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Digital transformation: A pillar of structural transformation of Moroccan economy

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Abstract

This article examines the crucial role of digital transformation in the success of the Moroccan economy's structural transformation (ST) process between 2015 and 2023. Based on this period, the study captures the hollow effects of digital transformation on Morocco's sustainable development. Analysis of this time series also enables us to identify the opportunities and challenges associated with implementing digital transformation in the Moroccan economy. It also offers valuable insights for guiding sectoral public policies and development strategies, maximizing the benefits of the digital revolution while minimizing potential risks. After establishing the theoretical foundations of ST, the study explores the complex dynamics between observed socio-economic mutations and the adoption of advanced technologies in Morocco. These theoretical frameworks help contextualize the empirical study that follows. The study continues with an in-depth econometric study, estimating a non-linear autoregressive distributed model (NARDL). This estimation aims to analyze the effect of various variables, such as high-tech exports, gross fixed capital formation, diversification of production and export structures, as well as GDP per capita in constant dollars, on the economic complexity index considered in this study as a proxy for the ST process of the Moroccan economy. The outputs of the econometric study highlighted the significant importance of these variables in the success of the Moroccan economy's ST process. These results demonstrate the potential of digital transformation as a catalyst for ST in the Moroccan economy, paving the way for a resilient and more dynamic economic future for Morocco.

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1. Introduction

Digital transformation is considered a phenomenon at the heart of contemporary economic dynamics, shaping the contours of our societies and overturning traditional paradigms. This digital transformation, marked by the emergence of NICTs (New Information and Communication Technologies) and the rapid

spread of digital tools in the economic, financial, social and even cultural spheres, represents a key driver of change and innovation on an international scale.

Digital transformation, a notion with far-reaching implications and multiple facets, transcends the traditional boundaries between sectors of economic activity, and re-explains modes of production, consumption and interaction in contemporary societies. It encompasses a wide range of processes and phenomena, from the digitization of companies to the emergence of new business models, via the spread of cutting-edge technologies such as the Internet of Things, blockchain and artificial intelligence (AI) (Benedetto-Meyer & Boboc, 2019).

In this wake, the concept of structural transformation (ST) assumes decisive importance often linked to profound changes in the organization and composition of economic activities, ST can be defined as a process by which countries evolve and adapt to socio-economic and technological fluctuations. Typically, it involves transformations in the distribution and diversification of production between sectors of economic activity and the modernization of infrastructure (Cadot & De Melo, 2016).

The aim of this article is to explore the relationships that might exist between digital transformation and the ST of the Moroccan economy, by studying the effect of digital transformation on the evolution of the Moroccan economy during the 2015-2023 period. As such, we aim to understand how advanced technologies and transformations in production and consumption patterns impact Morocco's development path?

This article is of specific interest in the Moroccan context, where digital transformation has become a national prerogative to encourage inclusive growth, promote competitiveness and achieve sustainable development. However, despite the efforts made by economic players and public authorities to promote the digitalization of the Moroccan economy, important questions remain as to the implications of this process for the country's socio-economic structure.

The issues addressed in this article crystallize around a number of essential questions, all centered on the link between digital transformation and the ST process of the Moroccan economy. How does digitalization impact Morocco's economic structure, and what are the mechanisms by which it influences structural transformation? What are the drivers of digital transformation and to what extent are they contributing to the modernization and diversification of economic sectors? Finally, what are the specific challenges faced by Morocco in its transition to a digital economy, and how do these challenges influence the dynamics of the structural transformation of the Moroccan economy? These questions guide our analysis and enable us to explore in depth the complex links between digitalization and the structural transformation of the Moroccan economy, thus offering enlightened perspectives on the stakes and opportunities of this process of change.

To answer these questions, this paper is divided into three basic segments. The first segment addresses the conceptual foundations of structural transformation, drawing on two major theories: regulation theory and Third World development theory. The second segment highlights the interconnection between digital and structural transformation. Finally, the third segment conducts an empirical analysis of the correlation between digital transformation and structural transformation of the Moroccan economy over the study period, through the application of a nonlinear distributed lag autoregressive (NARDL) model.

2. Theoretical Approaches to Structural Transformation

2.1. Structural Transformation: A Particular Mode or Regime of Accumulation

From 1928 to 1939, structuralist thinking on development was influenced by anthropological and linguistic structuralism[1]. Here, however, we will only consider the theory of structuralism through its Marxist approach and its extension[2], notably via the school of regulation[3]. This is approached as structuralist economic[4] thinking that could explain certain causes and determinants of ST. In the sense that it emphasizes the passage of economies through different stages of development, through phases of social reorganization of production relations, and even through situations of crisis and economic cycles that can trigger structural change. During these stages, phases, situations and crises, economies acquire forms of resilience in the face of different shocks affecting their accumulation regime[5] and their specific institutions. Indeed, the regulation of these economies at different levels of their development would depend on the said institutions, norms, conventions and rules that underpin the way their wealth is created and distributed. Hence a cyclical rather

[1] Originally, structuralist development thinking was linked to the work of linguistic anthropologists such as De Saussure (1987) the French school of Paris, and the Prague school of linguistic structuralism.

[2] In 1956, the Communist Party of the Soviet Union held its 20th congress, following Stalin's death in 1953. Nikita Khrushtev, the new General Secretary, presented his report, criticizing Stalin and launching de-Stalinization. The two leading thinkers of the French Communist Party, Sartre and Garaudy, felt that this change should be reflected in a shift in party thinking in favor of socialists, left-wing Christians and existentialists, so that Marxism would reconnect with its humanist roots.

[3] Regulation theory is the work of several of Althusser's disciples: economists from the French Communist Party, the Communist Party of the Soviet Union and Maoists. This theory stems from the Marxist treatment of capitalism. Its analytical tools were borrowed from American institutionalism and post-Keynesianism. The books "régulation et crises du capitalisme" by Aglietta (1976) "Accumulation, inflation and crises" by Boyer and Mistral (1979) "Crisis and inflation: why?" by Lipietz (1980) and the collective research work by the Centre d'études prospectives d'économie mathématique appliquées à la planification, "approches de l'inflation: l'exemple français" by Boyer and Mistral (1979) are the reference works for the regulation school.

