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GLOBAL VALUE CHAINS, NEW TECHNOLOGIES AND ECONOMIC DEVELOPMENT: EVIDENCE FROM LITERATURE

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Abstract: *Value chain analysis links both the top down and bottom up industrial activities performed by the lead firms in organization of global industries and their suppliers firms in upgrading respectively. Lead firms decide generation and distribution of resources and knowledge in the chain, which improves the capabilities and expertise of suppliers firms and facilitate their upgrading in developing countries by setting standards. Lead firms involve in product and brand development, marketing, distribution, and final assembly, whereas suppliers firms involve in selling products and related services. The growth of new disruptive technologies and automation in the manufacturing process is termed as Industry 4.0, which is likely to alter manufacturing. Automation has already ushered in large scale operations, while 3D printing is new in high value manufacturing operations, which led to substantial cost reductions and surge in technology adoption. New technologies have very high potential pay offs in automated manufacturing processes and automated logistics in production needs. Industry 4.0 tech has immense potential to improve productivity and reduce transaction costs in supply chains, thereby help small firms to compete the large firms. With above backdrop, the paper intends to review the available literature on GVCs, new technologies and economic development, role of new technologies in GVCs and its impact, and links between GVC participation and economic development using available literature.*

Keywords: *Global value chains, new technologies, economic development*

INTRODUCTION

A value chain refers to a set of activities performed by a firm to deliver a valuable product or service to the market (Porter, 1985). It refers to a set of businesses, activities and relationships engaged in creating a final product (UNIDO, 2009). A supply chain links companies to interchange materials and information to deliver goods to final users. It refers to production-related input-output links. Supply chain management (SCM) covers the entire value chain, which link the manufacturing process from raw materials to the end users (New and Payne, 1995). SCM refers to managing business activities and relationships internally

as well as externally with suppliers and customers (Harland, 1996) to increase competitiveness (Farley, 1997) by coordinating manufacturing, logistics, and materials management (Lee and Billington, 1992; Park, Nayyar, and Low, 2013) and improvements in the organizational structure and process (Mentzer *et al.* 2011).

Global value chains (GVCs) imply the linking of local production into global markets (UNIDO, 2009). GVCs or global supply chains (GSCs) refer to cross-border production activities in different countries (Sturgeon and Memedovic, 2011). Global Production Network (GPN) refers to organizational arrangement coordinated by lead firm for producing goods or services across multiple geographic locations (Yeung and Coe, 2015). Global buyers and producers act as the major drivers of GVCs production process (Morrison at al., 2008). GVCs serve as 'backbone and central nervous system' of the global economy (Cattaneo *et al*, 2010, p.7) with the increased share of value added (Los *et al.*, 2015) in cross-border business activities through GPNs coordinated by lead firms (Yeung and Coe, 2015).

Value chain analysis links both the top down and bottom up industrial activities performed by the lead firms in organization of global industries and their suppliers firms in upgrading respectively (Gereffi and Fernandez-Stark, 2016). Lead firms decide generation and distribution of resources and knowledge in the chain (Gereffi, 1994), which improves the capabilities and expertise of suppliers firms and facilitate their upgrading in developing countries (Gereffi, 1999) by setting standards (Sturgeon, 2009). Lead firms involve in product and brand development, marketing, distribution, and final assembly, whereas suppliers firms involve in selling products and related services (Sturgeon *et al.* 2009).

The growth of new disruptive technologies and automation in the manufacturing process is termed as Industry 4.0 (Schwab, 2017), which is likely to alter manufacturing (Manyika *et al.*, 2015). Automation has already ushered in large scale operations, while 3D printing is new in high value manufacturing operations, which led to substantial cost reductions and surge in technology adoption (Manyika *et al.*, 2013). Supply chain digitalization refers to application of advanced data analytical tools (visualization, scenario analysis, and predictive learning algorithms) called information technology (IT) and physical technologies (robotics, drones, additive manufacturing -3D printing, and autonomous vehicles) called operations technology (OT) to enhance digital connectivity and technological capabilities of supply chains (Mussomeli

et al., 2016), which led to improved processing capabilities and computing power, and reduced costs of computing, storage, and bandwidth using big data and analytics, simulations, Internet of Things (IoT), cyber security, cloud computing, and additive manufacturing.

