

The Structural Change Theory – An Analysis of Success and Failures of Technology

John Stephen Agbenyo

Faculty of Social Science, St. Paul's University, Kenya

Abstract: - The key aim of this paper is to look at the role of technology in the structural change theory and to do an analysis of the success and the failures of technology within the context of the structural change theory. The paper begins by giving an overview of the structural change theory focusing on the Lewis Theory of Development.

The paper cites two case studies of the introduction of one technology or the other in an economy and how that has been sustainable or not.

Keywords: Structural Change, Dual Economy, Technology, Development

I. INTRODUCTION

Development means different things to different people. Development is multidimensional. It is a process that involves major changes in the social structures, attitudes and institutions. It also involves the acceleration of economic growth, the reduction of inequality, and the eradication of poverty. (Todaro & Smith, 2012, p. 16)

The concept of development has greatly informed public policy across the world. Development connotes “growth”, “progress”, “increase”. It is most commonly described as the creation of jobs and wealth, and the improvement of quality of life. It is a process that influences growth and restructuring of an economy to enhance the economic well being of a community. It is a set of changes that are interrelated to the structure of an economy. (Moshe Syrquin & Chenery, 1989)

The main goal of economic development is improving the economic well being of a community through efforts that entail job creation, job retention, tax base enhancements and quality of life.

The concept of development received close attention only after the end of World War Two. This attention led to various scholars researching into varied theories of development.

One of these theories is the structural change theory. According to Sewell, structure refers to any recurring pattern of social behaviour; or, more specifically, to the ordered interrelationships between the different elements of a social system or society. Social structure is generally agreed to be one of the most important but also most elusive concepts in the social sciences (Sewell 1992). It is sometimes used to refer to any observable „pattern“ in social activities, and empirical researchers, for example, have referred to statistical. Structural changes appear when some part or properties are

lost or added to the object, some relations appear, disappear or change their form. In other words, SC imply changes in the object identity.

The structural change theory focuses on the mechanism by which underdeveloped economies transform their domestic economic structures from a heavy emphasis on traditional subsistence agriculture to a more modern, more urbanized and more industrially diverse manufacturing and service economy.

II. THE LEWIS THEORY OF DEVELOPMENT

William Arthur Lewis was born on January 23, 1915 in the West Indies. In 1979 he was named a Nobel Prize winner in Economics. This was in recognition of his works on economic development and in particular developing a model on trade between developed and the less developed countries in relation to labour and productivity in agriculture. (“The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 1979,”).

Between 1957-1963, he served as an Economic Adviser to the Prime Minister of Ghana, Dr. Kwame Nkrumah.

In the late 1970s, there were visible changes in the socio-political world order. This led to a lot of interest in issues of structural changes. Structural change theories primarily focused on the mechanism by which underdeveloped economies transform their domestic economic structures from a heavy emphasis on traditional subsistence agriculture to a more modern, more urbanized and more industrially diverse manufacturing and service economy. (Moshe Syrquin, 1988).

Arthur Lewis has contributed greatly to the discussions on Structural Change. His theory, the Arthur Lewis Structural Change theory tries to explain the growth of a developing country in terms of labour transition between two sectors. As a result of this, his theory is sometimes also called the dual economic theory. It focuses on labour being transferred between 2 sectors.

The Agricultural Sector

This sector is also sometimes referred to as the subsistence, traditional or indigenes sector. In this sector, land is limited and mainly has to do with agricultural produces such as crops, grains, etc. There is an unlimited supply of labour with low or sometimes even zero marginal productivity of additional labour. Wage at this level is rated at the subsistence level.

The Industrial Sector

The modern, manufacturing or industrial sector on the other hand is said to be expansionary in nature. It is growing in nature. The main motive in this sector is to maximise profit by charging a price higher than the set wages. It focuses on more profits and higher wages. The wage that is provided under this sector is higher than what is provided in the agricultural sector. As a result, it serves as an incentive for the labour to migrate from the agricultural sector to the industrial sector.

