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CROSSING THE POVERTY CHASM: PRESCRIPTION FOR NIGERIA'S INDUSTRIALIZATION

Ejo-Orusa, Henry PhD

Department of Management, Faculty of Management Sciences, Rivers State University, Port Harcourt, Nigeria.

ABSTRACT

Nigeria has been trying to induce industrialization with the aim reducing poverty since its First National Development Plan of 1962/68 but has nevertheless retrogressed from being a middle income country in the 1970s to the poverty capital of the world in 2018. This poor economic performance calls for introspection. Drawing from the early canons of economic thought and from the history of industrial evolution, it is observed that poverty reduction comes from wealth creation which is intricately dependent on the capital goods sector. This stems from the fact that the sector is responsible for operationalizing inventions and innovations, perfecting the designs and production of all the machines and equipment that are in turn used for the production of all other machines - computers, robotics, 3-D Printing, AI and other emerging technologies – and the development of technological capability in the economy. Just like the woman's womb, the capital goods sector is the reproductive centre of the economy par excellence and the progenitor of all other industrial products. Thus, without a dynamic indigenous capital goods sector, the economy is technically 'barren' or in a stationery state. Unfortunately, this ubiquitous sector is absent in Nigeria and many less developed countries because their policy makers prioritize the finished products of industry over capital goods and technological capability which ensure the continuous birthing of new life-changing products that define our civilization and constitute the true novelty of industrialization. The nexus between the capital goods sector and the development of technological capability is demonstrated by focusing on technological learning-by-doing and technological entrepreneurship. It is argued that a populous country and a major oil exporter like Nigeria has the potential to satisfy the first two preconditions for the viability of the strategy - availability of investment capital and absorptive capacity. However, to invoke the cycle of indigenous industrial revolution, policies that will incentivize local and foreign organizations to invest in the capital goods sector (perhaps the most limiting precondition) must be put in place and the economic drivers must also intelligently actuate the creative destruction and or the reinvention of the socio-economic and institutional factors militating against economic development.

KEYWORDS: *Capital Goods Sector; Technological Capability; Wealth Creation; Technological Entrepreneurship; Technological Learning-By-Doing*

INTRODUCTION

Rethinking Nigeria's Industrialization Strategy

This paper is about why Nigeria is finding it difficult to achieve economic development and how to rewrite the narrative. Therefore, the logical starting point for addressing the matter is to brush aside the definitional, theoretical and conceptual controversies (Nafziger, 2005; Lal, 1985; Meier, 2005) often woven around development and focus more precisely on the heart of the matter - the people. Despite the proliferation of schools of thought and perspectives on development, there is nevertheless widespread consensus that the primary goal of economic development is the reduction or elimination of poverty (Seers, 1969; Sachs, 2006; Banerjee & Duflo, 2011; Vazquez & Sumner, 2013). Quite clearly, life in the 21st Century is so intractably dependent on the products of industry that modern civilization will grind to a halt without them and many people in less developed countries (LDCs) are quite rightly dreaming to partake of humanity's quantum leap in industrial progress. Therefore, industrialization is not just the distinctive feature of rich countries, it is also the only known panacea for poverty reduction.

Interestingly, Nigeria has been trying to promote industrialization starting with the 1962/68 development plan which predicted the attainment of technological and self-reliant development which it was hoped would significantly reduce poverty before the fourth plan period. Unfortunately, with Nigeria now adjudged by the Brookings Institution and some

United Nations agencies to be the poverty capital of the world ahead of India, it is clear that her industrialization objectives have not been met. The time is therefore long overdue for retrospection. To understand why Nigeria and indeed many other less developed countries (LDCs) are not industrializing and therefore have not meaningfully reduced poverty, we have to start by reframing and rethinking economic development. In doing this, the question that should agitate the minds of scholars, policy makers, politicians and 'intellectuals' who are the architects of Nigeria's economic underdevelopment should be informed by the historical process of industrial evolution on the one hand and economic theory on the other. Simply put, the matter can be summarized thus:

How is wealth created?

Curiously, the issue of wealth creation is conspicuous by its absence in the economic development literature and thus most of those who have attempted to explain why Nigeria and other less developed countries (LDCs) have remained poor fail to explore the matter based on requisite knowledge. Rather, they tend to concentrate overly on issues like imperialism and colonialism and lately some uniquely Nigerian socio-economic, political and institutional challenges like true federalism, resource control, corruption and democracy to mention only but a few. These are without doubt very important for economic development and a lot of ink and intellectual energy have been devoted to them but it has to be stressed that they did not conduce to the evolution of modern industry or to Nigeria's underdevelopment for that matter. They are in large part symptoms of underdevelopment and wealth distribution issues that moderate the wealth creation process. But wealth must first be created before distribution and issues that impinge on wealth distribution must therefore be visualized as the capstone rather than the cornerstone. Therefore, to borrow a football analogy; from the standpoint of stimulating industrialization and wealth creation in Nigeria, many issues that are the hobby horse of many scholars are 'off-target.'

Quite clearly, all the industrialized and semi-industrialized countries of today had unresolved socio-economic and political challenges of one form or another at the time of their industrial take-off. In some cases these challenges still remain but they did not stop them from becoming industrialized. In fact, many new and more potent challenges emerge after industrialization because as societies become more affluent, they also become more complex and sophisticated and citizens become more demanding about their needs and expectations. However, despite the obvious differences in the economic and industrial history of various countries and in the forces and factors that shaped and determined them, there is one factor that is fundamental for wealth creation which is common to all the industrialized countries. Therefore, at the risk of being considered to be deterministic in our conceptualization of development, we go ahead to conjecture that industrialization has its own internal dynamic or *motive force*. According to Ejo-Orusa (2014a), emphasis on the wrong factor(s) when attempting to promote industrialization is analogous to the case of medical myopia where if the problem is not properly diagnosed and thus the patient is left untreated, or treated for the wrong ailment, the situation will deteriorate and the patient may even die. For economies, continued relative economic decline is inevitable. Thus, to significantly reduce poverty, Nigeria must learn to create wealth by accurately isolating, understanding and internalizing the key factor behind modern industrialism.