New technologies have very high potential pay offs in automated manufacturing processes and automated logistics in production needs. Industry 4.0 tech has immense potential to improve productivity and reduce transaction costs in supply chains, thereby help small firms to compete the large firms (Manyika *et al.*, 2015). With above backdrop, the paper intends to review the available literature on GVCs, new technologies and economic development, role of new technologies in GVCs and its impact, and links between GVC participation and economic development using available literature.

REVIEW OF LITERATURE

Various studies (Gereffi, 1994; Humprey and Schmitz, 2000; Kaplinsky, 2000; Gereffi and Lee, 2012) and international organizations have analyzed global value chains in recent past (Cattaneo *et al*, 2010; UNCTAD, 2013; Elms and Low, 2013; Neilson *et al.*, 2014). The buyer-supplier relationship influence organizational performance (Adams *et al.*, 2012). GVCs differ from traditional production system due to customization of production, sequential buyer to supplier production decisions, high contract cost, and international production teams and ideas (Taglioni and Winker, 2016).

Studies by Gereffi *et al.* (2005), Morrison *et al.* (2008), and Pietrobelli and Rabellotti (2011) have focused on the role of lead firms, and governance structure and upgrading within GVCs. GVCs governance implies authority and power relationships to allocate financial, material, and human resources and their flow within a chain (Gereffi, 1994). In GVCs governance, some firms follow the standards set by powerful lead firms (Humphrey and Schmitz, 2008) based on their supportive relationships for mutual benefits (Frederick and Gereffi, 2009). Governance structure of GVCs controlled by transnational corporations (TNCs) or other large integrated industrial enterprises is termed 'buyer driven commodity chains' and governance structure of 'producer driven commodity chains' is dominated by large retailers, brand-named merchandisers and trading companies (Gereffi, 1994) and coordinated by the lead firms (Sturgeon *et al*, 2009). The main types of GVC governance include hierarchical value chains involving direct ownership of production processes and network-style governance through lead firm coordinating production and suppliers without direct ownership of firms (Gereffi *et al.*, 2005).

Lead firms govern suppliers firms in terms of price, quality, standards, and delivery times (Kaplinsky and Morris, 2001) and decides which firms and countries will participate in GVCs, how rents are distributed, how to support suppliers, sanction non-performing firms. The policymakers face the challenge of how to participate and upgrade in GVCs sustainably (Gereffi, 1994; Kaplinsky, 2005). Lead firms outsource less profitable and labour-intensive manufacturing activities. In developing countries, participation in GVCs has been limited to value-added manufacturing or supply of raw materials, while lead firms control intangible activities like design, R&D, marketing, retailing, and aftermarket services (Kaplinsky, 2005) due to knowledge and skills-gaps in developing countries and face difficulties in upgrading the value chain (Staritz, Plank and Morris, 2016).

GVCs participation increases the chances of upgrading for firms (Gereffi, 1999). Upgrading refers to improving economic competitiveness and social conditions of a firm, industry, or workers through learning (Frederick and Gereffi, 2009). Economic upgrading implies moving to higher value activities in GVCs through process upgrading (reorganizing the production system or introducing new technologies to increase efficiency, product upgrading (shifting to more sophisticated products with higher unit prices), end market upgrading (diversifying to new buyers or new geographic or product markets, linkages/ supply chain upgrading (establishing backward manufacturing linkages within the supply chain), and functional upgrading (increasing the range of functions or changing the mix of activities to higher value tasks) (Frederick & Gereffi, 2011, 2013). Social upgrading implies enhanced rights and entitlements of workers (Barrientos, Gereffi, and Rossi, 2011) through improved employment conditions, wages, social protection and working hours including freedom of association, collective bargaining, non-discrimination, and empowerment (Barrientos and Smith, 2007).

The mechanism of GVC upgrading remains ambiguous (Morrison *et al.*, 2008). Global buyers tend to impede functional and inter-sectoral upgrading in GVCs (Humphrey and Schmitz, 2000), while MNEs played complex role in economic and social upgrading in developing countries due to the power asymmetry between large MNEs and suppliers firms (Gereffi and Lee, 2012) and economic upgrading has accrued in only few countries (Bernhardt and Pollak, 2016). Overall, the GVC participation is not beneficial to all participants and tends to exploit the local institutions in developing countries (Rahman and Sayeda, 2016).

