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HOW PRODUCTIVITY, CAPITAL INVESTMENT, EMPLOYMENT, HUMAN CAPITAL AND ENERGY ARE AFFECTING ECONOMIC GROWTH IN MOROCCO? AN ARDL, FMOLS, DOLS AND CCR APPROACHES

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Original article

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ABSTRACT

This paper aims to scrutinize the effects of; productivity, capital investment, human capital, employment and energy intensity; on economic growth in Morocco under the Energy-augmented Cobb Douglas production function (CDPF) framework, using extended data from 1965 to 2022. The ADF unit root test confirmed the existence of cointegration among variables, then, the ARDL BTA/ECM model proved the presence of long-term relationship within, in which the explanatory variables progress all together positively and proportionally to generate economic growth, just as stipulate the standard CDPF. The outputs reliability was validated by FMOLS, DOLS, and CCR tests. Results implies that an additional unit in GDP corresponds, in terms of units to, 1.87 in productivity level, 0.12 in capital investment, 4.19 in of human capital, 0.98 in labor force and 2.52 in energy intensity, that Moroccan economy is human capital intensive unlike when it comes to physical capital. In the light of this findings, we think that Morocco should accelerate its industrial transition, proceed to a large modernization and mechanisation of its agriculture in order to inspire more productivity to its entire economy, keep acting in the sense of more structural reforms to improve the business environment, share out the public spending equitably following two dimensions, physical by upgrading local infrastructure to attract more investments, human by promoting human capital through education and social protection.

Keywords: *productivity, investment, employment, human capital, energy, growth, Morocco*

1. INTRODUCTION

Economic growth in Morocco, as in any country, is influenced by various factors such as productivity, capital investment, employment, human capital, as stipulated the Cobb-Douglas Production Function (CDPF), well known as being useful for analyzing the effects of the factors of production on production itself, assessing the exhaustive productivity, and understanding the nature of returns to scale in different industries, firms and economies.

Many previous studies have been interested to the impact of different macroeconomic factors on growth in the Moroccan case under the Cobb-Douglas model such as; public investment capital stock and the size of the employed labor force (Nounou et al., 2023) ; foreign direct investment and human capital (Abadli et al., 2022) ; labor, capital and total factor productivity

(Sekkat, 2007)... however no serious empirical work has been done before which attempted to measure the incidence of energy intensity on growth side by side with classical macroeconomic aggregates over the long run using the energy augmented CDPF excepted us.

Our added value enlightens the interconnectedness of the explanatory variables including the contribution of Energy in driving economic growth in Morocco for the first time. These insights will contribute to the existing body of knowledge on economic growth determinants and will offer valuable implications for policymakers and stakeholders in Morocco.

The first key mobilised in this study is productivity through its total factors, commonly referred to as TFP, which is used in economics to measure the impact of, technological advancements, changes in workers knowledge and their cultural adaptation, the improvement of the business environment, on the long-term output of an economic system. The second key is Capital investment which commonly refers to the funds invested in physical assets such plantations, equipment, inventories and land improvements, investments in research and development, besides financial investments in stocks bonds and securities. The third key in relationship to growth is Human capital; which represents the immaterial capital of a nation, acquired individually through the process of scholarship and professional training under the impulsion of the state's efforts. The fourth key is Total labor force, which comprises people ages 15 and older who supply labor for the production of goods and services during a specified period. The last key is Energy intensity, defined simply as the amount of energy consumption required to generate a unit of GDP, which can be declined at two dimensions, total and per capita. So, on the light of this initiation, how can we describe the nexus between these key factors over the long run? Or, much directly: How productivity, capital investment, employment, human capital and energy intensity are affecting economic growth in Morocco? In order to bring the right answers, we conducted a study utilizing an extended dataset spanning from 1965 to 2022, under the energy-augmented CDPF framework, which provides a structured approach to understand the relationships between these key variables, allowing for a comprehensive analysis of long-term trends and dynamics in the Moroccan economy. This extensive data coverage enhances the robustness of the findings and supports a thorough investigation of the research questions. But first of all, let's take a glance on the related literature review and the stocktaking of Morocco regarding these keys.

