly global in nature as the industrial segment is also a leading supplier of specialty closures and other piping components for use in the construction and maintenance of strategic oil, gas and petrochemical projects around the world. They state:

> Our highly-engineered products can be found in some of the world's most challenging projects, including the Trans–Alaska Pipeline and the Strategic Petroleum Reserve in the US, the Keiyo Gas Pipeline and Kawasaki Power Plant in Japan, the Tengiz Oil Field in Kazakhstan, the Rabigh Desalination Plant in Saudi Arabia, the FPG Glycerin Refinery in Malaysia and the Ca Mau Gas Pipeline in Vietnam (Syris Solutions, n.d.).

Sypris Technologies entered into a long-term partnership with Meritor in 2014 with the purpose of supplying its drive axle and trailer axle assembly operations in North America (Sypris Technologies, Inc., 2014).

4.7 American Emergency Vehicles

American Emergency Vehicles began manufacturing emergency vehicles in 1982 in Jefferson, NC, which is located in Ashe County. The largest aspect of the company includes the manufacturing and assembling of emergency vehicles. AEV is a subsidiary of Halcaore Group Inc. ("American Emergency Vehicles, Inc.", n.d.) AEV's vehicles are sold by independent dealers across the country and around the world. Thus, AEV has recognized that instead of being a captive supplier in the greater automotive value chain, the firm can reduce their risk of being overly reliant on lead firms by being an independent entity.

AEV manufactures a diverse collection of emergency vehicles and also provides services such as repair. Specifically, AEV supervises the manufacturing of ambulance models in Type II, Type III, Type I, and medium-duty units as well as crewcab, NeoNatal, and CCT units, and specialized vocational vehicles. The company also sells replacement parts and components. Besides manufacturing, AEV offers services and repairs including dismounting and remounting the body from an old chassis, performing repairs, vehicle refurbishing, modification, and uplifting services ("American Emergency Vehicles, Inc.", n.d.). American Emergency Vehicles is the largest manufacturer of ambulances for domestic use in the United States and has had a 10% average annual growth rate for the past decade (Howell, 2015). AEV sells their vehicles to the emergency vehicle industry through independent dealers throughout the United States and the entire world.

AEV's business strategy merges time tested ambulance-building methods, new engineering concepts, and reputable materials to create the best emergency vehicles in the industry. AEV is committed to giving their customers a vehicle that fits their needs and custom designs each vehicle to ensure the best functionality, service and trust in the product. To accomplish this task, AEV builds most of the products in the Jefferson, NC facilities with highly skilled technicians and the newest technological advances so that AEV can control the quality in house. AEV has even earned the Ford Motor Company Qualified Vehicle Modifier every year of its existence thanks to the company's strict and innovative process and quality control procedures.

AEV is located in Jefferson, NC and carries out all aspects of business in the county. The company has had continued growth for the past decade in Jefferson and, as a result, has acquired a grant from the North Carolina Department of Commerce to renovate and expand the old Gates Building in their facility. Through this expansion and grant, AEV will be able to create 50 new jobs. A few years ago, the company only had 50 employees, but now AEV has over 300 employees, representing remarkable growth when given government support. Additionally, the grant will allow the company to increase the new hires' salaries and pay for 50% of their health insurance. AEV strives to create not only jobs, but high-quality jobs to support the region. The company offers jobs in multiple fields including engineering, sales, information technology, manufacturing supervision, painting and general assembly and manufacturing support. AEV is instrumental in creating growth in the economy in Ashe County and represents a new type of niche area growth that could be instrumental when considering value chain implications of supplier-only firms in Appalachia.

There are two main takeaways from AEV. First, the ability of rural regions to use specialization and customization to further secure their presence. Given the automotive industry's relational governance structure and history of relocating to lower-cost regions, rural regions can be vulnerable to powerful lead firms. Second, by

manufacturing all ambulances and limiting their activities to be entirely within Appalachia, AEV has remained largely outside the GVC and isn't dependent on lead firms.

The firms in North Carolina's Appalachia have a significant presence not just in the region, but are often located or centered in other automotive hubs, giving North Carolina incentive to strengthen the automotive cluster within the state.

5.0 Discussion

The automotive industry is a large part of the North Carolina economy and is growing in counties making up the ARC region in North Carolina. Within the industry, there are a variety of trends in (a) passenger vehicles, (b) SUV and light truck manufacturing, and (c) truck, trailer and motor home manufacturing. Within passenger vehicles, we saw changing technology, revenue volatility, and an increase in regulation and policy. Similarly, there is changing technology in lightweight vehicles as well as increased environmental regulation. Within heavy-duty parts manufacturing, there is evidence of downstream demand, increased regulation, additional profit, and more light-weight technology. These trends show evidence of growth in the industry, which will hopefully benefit the ARC region.

Another important aspect of the industry is workforce development—the training of employees to work in specific jobs in auto-related companies. Community colleges are the vehicle to train future employees and equip them with skills for the industry. Research indicates that the most successful community colleges partner with companies in the area in order to ensure that they are teaching the necessary skills for jobs. The NCWorks program connects companies and community colleges in order to achieve this.