[4] However, in order to raise the principles of ST according to the regulation school, it is interesting to begin by situating the philosophical framework of this school's theory, starting with its precept of Althusserism, founded by Louis Pierre Althusser (Lubitz, 2009).

[5] The accumulation regime can be described as the iterative data of the productive branches and the demand or production of sections, and is called the macroeconomic structure or reproduction scheme. In effect, this regime is a mode of joint accounting transformation of the rules of production and consumption.

than linear vision of ST. This transformation would be the result of technological changes arising from innovations or political or other evolutions, and would affect overall social and economic regulation.

Regulation theory, which is an economic approach that deals with the temporal evolution of economic and social structures, therefore historically and concretely analyzes the accumulation system as a structural scheme for the reproduction of social relations in time and space, in the knowledge that structural forms constitute the mode of regulation that ensures this reproduction. This assumes that the object of ST is to study the specific development models and modes of operation of capitalism, treated as combinations of a mode of regulation[6], a regime of accumulation and a particular technological paradigm.

The latter is not sufficiently developed by the regulation movement. This current could refer the ST process to the idea that there is a relationship between the innovation process existing in the secondary sector, macro-economic dynamics and overall technological structures in an economy. This way of looking at macro-economic dynamics would also be a Schumpeterian vision of ST.

Moreover, this school of regulation believed that each stage in the development of capitalism corresponds to technological and technical structures that influence the country's macro-economic dynamics. But this school of thought did not address this issue sufficiently. Indeed, it saw the technological paradigm that characterized the glorious thirty years under the name of Fordism as a regime of intensive accumulation[7]. It would therefore favor intensive ST. This was in contrast to the regime of extensive accumulation that had prevailed prior to this period. It would favor extensive ST. Hence the interest in using macro-economic data from national accounts to characterize the ST following the rhythms of variations in savings, investment, consumption, productivity, profits, wages, prices, value, surplus value...

On the other hand, ST would be approached, via the current mode of regulation, by consumer structures adapting to productive structures. For ST to be successful, it is not enough to adapt rigid structures to the new demands of transformation, but rather to ensure the joint compatibility of the transformation of two structural forms: the social and institutional forms contributing to the imposed mode of economic regulation, and the instances, procedures and social norms ensuring this accounting. These two structural forms at the origin of ST also deal with questions of currency, modes of state intervention, inter-capitalist market relations, and the form of insertion of the economy in question, and its wage relations, into global economic relations.

The evolution of these structural forms underlying the ST process had been the subject of in-depth study by the regulation school. Each theorist of this school, in his own field of expertise, contrasted the post-war monopolistic or Fordist mode of regulation with the older competitive mode of regulation of the nineteenth century. The latter was characterized by low wages, no social benefits and the circulation of metallic money. In this mode, there was also strong price competition between firms and between the gendarmerie state, which ensured the safety and external defense of capitalist economies, and their agents. Here, ST would be dictated more by competitive market mechanisms than by public policy. On the other hand, in the monopoly mode of regulation, which combined rising wages with strong social protection under a monetary credit regime, ST would be achieved through controlled competition under the aegis of a rent and technological quality that differentiated economies. In this ST, the welfare state, which ensured the extension of social rights and the generalization of social protection, would have a fundamental role to play.

What's more, the regulatory theory that had first succeeded in explaining the beginnings of the crisis of the Thirty Glorious Years would also explain the genesis of a ST stemming from the major economic imbalance of the time: stagflation opposing unemployment and inflation via the Philips curve. This type of ST was unimaginable in standard classical and neo-classical theoretical schemes. Then, in 1989-1991, with the fall of the Berlin Wall and the Soviet Union, the Washington Consensus[8], which had founded today's liberalism through the deregulation of economies, heralded a new generation of ST, particularly in the BRICS (Brasil, Russia, India, China, and South Africa) and other world's emerging countries. Thus, in this new ST, or new mode of regulation, of emerging economies, it was deregulation and market liberalization that had provided a way out of the crisis experienced by the regime of Fordist accumulation. Since then, however, regulation theory has been eclipsed.

As a result, the explanation of ST expanded into other registers of thought. It was particularly thanks to successive technological and scientific revolutions, which had given rise to a number of disruptive innovations from the 90 onwards, that emerging economies had been transformed differently and more radically. ST can be explained in terms of a new capitalist mode of production, in which the classic distinction between consumption and production is completely challenged. In this mode, would the production of material goods and the wage relation still be the determinants of such ST, or would it already spill over into other, more essential factors? In this respect, the theoretical explanation of ST would then require an assessment of the mode of development, or regime of accumulation, dominating the economy concerned by this ST.

2.2. Structural Transformation, A Third World Development Approach

[6] Mode of regulation: for more details, see "de l'althussérisme à la théorie de régulation" (Lipietz, 1988) orange cover n°8920, 1988.
[7] National accounting was used to describe these regimes of intensive and extensive accumulation, showing the dynamic equilibrium between accumulation and consumption; that is, between value added and its uses.
[8] The Washington Consensus is a set of liberal-inspired measures taken during the Reagan period in the USA to boost economic growth and economic regulation worldwide.

In Sauvy (1952)[9] coined the term "Third World" following the independence of Latin American countries between 1810 and 1830. After the Second World War, supranational organizations such as the Bretton Woods institutions, the United Nations (UN) and the World Bank were particularly concerned with the development and underdevelopment of Third World economies[10]. In this respect, stage-growth theorists observed that Third World countries were lagging behind other developed countries. They would go through stages of growth in order to achieve and ensure sustained, sustainable development that would enable them to catch up and emerge from underdevelopment. In many respects, ST would fit in well with these stages of development.