With utmost respect to contemporary development economists, practitioners and policy makers in the LDCs, they have shown unpardonable ignorance about the *motive force* of the industrial society and have therefore failed, and are still failing, the industrialization leitmotif test by a wide margin. Their economic prescriptions are consequently never based on solid understanding of the historical process of industrialization or economic theory. These pseudo-experts are not different from blind watchmakers or native doctors who work by trial and error and expectedly end up with contortions that are not symptom or organ specific, contain questionable and variable concentrations of the active ingredients, and have no indication of the possible side effects or the antidotes. But as unscientific as native doctors are, their prescriptions have a better chance of making patients better than the jaundiced economic prescriptions of the pseudo-experts transforming a backward traditional society to an affluent industrial economy.

Regrettably, not only are development practitioners in Nigeria still ***'planning without facts'*** as Wolfgang Stolper (1966) pointedly reminded us in his book with the same title, they have descended further down the road of historical and intellectual amnesia to plan without knowledge and understanding. This is a serious indictment of Nigeria's 'intellectual' community and they should do well to start acquiring the knowledge that will enable them to enrich their thinking and begin the quest to search and hopefully discover the missing ingredient that will make their prescriptions for industrialization more efficacious. To properly understand economic development in general and wealth creation and poverty reduction in contemporary LDCs in particular, we have to go back to the Industrial Revolution which started in England around the 1700s and the foundation fathers of economic thought.

INDUSTRIALIZATION AND WEALTH CREATION:

Perspectives from Early Economists

Adam Smith's Wealth of Nations which was published in 1776 is clearly the natural starting point for exploring the issue of wealth creation (Smith, 1983). Although Smith's treatise was mainly devoted to the doctrine of trade which was critical to the British Isle of his time, he aptly realized that trade was not by itself the motive force behind economic development. He thus used his framework to formulate a theory of economic development in which the 'division of labour' played the key role. In Smith's schema of the economic development process, the division of labour is the primary driver of economic growth through the fact that it promotes specialized inventions and the improvement of machinery. The inventions and improved machinery so generated in turn give rise to cheaper, more and new products which give the economy comparative advantage in international trade. The economy is therefore, able to win a large share of the market and to generate increased profit which is further reinvested to create new, improved and or more machinery. This in turn keeps the industrialization process going and takes the economy to a higher level of mechanization.

A measure of the importance Smith attached to wealth creation and the stamp of his authority as an unsurpassed development economist is discernable from his famous case study of a pin manufacturing factory that applied the principles of division of labour in its operations. In this well recounted case study, after the introduction of the division of

labour, each worker performed one or two of the eighteen specialist tasks involved in making a pin and ten workers produced over 48,000 pins a day; an average of 4,800 pins per workman per day. However, before the application of division of labour, each workman produced between 1 and 20 pins a day. Thus, the application of division of labour increased productivity geometrically. The true significance of the division of labour and the application of machinery in production for economic development comes to the fore when it is realized that the productivity improvements are continuous and apply to most areas of manufacturing hence the economy moves to a quantitatively and qualitatively higher threshold with each successive cycle. Implicit in Smith's analysis is that without the improvement of machinery which is spurred by the division of labour, economies would ultimately grind to a stationery state or cease to experience economic growth. Put rather differently, economies that do not adopt new industrial machines; improve the machinery in use or indeed undertake their economic activities based on the principles of division of labour are presumed to be in, or moving to a stationery state.

Another classical Scottish economist, John Rae was probably the first writer to offer a wholly technological theory of economic development and his insights are very important for the contemporary debate on industrialization. Rae realized that capital is dependent on technology before it can serve as a useful factor of production. Far ahead of his time, he postulated that it is the technology embodied in machines that guarantees wealth creation, ensures the production of new goods, adds value and ensures viability. Rae strongly argued that the most effective way to ensure that economies attain a higher level of development is through extensive mechanization of the production process and the adoption of new inventions. He went further to contend that mechanization and invention should be promoted because they are fundamental for economic growth (Heertje, 1973, pp. 81-2).

J. R. McCulloch was also an insightful early economist who was very explicit about the motive force in the economic development process. As recounted in McCulloch's biography by D. P. O'Brien (1970), machinery and invention open up limitless possibilities for economic growth. McCulloch anticipated the modern debate on human capital and argued more forcefully than any scholar before him that education accelerates the pace of invention and that productivity is increased with the accumulation of knowledge - a forerunner to the contemporary view that 'learning' is critical for gaining competitive advantage.

However, Marx was undoubtedly the supreme development economist and he, more than any other writer demonstrated clear, unique and unrivalled understanding of the process of industrial evolution. He noted the contributions of Adam Smith and other writers before him but went much further than they did. It was Marx's unsurpassed genius to take into account the limitations in their analyses, particularly their neutrality about the economic sub structure. Marx further departed fundamentally from his predecessors on their lack of emphasis on the evolution of the capitalist mode of production. More specifically, Marx noted that the capitalist system has, within a relatively short space of time, created more extensive productive forces than have all the previous generations put together. Marx explicated that capitalism was the most productive form of economic organization and that this success stems from its capacity to systematically and intensively apply science and technology in the production process.

For Marx, technology is unambiguously central to economic progress but not in the deterministic sense often attributed to him by many critics. Many scholars often mistake the strategic role which Marx assigned to technology to constitute technological determinism. But in actual fact, Marx was probably the first writer that showed in detail that technology is interrelated to, and even dependent on, wider multifarious societal dimensions (Marx & Engles, 1951). A powerful exposition of this point was advanced by Nathan Rosenberg (1976 & 1982, Chapter 2). Marx's thesis is that the capitalist economy cannot be in a stationery state due to its effectiveness in developing and using technology. For example, deliberating on the Malthusian controversy regarding the slow growth of agriculture, Marx contended that technological knowledge is unquestionably a factor of production with unlimited possibilities. Hence, the omission of this critical factor of production by Malthus rendered his proposition highly implausible (Meek, 1953).