We analyzed information about employment, establishments, and wages from the Census of Employment and Wages. From this information, we learned that the ARC region is especially strong in the 'Components and Sub-Assembly' segment of the value chain.

Research found that Meritor, Inc., American Emergency Vehicles, Sypris Technologies, Inc., Continental Automotive Systems, and BorgWarner Turbo Systems, Inc. are especially strong in the region. Some of these companies, such as American Emergency Vehicles, have partnered with community colleges and high schools to create training programs for students to learn the specific skills needed in the industry. Most of these companies fall under the 'Components and Sub-Assembly' segment of the value chain, which further shows the strength of this segment in the ARC region.

The utilization of the GVC framework provided the vision for further researching industry trends, workforce development and current data on the Appalachia region. To fully utilize the framework, researchers synthesized findings across all these areas as well as the map for the value chain to develop recommendations on the best strategic decisions for Appalachia. Thus, research on GVCs in Appalachia revealed that the heavy-duty parts manufacturing industry is particularly active in North Carolina's Appalachia region. By separately analyzing the value chain, identifying the 'Sub Components and Assembly' segment as being uniquely strong in Appalachia, and probing workforce development, industry trends, and leading firms the GVC framework was able to integrate the collective strengths of Appalachia. As a leader in high-value parts of the vehicle, Appalachia has the opportunity to grow activities in this space. Given the value of axles and chassis systems, North Carolina

should push to bring manufacturing of engines, high-tech lighting and electrical systems to the region. Value chain literature shows that the greater the intensity of technology in a product, the greater the economic payback. As indicated by the research, the region should use the capacities of an already strong community college system to facilitate training of workers to gain skills in technology intensive roles to promote progress for firms. By further strengthening the presence of the automotive industry, North Carolina plays into the strengths of the automotive industry, in which interviews with leaders in the industry indicate a trend towards geographic consolidation.

North Carolina finds itself in a very interesting position within the automotive industry. The Appalachian region has an opportunity to upgrade manufacturing and begin investing in lightweight, clean technologies that will direct where the industry will go in the future. Strategically speaking, the heavy-duty automobile industry will likely continue to be domestic and resistant to manufacturing abroad due to logistics. The Appalachian region's competitive advantages are intrinsically linked to strong partnerships with community colleges and talent within the region that should continue to be nurtured.

5.1 Implications for Appalachia's Automotive Industry

Previous research using GVCs in rural areas is mostly limited to rural countries. However, the case study of GVC research in Appalachia provides an in-depth understanding and analysis of rural areas. The implications of the research within Appalachia have found that there is a serious challenge for workforce development in the rise of automation causing a decrease in the number of available jobs. On the other hand, the jobs that are available require skills, but are well compensated. Appalachia's competitive advantages are intrinsically linked to strong partnerships with community colleges and talent from within the region.

An interesting finding in the research is that Appalachia's strength as a furniture producer makes it an increasingly competitive region for the automotive industry, which seeks workers with similar skill sets. The importance of cross-industry skills in the workforce, particularly within regional clusters, has been researched in pre-existing literature. There are many regions that have leveraged inherent workforce skills present in their region to move into new industries. For example, Houston was a stronghold for the oil and gas industry due to the presence of natural resources and a rich history of skill development in the industry. Today, the natural resources formerly present in Houston have largely been exhausted, but the cluster still thrives due to the, "capability built over time from selling the natural resources… to the exploration and use of new skills and knowledge for development of new products and services" (Ketels & Memedovic, 2008, p. 381). A region's ability to take existing skills in one industry and leverage that knowledge into another industry has also been seen in San Diego in the 1990s, when a US Navy research facility was shut down, but created a thriving telecommunications sector (Ketels & Memedovic, 2008). Workforce skills tend to be relevant across industries and many rural regions can seek entry into new industries which draws from pre-existing skill sets in their workforce.

The community college system has done a terrific job partnering with firms in the area and preparing a work force that fits the needs of local firms. Interviews suggested that there is significant crossover in skills between other industries in the region. Workers with a background in the furniture industry are often sought after by the automotive industry. Given the strength of the furniture industry in the region,

Appalachia has a unique competitive advantage in the workforce. The automobile and heavy-duty truck industry is a particularly safe industry for North Carolina to invest in. The heavy-duty nature of trucks ensures the likelihood that manufacturing will continue to be domestic and resistant to manufacturing abroad. In order to raise the profile of the heavy-duty truck industry North Carolina has opportunities to invest in light-weight, clean technologies that direct where the industry will go in the future. While there are many avenues governments can take to foster this type of activity, some potential options are providing financial support to companies through tax breaks for firms that help provide training to workers. Other options are to recruit new firms to start investing in the region, ensure strong funding and support to community colleges, emphasize the importance of technical skills such as engineering, consider greater economic diversification in the region overall and encourage firms like AEV that contain almost all their activities within North Carolina.

