Structural change and Digital Transformation Nexus: Drivers and Determinants

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Abstract:

The study aims to investigate the drivers and determinants of structural change and the relationship between digital transformation and structural change, highlighting with literature review aspects, using descriptive analysis approach.

The main findings of the study: that Changes in relative sectoral prices, Real aggregate income, Input-output or sectoral linkages and international trade influences the process of structural change through its contribution to technology-driven productivity and share of employment in the board sectors (industrial, agriculture and service) of the economy in developing economies in addition, there are tight connections between changes in sectoral linkages and globalization.

Keywords: Structural change, Digital transformation, drivers, determinants.

العلاقة بين التغير الهيكلي والتحول الرقمي: العوامل والمحددات

ملخص الدراسة:

تهدف الدراسة إلى دراسة المحددات والعوامل المؤثرة على التغيير الهيكلي والعلاقة بين التحول الرقمي والتغيير الهيكلي، مع تسليط الضوء على الأدبيات الاقتصادية التي تدعم ذلك، باستخدام منهج التحليل الوصفي.

النتائج الرئيسية للدراسة: أن التغيرات في الأسعار النسبية بالقطاعات المختلفة، الناتج الكلي الحقيقي، والمدخلات والمخرجات أو الروابط القطاعية والتجارة الدولية تؤثر على عملية التغيير الهيكلي من خلال مساهمتها في الإنتاجية المدفوعة بالتكنولوجيا ومشاركة العمالة في القطاعات الرئيسية (الصناعية والزراعة والخدمات) للاقتصاد في الاقتصادات النامية، بالإضافة إلى ذلك، هناك روابط وثيقة الصلة بين التغيرات في الروابط القطاعية والعولمة.

الكلمات المفتاحية: التغيير الهيكلي، التحول الرقمي، محددات.

1. Introduction

Structural change indicates essentially a qualitative transformation and evolution of the economic systems, as it is not only a source of higher productivity growth and rising per capita income, but also a mechanism that helps to accomplish more diversity of the economic structure, which creates a country's resilience to vulnerability to poverty and external shocks (UNIDO, 2012).Structural transformation is emphasized by institutions and policies that foster the development, adoption, and the usage of technologies to change what an economy produces and how it does so.

The rise of new economic powers has generally been driven by the rapid structural change of their economies featured by the shift from primary production, such as mining and agriculture to manufacturing; and, in manufacturing, from natural-resource-based- to more sophisticated, skill- and technology-intensive activities. (UNIDO 2010). Since the nineteenth century, countries have reached peak manufacturing employment at incomes that are at around one third of the levels experienced before [1]. Although there are many countries striving for income growth through structural change, there is only a very limited amount of countries that have become 'developed' in terms of GDP and per capita income [2].

Correspondingly, it is contested to the least developed economies over the world whether the economic prosperity can be achieved through structural changes mechanism as developed countries. In the face of uncertainty surrounding economic and technological development, policy makers in many developing countries formulate ambitious goals for digitalization and its positive impacts on accelerating structural change. For instance, many African digital policies expect digitalization to lead to productivity growth, job creation, environmentally friendly digital transformation in industry, the adoption of digital transformation initiatives in all sectors and transforming countries into knowledge-based economies. However, the predicted impacts of digitalization are rarely supported in

theoretical or empirical evidence [3,4] and it is still unclear how digitalization will impact structural change in the long run.

2. literature review

- **(ROMÁN et al., 2021)**

They have found that growing interest in diversifying the economy, improving technology and specializing production again puts structural change at the center of economic development theory. The authors seek to fill this gap by using a synthetic indicator that reflects the dynamics of structural changes in the long run and allows to identify various patterns of development

- **(SHEVANDRIN et al., 2020)**

Their study is based on the quantitative assessment and identification of the relationship between economic growth and structural and technological changes in the economies of the regions, which allows us to conclude about the quality of the observed economic growth or factors of economic downturn. According to the research of scientists, it is concluded that there is no positive impact of structural changes on economic growth in the regions.

- **(DÁVILA-FERNÁNDEZ et al., 2020)**

They investigate and analyze the interaction of structural and institutional changes. Emphasis is placed on the sharp contrast between societies. Using Tearwall's law as a connecting

bridge, the authors present empirical evidence regarding the attitude and production structure for a sample of 20 Latin American and 14 Asian countries.

- **(SONI et al., 2020)**

They made empirical analysis of the nature and causes of structural changes in the Indian economy shows that industry and the economy are driven by the services sector, and the growth and dominance of the sector are influenced by external factors such as foreign direct investment.

- **(RAMSTETTER, 2019)**

The aim of the study is to assess the extent to which foreign direct investment in developing countries is associated with structural changes in the Asia-Pacific region.

- **TRESHCHEVSKY et al., 2018)**

The purpose of the article is to identify promising areas of structural change in the regions based on economic and statistical analysis. The authors propose for each group of municipalities promising areas of structural change in the economic and social spheres .

- **(SAVELIEV, 2013)**

The author of the article analyzes the regions, which allows to determine the factors of their competitiveness and assess how effectively they are used. According to the research results, standard strategies for modernization and increasing the competitiveness of regions are proposed.