2.2.1. Structural Transformation "From within": Import-Substitution Industrialization

The explanation of ST could be inspired by the theory of economic dependence. Indeed, Raúl (1981)[11], in agreement with Rostow, had considered the process of development, or structural change, as a continuous evolutionary and dependent phenomenon. Indeed, the author assumed that underdevelopment would only be a stage preceding development proper. He also recognized that the latter requires indispensable conditions, such as the political, institutional, economic and social modernization of structures in developing countries. In his analysis of the colonial period, and of South American economies and societies, he noted a modern agriculture run by the colonizers, the beginnings of an industry that essentially met their needs, and few services and financial institutions. After this period of colonization, when foreign companies left these countries, they found themselves with juxtaposed, unconnected sectors. On the one hand, a primary sector subdivided into two, a traditional food-producing sector run by indigenous companies, and another mechanized sector geared towards export markets, which was mainly the preserve of foreign firms. On the other hand, a modern secondary sector alongside an ageing craft industry, and an underdeveloped tertiary sector. The author called this a situation of structural dualism. A situation, according to the author, which hinders development, and which would then pose a problem, even today, to any successful ST in developing countries, including Morocco.

In this respect, the ST to be implemented in these developing countries would be that geared towards import-substitution industrialization (ISI). ISI would enable them to avoid dependence[12] on foreign trade and international exchange in general. This ST, based on ISI rather than on the principle of comparative advantage underpinning free trade and the usual income redistribution policies, would boost domestic productivity, lower production costs and improve the social and economic conditions of the population. Fundamentally, it would be a nationalist development strategy, favoring economic patriotism in favor of domestic industry and its jobs, to the detriment of foreign industry.

Thus, in this register of economic dependence theory, ST would be designed either to encourage the ISI strategy, particularly in high value-added industries (electronics, semiconductors, metallurgy, steelmaking, chemicals and parachemistry). Or to put private initiative by national players, in preference to foreign players, back at the heart of the country's economy. Or to maintain state control over large public firms in strategic sectors. Or to free up the exchange rate to guarantee the competitiveness of the national economy. Or, finally, to privatize hitherto state-owned sectors lacking in competitive efficiency, such as transport, network industries and other non-performing public firms. This ST would therefore be a tool for reducing economic inequalities between the South and the North. It would promote the development of both metropolises, or centers, and peripheral areas in satellite[13] developing countries. On the other hand, the catching-up of development gaps between developing and developed countries, which would be induced by this ST, would not be tolerated by the lack of conditions for wealth creation or by the survival of old, unproductive socio-economic structures. Rather, it would be the developing countries contribution to international trade based on the principle of comparative advantage that would favor their dependence and accentuate the imbalances in their economic structures. These structural imbalances would further deepen their underdevelopment, calling more than ever for oriented ST, far removed from the unequal exchange that resulted in the brigandage and exploitation of such developing countries. ST would therefore be relative, evolving over time and multiple depending on the territories undergoing transformation. What it would have in common, however, is that it would pave the way for the integration of its developing countries, whatever their structural rigidities on the supply or demand side, into the new international division of labor. This is a division of labor that, completely independent of foreign competition, rebases the internal specialization of economies on the specific capacities of their territories and indigenous players.

[9] Alfred Sauvy: French historian, demographer and anthropologist. For him, the Third World wants to have a say in international relations, after a phase of colonization and dependence.

[10] Walt Whitman Rostow was one of the most influential of the early economists to address this issue within the UN framework. In Rostow (1960) was on the UN Economic Commission for Europe. Rostow wrote "the process of economic growth", as well as "the stages of economic growth: a non-communist manifesto" in 1959. See also Clark (1967). The conditions of Economic Progress, Myrdal (1957). Economic Theory and Underdeveloped Regions et Tinbergen (2013) optimal regime theory. In Economic models, risk estimation and programming: essays in honor of Gerhard Tintner.

[11] Raul Prébisch: Argentina's Keynes, he drew up an emergency plan for the ailing Argentine economy, whose situation is characterized by a 400% inflation rate, unsustainable foreign debt and a 4% recession. He also held many important positions, such as Governor of the Argentine Central Bank between 1935 and 1948, Director of United Nations Conference on Trade and Development (UNCTAD), and advisor to the Argentine President in 1983...

[12] The Egyptian economist Samir Amin, the Frenchman François Perroux and other economists such as: Kunibert Raffer, Keith Griffin, Pablo González Casanova, Walter Rodney, Andre Gunder Frank, Ernest Feder, Kurt Rothschild, Herb Addo, Walden Bello, Fernando Henrique Cardoso, Enzo Faletto, Theotonio Dos Santos, Ruy Mauro Marini, Armando Cordova and Paul Israel Singer have all participated, outside the United Nations Economic Commission for Latin America, in research related to the dependence of developing countries.

[13] Satellite countries: Are de jure independent countries, but under the strong military, economic and political impact of another country, resembling moons, which revolve around the planet.

2.2.2. Structural Transformation "From the Outside" or Through Integration into the Global Economy

The historic failure of the ISI strategy, particularly in Latin America and many other developing countries, would also call into question the success of ST based on structuralist theories of economic dependence. ST through self-centered development, the original ISI policy, would no longer be intelligible in economic contexts that are increasingly interdependent and open to global competition. Hence the need, in order to define ST in the context of developing countries, to rework the theory of early structuralism to adapt it to the external constraints of these countries. The shift from introverted (inward) development via ISI to development from the inside out towards the rest of the world would then be the new foundation of all successful ST. This new model of ST would be the basis for a industrialization, with production destined for both internal and external markets. This would involve ST by integrating the economies of developing countries into the global value chain (Sunkel, 1989).