Further, Marx (1906) rigorously analyzed industrial evolution by dividing the history of industrial production since the middle ages into three phases - 'handicraft', 'manufacture' and 'modern industry' - and concluded that modern industry only emerged at the third phase when the production system could be mechanized such that workers became separated from their products. At that phase of industrial evolution, productivity improvement was no longer limited by the physical and mental capabilities of the workers. Machines were much more suited to the application of scientific laws because of the absence of the subjectivities, idiosyncrasies, refractory temperament and unpredictability associate with human beings. Through the differentiation of tasks, specialization and the increased application of scientific knowledge to production, the rate of mechanization and inventions increased and this in turn, fostered the growth of scientific knowledge and indeed of machine production. Each phase of mechanization led to further mechanization thus paving the way for more intensive application of scientific knowledge in production. The resultant effect of the ever increasing application of scientific knowledge to production and mechanization was the evolution of the machine building industry. At first, mechanization was concentrated in some sectors of industry and within these, specific areas of operation but with more sophisticated accumulated scientific knowledge base, machine building experienced more developed forms of division of labour and ultimately more inventions and a higher level of scientific knowledge which made it possible for whole processes to be mechanized.

The integration of scientific knowledge with production took on a dynamic character of its own with mechanization and inventions in one given area sparking off changes and more mechanization in other areas. The term 'technological convergence' has been used to refer to the organic interrelationships between many of the early changes within and across industries (Rosenberg, 1976). In the cotton textile industry for example, major changes that raised the output of cotton yarn led to corresponding changes in the techniques required for weaving yarn into cloth. With the mechanization of machine building, the main concern of industry shifted to the question of how to make machines so that they can perform specialized tasks more efficiently. The focus on the

scientific and technical possibilities of machines offered more scope for technical progress as the physical and mental capabilities of the workers no longer set the limits to the rate and form of technical advance which can be achieved within the production system. The resultant effect of this development was the emergence of a society that is qualitatively better equipped to sustain the progress made and to build on it. This is precisely what the early economist and Max in particular meant by economic development and it is akin to Schumpeter's 'creative destruction' and quite clearly a true example of a paradigmatic change in the pure Kuhnian usage of that term (Kuhn, 1970). Therefore, to say that a society has achieved economic development, it should have the capacity to create, renew and increase wealth on a continuous basis (Cooper & Kaplinsky, 1989).

Max and other perceptive students of the history industrialization, contend that the emergence of the modern industrial epoch was not an isolated event but took place concurrently with changes in response to the needs of industry. More specifically, it was the convergence and interaction of far reaching interdependent, interrelated and mutually reinforcing social, economic, political, cultural, behavioural, organizational, institutional and scientific forces that led to the evocation of the industrial society (Rosenberg, 1976; Rosenberg & Birdzel 1986; Landes 1969 & Nef, 1958). Max Weber (1940) used the terms **'Protestant Ethics and Spirit of Capitalism'** to explain some of the forces that conduced to the invocation of the Industrial Revolution in Britain while Niall Ferguson (2011) in **Civilization: The West and the Rest of Us** conceptualized the drivers of the industrial society as the '**Six Killer Apps'** which included science, competition, property rights, medicine, consumerism and work ethics.

Drawing from the above brief history of industrial evolution as visualized by the masters of economic thought, the mechanization of machine production led to the emergence of the capital goods sector and this promoted the consolidation and consummation of the Industrial Revolution. Thus, the emergence of the capital goods sector clearly marked the tipping point for the transition from the traditional to an industrial society when industrialization become self-regenerating and irreversible. In fact, the acquisition of the technological capability on which industry depends and the source of its dynamism take place principally within the capital goods sector (Rosenberg, 1976; Ejo-Orusa, 1997; 2014a). Thanks to the reproductive capability of the capital goods sector, the present civilization unlike earlier ones that tended to conform to the life cycle theory of takeoff, growth, maturity, slowing growth and decline; the industrial society has inbuilt negative entropy and is constantly reinventing itself. Therefore, the omission of the capital goods sector in the received economic development literature in general and in Nigeria's development debate in particular is an intellectual weakness that is difficult to rationalize.

THE CAPITAL GOODS SECTOR:
The Iron Law of Industrialization

The classification of goods into different categories is based on the division of the total production of society into two sections - Group A (producers' goods) and Group B (consumer goods) - that was originated by Marx. However, the convention generally adopted for the analysis of industrial production is the Harrod-Domar model and the term 'capital' is used in the place of producers. The strategic importance of the capital goods sector can be seen in the context of the linkage doctrine of Albert Hirschman where the emphasis is on the structural and dynamic factors in the development process. We notice that there is parallelism between Schumpeter's model of economic development and Hirschman's unbalanced growth strategy (Hirschman, 1958; Schumpeter, 1961; Schumpeter, 1987). In both models, investment decisions must allow the firm or economy a means of escape. Through the backward linkage effects of the capital goods sector and as the perfecting centre for technological changes in the blueprint, inducement is provided for the development of industries that supply inputs or raw materials to other sectors. The expansion of the capital goods sector, therefore, promotes technological progress almost contemporaneously with enhancing the expansion of the economy; particularly the industrial base.