3.Statement of the problem:

In the new economy, knowledge, skills and innovation are key inputs in the production function. Unlike traditional economies in which capital and natural resources represent key drivers of economic growth, the new economy entails building knowledge and innovation capabilities with a view to enhance productivity value-added of the board economic sectors (industrial, agricultural and services).

In accordance with the above, the research problem can be formulated in the form of set of questions:

- What are the main drivers of the variables under consideration (i.e digital transformation and structural change)?
- How far the technological innovation (digitalization)and the productivity of the board sectors related?

4.Objectives

Main objective: - This study pursues to analysis the relationship between digital transformation and structural changes by answering the mentioned earlier questions.

Following research sub-objectives would facilitate the achievement of this main:

1. Highlighting the drivers and determinants of structural change.
2. Providing recommendations to the policymakers in terms of the acceleration of the growth rates and enhancing the digital transformation process.

5.Hypothesis

It is hypothesized that:

Changes in relative sectoral prices, Real aggregate income, Input-output or sectoral linkages and International trade influences the process of structural change through its contribution to technology-driven productivity and share of employment in the board sectors (industrial, agriculture and service) of the economy in developing economies.

6. Drivers of structural change

There are four drivers of structural change first: Technology which affects productivity and thus sectoral prices, the next driver is Preferences whereas asymmetric demand drives the production of goods and services. Moreover, the third one is Input-output linkages since the dissociation of manufacturing processes is linked by more shares of intermediate inputs. The last one is Trade and Specialization concerning comparative advantage. Each one will be explained in detail.

6.1 Relative sectoral prices: 'technology-driven structural change'

Changes in relative sectoral prices result from the differences between sectors in using technology and technological progress and consequently the change in their productivity, hence the higher the relative sectoral productivity, the lower the relative sectoral cost of production and the price level, moreover the existence of these differences is closely related to the nature of the final product, with important implications in terms of innovation, rationalization, or labor division. This claim could be explained by a pioneer study of structural change driven by cross-sector differences in technology is (Baumol, 1967) model about the unbalanced growth, he divided the economic activities into two groups: technological progressive activities characterized by innovations, capital accumulation, and economies of large scale (i.e progressive) while the other activities are primitive and make irregular increases in productivity (i.e non-progressive).

Hence, structural change was regarded as a supply phenomenon. Sectors with low technical progress suffer from the" cost disease", i.e., rising relative costs and prices as the wages for the productive group will rise compared to the others but their productivity will serve as a compensation for the wage rising whereas the less productive cant present this compensation corresponding addition cost to the economy. Thus, the

technologically progressive sectors certainly add to the costs of the technologically unchanging sectors of the economy, unless somehow the labor markets in these activities can be sealed off and wages held constant, and he assumed that this phenomenon tends to make labor move in the direction of the non- progressive sector.

In a main document made by (Ngai & Pissarides, 2017), they have generalized Baumol's theory and provide it with stronger substances. They derive the conditions under which non-balanced technical progress – unequal (exogenous) rates of Total Factor Productivity (TFP) growth across sectors – can generate a balanced growth along with structural change in a multi-sector growth model with homothetic tastes and two production factors, namely labour and capital. In the model of (Ngai & Pissarides, 2017), structural change results from changes in relative (sectoral) prices driven by cross-sector differences in productivity growth. For the model to be able to reproduce the trajectory of the employment shares observed in the data for most advanced countries, a few assumptions need to be made. More particularly, in the case in which the elasticity of substitution across the broad sectors – agriculture, manufacturing and services – is relatively small, one needs to assume that productivity is growing at the fastest rate in agriculture and at the slowest rate in services.

Likewise, (Herrendorf et al., 2013) find that agriculture had the highest total factor productivity (TFP) in many of today's

advanced economies, however TFP in services grew the slowest. Hence, the hypothesis that sectoral variations in technological progress drive structural change is emphasized by evidence that labor movements happened from technologically progressive sectors to sectors with slow growth in TFP.

Changes in relative sectoral prices can also be related to sectoral differences in the elasticity of substitution between capital and labor as discussed by (Alvarez-Cuadrado et al., 2017), Their mechanism is as the wage to rental rate ratio changes, the more flexible sector will be the sector with a higher elasticity of substitution between capital and labor. As a result, sectoral capital–labor ratios grow at different rates, and the fractions of aggregate capital and labor allocated to a sector change by different amounts. It is even possible for the fraction of aggregate capital allocated to a sector to increase, while the fraction of labor declines. Therefore, structural change in their model ceases in the limit, and the economy eventually reaches a constant growth path where the fractions of employment and capital in both sectors are positive and constant.

Against this backdrop, (Herrendorf et al., 2015) Found that differences in labor–augmenting technical progress are the predominant force behind structural transformation and that sectoral Cobb–Douglas production functions with equal capital shares (which by construction abstract from differences in the elasticity of substitution and in capital shares) do a reasonably

good job of capturing the main trends of US structural transformation.