This ST, based on integration into the global value chain, would be centered more on a supply-side economy than a demand-side one. Indeed, it would be based on neo-structuralist arguments, making the self-sustained development of territorial wealth-creation capacities, which comes purely from within, the lever for local industrialization that is integrated into global value chains. This local industrialization could be fuelled from abroad, in particular by Foreign direct investment (FDI) from multinational companies. This would make it possible to raise, since the Washington Consensus, a neo-structuralist ST model, more precisely just after the economic and financial crises that had revealed the failure of neoliberalism in both developed countries and the associated structural adjustment programs in developing countries. A model that links countries' macro-economic balances and development more closely to foreign trade, economic openness (including through the attractiveness of FDI) and industrialization, with the aim of integrating local territorial capacities into the global value chain of multinational firms, now considered an essential partner for all ST. The latter combines the constraints of external trade openness and international industrial competitiveness with those of territorial attractiveness for FDI projects. In this logic of openness to the outside world, and through its various advantages for the host country, the latter would be an essential instrument of industrialization, development and ST.

Consequently, in the sense of this neo-structuralist ST, the neo-liberal state would be a democratic actor, more participatory than classic interventionist, and under the constraint of preserving the main macro-economic balances, such as price stability (inflation, wages, exchange and interest rates), budgetary equilibrium, economic growth, purchasing power and employment. It would be a development process requiring the use of all available domestic resources to consolidate capital accumulation and technical progress. In developing countries particularly affected by chronic unemployment, its primary objective would be to achieve full employment of available labor resources.

Such full employment would increase the sectoral productivity of these developing countries, ensuring a continuous process of transfer and migration of labor from low-value-added primary sectors to more productive, high-value sectors. This self-sustaining process would take place within a Keynesian logic of interdependent markets (for goods and services, labor, money, finance and foreign exchange), with the state playing an indispensable role in providing and guaranteeing adequate and appropriate institutions for successful ST. These institutions would accompany the evolution of social, economic, financial and political structures in the service of diversified, more sophisticated and high value-added production, in order to consolidate the structural competitiveness of the national economy. In this way, ST in developing countries, which is not on the margins of globalization, would require a national strategy that takes advantage of all global opportunities in terms of various sources of technological learning, notably through the attractiveness of FDI projects, the removal of barriers to innovation determined by intellectual property rights, and global economies of scale on a planetary scale.

Despite the relevance of industrial economic policy and the Schumpeterian model of development, the demand aspect would be just as important for any ST in developing countries. In the latter, rigid structures would slow down investment and demand: wage growth is less proportional to that of factor productivity. In these countries, this wage trend can be explained by the rigidity of the labor market and the abundance of an often low-skilled workforce, which has a negative impact on productivity and leads to a worsening of income inequalities. A social policy of guaranteed inter-professional minimum wage (GIPMW), in favor of the destitute, should neutralize the consequences of this trend.

Furthermore, the ST of developing countries would be limited by the ongoing overvaluation of their respective currencies. In particular, this overvaluation is encouraged by the Ricardian rent generated by the export of either cheap labor-intensive production, or primary natural resources with little or no processing, which would lead to a "Dutch disease"[14] ST. The latter would block the development of high value-added, capital-intensive tradable goods industries. The latter would require strong national savings, which the economies of developing countries cannot easily generate. Hence their growing interest in attracting external savings and investment to serve their ST. For this reason, the long-term relationship between Gross Domestic

[14] Dutch Syndrome: Inspired by the case of the Netherlands in 1960, an economic phenomenon that describes the adverse consequences caused by a remarkable rise in natural resource exports to the decline of domestic manufacturing.

Product (GDP) and public debt would need to be balanced, under the constraint of a real exchange rate that takes into account the negative influences of Dutch disease on the manufacturing sector.

In order to catch up with other developed countries, developing countries would have to rethink their ST model, going beyond an ISI strategy or integration into the global economy via the global value chains of multinational firms, according to a new vision: that of the "Sao Paolo consensus". From this point of view, ST would operate through very specific mechanisms. These would be made more fluid by public policies giving greater importance to education, higher education, scientific research, digitalization, innovation and sectoral priority to trades and activities in the information economy, the blue economy, the green economy and new renewable energies.

3. Structural Transformation Through Digital Transformation

ST, a process of profound change in the composition and distribution of economic activities within a society, is increasingly influenced by digital transformation. This evolution, fueled by the rise of digital technologies, is redefining business models, production processes, human resource management and even relationships between economic players. The question is how digital transformation contributes to ST?

In fact, digitization is opening up vast economic horizons by introducing new business models and fostering the emergence of innovative sectors that are key to the success of the ST process in developing countries. These include artificial intelligence, which opens up possibilities for data analysis and processing on an unprecedented scale, and the platform economy, which is revolutionizing the way goods and services are exchanged. In addition, the Internet of Things (IoT) aims to transform everyday objects into connected devices, paving the way for new applications in fields as diverse as logistics, agriculture and healthcare. Finally, blockchain technology is revolutionizing transaction verification and validation processes, opening up opportunities in logistics, finance and supply chain management (World Bank, 2020).

These highly advanced technologies not only enable the creation of new products and services, but also bring about profound changes in production and consumption patterns. For example, the platform economy facilitates direct contact between service seekers and service providers, bypassing traditional intermediaries and reducing market friction. Similarly, artificial intelligence makes it possible to automate tasks that were previously performed by humans, also improving firms' performance and productivity. These STs are leading to a reorganization of economic activity sectors and the emergence of new dynamics of innovation and competitiveness on a national and international scale (World Bank, 2020).

The effect of digitalization on the ST of economies is also noticeable in job creation. While some tasks are being robotized, new job opportunities are emerging in NICTs-related sectors, as well as in cybersecurity, data management and software design. However, these transformations require rapid adaptation of workers' qualifications and skills, posing challenges for education and training (World Bank, 2020).

In fact, advanced digitalization technologies offer firms undeniable opportunities to optimize their operational tasks at every level. The robotization of the latter with the help of AI and robots makes it possible to both reduce labor costs and improve production time and quality. In addition, companies can make more informed decisions, thanks to the use of data analytics, fueled by the vast amounts of information available and anticipate market trends, which strengthen their ability to avoid risks and seize opportunities (UNCTAD, 2019).

The application of cloud computing solutions also represents a key lever for process optimization. By opting for cloud-based services and outsourcing their IT infrastructures, firms can benefit from greater flexibility, reduced costs, lower repair rates and greater resilience in the face of failures and cyber-attacks. This shift to cloud computing opens up the possibility of more efficient collaboration between a firm's various departments and subsidiaries, facilitating the integration and coordination of different activities (UNCTAD, 2019).