Greater GVC integration leads to efficient functioning and higher gains from trade (Blanchard, 2015) and facilitate economic development using productivity benefits and technology spillovers (Baldwin and Yan, 2014). The least developed countries are exporting primary products, while developed and emerging economies are engaged in intermediate and processed production (Taglioni and Winkler, 2016), which acts as disadvantage to developing countries due to excessive exploitation of natural resources and associated environmental hazards, poor work conditions and inequality (Neilson and Pritchard, 2009), high risk of exposure to global economic shocks via the bullwhip effect (Altomonte, *et al* 2011), and possibility of Dutch Disease (possible de-industrialisation) or immiserising growth due to falling costs of primary products relative to skill-intensive downstream activities (Sachs, 1997). Over the period, the value-added between downstream and upstream activities in value chain have widened (Baldwin, 2014), which suggest moving up from upstream to downstream value chain activities over time to facilitate equitable economic development through trade (Dollar, 2017).

In the last three decades, trade liberalization and new technologies have profoundly changed the global production and trade (Gereffi and Sturgeon, 2013), which led to more vertical specialization in supply chain activities in labour intensive industries like apparel and electronics (Gereffi, 1994) and more advanced manufacturing sectors like automotive including agriculture and services (UNCTAD, 2013). Gereffi and Lee (2012) have extensively documented these changes to understand the evolution of GVC and the phenomenon of globalization.

NEW TECHNOLOGIES AND GVCs

GVCs are evolving due to changes in demand, trade, investment, and technological advances. In recent years, rationalization, reorientation, automation, and servicification have changed GVC dynamics. Industry 4.0 has altered automation in tangible production operations, while servicification has impacted intangible operations in chains. Servicification refers to increasing the role of services in the GVCs (Low and Pasadilla, 2016) due to rapidly changing technology, pay-by-use and subscription services. For instance, car manufacturers are investing in ride sharing operations such as Lyft and ZipCar (Porter and Heppelmann, 2014), which benefit the customer without owning and maintaining a car that remained idle for longer time with less disposable income (Hodges-Copple, 2017) through on-demand transportation services. Similarly, costly capital equipment in aerospace and extractive industries can

be used on a fixed subscription cost or variable "per-use" fee (Mussomeli *et al.*, 2016). These changes are facilitated by growth of the Industry 4.0 technologies such as the Internet of Things and Big Data (Porter and Heppelmann, 2014). Learning and innovation determines competitiveness (Morrison *et al*, 2008) and firms' participation in GVC improve chances to learn and build technological capabilities (Gereffi *et al.*, 2005), which includes technical, managerial or organizational skills to use the hardware (equipment) and software (information) of technology efficiently (Morrision *et al.*, 2008).

New technologies and servicification change the value distribution within GVCs. Automation and 3D printing improve production processes and reduce dependence on labour-intensive assembly operations. Automation technologies improve productivity and reduce labour cost (Bughin *et al.*, 2017). However, it is not necessary for the country to be a manufacturing hub to participate in manufacturing GVCs, rather the countries can use services such as data analysis for unbundling in GVCs (Fernandez-Stark *et al.*, 2011). The disruptive technologies can influence the business model and GVCs through rapid manufacturing (Tuck *et al.*, 2007).

The additive manufacturing (AM) helps to switch from traditional mass production methods to small batch production at reduced costs (Despeisse and Ford, 2015). New technologies can speed the transmission of data (Baldwin, 2013) and improve product quality by using an integration strategy (Ionescu, 2015). Disruptive innovation could impact performance of firms (Mohr and Khan, 2015). AM strategy can lower financial and energy resource inputs into production processes (Gebler *et al.*, 2014. The technology disruption such as artificial intelligence, robotics, the Internet of Things, autonomous vehicles, 3D printing, nano-technology, bio-technology, materials science, energy storage, and quantum computing has potential to generate greater inequality and disrupt labour markets (Schwab, 2015). The application of 3D printing can reduce the outsourcing of some activities in the supply chain (Brody and Pureswaran, 2013).

Lead firms are actively strengthening more technologically capable and strategically located suppliers to reduce transaction costs by engaging more efficient and highly capable suppliers in supply chains of hallmark global industries like apparel (Gereffi and Frederick, 2010), automobiles (Sturgeon and Van Biesebroeck, 2011) and electronics (Sturgeon and Kawakami, 2011), which led to growth of large suppliers and intermediaries and crowding out of smaller firms in GVCs (Bamber *et al.*, 2013; Bamber *et al.*, 2016).

Manufacturing related services are vital sources of revenue to firms (Low and Pasadilla, 2016) specifically in capital equipment sectors (Bamber *et al.*, 2016). This shifts the balance of power within value chains (Gereffi, 2014) in favour of powerful suppliers who use new technologies and upgrading than traditional lead firms. The emergence of new technologies also changes the potential geographic distribution of chain activities. Automation facilitates relocation of manufacturing activities closer to their markets. Industry 4.0 technologies and digitalization of routine manufacturing tasks increase the capabilities of the firms.