Other scholars have developed models in which changes in relative prices – which led the households to modify the sectoral allocation key for their total nominal income – are not driven by cross-sector differences in TFP growth rates. For instance, assuming that technological progress is neutral across sectors but differentiating between skilled and unskilled workers, (Caselli & Coleman, 2001) present a model in which the decline in effective education cost, a situation observed in the first half of the 20th century, increases the relative supply of skilled workers and so decreases the industries' of non-agricultural products, which are more skill intensive, thus contributing to a movement of labour out of agriculture and towards modern industries.

6.2 Real aggregate income: 'preference-driven structural change'

Changes in real aggregate income led to structural change through changes in the structure of demand, in other words, structural changes could be treated as a demand phenomenon. Based on Engel's consumption cycles the fundamental source of structural change is the hierarchical nature of wants which implies that structural change takes the form of a reallocation of resources from old to new industries to adapt with the consumers changeable needs and demands. Consequently, old industries

supply the necessities and new industries supply luxuries. (Echevarria, 2000)

Theoretically labeled as a possible driver of structural change, the existence of differences in income elasticity across sectors has logically been empirically investigated in the literature. A recent empirical study seeking to take explicitly into account both income and (relative) price effects on the demand for agricultural goods, manufactures and services, is provided by (Comin et al., 2015), They estimated a full demand system derived from non-homothetic CES preferences, using historical data on sectoral shares from 25 countries and household survey data for the postwar period. Among others, they found that the difference in the elasticities of income between agriculture and manufacturing is negative while the difference between services and manufacturing is positive. Moreover, they found that these differences are remarkably stable over time, a result which contrasts with some previous empirical studies and does not give support to the evolution of sectoral income elasticities observed in the model of, for example Foellmi and Zweimuller (2008).

According to the study of (Foellmi & Zweimüller, 2008), Structural change is driven by non-homothetic tastes, such as the Stone-Geary preferences, which generate non-linear Engel curves. Structural change results from variations in income elasticities over sectors. As income rises, the marginal rate of substitution between the different goods adjusts, prompting some

activity reallocation towards the sectors which provide goods meeting relatively higher hierarchical need. In line with this approach, the three broad sectors of activity – agriculture, manufacturing, and services – are supposed to satisfy the most and the least urgent needs as well as the most luxurious ones respectively.

Other studies find that goods which show a relatively strong growth in increased demand due to rising incomes – i.e. those with a high income elasticity – are more intensive in skilled labor based on a data set comprising 94 countries with a wide range of income levels, 56 broad sectors – including manufacturing and services – and 5 factors of production – including the disaggregation of skilled and unskilled labour – (Caron et al., 2014) show that the income elasticity varies considerably across goods from different sectors, with the production of income-elastic goods being (on average) more skilled-labour intensive.

6.3 Input-output or sectoral linkages

While the recent multi-sector growth literature has primarily investigated the final demand channels – particularly the income and relative price effects – through which the structural change process can take place in market economies, several studies stress the importance of taking explicitly into consideration the input–output – or sectoral – linkages, as firms offering final goods and services are in turn ‘consumers’ of

intermediates , whereas these interrelations have the potential to dramatically influence the sectoral allocation of labor and structural change.

As evidenced by (Jones, 2011) by means of input–output data, the share of intermediate goods in total gross output is about one half across a large range of countries, with large disparities across sectors of activity – for instance, services typically have a lower share. As a result, changes in the composition of intermediate goods, that is changes in the input–output linkages, have the potential to dramatically influence the sectoral allocation of labour and structural change.

Using an open-economy setting, (Sposi et al., 2015) also investigates the role of input–output linkages in affecting the allocation of economic activity across the three sectors (agriculture, manufacturing, and services). Documenting that input–output linkages systematically differ across levels of development, particularly the service intensity of manufacturing, they argue that there are two main channels through which input–output linkages matter for structural change. The first channel is related to how input– output linkages influence the impact of productivity shocks on relative (sectoral) prices. Thus, the impact of an increase in (relative) manufacturing productivity on (relative) manufacturing price is dependent on the use intensity of services as intermediate goods in manufacturing final production. Accordingly, a same increase in (relative)

manufacturing productivity translates into a larger decline in manufacturing price in developing countries – compared to rich countries – because they typically use manufacturing goods more intensively.

The second channel is related to how changes in final demand patterns map into changes in the sectoral structure of both value added and employment, which exclusively depend on input–output linkages. Sposi (2016) more exclusively examines the extent to which cross-country differences in intermediate-input intensities can explain cross-country differences in the composition of economic activity. As a result of a quantitative exercise, which consists of a set of counterfactuals, the author finds, among others, that cross-country differences in sectoral linkages account for about 74% of the curvature in the hump shape in the share of manufacturing in value added across levels of economic development. Accordingly, this is twice as much as can be explained by changes in the composition of final demand (final domestic expenditures plus net exports). These results clearly give support to considering input–output linkages in the study of structural change in future work. (van Neuss, 2019)

6.4. International trade

The role of trade in directing structural change has not been integrated in the majority of studies employing a multi-sector growth model. Neo-classical economic theory suggests that opening the borders between countries induces them to

specialize in – comparative advantages - industries and sectors. These national specialization processes which are driven by technology and factor endowments lead to structural change. Thus, a country's economic structure is directly influenced by the specialization patterns induced by international trade.