In addition, the digitization of logistics and distribution processes helps to improve inventory management, reduce delivery times and optimize the entire supply chain. Thanks to the use of highly advanced technologies such as IoT sensors, radio frequency identification (RFID) and real-time tracking systems, companies can perfectly control and track the movement of products, from manufacturing to delivery to end consumers. This increased visibility of the supply chain helps optimize the use of resources, anticipate potential problems and ensure optimal customer satisfaction (UNCTAD, 2019).

Digitalization has paved the way for a new development model characterized by their adaptability, capacity and agility to respond to different customer needs. For example, the sharing economy enables people to leverage their under-utilized assets by making them available to others via online platforms. In fact, the sharing economy is revolutionizing sectors such as accommodation, self-employment and transportation (with companies like Uber and Airbnb), offering new sources of income and encouraging more efficient use of resources (UNCTAD, 2019).

At the same time, on-demand services are gaining in popularity, offering customers immediate access to a range of products and services via online platforms and mobile apps. Multinational firms such as UberEats, Glovo and Deliveroo offer a variety of fast delivery services, while apps such as TaskRabbit offer the opportunity to quickly find free workers for particular tasks. This trend towards immediacy and convenience is transforming the way firms interact with their consumers, and opening up new prospects for growth. Personalizing products and services is also seen as an indispensable aspect of new business models. Thanks to

AI and data analysis, firms can now grasp consumers' individual needs and preferences and present them with tailor-made offers. Multinational firms like Spotify and Netflix use recommendation algorithms to persuade content tailored to each user's preferences, while fashion brands like Nike offer individualization options for their products. Indeed, this increased personalization incentivizes consumer engagement and strengthens long-term loyalty (UNCTAD, 2019).

Thanks to the decisive role played by digital transformation in promoting economic inclusion, marginalized populations can gain access to essential services. Indeed, advanced technologies offer individuals in remote or disadvantaged regions the possibility of benefiting from various public services such as financial, educational, health and other services through digital platforms. By way of example, mobile payment services enable unbanked individuals to access basic banking services and carry out financial transactions without having a personal bank account (Korovkin, 2019).

This financial inclusion brought about by digitization helps to reduce socio-economic inequalities between social strata, enabling a large cross-section of people to access economic opportunities and participate fully in the formal economy. By guaranteeing accessible and secure means of payment, advanced technologies offer merchants, self-employed workers and entrepreneurs the chance to access new markets and develop their activities, fostering both financial autonomy and economic resilience. Similarly, the digitization of education and healthcare is opening up new prospects for inclusion by enabling excluded populations to access essential public services. For example, students living far from traditional teaching centers can access courses and educational resources via e-learning platforms. And patients living in rural areas can obtain medical advice and diagnoses remotely, thanks to teleconsultation services. These initiatives help to lower disparities in access to education and health services, also strengthening social cohesion and consequently human development (Korovkin, 2019).

Although digital transformation brings with it socio-economic opportunities, it also generates complex challenges that require special attention from economic players and political decision-makers alike. Among the major challenges of this transformation is that of data security, which is of paramount importance. Indeed, with the increasing storage of sensitive data on automated platforms and the multiplication of online transactions, the prevention of cyber-attacks and the protection of personal information have become major issues. Recent large-scale cyberattacks have highlighted the vulnerability of IT systems and the need to reinforce security measures to ensure data integrity and confidentiality (Litvinenko, 2020).

This confidentiality represents another major challenge linked to digital transformation. With the huge collection of individual data by governments and firms, issues related to the control of people's individual information and confidentiality have become progressive concerns. At European level, the General Data Protection Regulation (GDPR) aim to support the protection of individual data, but their application is finding major challenges in many countries. In addition, the ethics and regulations surrounding the use of highly advanced technologies open up more complex debates. For example, rapid advances in automation and AI raise ethical questions in relation to the effect on automated decision-making, employment and corporate social responsibility. Policymakers need to strike a balance between promoting innovation and protecting the rights of workers, consumers and society as a whole (Litvinenko, 2020).

Despite these challenges, digital transformation also offers unprecedented opportunities to promote sustainable and equitable ST. By investing in digital technologies and promoting the widespread adoption of innovative solutions, governments and businesses can boost economic growth, increase productivity and improve citizens' quality of life. However, this requires a holistic approach that takes into account the technological, regulatory, ethical and social aspects of digital transformation to ensure positive long-term results.

4. Empirical Study: Impact of Digital Transformation on the Structural Transformation of the Moroccan Economy, What Relationship?

After discussing the theoretical underpinning of ST, then the relationship between the latter and digital transformation, this third axis serves to verify the existing relationship between digital transformation and ST in the Moroccan economy between 2015 and 2023. The econometric model of this work corresponds to a non-linear distributed lag autoregressive model (NARDL), and its processing goes through a set of steps, with the aim of defining the structure of the econometric model. To do this, we will specify the model, determine the steps involved in processing it and discuss the main results obtained.

4.1. Model Specification

To verify whether digital transformation impacts the ST of the Moroccan economy over the period 2015-2023, and to deduce whether it is the right tool to boost the ST of the Moroccan economy, we will estimate a NARDL model. This model belongs to the class of dynamic models. It is used to model long-term relationships between variables, taking into account the possibility of asymmetric and non-linear responses to shocks. NARDL can be used to analyze the short- and long-term effects of explanatory variables on a dependent variable, taking into account adjustment lags and threshold effects.

In this work, we seek to capture the effects of digital transformation (High Technology Exports (HTE)) as a variable of interest on ST (Economic Complexity Index (ECI)) as a dependent variable and proxy for the Moroccan economy's ST, during the study period, taking into consideration the other control variables

essential for the model, whose influence improves the results. These variables are commonly used in many studies relating digital transformation and ST, namely: Diversification of Production and Export Structure (DPES), Gross Fixed Capital Formation (GFCF), Gross Domestic Product per capita expressed in current dollars (GDPPC) and Trade Openness Rate (TOR). The variables in the empirical study are drawn from The Atlas of Economic Complexity, UNCTAD, World-Development-Indicators (WDI) and Our World in Data databases.