The findings of the Appalachian case study provide direction and valuable insight for policy experts and economists interested in reviving the region. By taking an analytical approach that explains what is happening globally in the industry and using several methods to understand the capabilities of the region, the state of the workforce, and the nature of the industry in the region, the GVC framework can assist rural regions. Although there is not a strong body of existing literature on GVC analysis in rural regions, the Appalachia case study provides evidence that GVCs can be critical tools to assisting rural regions compete and thrive in globalized economies.

5.2 Implications for Rural Regions in Utilizing GVCs

The Appalachian case study of applying GVCs to rural regions reveals a powerful analytical tool for rural regions to assess the strengths and opportunities of various industries. However, when leveraging the GVC framework, rural regions must also consider the opportunities and consequences of being part of a global value chain.

One of the most powerful aspects of the GVC framework is leveraging the understanding that upgrading is a function of governance. The governance structure of an industry in a region sets the parameters for upgrading. As discussed earlier, upgrading opportunities within particular governance structures strongly limit how local firms can engage within a global value chain. The relational governance structure between lead firms and suppliers in the automotive industry poses a significant risk for rural regions. Because suppliers within a relational value chain are vulnerable when lead firms reposition or leave the industry, rural regions specializing on a single industry risk being ‘hollowed out’. Rural regions which are heavily dependent on large firms to support suppliers struggle with being increasingly isolated when competitive factors in the industry make lead firms reconsider domestic production. Thus, rural regions engaging in GVCs must also prioritize economic diversification, which has been one way to address reliance on single industries for regional employment.

Rural regions must also consider the long history of industrial transformation in the North American automotive industry moving towards lower-cost regions. During the 1980s the first wave of Japanese firms built expansive manufacturing facilities in Ohio and Tennessee. This flood of foreign automotive activity transformed the industry in the US and smaller firms such as BMW and Daimler-Benz moved to the lower-cost American South in the mid-1990s. Following this trend, Hyundai and Kia opened new facilities in Alabama and Georgia. As fierce competition over the North American automotive market ramped up, manufacturers chose their plants

strategically and looking to lower foreign direct investment. Over time, manufacturing plants in the United States have proved to be transient, migrating to regions with lower operating costs. Globally, manufacturers show the same tendency to relocate to increasingly cost-efficient locations. Value chain analysis conducted on the global automotive industry confirms that "within regions, there is a gradual investment shift toward locations with lower operating costs: the U.S. South and Mexico in North America; Spain and Eastern Europe in Europe and Southeast Asia and China in Asia" (Sturgeon et al.,2008, p. 303).

While relational governance structure and history of transformation in the automotive industry are potential drawbacks for rural regions seeking to link into GVCs, the Appalachia case study revealed positive implications as well. The key for rural regions considering linking into GVCs is to be cognizant that global industries are forever dynamic and evolving. In an interview with Michael Porter, he advocates for regional clusters saying:

> My argument is that, in the global economy, so long as you have the clusters—the critical mass—a particular field of business activity can be extremely efficient and productive. This does not require a large local market; you just need a very high-quality local market (Snowdon & Stonehouse, 2006, p. 166).

Additionally, the Appalachian ambulance manufacturing company, AEV, demonstrated how rural regions can use specialization—ambulance manufacturing within the automotive industry—to circumvent lead firms and engage in high value customization. Thus, rural regions which emphasize high quality production and develop niche capabilities can protect their clusters.

On one hand, access to GVCs promotes opportunities for rural regions to upgrade activities and thus provide greater economic opportunities for a region. The Appalachian automotive industry, for example, is a critical source of economic prosperity in an otherwise struggling region. However, all regions must acknowledge that focusing on a single industry makes the region vulnerable to global industry-wide trends. This concern for rural regions can be mitigated by still focusing on economic diversification, building niche capabilities within an industry, and using Porter's theory to create an exceptionally high-quality local market.

6.0 Conclusion

As changes in technology and industries continue to evolve, rural regions will undoubtedly face increased challenges to maintain competitiveness. As economically repressed areas, rural regions face challenges regarding infrastructure and economic dependence on lead firms, but research also suggests that collaboration between local, economic, and social agents fosters rural economic success (Leigh & Blakely, 2013). A rigorous application of the global value chain framework in the iconic Appalachia region of the automotive industry reveals some true strengths, such as the community college system, which stands as a testament to the resilience that rural regions are capable of. The framework also revealed the broader trends in the industry towards technology intensive light-weight materials, which was identified as an area of opportunity for Appalachia to capture.

The Appalachian case study further supports the viability of the GVC framework to be used in specific rural regions. Previous literature on the framework in rural contexts emphasizes only rural countries and does not account for rural regions that could access resources and infrastructure in developed countries. The implications of the GVC research can be expanded to understanding the framework in natural resource industries in rural regions, manufacturing or even medical and pharmaceutical industries in rural regions. In general, more research needs to be conducted about how rural regions can participate in GVCs and the implications of greater linkages with the global economy.

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