For instance, (Matsuyama, 2008) is one of the earlier studies that examined the impacts of globalization and trade on structural change and, more specifically, on the drop in manufacturing employment. He forms a simple two-country Ricardian model in which the representative household maximizes his utility over three consumption goods (food, manufactures and services), which are produced with technologies which are linear in labour – the only production factor. (Matsuyama, 2008) shows that a country characterized by comparatively faster productivity gains in manufacturing can delay or slow down its deindustrialization process.

Similarly, (Uy et al., 2013) also recommend a two-country (Ricardian) model of trade in which the reallocation across the broad sectors can occur over income and relative price effects, and over international trade according to international differences in relative (sectoral) productivity show that a country having or reinforcing a comparative advantage in the manufacturing sector due to lower trade barriers or lower transportation costs.

However, other authors argue that a lack of diversification and sophistication of production and export structure in line with

specialization in sectors of high comparative advantage is one cause for deteriorating incomes in middle income ranges (Wade, 2016). Conversely. (Felipe et al., 2012) found that by comparing the exports of countries in the middle-income trap with countries outside it, over eight dimensions capturing a country's abilities to experience structural transformation to exceeds the middle-income trap. Results found evidence for higher per capita income through more diversified exports.

TO empirically explore why some countries consistently better than others using four different aspects of competitiveness (technology, capacity, demand, and price), (Fagerberg et al., 2018)found that the former is one of the main explanations behind the continuing good growth performance of the Asian tigers relative to other major country groups. Deteriorating technology and capacity competitiveness are, together with an unfavorable export structure, the main factor hindering developing countries in misusing the capacity for catch up in technology and income. When unfavorable geography, nature and climate add to the effects of failing competitiveness serious problems may arise, as represented by the countries of Sub-Saharan Africa.

In the 1980s the emergence of Global Value Chain (GVCs) lead to a permanent restructuring of global comparative advantages, which are now known in terms of intermediate goods and services or specific tasks in the value chain, rather than just

in terms of final products. Pre-globalization of production, industrialized nations supplied the main part of manufacturing production, the G7 countries accounting for around 52% of global manufacturing value added in 1991. After that, North-South trade started to speed up. Firms from developed countries used managerial and manufacturing know-how in foreign markets to profit from lower wages in developing countries. Specialization began to happen on the level of stages of the production chain instead of on the country or sector level, causing a "denationalization" of comparative advantage. (Amador & Cabral, 2016)

Globalization enables the specialization in tasks and product parts, which reduces the individual capabilities needed to fulfill these tasks in global trade. However, trade gains were distributed unequally. The contribution of developing countries to manufacturing trade rose significantly for a few countries (China, Korea, India, Indonesia, Thailand, Turkey, and Poland) but remained low for all other countries, i. e. less than half a percentage point rise in manufacturing value added from 1990 to 2010 according to an analysis by (Baldwin et al., 2013).

In an ideal-typical scenario, trade is expected to foster technology transfer and technological learning between firms, sectors and national economies. For instance, organization of manufacturing processes in GVCs allows international firms to keep control over intellectual property and only passively

integrate local firms into labor-intensive parts of regional value chains with little or no technology and know-how transfer (World Trade Organization., 2012). This is also important against the backdrop that economic development in terms of employment growth and income growth not only requires more efficient production, but also increasing the variety and quality of output. (Saviotti, 2013)

7. Economic impacts of digital transformation

In this section, we review literature about the economic impacts of digitalization.

7.1 Impact of digital technologies on productivity and growth

A plethora of studies examine the relationship between digitalization and productivity. On an aggregate level, several studies indicate a positive relationship concerning the use of or the access to digital knowledge and the expansion of economies. For example, (Qiang et al,2021) assessed the macroeconomic effect of broadband for developing economies, this study represented a first attempt at macro econometric analysis and validation of the positive impacts that broadband, as a proxy for the more persistent role of networks, can have on economic growth. The empirical findings here propose that broadband's gains are major and robust for both developed and developing countries, although the significance is higher for the former, which have a longer track record of broadband transmission. Since, they a 10% increase in broadband penetration leads to a

higher (1.38%) GDP increase in developing economies than in high-income economies (1.21%).

(Irawan, 2014) corroborated these findings by highlighting the positive correlation between ICT usage and GDP growth. Likewise, (Donou-Adonsou et al., 2016) found that in sub-Saharan countries, telecommunication infrastructure and usage are positively correlated with economic growth. Implementing a broader perspective, (Strohmaier et al., 2019) examined the relationship among socioeconomic performance and digitalization using proxies as access and quality of broadband in Asian and Western countries for the period (2007 – 2016) and found positive evidence in almost all countries.

Furthermore, (Banga & Willem Te Velde, 2018) realized that a doubling of internet access rate enhances labor productivity by 10% on average for a sample of high- and low-income countries. While (Farhadi et al., 2012) hold that the effect of ICT access is higher in high-income countries relative to low-income countries. It worth to be mentioned that the positive effect of ICT penetration on economic growth diminishes with increasing penetration rates, as proved by (Vu, 2011).