If we propose to capture the short- and long-term effects of explanatory variables on ST, the NARDL representation will be as follows:

$$\Delta LnECI_t = Ln\alpha_0 + \sum_{i=0}^{g-1} \alpha_1 \Delta LnECI_{t-1} + \sum_{i=0}^{p-1} \alpha_2 \Delta LnHTE_{t-1} + \sum_{i=0}^{r-1} \alpha_3 \Delta LnDPES_{t-1} + \sum_{i=0}^{h-1} \alpha_4 \Delta LnGFCF_{t-1} + \sum_{i=0}^{m-1} \alpha_5 \Delta LnGDPPC_{t-1} + \sum_{i=0}^{q-1} \alpha_6 \Delta LnTOR_{t-1} + \theta_1 LnECI_{t-1} + \theta_2 LnHTE_{t-1} + \theta_3 LnDPES_{t-1} + \theta_4 LnGFCF_{t-1} + \theta_5 LnGDPPC_{t-1} + \theta_6 LnTOR_{t-1} + \varepsilon_t$$

With: Δ: the first difference operator; α1- α6: the error-correction model representation; Θ 1- Θ 6: signifies long-term relationships; g-1, …, q-1: are the lag numbers of the variables.

However, the initial structure of this model does not take into account the direction of digital transformation. In other words, it does not take into account the possible asymmetrical effects that this transformation could have on the structural transformation of the Moroccan economy. Various events, such as cyber-attacks and hacking, political instability, regulatory impediments, major technological breakdowns, disparities in access to technology, digital skills deficits, lack of investment in infrastructure, as well as threats to privacy and security, could contribute to significant institutional degradation. Consequently, it is imperative to use a more suitable model to accurately reflect the complexity of the real context. With this in mind, we turn to the NARDL model developed by (Shin, Yu, & Greenwood-Nimmo, 2014).

Several previous researches such as Schorderet (2003) and Shin et al. (2014) have shown that the starting point is to decompose digitalization (HTE) time series (HTE) into its positive (HTE_t^+) and negative (HTE_t^-) partial sums:

$$Positive = HTE_t^+ = \sum_{j=1}^{t} \Delta HTE_j^+ = \sum_{j=1}^{t} max(\Delta HTE_j, 0)$$

$$Negative = HTE_t^- = \sum_{j=1}^{t} \Delta HTE_j^- = \sum_{j=1}^{t} min(\Delta HTE_j, 0)$$

With: Δ HTE_t^+ and HTE_t^- capturing improvements (+) and degradations (-) evolutions in digitalization. Hence, the model to be estimated follows the demonstration of Shin et al. (2014) as follows:

$$\Delta LnECI_t = Ln\alpha_0 + \sum_{i=0}^{g-1} \alpha_1 \Delta LnECI_{t-1} + \sum_{i=0}^{p-1} \alpha_2 \Delta LnHTE_{t-1}^+ + \sum_{i=0}^{p-1} \alpha_2 \Delta LnHTE_{t-1}^- + \sum_{i=0}^{r-1} \alpha_3 \Delta LnDPES_{t-1} + \sum_{i=0}^{h-1} \alpha_4 \Delta LnGFCF_{t-1} + \sum_{i=0}^{m-1} \alpha_5 \Delta LnGDPPC_{t-1} + \sum_{i=0}^{q-1} \alpha_6 \Delta LnTOR_{t-1} + \theta_1 LnECI_{t-1} + \theta_2 LnHTE_{t-1}^+ + \theta_2 LnHTE_{t-1}^- + \theta_3 LnDPES_{t-1} + \theta_4 LnGFCF_{t-1} + \theta_5 LnGDPPC_{t-1} + \theta_6 LnTOR_{t-1} + \varepsilon_t$$

With:

$-\theta_2/\theta_1'$ $-\theta_3/\theta_1'$ $-\theta_4/\theta_1'$ $-\theta_5/\theta_1'$ $-\theta_6/\theta_1'$ are the long-run coefficients. We anticipate that the readjustment coefficient $\Theta_1 < 0$.

Thus, we can rewrite the long-run coefficients form of as follows:

$$ECI_t = \pi_0 + \pi_1 LnECI_{t-1} + \pi_2 LnHTE_t^+ + \pi_2 LnHTE_t^- + \pi_3 LnDPES_t + \pi_4 LnGFCF_t + \pi_5 LnGDPPC_t + \pi_6 LnTOR_t + \varepsilon_t$$

4.2. Estimation Procedure of NARDL Model

In any time-series analytical approach, the first step is to evaluate the order of integration of the variables. For a NARDL model, it is imperative to guarantee the absence of second-order integration, noted as I(2), for any variable under consideration. The second step involves an examination of co-integration between the variables to validate the existence of a long-term relationship between them. In light of the results of the unit root tests, the use of the Pesaran, Shin, and Smith (2001) test proves crucial in establishing this co-integration. Unlike the approaches of Engle and Granger (1987); Johansen (1988) and Johansen (1991) the co-integration limit test advanced by Pesaran et al. (2001) stands out for its ability to handle series with mixed orders of integration. In our analysis, where some variables show stationarity while others do not, this test formulates the hypothesis accordingly.

H_0: $\Theta_1 = \Theta_2 = \ldots = \Theta_6$.

Contrary to the alternative hypothesis:

H_0: $\Theta_1 \neq \Theta_2 \neq \ldots \neq \Theta_6$.

We therefore need to compare Fisher's values with the simulated critical values. If we assume that LB is the lower bound and UB is the upper bound. We then have:

F < LB ➔ No co-integration;

F > UB ➔ Existence of co-integration;

LB < F < UB ➔ No conclusion.