Hoffmann (1958, p.100) went further to divide industrialization into three stages and inferred from the Soviet example that no economy can be categorized to be fully industrialized until it has reached the third stage where the proportion of consumer goods and capital goods output have come to the equilibrium point. Hoffmann's work also suggested that state action may be required to bring about this crucial structural change as was the case in the Soviet Union (Gerschenkron, 1962; Wilber, 1969; Nove, 1992). The industrial history of Japan also demonstrated the viability of the capital-goods sector led growth strategy (Inkster, 1980; Lockwood, (1968); Johnston, 1982). Some writers have therefore gone ahead to prescribe the capital-goods sector led growth strategy as development model for less developing countries. However, they went further to postulate that three major preconditions must be met for the viability of the capital-goods sector led growth strategy in any economy (Dobb, 1967; Stewart, 1977). The preconditions are:

1. Availability of investment capital;
2. Availability of absorptive capacity; and
3. Willingness to invest (in capital goods).

The above preconditions are very stringent and many developing countries will obviously have difficulty in meeting them. Therefore, the matter can be reduced to two questions:

Question 1: Is the capital-goods sector led growth strategy useful and can less developed countries satisfy the preconditions for the strategy?

Question 2: Does Nigeria have the potential to overcome the preconditions for a capital-goods sector led growth strategy?

In our attempt to explore Question 1, we have to rely on the work of scholars who have rigorously examined the subject. In a study of the applicability of the capital goods-led growth strategy in the LDCs, Charles Wilber (1969) hypothesized that the capital-goods led growth strategy is feasible in fairly large economies that have natural and human resources together with the market potential to absorb the output of capital goods industries and he went further to identify countries such as China, India, Brazil, Indonesia, Mexico, Turkey and Nigeria among others as having the potential to satisfy the preconditions. Interestingly, some countries on Wilber's list were already at different stages of implementing the capital-goods sector led growth strategy when the theory was postulated. The viability of the strategy has been documented for China (Cheng, 1972; Rawski, 1980). In fact, that China is now the world's industrial workshop and the second largest economy in the World lends additional

support to the viability of the strategy. Further, some countries on Wilber's list such China, India, Brazil, Mexico and Turkey have developed dynamic local capital goods sectors, extensive technological capability and are exporters of technology (Lall, 1980; Kim, 1980; Katz, 1984; Dhlman & Sercovitch, 1984). Again, China, India and Brazil and are leading members of BRICS and another three countries Indonesia, Turkey and Mexico are poised to join BRICS. It is uncontroverted that quantum progress has been made by many countries on Wilber's list. Further, the Asian Tigers such as South Korea, Taiwan etc which are relatively smaller countries and therefore not included in that list have within the period established dynamic capital goods sectors, are now major technology exporters and are either semi or fully industrialized. It is therefore reasonable to conclude that the theory has strong predictive power and that less developed countries (even smaller ones) can, and have overcome the preconditions for a capital-goods sector led growth strategy and have developed viable indigenous capital goods sectors.

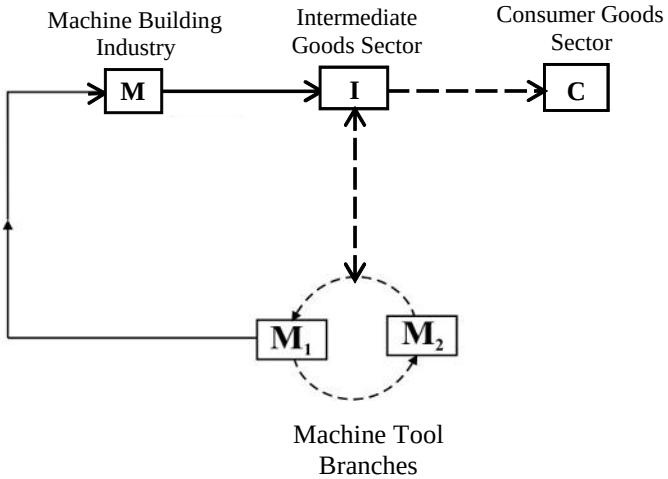
Moving on to Question 2, Nigeria which is our main focus in this study was also listed as having the potential to satisfy the preconditions. As a large country and a major oil exporter; the availability of investment capital should more readily be met in Nigeria. Provided that there is the willingness to promote investment in capital goods, the government can and should have addressed most the factors that negatively impinged on absorptive capacity and also developed incentive packages that would help to raise return on investment in the sector to a level that would incentivize investors to channel resources to the sector. The ill fated attempt to build the Ajaokuta Steel Complex further undermined Nigeria's capacity and willingness to invest in capital goods. Therefore, that Nigeria has not made appreciable progress in domesticating the capital goods sector is quite clearly not because of lack of potential, but a result of poverty of understanding that precluded the policy makers and economic managers to pursue the capital-goods sector led growth strategy as a development option.

Apart from the preconditions of the model, the mystique which surrounds the capital goods sector also tends to frighten away many LDCs from seriously considering the strategy as a feasible development model. The very term "capital goods" gives the impression of large plants which derive competitive advantage from economies of scale. But in actual fact, economies of scale may not necessarily be applicable at the firm level in the machine tool branch and the machine building industry of the capital goods sector as their products tend to be broadly heterogeneous. Essentially, what we have in the capital goods sector is economies of specialization. Due to the specialized nature of capital goods firms, the sector is 'skill intensive' and requires that individual firms have large demand for their products. Thus, by the nature of the capital goods sector it is not uncommon to have small firms co-existing with large ones, producing a significant amount of value added and operating competitively. Further, there is a misunderstanding among economists and policy makers that iron and steel is the motive force of industrialization and many developing countries including Nigeria have erroneously gone ahead to embark on gigantic iron and steel complexes. Unfortunately, they are wrong. For example, an iron and steel complex such as Nigeria's Ajaokuta Steel Rolling Mill is essentially an assemblage of capital goods.

THE CAPITAL GOODS SECTOR DEFINED

With the mystique and ambiguity surrounding the capital goods sector still unabated, some clarifications are in order and a simple illustration is presented in Figure 1 below. It can be deduced from Figure 1 that all machine tools, machines, engines, equipment, plants, factories, assembly lines, robots etc required by various sectors of the economy (all manufacturing including iron and steel, agriculture, power generation, car plants, oil and gas, petrochemicals, mining, woodworking, construction, ship building, telecommunications, aviation, railways, armament, microelectronics, 3-D Printing, nanotechnology, Robotics, other emerging technologies, etc) have to be designed and built by the capital goods sector.