Similarly, a World Bank (B. Mundial, 2016) report finds that labor productivity is 3.7 times higher in African firms using the internet, as opposed to firms without internet access. Moreover, the use of cloud computing was found to disproportionately foster the productivity of young firms through

reduced costs of learning about IT needs. Furthermore, there are gender-specific results regarding firm leadership. Whereas ICT access was found to increase business growth in microenterprises owned by women, (Chew et al., 2010) found little evidence that women microentrepreneurs used ICTs to participate in business relevant social networks, either by mobile or online. Also (Menon, 2011) Results implied that for firms with female owners, technology adoption enhances value-added per worker by about 49 percentage. It was also statistically evident that for such firms, the ownership of technologies such as computers, cellphones, and generators succeeded in mitigating the costs of business obstacles.

7.2 Impact of digital technologies on employment and income

(Autor et al., 1997) by making a time analysis of aggregate changes in the relative supply, wage, and wage-bill share of college graduates over the period (1940-1996) in U.S, they suggested robust relative demand growth preferring highly educated workers, also they found that skill upgrading increased within the industry concurrent with higher rates of employee computer, usage, computer capital per worker, and the rate of computer investment. Thus, skill-biased technological and organizational changes that accompanied the computer revolution appear to have contributed to faster growth in relative skill demand within detailed industries starting in the 1970s.

Subsequent studies built on interpreting the impact of the technical change on labor market outcomes, (Acemoglu & Autor, 2010) found that new technologies could substitute for tasks functioned by workers of various skill levels which is known as job polarization. Moreover, negative correlations between technical change and employment in middle-skill occupations were found, whereas positive correlations with low- and high-skilled occupations were found because of the redistribution of real wages of the middle group that is being directly replaced by the machinery more likely.

In addition, other studies found that the faster the growth in ICT in industries, the higher the demand for the most educated workers over workers with intermediate levels of education, consistent with ICT-based polarization. Moreover, technical change can account for up to a quarter of the growth of the college wage bill share in the economy as a whole (and more in the tradable sectors).(Michaels et al., 2014)

In this context, (Hjort & Poulsen, 2019) investigated how fast Internet affects employment on a sample of 12 African countries. They found a substantial and large increase in the employment rate in connected areas, also they pointed out that the technology's impact is driven by a rise in employment in higher-skill occupations. Furthermore, (Banga & Willem Te Velde, 2018) examined the future of production in developing countries in the context of growing digitalization, they found that

employment growth is not significantly different for firms with and without internet, implying that digitalization did not lead to substitution of labor in Kenya.

With regards to income effects, (DiMaggio & Bonikowski, 2008) investigate the relationship between internet use and earnings. Their analyses show robustly significant positive correlations among Web use and earnings growth, implying that some skills and behaviors associated with Internet use were compensated by the labor market. Consistent with human-capital theory, current use at work had the strongest effect on earnings. In contrast to economic theory (which has led economists to focus exclusively on effects of contemporaneous workplace technology use), workers who used the Internet only at home also did better, suggesting that users may have benefited from superior access to job information or from signaling effects of using fashionable technology.

Relating skill-biased technology with income effects in the U.S, (Atasoy, 2013) found substantial effects of broadband extension on the employment rate using a county and time fixed effects model: moving from no availability to full availability increases the percentage of population employed by 1.8 percentage points. The employment effect is larger in rural and more isolated areas.

In a study studying the skill complementarity of broadband in Norway, (Akerman et al., 2013) found that broadband

adoption promotes skilled labor over unskilled labor by increasing its relative productivity. The estimated increase in productivity of skilled labor is especially large for college graduates in high return fields such as science, technology, engineering, and business. It was estimated that in 2007 wages were 1.8% higher for skilled workers, but 0.6% lower for unskilled workers, than they would have been without broadband expansion.

Studies also investigated the relationship between digitalization and poverty eradication. (Katz & Callorda, 2013) find that broadband deployment in Ecuador has led to an increase in average income by US$ 25.76 (a rise of 3.67% annually) on a monthly income of US$ 353.45. Furthermore, this impact on income tends to increase with technology adoption (computers, Internet, dial-up access) noting the positive impacts of digitalization on poverty eradication.

7.3 Impacts of digital technologies on input-output linkages

Technology can be considered a condition and accelerator for the evolution of input-output structure, namely: vertical disintegration and specialization, outsourcing and "servicification". For instance, over recent decades, firms have progressively sought to specialize in their main competencies, outsourcing non-core activities to external suppliers. Facilitated by the gradual diffusion of ICT in the whole economy, this movement of vertical disintegration has been encouraged by

rising globalization, the rising complexity of business operations, the rising cost of monitoring workers, and the fast rate of technological progress in ever more specialized service activities. (van Neuss, 2019).

With respect to vertically disintegrated production processes, (Baldwin, 2006) concluded that all sorts of economic relationships were bundled spatially to prevent or minimize transportation, therefore, reductions in communication and coordination costs have enabled accounting in terms of value added and production stages rather than final products.