The third step in this methodology involves the evaluation of long-term $\theta_2^+ = \theta_2^-$ and short-term $\sum_{i=0}^{p-1} HTE_t^+ + \sum_{i=0}^{p-1} HTE_t^-$ symmetry, achieved by comparing the sum of positive and negative dynamic coefficients.

Similarly, the fourth step is to evaluate the model's resistance using various diagnostic tests.

4.3. Discussion of Results Achieved

4.3.1. Stationarity Test

To avoid misinterpreting the regressions, it is imperative to examine the presence of unit roots in the series in order to assess their stochastic characteristics. This check is carried out using two well-known tests, namely the augmented test of Dickey and Fuller (1981) and the test of Zivot and Andrews (2002). Under the null hypothesis, these tests are based on the idea that the series has a unit root, either with or without interruptions.

The alternative hypothesis is that the series is stationary, either consistently or with a single break. In the event of a discrepancy between the results of the two tests, preference is given to the conclusions drawn from the Zivot-Andrews test. Based on the results of the stationarity tests (Table 1), the ADF test showed that the LnECI, LnHTE and LnGFCF series are stationary at first difference, while the LnDPES, LnGDPPC and LnTOR series are stationary at level. Compared with the ZA test, the results show that all series are stationary at first difference.

Table 1. Results of the stationarity test.

Variables	Stationarity	
	Augmented Dickey and Fuller (1981) (ADF)	Zivot and Andrews (ZA)
Logarithm of economic complexity index (LnECI)	I(1)	I(1)
Logarithm of high technology exports (LnHTE)	I(1)	I(1)
Logarithm of diversification of production and export structure (LnDPES)	I(0)	I(1)
Logarithm of gross fixed capital formation (LnGFCF)	I(1)	I(1)
Logarithm of gross domestic product per capita expressed in current dollars (LnGDPPC)	I(0)	I(1)
Logarithm of and trade openness rate (LnTOR)	I(0)	I(1)

4.3.2. Cointegration Test

Table 2. Pesaran boundary cointegration test.

F-bounds test					
Model	**Test statistic**	**Value**	**Signif.**	**I(0)**	**I(1)**
LnECI-LnHTE	F-statistic	**4.68**	2.5%	3.08	**4.15**

Pesaran cointegration test reveals the existence of a long-term relationship between the variables studied. Indeed, the value of the F statistic, evaluated at 4.68, exceeds the upper limit of 4.15 at the 2.5% threshold. Consequently, the null hypothesis of no cointegration between the variables is rejected. The results of the cointegration test are summarized in Table 2.

4.3.3. Estimation and Asymmetry Results

Table 3. Non-linear results of long-term estimation.

Variable	Coefficient	Std. error	t-statistic	Prob.
Logarithm of Economic Complexity Index (LnECI)*	-0.078	0.002	-2.143	0.978
Logarithm of High Technology Exports (LnHTE)	0.032	0.040	2.001	0.001
Logarithm of Diversification of Production and Export Structure (LnDPES)	0.012	0.055	3.001	0.010
Logarithm of Gross Fixed Capital Formation (LnGFCF)	0.035	0.001	2.453	0.000
Logarithm of Gross Domestic Product per capita expressed in current dollars (LnGDPPC)	0.022	0.022	1.987	0.040
Logarithm of and Trade Openness Rate (LnTOR)	-0.067	0.000	-1.564	0.965

Note: * Dependent variable of the model

Table 4. Short-term estimation results.

Variable	Coefficient	Std. error	t- statistic	Prob.
Logarithm of economic complexity index (LnECI)*	0.980	0.140	2.100	0.311
Logarithm of high technology exports (LnHTE)	0.356	0.731	2.745	0.242
Logarithm of diversification of production and export structure (LnDPES)	0.111	0.696	2.786	0.263
Logarithm of gross fixed capital formation (LnGFCF)	0.261	0.040	2.678	0.367
Logarithm of Gross domestic product per capita expressed in current dollars (LnGDPPC)	0.011	0.527	3.008	0.246
Logarithm of and trade openness rate (LnTOR)	0.540	0.023	2.831	0.924
CointEq(-1)	-0.731	0.300	-4.322	0.000
R-squared	0.775	Mean dependent var		0.034
Adjusted R-squared	0.743	S.D. dependent var		0.501
S.E. of regression	0.044	Akaike info criterion		-3.001
Sum squared resid	0.501	Schwarz criterion		-2.145
Log likelihood	48.001			
Durbin-Watson stat	2.134	Hannan-Quinn criter.		-2.233

Note: * Dependent variable of the model

Table 3 presents the results of the long-run estimation of the econometric model to explain the dependent variable LnECI. In fact, the variables LnHTE, LnDPES, LnGFCF and LnGDPPC are significant at the 5% level. The other two variables, LnECI and LnTOR, are not significant at the 5% level.

In fact, a 1% increase in high-tech exports (LnHTE) boosts the ST of the Moroccan economy by 3%. Similarly, a 1% increase in public and private investment (LnGFCF) as a percentage of GDP accelerates the Kingdom's structural transformation by 3%. In addition, increasing the diversification of production and export structures (LnDPES) by 1% improves the success of Morocco's ST by 1%. Finally, a 1% increase in GDPPC encourages the ST of the Moroccan economy by 2% between 2015 and 2023.

The short-term estimation results (Table 4) showed non-significant probabilities exceeding the 5% threshold for all the variables in the study. As expected, the restoring force CointEq (-1) is negative and significant, guaranteeing a long-term relationship between the sub study variables. This model also has a predictive power of 77%.

Table 5. Asymmetry test.

	LnECI-LnHTE	
Wald test	**X^2 chi-square**	**Probability**
Wsr	5.050	0.022
Wlr	0.020	0.779

Note: The null hypothesis assumes that the coefficients are symmetrical. The terms Wsr and Wlr refer respectively to the symmetries of the short- and long-term Wald statistics.

Table 5 shows the results of the symmetry test. The statistic calculated for the model's long-term term is 0.020, with a probability of 0.779, thus exceeding 5%. Consequently, the null hypothesis is confirmed, while the alternative hypothesis of asymmetry is rejected. This finding suggests that the ST of the Moroccan economy, represented by the LnECI as a proxy, reacts similarly in the long term to positive and negative variations in digitization.