Structural Change therefore sees economic development as a set of interrelated structural changes. This mainly has to do with the move from being an under developed country to a developed country. This requires a set of structural changes to sustain a continuing increase in income and social welfare” (Chenery, 1982)

The agricultural sector plays a role in the GDP and employment of most developing countries. A prominent view to understand the impact of agricultural technology in contrast to agricultural productivity was contributed by Markus Eberhardt and Dietrich Vollrath (Eberhardt & Vollrath, 2016) using a simple model of the process of structural change and development. Technology plays a critical role. But to what extent has this been successful?

According to a UN working paper, technological advancement fuels productivity growth. (Szirmai, 2008, p. 9). The paper further opines that technological success is success that generates further success. “Once dynamic processes of economic and technological change have been set in motion, these mobilise and call forth new talents and resources, which contribute to further development (Szirmai, 2008, p. 9).

Focusing on what is called the Asian Miracle or the Chinese Miracle, the paper opines that it is a misnomer. This is so because according to the paper, “very high growth rates are the normal pattern in a catch up process, where technological backward countries can profit from international available technological knowledge without bearing the costs and risks of developing new knowledge. If catch up takes place, it is usually happens very rapidly. If not, then a country will continue to fall behind” (Szirmai, 2008, p. 12).

For the analysis of success and failure in long-run economic development, the paper focuses on the framework of proximate and ultimate sources of growth developed by among others Angus Maddison (1988). The proximate sources of growth suggest ways in which countries can try to improve their position in the international technology and productivity race. The proximate sources refer to the directly measurable sources of growth of output such as capital accumulation, embodied technological change, growth of labour input and human capital. (Szirmai, 2008, p. 13)

Changes in science and technology are among the ultimate sources of increases in productive capacity. The locus of such change is in the most advanced economies of the world economic order. From there technological change spreads and

diffuses to those developing countries that have sufficient absorptive capacity to profit from global technological change. For some countries technological change creates new opportunities for catch up and even technological leapfrogging. Thus, rapid advances in communication and information technology in the post-war period allow for the emergence of global production chains and the rapid outsourcing of large parts of manufacturing production to developing countries.

Szirmai (2008) focuses on 3 propositions that influence success and failure in development. Two of these propositions that focus on technology are that;

1. Technological change is generated in the leading economies of the international economic order.
2. Developing countries that are able to absorb internationally generated technology can profit from the advantages of technological backwardness. They can experience accelerated catch up. Countries that are not able to absorb technology will tend to fall behind.

The paper opines that given the location of technological advancement, catch up in the post-1950 globalised economy is only possible if developing countries develop the capabilities to acquire, master and adapt international technology. There is not a single example of successful catch up since the late nineteenth century which did not involve tapping into international technology – e.g. Germany, Russia, Japan, Korea, Singapore, Taiwan and Hong Kong, China and India. The countries that, for some reason or other, are not able or not willing to tap into global technology flows, are the countries that are falling behind and are becoming marginalised in the world economy (Szirmai, 2008).

Case study 1 - Organic and Inorganic/Mechanized Agriculture

By the end of the 19th century, there was a great technological influx that revolutionised food production. The invention and use of farm machines, agrochemicals (pesticides, fertilizers, weedicides), and hybrid seeds led to an increase in total food production globally. (Eberhardt & Vollrath, 2016) The per capita food produced in the world annually increased by 15 percent over the past thirty-five years. (Rosset, 2000, pp. 203–213) Countries that have adopted this mechanized system of agriculture, have had their agricultural output increased by a hundred-fold. For example, technological development in Agriculture led to an increase in farm output by 170% between 1948-2015 in the United States, with just 2% of the population employed in the agricultural sector, compared to Ghana’s agricultural output (low mechanized and rain-fed method of farming), that continues to experience decline for the past 25 years, although it employs the highest percentage of the population (44.7%). (Wang, 2018). The United States is still one of the leading agricultural export as a result of its mechanized system of farming adopted over 40 years ago. In 2017, the country made an amount of \$59.3 billion from

agricultural export alone (United States Department of Agriculture, 2018). In this situation, technological intervention in the Agricultural sector have been successful.