Figure 1: A Schematic Representation of Industrial Production



Note: The capital goods sector is made up of the ***machine tool branches*** *(M_1 and M_2) and the* ***machine building industry*** *(M). The sector supplies machinery and equipment to the intermediate goods sector and is in turn dependent on inputs (iron and steel) from the later.*

Put rather differently, the capital goods sector is responsible for building all the machines that are in turn used to build other machines. Even iron and steel which are very critical for industrialization acquire true economic significance after conversion into capital, intermediate and consumer goods while micro-electronics, cloud computing and artificial intelligence (AI) derive their efficacy by driving and being embodied in capital goods. Further, the capital goods sector is the main market for iron and steel plants and they should therefore logically be established early in the investment cycle. Perhaps more importantly, an iron and steel complex is very capital intensive, requires extensive economies of scale and depends on a large market base for viability - conditions that are lacking in most developing countries. Indeed, with the extreme misunderstanding of the capital goods sector, it is little wonder that this uniquely ubiquitous sector is almost nonexistent in Nigeria.

A measure of how far Nigeria is from entering the industrial epoch can be gleaned from the fact that even to manufacture something as basic as 'pin' which Adam Smith used in his famous case study to demonstrate the potency of division of labour in the Wealth of Nations, the machinery and equipment that will be needed for this basic engineering undertaking will have to be imported. Again, a brief look at the cotton textile industry which played a key role in the industrial growth of Britain in the Nineteenth Century can also help us to situate Nigeria's industrial backwardness more appropriately. We notice that Nigeria, a major source of cotton that sustained the British cotton-textile industry during the colonial era still cannot design and construct textile mills, sewing machines and other machines and equipment used in that industry after about 280 years of the Industrial Revolution. The perceptive reader should by now know that the clothes most Nigerians are wearing and indeed the President's beautiful ***kaftans*** are not and cannot be made in Nigeria.

We acknowledge that it is not remotely contemplated, particularly in the globalized world of today, that any country should have the comparative advantage to justify producing all its capital goods stock. Nevertheless, all the truly industrialized countries have the capacity to quickly direct and redirect their resources to areas prioritized to be of strategic importance. No doubt, large countries require a lot of capital goods to drive their economies and this will obviously pose serious foreign exchange challenges if they have to depend exclusively on imports. This is why the capital goods led growth strategy is advocated for large countries. For example, Nigeria's grid power of about 7000MW is grossly inadequate for the seventh most populous country in the world. But, a semi industrialized Nigeria which should have dispensed with its generator addiction would require well over 100,000MW of grid power as against the miniscule power generation of today. Without the indigenous capital goods firms to design and build the power plants, turbines, sub-stations, transmission lines, electrical exchanges, transformers etc, Nigeria will continue to rely almost exclusively on foreign capital goods manufacturers for such a mammoth undertaking. The foreign exchange so far expended on power infrastructure in Nigeria today will obviously pale into insignificance. Further, dependence on imported capital goods means that the expected positive externalities such as employment generation and capacity building in the design and production of capital goods will be domiciled in the countries from where such capital goods originate. We therefore notice that Nigeria is continuously missing the employment generation, wealth creation and thus poverty reduction opportunities associated with power generation. There is no sector of the Nigerian economy that is not going through this uncontrollable vicious circle which only a dynamic local capital goods sector will mitigate.

Therefore, without been overly pessimistic, the point must be made that Nigeria's oil dependent economy (***Nigeria's per capita oil income is low relative to the OPEC average as a result of her large population***) cannot sustain the importation of all the capital goods required to drive the economy. This is why industrialization, particularly in large countries even those that are natural resource rich cannot be imported but endogenously determined. Contrary to the unrestrained importation of capital goods which is unfortunately the norm in Nigeria and many LDCs today, all the industrialized countries that came after Great Britain such as Germany, USA and Japan aggressively borrowed technology from other countries, internalized the borrowed technology and used them as the platform for developing indigenous technological capability and industrial take-off (Rosenberg, 1976; Inkster, 1980; Kenwood & Lougheed, 1982; Johnson, 1982).

Some writers may contend that emphasis on the capital goods sector does not hold true in the present day globalized world where the ubiquitous microelectronics (including ICT) is now also a critical success factor for industrialization. We must underline the point that microelectronics cannot on its own kick-start the process of industrialization or drive industry and no country can become industrialized based solely on this sector. The hardware (capital goods) and software (microelectronics) must be present and reinforce each other. This is because microelectronics and the associated technologies acquire true economic significance in industry due to the fact that they fundamentally improve the design, production and performance of capital goods as well as raising the productivity and innovativeness of manufacturers and users of capital goods. Therefore, in the present 4th Techno-economic Paradigm, the fusion of microelectronics and capital goods makes the former a new critical factor in the industrialization and techno-economic development matrix that cannot be ignored but that does not invalidate the primacy of the capital goods sector for industrialization (Ejo-Orusa, 2014b).

We take the view that Nigeria's policy makers, economic managers and the general populace have unfortunately been seduced by the products of modern industry without understanding the industrialization process. Whitehead (1925, p.141) brilliantly captured this paradoxical intellectual poverty about a century ago thus: ***"The greatest invention of the nineteenth century is the invention of the method of invention. A new method entered into life. In order to understand our epoch, we can neglect all the details of change such as railways, telegraphs, radios… we must concentrate on the method itself: that is the real novelty that has broken the foundations of our civilization".*** We can go ahead to include personal computers, mobile phones, the internet, communications satellites, robots, spacecrafts, AI and many other wonders of the industrial age that were not even contemplated at the time of Whitehead's writing to the list of industrial products or 'details of change' as he called them.