2. LITERATURE REVIEW

In economic theory, a production function is defined as a simple description of the technical relationship between economic inputs and outputs (Cheng & Han, 2017). In the neoclassical tradition, it is the conversion of production factors which design the effective resources used in the production process and enabling production into output, and their combination in a mathematical relationship is qualified as a production function (Besanko & Braeutigam, 2010). In literature, very often used production functions are linear production functions, such as Cobb Douglas Production function (CDPF), Constant Elasticity of Substitution production function (CES), Variable Elasticity Substitution production function (VES), Leontief Production function, and Translog production function (Cheng & Han, 2017).

The starting point of this study is the theoretical framework that served to, which is the Cobb Douglass production function, in the way it was presented as an aggregate homogenous linear function for the first time by (Cobb & Douglass, 1928), where production is estimated basically by the amount of Labor and the amount of investe d capital, Later, Douglas analyzed the production function developed under different nominations in various contexts using basically regression analysis (Gunn & Douglas, 1941, 1942; Daly, Olson, & Douglas, 1943).

The CDPF was severely criticised for its limitations since it takes only into account two factors main of production among many and its inflexibility (Lau, 1986), but for the most of all, on two main aspects: the assumption of constant return on scale on a macroeconomic level and the omission of technological change which can accurate during the production process.

Constant return on scale of an economy supposes that the inputs in the related model keep either increasing or decreasing, strictly, during the interval of any study, thus, this hypothesis, makes certainly the CDPF simple to use and fit many data sets very well for empirical forecasting (Miller, 2008), but it make it unreliable and abstract from a practical perspective. Furthermore, the omission of technical change in the specification of the Cobb-Douglass model is considered as a serious limitation to the acceptance of its assumptions (Fraser, 2002), because Cobb and Douglass within the period when they developed their study, disregarded the susceptibility of technological development which can tremendously affects the production , in efficiency and in volume. Solow and Swan (1956) worked on its improvement by introducing the concept of productivity, predicting that at the macro level any economy converge to a long run balanced-growth equilibrium, thankfully to capital accumulation, labor force amplification induced by population growth, and augmentation in productivity largely driven by technological progress (Mixon & Sockwel, 2007).Then, the Solow growth model was recaptured by (Mankiw et al., 1992) to take into consideration human capital, which yields to its human capital-augmented specification expressed as following: $Q=A\,K^{\alpha}(HL)^{\beta}$

where Q represent total economic production, A, K, H, L represent, the inputs of, productivity, capital, human capital, labor force, respectively. We can notice that the Neoclassical tradition do not take energy as a factor into account due to its view of energy as an intermediate product, but successive energy crises throughout history have emphasized the role of energy in economic growth (Basegmez, 2021) This has pushed some researchers to include energy in the production function (Brockway et al., 2017) based on the proven linkage established between energy consumption and economic growth (Behera & Mishra, 2020), on this basis, The energy-augmented CDPF specification is expressed as: $Q=A\,K^{\alpha}L^{\beta}E^{\chi}$

As in (Solow 1974, p.34; Stiglitz, 1974, Eq.(1), p.141; Kümmel et al.,2010, Eq.(50), p.166). Where Q represent the output of total economic production, A, K, H, L, E represent, the inputs of productivity, capital, human capital, labor force, and energy, respectively. Solow, Stiglitz and Dasgupta papers uses E for "exhaustible natural resources" (Solow, 1974; Stiglitz, 1974, 1979; Dasgupta & Heal, 1979), which can be interpreted as a proxy for energy, while the Kummel paper uses dimensionless values for Q, L, K and E (Kummel et al.,1985, 2000, 2010). The Greek letters α, β, χ are parameters expressing elasticities to their respective inputs in the energy-augmented CDPF, where they all fall within 0 and 1. The Standard CDPF has the underlying assumption of constant return to scale, thus, the sum of the inputs respective elasticities is $\alpha + \beta=1$, this condition is maintained in the energy-augmented CDPF by introducing the energy's elasticity as $\alpha + \beta + \chi = 1$. The contribution of energy intensity in production remains parsimonious as a third input in energy-augmented CDPF comparatively to capital and labor, but from an epistemological perspective, energy is an essential input of both capital and labor, without which production is impossible. the elasticities for the energy-augmented CDPF would be $\alpha = 0.3$, $\beta = 0.63$, $\chi = 0.07$ under the assumption of constant returns to scale, which implies that a 50% increase in energy input (while holding L and K constant) would cause only a 3% increase in output, Similarly, it implies that a substantial fall in energy input—say a 10% fall below current levels—would cause only a 0.7% fall in output, extreme falls in energy input also have trivial effects: a 90% fall in energy input would cause only a 15% fall in output; even a 99% fall in energy input would cause only a 28% fall in output (S. Keen et al., 2019). While the CDPF is useful for understanding the production process, it does not inherently account for