GVCs AND ECONOMIC DEVELOPMENT

The ultimate goals of development include socio-economic upgrading via decent jobs, sustainable resource use, robust governance and political stability. Socio-economic upgrading is linked to industrial transformation and trade within GVCs (WTO, 2014). Before mid-1980s, industrialization has focused on building the whole supply chain within an economy. With more specialization of production, participation in GVCs has provided immense benefits from trade (Baldwin, 2011). The participation in GVCs enhances trade and economic development through technology and knowledge transfer, rising FDI, and human capital upgrading (Taglioni and Winkler, 2016). GVCs facilitate specialization in specific activities (Criscuolo, Timmis, and Johnstone, 2016), improve productivity and resource allocation (Grossman and Rossi-Hanberg, 2008), and provide quality of foreign inputs (Bas and Strauss-Kahn, 2015) via the diffusion effect (MNEs assist local firms in knowledge and technology sharing), availability and quality effect (increases the availability and quality of inputs) and the demonstration effect (technology and knowledge spillovers) (Taglioni and Winkler, 2016). The outsourcing and offshoring of less efficient activities to more efficient firms can increase productivity. The domestic firms have opportunities to benefit from knowledge and technological spillovers of large MNCs (OECD, 2013) and use of vast trade infrastructure (Stone and Shepherd, 2013).

There has been notable emergence of GVCs in Asian economies due to rapid surge in local demand, low labour cost and increasing industrial activities in apparel, chemicals, electronics and shipbuilding (Bamber *et al.*, 2016). Southern share of global trade is likely to overtake the northern by 2030 due to a significant shift in demand and supply. Small developing economies have opportunities to participate in GVCs, thereby generating local jobs and value-addition in productive activities via trade and competitiveness upgrading. GVC

participation helps firms in developing countries to benefit from international production networks of MNCs through upgrading, which can be process upgrading by introducing superior technology, product upgrading by using more sophisticated product lines, functional upgrading by acquiring superior functions, and inter-sectoral upgrading by using the competences to move into a new sector (Humphrey and Schmitz, 2002), However, some economies may face a slowdown (Engel and Taglioni, 2017), which can be offset by moving towards higher-value activities (OECD, 2013).

CONCLUSION AND POLICY IMPLICATIONS

Value chain consists of production activities linked to designing, developing and innovation. Upstream phase includes sourcing of primary products, while manufacturing and assembly are in middle phase and downstream phase includes transporting, branding, marketing, and post-sale services. Upstream and downstream phases of production consist of high value-added activities and yield high returns. In developing economies, skill-intensive R&D and designing is problematic, if the industry is located in other country. Firms mostly participate in upstream activities in supply of raw materials or semi-processed intermediates to gain from trade. GVC participation occurs through either backward participation (importing primary products or semi-processed to produce a consumable or processed product for value addition or final consumption) or forward participation (exporting primary products for value addition) or both. The resource- and technology-rich economy has lower GVC participation and high domestic value-addition in their exports, while resource-driven countries have high backward and forward participation and lower value addition in their exports. Trade policy including tariff and non-tariff barriers also influences GVC participation.

In recent years, the GVCs have become an active policy tool to create new industries for economic development (Gereffi, 2014; Taglioni and Winkler, 2016). GVC-oriented industrial policy has strong role in economic development by improving productivity, quality and competencies in supply chain. In emerging economies, the participation in GVCs help the firms to switch from low technology to very high-tech sectors (Bamber *et al.*, 2016), which provide the opportunity to create employment, value addition and economic diversification via liberalized trade, labour market flexibility and improved infrastructure (Bamber *et al.*, 2013). In developed countries, firms have increased their competitiveness by successfully using lower cost locations in developing countries by offshoring and outsourcing labour-intensive tasks, and maintaining core and high value adding

tasks like branding and R&D at home. Due to eroding of competitive advantages in production, developed countries have focused on sectors and activities having comparative advantage in knowledge and innovation and remained innovative without a manufacturing base (Gereffi, 2014) by hollowing out of industries (Goos and Manning, 2007; Goos *et al.*, 2009, 2014) with significant implications for labour markets and skills (Bacchetta and Jansen, 2011), which led to demand for more protectionist policies.

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