Indeed, all the much loved products of modern industry which the great mathematician was talking about are consumer goods and they can only be built after appropriate capital goods have first been designed, produced and deployed for use in the manufacturing process (Rosenberg & Birdzel, 1986). This is to say that consumer goods come after the capital goods and not the other way around. The **'method of invention'** that has broken the foundations of our civilization is quite clearly the technological capability which is in large part dependent on, and embodied in capital goods and in today's high-tech world these are further infused with the modern technologies of our civilization. Thus, even emerging technologies such as Robotics, nanotechnology, 3-D Printing, AI etc or the entire gamut of Industry 4.0 for that matter cannot be operationalized without a dynamic capital goods sector. In fact, no matter the nature and form of invention and technological innovation; whether it is a new product or process; improvement to an existing product or process, it will require new, improved or modified machines that conform to defined technical specifications and capital goods firms have to design and produce them.

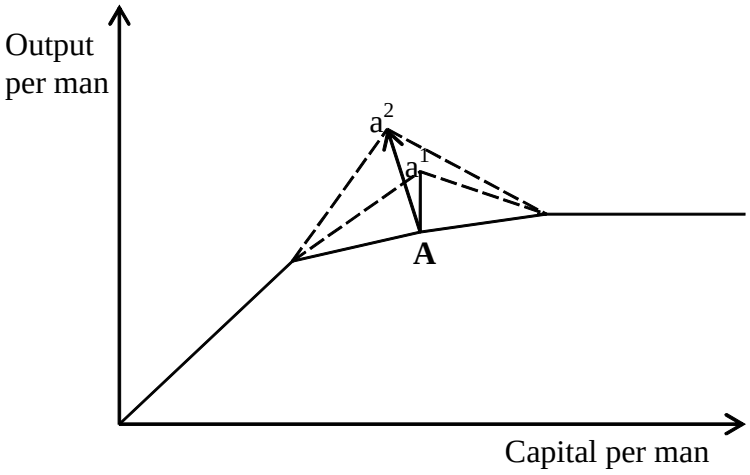
From the reading of economic history in general and drawing from unrivalled insights from perceptive students of the evolution of modern industry in particular, presence of an indigenous capital goods sector is the iron-law of industrialization (Rosenberg, 1976; Mumford, 1972; Hoffmann, 1958). The capital goods sector is the hub for technological change in the manufacturing industry and the medium via which an economy acquires and improves its technological capability. The lack of local capital goods firms that can design and produce simple machines and equipment on demand to kick-start production is therefore seriously militating against small business start-ups and growth that will help to exploit the latent economic opportunities in the country, increase foreign exchange earnings, generate employment, create wealth, add value to the economy and reduce poverty.

The absence of a vibrant local capital goods sector in any economy means that the rate and form of technological innovation will be very limited. Unfortunately for Nigeria and many other LDCs, their economic policy makers seem to be interested in the artifacts of modern industry but mute and even contemptuous of the capital goods sector that is responsible for producing the machinery and equipment that are used to produce them. This is like putting the cart before the horse. When a society has acquired the technological capability, it becomes reproductive in character and is thus able to invent new industrial products and to produce them as and when required and at will. Conversely, countries like Nigeria where the capital goods sector is absent or weak are presumed to be in a stationery state. However, apart from education, research and development and technology transfer and licensing, other critical mechanisms through which a society acquires technological capability remains under-researched and therefore widely misunderstood. A tentative attempt is therefore made in the pages that follow to fill this lacuna by examining technological learning-by-doing and technological entrepreneurship which are two ways in which the capital goods sector contributes to the development of technological capability.

THE CAPITAL GOODS SECTOR AND TECHNOLOGICAL LEARNING-BY-DOING

According to Arrow (1962), through the repetition of initial tasks in the capital goods industries and the ironing out of bottlenecks associated with them, not only will productivity rise, but more importantly, transferable skills that can facilitate the performance of related, but relatively more complex and hitherto untried tasks and operations will be developed. However, the most carefully articulated exposition of the learning-by-doing hypothesis was articulated in a seminal paper by Atkinson and Stiglitz (1969). They hypothesized that there can be forms of technological changes that may, in fact, be localized as shown in Figure 2 below. For example, learning can take place within a particular manufacturing process or technique of production, say A, but does not result in spillovers that may be relevant to other techniques. Rather, the learning and or technological change shifts the production frontiers to a^1 and subsequently to a^2. It therefore follows that workers and economies outside technique A will miss the associated technological learning-by-doing opportunities.

Figure 2: Learning-by-doing with Localized Technical Progress



There is ample empirical evidence from industry in support of this theoretical proposition. For example, it has been demonstrated that unit variable costs decline with the growth of production experience as measured by cumulated output of the given production run (Alchian 1963). Also, in a study based on the production of machine tools; unit cost was found to fall by approximately 20 per cent with every doubling of cumulated output of the given type of machine (Hirsch, 1975). The study of Swedish steelworks, commonly christened the Horndal Study, showed that output per man hour increased by 2 per cent per annum for 15 years when production techniques remained unchanged (Paul David, 1975, pp.174-191). Based on this study, learning-by-doing with fixed facilities is now popularly referred to as the 'Horndal Effect'.

The capital goods sector promotes technological learning-by-doing because operators in the sector are exposed to opportunities to upgrade their skill in the design, production and maintenance and to pursue new innovation possibilities. Therefore, when you import capital goods, you merely receive the hardware, and so the operatives who will use them miss out on the critical knowledge, technical skills and the organizational know-how needed to make them function efficiently, to produce more and enhanced capital goods or to take the economy to a higher technological threshold. In the absence of a large pool of workers who are knowledgeable about capital goods design, production and maintenance; machinery and equipment will also function inefficiently when in use and repairs will also be poorly executed and at higher costs.