Particularly through the industrial applications of digital technologies, e.g. the industrial internet of things and automated data assessment, cost of fragmented production across firms, industries, and economies is expected to decline further . This opens up opportunities for firms to move into new industrial activities. However, this opportunity may depend on the level of sophistication of digital technologies on firm and industry level. (Hallward-Driemeier & M., 2017)

A study on the tea, tourism and business processes outsourcing sectors in Kenya and Rwanda(Foster & Graham, 2017) found that the digital integration of surveyed firms is marginal. Although there are efficiency gains and better networks, digitalization of respective firms did not improve their positioning in terms of upgrading the production process and executing tasks with higher value added.

With respect to outsourcing and "servicification", according to (Goldfarb & Tucker, 2019)a core theme about the impact of digitization on economic activity is that it has reduced a number of specific economic costs such as search, reproduction, transportation, tracking, and verification. In other words, it becomes easier and less risky to hire subcontractors for information-related tasks. Services become more efficiently tradable online.

Digital technologies provide individual workers with tools to execute more tasks, e.g.(Baldwin, 2012) presented an economic perspective of the future of global supply chains in the existence of interacting with suppliers and customers on platforms. As they will be affected by four main factors: 1) improvements in coordination technology that lowers the cost of functional and geographical unbundling, 2) improvements in computer integrated manufacturing that lowers the benefits of specialisation and shifts stages toward greater skill-, capital, and technology-intensity, 3) narrowing of wage gaps that reduces the benefit of North-South offshoring to nations like China, and 4) the price of oil that raises the cost of unbundling.

However, (Foster & Graham, 2017) highlighted perspective dependency toward how technology is attracted in a specific country or sector. Focusing on the Rwandan tea industry, they found that while the introduction of digital technologies can

remove intermediaries, it also forced sellers to adapt software systems, limiting their flexibility and adaptability.

7.4 Impacts of digital technologies on trade

Digital technologies lower the cost of communication, coordination, transportation, and information procurement, i. e. transaction costs which in turn facilitates trade.

For instance, (Meijers, 2014) found that internet use positively affects economic growth through promoting openness to trade and thus much more emphasized in non-high-income countries than it was in high income countries. Focusing on digitalization and trade in Africa, (Hjort & Poulsen, 2019) found more suggestive confirmation that fast Internet seemed to enable firms in Ghana, Kenya, Mauritania, Nigeria, Senegal, and Tanzania to export more, perhaps in part because online communication with clients became easier.

However, (Zanello et al., 2016) found that the empirical evidence is mixed, indicating geographic differences in profiting from technological opportunities. In one hand, they found that the economies witnessed a substantial and rapid spread of ICTs (internet and mobile phones) in most LICs that has reduced the state of "informational isolation" of many countries. Entrepreneurs could rely on information found on internet and the use of mobile phones allowed a more reliable and quicker communication within a country. This could also support a greater integration of national Institutions, for example better

connecting and coordinating Universities and research institutes. On the other hand, they found that using mobile phones to gain market information does not lead to increased selling to distant markets. Instead, the information is used to increase the bargaining power in closer markets.

(Unctad, 2017) emphasizes the discrepancy of e-commerce participation between developed and developing countries. As international trade becomes increasingly affected by the digitalization of economic activities, there is a growing need for countries to consider how best to address the interface between trade policies and Internet policies. At the bilateral level, a number of free trade agreements have included provisions related to e-commerce and cross-border data flows. Some plurilateral agreements have also included similar references, but their future was at the time of drafting this report highly uncertain. At the global level as well, it remains to be seen if and how issues related to e-commerce and the digital economy may be reflected in future work of the WTO. Although the size of the global e-commerce market was estimated at $23 trillion, 32% of global GDP, only 5 developing countries were placed in the top 50 among a ranking of e-commerce activity in countries.

References

Jones, C. I. (2011). Misallocation, Economic Growth, and Input-Output Economics. In *NATIONAL BUREAU OF ECONOMIC RESEARCH* (16742). http://www.nber.org/papers/w16742

DiMaggio, Paul., & Bonikowski, B. (2008). Make Money Surfing the Web? The Impact of Internet Use on the Earnings of U.S. Workers. *AMERICAN SOCIOLOGICAL REVIEW*, *73*, 227–250. https://doi.org/10.1177/000312240807300203

Katz, R., & Callorda, F. (2013). Economic Impact of Broadband Deployment in Ecuador. *Regional Dialogue on the Information Society*,. http://hdl.handle.net/10625/53797

Acemoglu, D., & Autor, D. (2010). *SKILLS, TASKS AND TECHNOLOGIES: IMPLICATIONS FOR EMPLOYMENT AND EARNINGS Skills, Tasks and Technologies: Implications for Employment and Earnings* (16082). http://www.nber.org/papers/w16082

Akerman, A., Gaarder, I., & Mogstad, M. (2013). *The Skill Complementarity of Broadband Internet* (7762). https://doi.org/10.1093/qje/qjv028

Alvarez-Cuadrado, F., Van Long, N., & Poschke, M. (2017). Capital-labor substitution, structural change, and growth. *Theoretical Economics*, *12*(3), 1229–1266. https://doi.org/10.3982/te2106

Amador, J., & Cabral, S. (2016). Global value chains: A survey of drivers and measures. *Journal of Economic Surveys*, *30*(2), 278–301. https://doi.org/10.1111/joes.12097