Despite the successes indicated above, there is an extensive debate on the use of chemicals in food production and its effects on health and on the environment as a whole. According to the World Health Organisation, (WHO), globally, an estimated three million cases of pesticide poisoning occur every year, resulting in an excess of 250,000 deaths (WHO, 2004).

Inorganic foods have been associated with increased incidence of miscarriage, birth malfunctions, still births and delayed pregnancy (Ransom, 2002). Pesticides, herbicides and fertilizers have been implicated in human studies with leukaemia, lymphoma, aplastic anaemia, soft tissue sarcoma and cancers of the breast, brain, prostate, testis and ovaries (IARC, 2015).

The International Agency for Research on Cancer (IARC) in its recent evaluation has found "sufficient" evidence of carcinogenicity in eighteen Pesticides, herbicides and fertilizers applied in food production.

Thus, the extensive use of chemicals and antibiotics in inorganic food production technology and the impact in all three dimensions of sustainability has compelled the health-conscious people to explore alternative method of food production and support organic foods. (Kumar, Singh, Krishna, Anokhe, & Prakash, n.d., pp. 390–394)

Several years ago, Africa was predominantly an organic agrarian economy. Mostly done on the subsistence level. Then modernized agriculture was introduced. Africa gradually developed huge appetite for modernized agriculture. The irony however was that when so called developed countries saw the need now for organic foods and started turning away from the science-based farming in the 1980s, external assistance for agriculture in poor countries was cut sharply. The U.S. Agency for International Development which was devoting 25% of its official development assistance to the modernization of farming has today dropped its assistance to just 1%. Years ago, nearly 30% of World Bank lending once went to agricultural modernization. Today, however, this has been reduced to just 8%. (Paarlberg, 2008)

Case study 2 -Herbal Medicine and Modern Medicine

The birth of modern medicine is regarded as the most significant technological invention in human history and it indicates the enormous efforts of humans preventing death from cheating life. For example, the invention of vaccines represents the holy grail in modern medicine. The World Health Organization estimates that vaccines prevent 2 to 3 million human deaths annually, and these numbers would increase by at least 6 million if all children received the recommended vaccination schedule (WHO, 2017). Prevention, cure, longevity and well-being have been the trademark of contemporary medicine over the years.

However, recent studies have shown some flaws in this technology.

As of 2013, it is reported that globally, an estimated 142,000 people have died from adverse effects of medical treatment, up from 94,000 in 1990 (Vos et al., 2015). Medical imaging (radiology), introduced in 1895 for diagnosing and treatment of diseases within the body has been attributed to increased longer-term risk effects of cancer, infertility and hair loss (WHO, 2016).

Herbal medicine has been recommended for the treatment of chronic disease such as diabetes, heart diseases, kidney diseases and HIV/AIDS for which modern medicine is unable to (WHO, 2003; Mills et al., 2005; Zou et al., 2012). In China, for example, herbal preparations account for 30% - 50% of the total medicinal consumption, and largely recommended for the treatment of patient's long ailments, chronic sore or fracture. In Ghana, Mali, Nigeria and Zambia, the first line of treatment for 60 percent of children with high fever resulting from malaria is the use of herbal medicines at home, with high efficacy rate (WHO, 2003).

It is an undeniable fact that modern medicine has a significant role in the treatment of large numbers of diseases. However, modern medicine had been flawed in the treatment of chronic diseases. For example, the traditional African herbs called Hypoxis and Sutherlandia have been recommended as herbal medicines for the treatment of HIV (Mills et al., 2005). WHO therefore recommends the integration of traditional medicine and modern medicine to improve health outcomes?

III. FROM THE RURAL AGRICULTURE SOCIETY TO THE URBAN INDUSTRIAL SOCIETY

To propound on the basic sectors of development as explained in the Arthur Lewis structural change theory, we shall closely look at the transition with technology as the primary backbone and point of distinction between those countries that developed and those that were left behind.