Further, repairs also take long to be completed as spare parts usually have to be imported from the original manufacturers with grave consequences for limited foreign reserves, productivity, efficiency and employment. Additionally, in the absence of a dynamic local capital goods sector, the imported machinery and equipment will not perform optimally because they cannot be efficiently and effectively adapted, modified or re-tooled to suit local endowment constraints. These problems are part and parcel of Nigeria's industrial experience as is clearly demonstrated in all sectors of the economy. Further, since the capital goods sector is the 'custom house' or the reproductive centre for the entire economy, the sector's technological progress is more rapidly diffused to other sectors of the economy. Nigeria's undue reliance on imported capital goods means that the technological learning-by-doing opportunities in the design, production and maintenance of capital goods does not take place; a vicious cycle that perpetuates and reinforces technological dependence, backwardness and passivity.

THE CAPITAL GOODS SECTOR AND ENTREPRENEURSHIP

Following the original insights of Joseph Schumpeter (Schumpeter, 1961; Schumpeter, 1987; McCraw, 2007), it is acknowledged that the heroic entrepreneurs invoke the process of creative destruction using breakthrough innovations to engender economic development in general and wealth creation in particular. But, who are the heroic entrepreneurs and what type of entrepreneurship is critical for economic development in the Schumpeterian model? Also, what skills, attributes and competencies are needed for Schumpeter's entrepreneurship and where and how are those skills, attributes and competencies developed? Fortunately, some perceptive scholars of industrial evolution have tried to elucidate on some of the issues raised in Schumpeter's thesis. Focusing on the industrial history of the United States for example, it was found that the main locus of technological change in industry was the capital goods sector and that many of the major technological innovations have historically taken place in that sector. Thus, wealth creation and indeed economic development is contingent not just on entrepreneurs broadly construed, but on the availably of technologically oriented entrepreneurs who are knowledgeable about capital goods and are willing to invest in this important sector of the economy (Rosenberg 1976, p. 143 & 164-165). David Granick (1967) used the example of Soviet Union, Kenwood and Lougheed (1982) drew from Japan while Rawski (1980) used the example of China to arrive at the same conclusion.

The positive impact of the capital goods sector for the development of technological entrepreneurship flows from the fact that no matter the sector of the economy from where an innovation originates, it has to be made functional by the capital goods sector. In particular, even when inventions or innovations have been theoretically conceived, they remain of little economic significance until the technical and mechanical bottlenecks associated with them have been resolved and incorporated into machines. Most sharply framed, abstract industrial inventions and innovations whether they relate to new products and or processes often require the production of new machines or the modification of existing ones to meet the required engineering specifications and this is the function of the capital goods sector. Thus, it is the entrepreneurs who are technically competent to operationalize new products and processes or to modify existing ones that actually drive the economic development process. Expectedly, the skills, attributes and competencies of Schumpeter's heroic entrepreneurs are horned in the capital goods sector but the entrepreneurs of the Nigerian genre are generally involved in middlemanship and trading (Stevens, 1982). This anomaly is why the exaggerated 'high entrepreneurial metabolism' of Nigerians has not translated to a floodgate of new ventures, wealth creation and employment generation.

As the reproductive centre for the entire economy par excellence, firms within the capital goods sector serve as incubators and repository for technical expertise with the effect that workers and entrepreneurs who move to other firms or industries carry along the knowledge gained in the form of invaluable human capital thus 'infecting' their new hosts and thereby promoting technological diffusion and ultimately raising the technological capability of the entire economy. It should be remembered that workers in the capital goods sector also become entrepreneurs either within the sector or in other industries and help to increase the technological base of the entire economy by passing on their expertise. What is particularly unique about the capital goods sector is that it permeates all areas of industry and is, therefore, an indispensable medium for the development of technical know-how. We therefore notice that economies that have dynamic capital goods sectors also have more successful, effective and technologically oriented entrepreneurs than those where the sector is weak or non-existent. The bone of contention is not whether entrepreneurs are important, because, to be sure, they are. The critical point is that Schumpeter's model of economic development is dependent on the heroic or technologically oriented entrepreneurs who use their technical mastery to invoke the process of creative destruction.

CONCLUDING REMARKS AND POLICY DIRECTION

From the above *tour de horizon*, we notice that just as the woman's womb is the perfect incubator that guarantees procreation, so is the capital goods sector the wealth creation hub per excellence in any economy. Simply put, a dynamic capital goods sector gives the economy the capacity to become reproductive in character and thereby equipped to tackle the challenges of underdevelopment and to shape its own future. Put rather differently, the capital goods sector imbues the economy with the capacity to invent and reinvent itself and to create the wealth required to effectively reduce poverty – the primary goal of economic development. Expectedly, from the Industrial Revolution to the present techno-economic paradigm (Ejo-Orusa, 2014b) which is often referred to as Industry 4.0, no large country, of which Nigeria is a typical example, has become industrialized without an indigenous capital goods sector. We are therefore led to conclude that Nigeria is not industrializing or reducing poverty precisely because of the absence of an indigenous capital goods sector. Whilst a full battery of the policies needed for the industrialization of Nigeria cannot be provided in the limited space available, some highlights are presented below.

First, contrary to the received wisdom that unbridled capitalism and indeed 'perfect competition' will conduce to economic development and indeed to industrialization, the facts suggest otherwise. It is an indisputable historical fact that from the first industrial nation, England, to Germany, USA and Japan and to the more contemporary industrializing countries as epitomized by the BRICS and the Asian Tigers, that the state has consistently played the leading role in industrialization. The protection of German infant industry is a case in point (List, 1904). In fact, the role of the state has been found to increase with lateness in industrialization (Gerschenkron, 1962). This is because perfect competition which is so beloved by economists, particularly those of the free market hue, with all its potency and corrective mechanisms cannot be relied upon to mobilize and appropriately allocate resources to start the cycle of industrialization. It has to be understood that industrialization is by far the most serious battle for survival that any country will ever face and the responsibility for such a critical challenge for national survival cannot be abdicated by the state.