In contrast, for the short term, the calculated statistic is 5.050, with a probability of 0.022, below the 5% threshold. Consequently, the null hypothesis is rejected in favor of the alternative hypothesis. This discrepancy indicates that the effects of digitization on ST are asymmetrical in the short term.

Table 6. Assumption testing.

Model	Autocorrelation Breusch Godfrey	Heteroscedasticity test Breusch-Pagan-Godfrey (BPG)	Heteroscedasticity test AutoRegressive Conditional Heteroskedasticity (ARCH)	Normality test	Ramsey test
LnECI-LnHTE	0.19 > 5%	0.75 > 5%	0.84> 5%	0.25 > 5%	0.56>5%

4.3.4. Diagnostic Tests NARDL

Table 6 shows the results of the autocorrelation, heteroscedasticity, error normality and specification tests. The Breusch-Godfrey test is used to test error autocorrelation for the model. This test confirms the absence of error autocorrelation at the 5% threshold for the model. The Breusch-Pagan-Godfrey and ARCH tests are used to test for error heteroscedasticity. These tests show values of 0.75 and 0.84 for model (the values of these tests are greater than 5% for model). The null hypothesis of no error heteroscedasticity is therefore accepted for model. The Jarque-Bera and Anderson Darling tests show that the errors follow a normal distribution in the estimated models (0.25 > 5% for the model). The Ramsey test shows that no variable is omitted and that the estimated model is therefore well specified (0.56 > 0.05).

4.3.5. Discussion of Results

The results obtained from the NARDL econometric model provide valuable insights into the determinants of the ST of the Moroccan economy between 2015 and 2023. Looking at the long-term effects, we find that LnHTE play a positive and significant role in promoting this transformation. This indicates that developing and promoting exports of high value-added products contributes to the diversification and evolution of Morocco's economic structure towards more innovative and technology-intensive sectors.

Similarly, investment (LnGFCF) is another key driver in the success of the ST process. Indeed, encouraging domestic public and private investment will lead to a significant and positive improvement in this transformation. This shows the decisive importance of investment in consolidating productive and exporting capacities, as well as modernizing the country's infrastructure, thus fostering a shift towards more diversified, sophisticated and competitive productive activities.

Furthermore, this article has shown the major role that horizontal and vertical diversification (LnDPES) can play as an indispensable element in stimulating the success of the Moroccan economy's ST process. Certainly, increasing diversified products and exports upwards from primary production to complex products and services both enables a more balanced distribution of resources and contributes to the achievement of future inclusive and sustainable growth.

In relation to GDP per capita (LnGDPPC), the study highlights its positive effect on the success of Morocco's ST process. This underlines the fact that improving the standard of living of the Moroccan population stimulates domestic demand, fostering growth and innovation in the various economic sectors.

On the other hand, the econometric results indicated non-significant probabilities for the other control variables, namely: the trade openness rate (LnTOR) and the lagged value of the economic complexity index (LnECI), raising questions about their participation in the success of the Moroccan economy's ST process between 2015 and 2023.

Thus, the results obtained from the short-term model highlight a negative and significant cointegration relationship, which guarantees the presence of a long-term relationship between the variables in the study. This shows certain stability in the economic relationships between the various factors of the ST process analyzed.

Finally, the results of the NARDL econometric model provide valuable insights into the stimulators and mechanisms of the Moroccan ST process, highlighting the importance of developing policies and strategies conducive to digital transformation, through different indicators such as investment, high-tech exports, diversification of productive structures, integration into global value chains, creation of decent employment and improvement of living standards to achieve future, inclusive and sustainable economic growth.

5. Conclusion

Currently, digital transformation is considered a ubiquitous phenomenon that has emerged and in the international economic landscape, assumes a primordial place to succeed in the ST process of economies, including that of Morocco. In this article, we take a close look at the implications of digitization for promoting sustainable development in Morocco between 2015 and 2023. The econometric results obtained are the fruit of a rigorous study based on a NARDL econometric model, taking into consideration several determining aspects that deserve to be highlighted and explained in greater depth.

At the outset, this study has shown that upward exports, i.e. high-tech exports, exert a significant and positive influence on the success of the Moroccan economy's ST process. This underscores the need to promote sectors characterized by high added value and advanced technologies, in order to diversify and sophisticate economic activities and ensure the international competitiveness of the Moroccan economy.

Similarly, investment appears to be an indispensable catalyst for the success of the ST process, helping to build productive capacity and modernize the country's infrastructure. This underlines the crucial role of domestic public and private investment in sustainable development and the creation of decent jobs in Morocco.

Moreover, the diversification of production and export structures also appears to be a key lever in the success of this process within Morocco, as it encourages an equitable distribution of resources while fostering the emergence of new, more productive sectors of activity. Of course, diversifying production and exports helps to strengthen economic resilience and stimulate inclusive long-term growth.

However, a number of factors, such as the economic complexity of the previous year and trade openness, did not have the desired impact on the Moroccan ST process during the study period. Thus, the results underlined the need for an in-depth analysis of the underlying mechanisms of the ST process and the identification of the most relevant levers of inclusive growth for Morocco.

In addition, it is important to realize that digital transformation encompasses economic, social, cultural and environmental aspects. In this respect, it is imperative to adopt a holistic and integrated approach to digital transformation, focusing on the multidimensional implications for Morocco's inclusive and sustainable development.

In this wake, economic players and public authorities should implement policies and strategies aimed at promoting a future, equitable and inclusive digital transformation that benefits Moroccan society as a whole.

Finally, the econometric results obtained show that digital transformation can be considered a fundamental pillar of the success of the Moroccan economy's ST process. This digital transformation makes it possible both to capitalize on the opportunities offered and to overcome the associated challenges. Morocco can therefore aspire to sustainable, more resilient inclusive growth capable of meeting the aspirations of its citizens and contributing to its long-term sustainable development.

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