The structural change had enormous dynamics in the shifting and transformation of an agricultural sector to an industrial industry. One of them is the productivity growth that extensively affects workers. Thus these two industries operate in an open market economy with the income generation of industries being higher than the agricultural sector.

The same has been witnessed from an employment point of view; the agricultural sector generally under-employs workers and bears a labour productivity which is null, this has of course caused an instant transfer of workers to the more productive industrial sector. Increased labour has an abrupt impact on profits eventually leading to a self-sustaining economy. The transformation of modern economics is quite phenomenal according to Lin (2009) it has moved from the subsistence agriculture to the post industry, heavy industry, then the high tech industry and finally a post industrialisation phase that boasts of a sustained growth as discussed already. This has

been the basis of the evolution and success of technology and can be summarised into:

1. Technical innovations leading to improved quality and lower production costs in accommodating labor.
2. A dynamic industrial change process which is inclusionary of the development of different goods and services produce continuously.

To get a better understanding of this shift we must first analyse the sequence of structural change and specifically the manufacturing industry since it's the "urban one", this is subsequently related to the changing structures of infrastructure which wholly denotes the role and success of technology. The sequence involves:

- i. The transition from primary and light industry sectors to large scale processing industries such as cement.
- ii. The emergence of the capital goods sector and its transformation into a key sector
- iii. The emergence of high technology industries

These three proponents undeniably form a unifying mutual relationship on each other. For example the high technology phase takes place after a capital sector has been well developed and these two eventually amount to the transition to large scale processing. This sequence has been highly acclaimed and successful in the economic development of countries like South Korea, India and Brazil (Justman and Teubal, 1991).

This paper has highly stressed the component of an economic growth to an increasing labour force bringing intangible capital through their skills, as opposed to the neoclassical perspective which mainly emphasised on the accumulation of physical capital. It has so far been successful generating business opportunities and new sources of inputs (Justman and Teubal, 1991). This can be correlated with the concept of proximate, intermediate and ultimate sources of growth to further analyse the role technology has played. Some countries have heavily adapted to the technological race that has waged an economical growth rate for centuries, however technology cannot always improve the structure of a country unless it is accompanied by these proximate sources and that brings us to some of the inevitable failures of technology. The most obvious fact has been the dynamic shift caused by technology from a laborforce oriented economy to an unemployed one, which many people opting out of the economic growth to seek employment elsewhere. This has led to a subsequent wave of brain drain.

The second problem has been transferring technology from an economic sustainable country like United States, China, and Korea to the developing countries. Furthermore the crippling investments needed to explore technological advancements that will push the modern manufacturing sector forward are a hindrance. The agricultural sector is the main driving force in most developing countries so it is only right for the transfer of

technology to be made easier by the expansion of markets in these countries and a positive attitude towards the dynamics associated to technology (Loo, 1999).

IV. TECHNOLOGICAL INVENTIONS AND ECONOMIC GROWTH

Now that we have thoroughly assessed the transformation of the economy from a tradition focused agricultural sector to the modern manufacturing empire. We must delve deeper into the role that technology has played and to be specific, how technological innovations have been a successful hit in driving the economic growth bandwagon. Innovations have enabled enterprises to differentiate, give rise to imperfect competition and broaden the market sharing economy. (Zalewski and Skawinska, 2009). The modern technological landscape has been pushed to automation and artificial intelligence, so it is only right to focus on how these will improve the growing economy of nations

So far technological innovations have transformed society and increased labour productivity in the following ways.

1. Replacing workers with machines hence cutting down on cost and producing better and qualified output
2. Boosting existing workers by supplying them with better and faster tools
3. Giving rise to a bigger technological driven industry.

This has definitely has a ground breaking improvement in the structural change developed by Arthur Lewis the main sector has now been fully transformed into a modern one.