Atasoy, H. (2013). THE EFFECTS OF BROADBAND INTERNET EXPANSION ON LABOR MARKET OUTCOMES. *ILR Review*, *66*(2), 315–345. http://www.jstor.org/stable/24369536

Autor, D. H., Katz, L. F., & Krueger, A. B. (1997). *COMPUTING INEQUALITY: HAVE COMPUTERS CHANGED THE LABOR MARKET?** (5956). https://ssrn.com/abstract=225736

Baldwin, R. (2006). *Globalisation: the great unbundling(s)*. https://repository.graduateinstitute.ch/record/295612/files/Baldwin_06-09-20.pdf

Baldwin, R. (2012). *Asian Perspectives Global Issues Global Supply Chains: Why They Emerged, Why They Matter, and Where They Are Going* (FGI). www.fungglobalinstitute.org

Baldwin, R., Lopez-Gonzalez, J., Timmer, M., Miroudot, S., Johnson, R., Schott, P., & Bernard, A. (2013). *SUPPLY-CHAIN TRADE: A PORTRAIT OF GLOBAL PATTERNS AND SEVERAL TESTABLE HYPOTHESES* (18957). http://www.nber.org/papers/w18957

Banga, K., & Willem Te Velde, D. (2018). *DIGITALISATION AND THE FUTURE OF MANUFACTURING IN AFRICA*. https://set.odi.org/wp-content/uploads/2018/03/SET_Digitalisation-and-future-of-African-manufacturing_Final.pdf

Baumol, W. J. (1967). American Economic Association Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis. In *Source: The American Economic Review* (Vol. 57, Issue 3).

Caron, J., Fally, T., Markusen, J. R., Fontanie, L., Hallak, J. C., Hanson, G., Hausman, J., Helpman, E., Karp, L., Keller, W., Ligon, E., Maskus, K., Seidel, T., Simonovska, I., & Weinstein, D. (2014). International trade puzzles: A solution linking production and preferences. *The Quarterly Journal of Economics*, *129*(3), 1501–1552. https://doi.org/10.1093/qje/qju010

Caselli, F., & Coleman, W. J. (2001). Cross-country technology diffusion: The case of computers. *American Economic Review*, *91*(2), 328–335. https://doi.org/10.1257/aer.91.2.328

Chew, H. E., Ilavarasan, P. V., & Levy, M. R. (2010). The Economic Impact of Information and Communication Technologies (ICTs) on Microenterprises in the Context of Development. *The Electronic Journal of Information Systems in Developing Countries*, *44*(1), 1–19. https://doi.org/10.1002/j.1681-4835.2010.tb00316.x

C.Z.-W. Qiang, C.M. Rossotto, K. Kimura, Economic impacts of broadband, Information and communications for development 2009: Extending reach and increasing impact 3 (2009) 35–50.

Comin, D. A., Lashkari, D., & Mestieri, M. (2015). *STRUCTURAL CHANGE WITH LONG-RUN INCOME AND PRICE EFFECTS* (21595). http://www.nber.org/papers/w21595

Mundial, B. (2016). *DIGITAL DIVIDENDS,WORLD DEVELOPMENT REPORT 2016 ,Washington DC*. https://documents1.worldbank.org/curated/en/896971468194972881/pdf/102725-PUB-Replacement-PUBLIC.pdf

Donou-Adonsou, F., Lim, S., & Mathey, S. A. (2016). Technological Progress and Economic Growth in Sub-Saharan Africa: Evidence from Telecommunications Infrastructure. *International Advances in Economic Research*, *22*(1), 65–75. https://doi.org/10.1007/s11294-015-9559-3

Echevarria, C. (2000). Non-homothetic preferences and growth. *Journal of International Trade and Economic Development*, *9*(2), 151–171. https://doi.org/10.1080/09638190050028153

Fagerberg, J., Srholec, M., & Knell, M. (2018). The competitiveness of nations: Why some countries prosper while others fall behind. In *Innovation, Economic Development and Policy: Selected Essays* (pp. 233–258). Edward Elgar Publishing Ltd. https://doi.org/10.1016/j.worlddev.2007.01.004

Farhadi, M., Ismail, R., & Fooladi, M. (2012). Information and Communication Technology Use and Economic Growth. *PLoS ONE*, *7*(11). https://doi.org/10.1371/journal.pone.0048903

Foellmi, R., & Zweimüller, J. (2008). Structural Change, Engel's Consumption Cycles and Kaldor's Facts of Economic Growth. *JOURNAL OF MONETARY ECONOMICS* , *55*(7), 1317–1328. https://doi.org/10.1016/j.jmoneco.2008.09.001

Foster, C., & Graham, M. (2017). Reconsidering the role of the digital in global production networks. *Global Networks*, *17*(1), 68–88. https://doi.org/10.1111/glob.12142

Goldfarb, A., & Tucker, C. (2019). Digital economics. In *Journal of Economic Literature* (Vol. 57, Issue 1, pp. 3–43). American Economic Association. https://doi.org/10.1257/jel.20171452