Consigning Nigeria's industrialization solely to the free market is tantamount to continued dependence on foreign capital goods manufactures and the tech giants. This is a vicious cycle that perpetuates economic and technological backwardness and the acceptance of the prevailing world economic order. Therefore, to the extent that Nigeria's goal is rapid industrialization, the capital goods sector must be singled out and protected as an infant industry. In particular, resources available to the state particularly from depleting oil and gas resources should be deployed to grow and nurture the capital goods sector as the economy's reproductive and wealth creation engine. Further, special incentives should be used to encourage local and foreign investors, particularly leading producers of capital goods to set up full production plants (not mere assembling outfits) including research and development in Nigeria. The objective from the beginning must be to ensure that the new ventures are competitive and geared for the export market.

Secondly, Nigeria's economic managers must as a matter of urgency put in place a robust Industrial Development Plan incorporating a well articulated Science and Technology Policy (STP) that promotes scientific and technological infrastructure including; research and development, scientific and engineering institutions as well as the internalization of cutting-edge ICT capabilities. The STP should embody an innovation policy and explicitly and comprehensively address all the multidimensional factors that impinge on the development of technological capability. In particular, technological growth poles should be established by promoting technopoles or technopolitan cities including science and technology parks. The technopoles should be designed to attract local and international technology companies, increase the technological level of businesses and create World Class communities in which smart people want to live and work. The concentration of innovative companies, technology savvy workers and entrepreneurs operating at the cutting-edge of technology will help to increase the number of people involved in technology-intensive work. These will promote linkages among and between workers and organizations, upgrade the knowledge, skill sets, competencies and learning-by-doing rates, learning intensity of workers, facilitate self-propulsive industrial growth, encourage employment generation and wealth creation and thus promote poverty reduction.

Thirdly, a closely related issue that is in dire need of special and urgent attention is human capital development broadly construed to include education and training from the primary, secondary, technical to the university level and the training of specialist engineers (hardware and software). The objective will be to build a learning economy where people are equipped with quality technical, metal working and engineering knowledge; skills and competences required not just to operate, maintain, adapt and modify capital goods and ensure that they function optimally but also to produce state-of-the-art machines and equipment plus advanced computing, programming and software design capabilities critical for competition and survival in the knowledge-based world of the 21st Century. These will help to ensure the availability of a large pool workforce with the capacity to kick-start the cycle of indigenous industrial revolution.

Further, inclusive socio-economic institutions must replace the extractive ones that are stifling economic growth. In this regard, Arthur Young's observation close to 100 years ago that '***ownership is the magic that turns sand into gold'*** (Young, 1928) should not be lost on Nigerian policy makers. Therefore, as part of the package to build a robust entrepreneurial eco-system and to promote innovation, the obnoxious Land Use Act which vests all the land on the State should be abrogated without delay. Also, the establishment of more efficient property rights should be pursued with vigour. These inclusive institutional changes will not only stimulate the development of agriculture - a key precondition for industrialization - but perhaps more importantly, they will help to increase the economy's savings capacity and investment capital and thus release investable surplus thereby helping the economy to satisfy some of the preconditions for a capital-goods led growth strategy. Further, these changes will help to ensure that entrepreneurs and other investors have the bank compliant collateral they require to pursue new venture creation opportunities, to unleash their creative energies and to create wealth. As part of the institutional reform, Nigeria's legal framework including copyright and patent regimes should be strengthened.

Also, it has to be understood that modern industry evolved with, and is dependent on its own distinct value system such as culture, belief systems, myths, rituals, social structures, national outlook and psychology, patterns of behaviour and more importantly perception of science and technology (Ejo-Orusa, 1997; Guiso & Zingales, 2006; Harrison & Huntington, 2000; Nef, 1958; Morishma, 1982; Roche, 1976). As a corollary, industrialization is contingent on the adaptation to, and internalization of, the value system behind the evocation of the industrial era and those driving Industry 4.0. Therefore, as part of the drive for industrialization, conscious effort must be made to actuate the process of creative destruction by comprehensively modifying and realigning the innumerable anti-industry characteristics that are stifling techno-economic development to ensure convergence with the ethos of modern industry. This obviously calls for social engineering and creative adaptation which in turn demands visionary and transformational leadership. To be sure, reorienting the value system is an intractable task that is made more difficult by the fact that the high quality leadership that is needed for this paradigm shift is very often the scarcest resource in most countries, more so a country like Nigeria where what is called bureaucracy is in actual fact institutionalized banausocracy (Ejo-Orusa, 1997, pp. 107-109, 212).

A starting point for addressing some of the socio-economic challenges and institutional deficits stifling economic development will be to borrow from countries that have succeeded in crossing the poverty prism. For example, economic managers should focus on what the Lee Kuan Yew School of Public Policy christened the *'Pillars of Success'* - MPH - or what we may rechristen as the *Triangle of Success*. The M stands for meritocracy (using the smartest people in the society), pragmatism (not being boxed into any particular economic orthodoxy, flexibility, readiness to make changes and to borrow good ideas no matter where they may originate from) and honesty (zero tolerance on corruption in all its ramifications). On honesty and corruption for example, the warning by Charles Handy (1995) that; ***'it is tempting credulity to proclaim a crusade for the impoverished from a luxury apartment'*** (p. 107) is apt for Nigeria's kleptomaniac and intellectually bankrupt political and economic leaders.

Finally, we particularly need to deepen our understanding of the historical process of industrial evolution and perhaps more importantly technological progress in the 21st Century so that we can open up the idea-spaces and intelligently inform the industrial policy. However, in everything we do, we must be reminded that it takes a very long time to grow and nurture the capital goods sector to maturity and to develop technological capability. Therefore, the instruction of the French General and colonial administrator, Hubert Lyautey to his gardener that if a tree takes 150 years to mature, then it should be planted as soon as possible is as poignant as it is urgent.

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