V. CONCLUSION

The concept of development has greatly informed public policy across the world. Development It has been defined in terms of the quantitative increase in the economy of a country with an aim to achieving consistent rates of growth of income per capita.

Th structural change module which have primarily focused on the mechanism by which underdeveloped economies transform their domestic economic structures from a heavy emphasis on traditional subsistence agriculture to a modern, urbanized, and more industrially diverse manufacturing and service economy can be put to test.

As can be clearly gleaned from the two case studies above, while the movement from a heavy emphasis on traditional subsistence agriculture to a more modern, more urbanized and more industrially diverse manufacturing and service economy with technology at the heart, the introduction of technology per se in changing the structure of an economy does not mean success or sustainability for the said economy. On the other hand, the myth of indigenous technology suggests that there exists what is called "appropriate, indigenous technology" which is more adapted to the needs and traditions of developing countries. These technologies are mainly small scale, environmentally friendly, integrated into traditional

culture, etc and thus most likely not provide the momentum for growth and leapfrogging that is required to lift millions of people out of poverty.

Furthermore thisurbanized and diverse manufacturing economy is set to continually use the improving technological innovations. Despite the downsides that it has had like the problem associated with transferring technology to developing countries, enlarging market economies to accommodate it and the large investment plans that are required to fully catch up with the developed countries.

REFERENCES

- [1] Chenery, H. B. (1982). *Industrialization and growth: the experience of large countries* (No. SWP539; p. 1). Retrieved from The World Bank website: <http://documents.worldbank.org/curated/en/943471468741380757/Industrialization-and-growth-the-experience-of-large-countries>
- [2] Eberhardt, M., & Vollrath, D. (2016). The Effect of Agricultural Technology on the Speed of Development. *World Development*, 109, 483–496. <https://doi.org/10.1016/j.worlddev.2016.03.017>
- [3] Kumar, R., Singh, S., Krishna, K. R., Anokhe, A., & Prakash, N. R. (2017). *ORGANIC FARMING OF VEGETABLES: PROSPECTS AND SCENARIO*. 6 (2), 6.
- [4] Loo, D. I. (1999). The Impact on Economic Growth: Some New Idea and Empirical Considerations. *MERIT*. 6 (12), 1-10.
- [5] Lin, Y. J. (2009). Economic Development and Structural Change. *The World Bank*. 1-14.
- [6] Paarlberg, R. (2008, February 29). Africa's organic farms. *The New York Times*. Retrieved from <https://www.nytimes.com/2008/02/29/opinion/29iht-edpaarlberg.1.10576543.html>
- [7] Rosset, P. M. (2000). *Cuba - A Successful Case Study of Sustainable Agriculture*. 8.
- [8] Syrquin, Moises, & Chenery, H. B. (1989). *Patterns of development, 1950 to 1983*. In *World Bank Discussion Papers: Vol.41*. Washington, D.C: World Bank.
- [9] Syrquin, Moshe. (1988). Chapter 7 Patterns of structural change. In *Handbook of Development Economics* (Vol. 1, pp. 203–273). [https://doi.org/10.1016/S1573-4471\(88\)01010-1](https://doi.org/10.1016/S1573-4471(88)01010-1)
- [10] Szirmai, A. (2008). *Explaining Success and Failure in Development*. 46.
- [11] The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 1979. (1992). Retrieved February 23, 2019, from <https://www.nobelprize.org/prizes/economic-sciences/1979/lewis/biographical/> website: <https://www.nobelprize.org/prizes/economic-sciences/1979/lewis/biographical>
- [12] Todaro, M. P., & Smith, S. C. (2012). *Economic development* (11th ed). Boston, Mass: Addison-Wesley.
- [13] Wang, S. L. (2018). *Agricultural Productivity Growth in the United States: Measurement, Trends, and Drivers*. 78.
- [14] Zalewski, I, R .Skawisnka, E. (2009). Impact of Technological Innovations on Economic Growth. *Systemics, Cybernetics and Informations*. 7(6).2-6.