Herrendorf, B., Herrington, C., & Valentinyi, ï¿½kos. (2015). Sectoral technology and structural transformation. *American Economic Journal: Macroeconomics*, *7*(4), 104–133. https://doi.org/10.1257/mac.20130041

Herrendorf, B., Rogerson, R., Valentinyi, Á., Caselli, F., Ngai, R., Schoellman, T., Ventura, G., & Carey, W. P. (2013). *We thank*. http://www.nber.org/papers/w18996.ack

Hjort, J., & Poulsen, J. (2019). The arrival of fast internet and employment in Africa †. In *American Economic Review* (Vol. 109, Issue 3, pp. 1032–1079). American Economic Association. https://doi.org/10.1257/aer.20161385

Irawan, T. (2014). ICT and economic development: Comparing ASEAN member states. *International Economics and Economic Policy*, *11*(1–2), 97–114. https://doi.org/10.1007/s10368-013-0248-5

Felipe, J., Abdon, A., & Kumar, U. (2012). *Tracking the Middle-income Trap: What Is It, Who Is in It, and Why?* (715). https://www.levyinstitute.org/pubs/wp_715.pdf

Matsuyama, K. (2008). Structural Change. In *The New Palgrave Dictionary of Economics* (pp. 1–6). Palgrave Macmillan UK. https://doi.org/10.1057/978-1-349-95121-5_1775-2

Meijers, H. (2014). Does the internet generate economic growth, international trade, or both? *International Economics and Economic Policy*, *11*(1–2), 137–163. https://doi.org/10.1007/s10368-013-0251-x

Menon, N. (2011). *Got Technology? The Impact of Computers and Cell-phones on Productivity in a Difficult Business Climate: Evidence from Firms with Female Owners in Kenya* (5419). https://dx.doi.org/10.2139/ssrn.1741607

Michaels, G., Natraj, A., & Van Reenen, J. V. (2014). Has ICT polarized skill demand? Evidence from eleven countries over twenty-five years. *Review of Economics and Statistics*, *96*(1), 60–77. https://doi.org/10.1162/REST_a_00366

Ngai, L. R., & Pissarides, ChristopherA. (2017). Structural Change in a Multisector Model of Growth. *The American Economic Review*, *97*(1), 429–443. https://doi.org/10.1257/000282807780323460

Saviotti, P. P. (2013). FROM NECESSITIES TO IMAGINARY WORLDS: STRUCTURAL CHANGE, PRODUCT QUALITY AND ECONOMIC DEVELOPMENT. *Technological Forecasting & Social Change*, *80*(8), 1499–1512. https://ssrn.com/abstract=4156280

Sposi, M., Crucini, M., Felice, G., Lewis, K., Pandey, M., Yi, K.-M., & Zhang, J. (2015). *Federal Reserve Bank of Dallas Globalization*

*and Monetary Policy Institute Evolving Comparative Advantage, Sectoral Linkages, and Structural Change *.*

Strohmaier, R., Schuetz, M., & Vannuccini, S. (2019). A systemic perspective on socioeconomic transformation in the digital age. *Journal of Industrial and Business Economics*, *46*(3), 361–378. https://doi.org/10.1007/s40812-019-00124-y

Hallward-Driemeier, & M., & N. G. (2017). *TROUBLE IN THE MAKING? THE FUTURE OF MANUFACTURING-LED DEVELOPMENT*. https://ieg.worldbankgroup.org/sites/default/files/Data/reports/images/TroubleintheMakingThe%20FutureofManufacturing.pdf

Unctad. (2017). *Information Economy Report 2017*. https://unctad.org/system/files/official-document/ier2017_en.pdf

Uy, T., Yi, K.-M., & Zhang, J. (2013). Structural Change in an Open Economy. *JOURNAL OF MONETARY ECONOMICS*, *60*(6), 667–682. https://doi.org/10.1016/j.jmoneco.2013.06.002

van Neuss, L. (2019). THE DRIVERS OF STRUCTURAL CHANGE. *Journal of Economic Surveys*, *33*(1), 309–349. https://doi.org/10.1111/joes.12266

Vu, K. M. (2011). ICT as a source of economic growth in the information age: Empirical evidence from the 19962005 period. *Telecommunications Policy*, *35*(4), 357–372. https://doi.org/10.1016/j.telpol.2011.02.008

Wade, R. H. (2016). Industrial Policy in Response to the Middle-income Trap and the Third Wave of the Digital Revolution. *Global Policy*, *7*(4), 469–480. https://doi.org/10.1111/1758-5899.12364

World Trade Organization. (2012). *World trade report 2012 : trade and public policies : a closer look at non-tariff measures in the 21st century*. World Trade Organization.

Zanello, G., Fu, X., Mohnen, P., & Ventresca, M. (2016). THE CREATION AND DIFFUSION OF INNOVATION IN DEVELOPING COUNTRIES: A SYSTEMATIC LITERATURE REVIEW. *Journal of Economic Surveys*, *30*(5), 884–912. https://doi.org/10.1111/joes.12126

C.Z.-W. Qiang, C.M. Rossotto, K. Kimura, Economic impacts of broadband, Information and communications for development 2009: Extending reach and increasing impact 3 (2009) 35–50.