externalities. Externalities are costs or benefits incurred by third parties who are not directly involved in the production or consumption of a good or service. While the Cobb-Douglas function itself does not directly incorporate negative externalities, there are several ways in which negative externalities can arise in the context of this model:

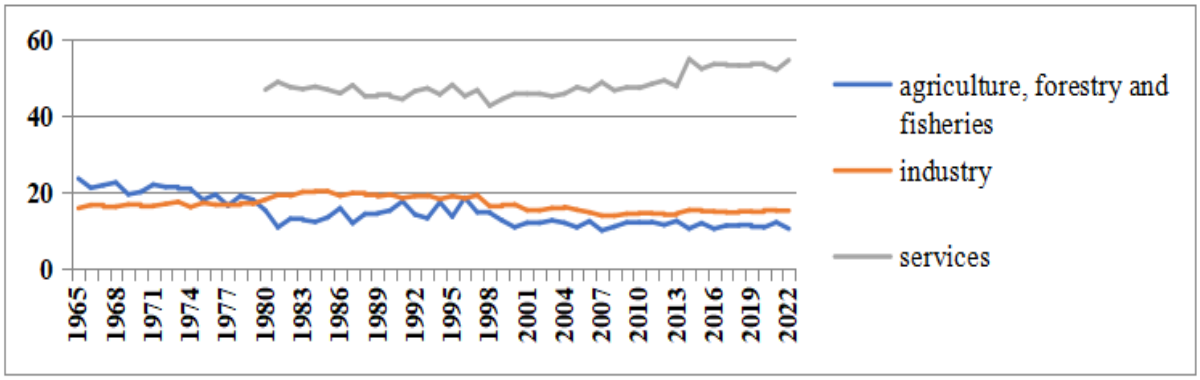
- Environmental degradation: Industries that do not internalize the costs of pollution infecting the air, the water and the sol, are adversely affecting the health and the well-being of nearby communities, including staffs, inducing overuse of natural resources (such as fossil fuels, minerals, and groundwater), harming ecosystems and compromises future generations needs, leading in fine to a loss of biodiversity, besides noise and visual pollution (Apostolov, 2016).
- Negative consumption: In a CDPF framework, a negative consumption externality is a necessary condition for the reversal of the Pigouvian ranking, where the second-best level of public good provision is greater than the first-best level. This can occur when the utility function is not too concave in the subutility of private goods (Wendner, R., 2008).
- Human Capital Spillovers: if the education and skills of one worker enhance the productivity of others, but the benefits are not fully captured by the skilled worker, it can lead to underinvestment in human capital and negative externalities (Apostolov, 2016)
- Labor market competition: when workforce is well educated, firms may invest more in physical capital, leading to higher productivity. However, if the distribution of human capital is unequal, it can create negative externalities where less skilled workers experience stagnant wages or job losses due to increased competition from more skilled ones (Apostolov, 2016).
- Social and economic inequities: if the gains from massive production are unevenly distributed, it can exacerbate income inequality within society, also Large-scale industrial projects can displace local communities, disrupting their livelihoods and social structures (Imeni et al., 2024).
- Market Distortions: when producers do not bear the full cost of production externalities it leads to overproduction and increased waste. Also, negative externalities can lead to market failures where the market does not allocate resources efficiently, resulting in welfare losses (Oliinyk, 2024).

3. STATUT REPORT OF MOROCCO

To palliate to the low productivity levels due to the historical reliability of the Moroccan economy on agriculture since its independence, characterized by cyclic intensive drought and limited quantities of harvests, Morocco has implemented various economic reforms aimed at liberalizing and modernizing the economy, improving the business environment, and attracting foreign investment. The ambition to industrialize the economy took the form of many unachieved initiatives adopted by successive governments such as the 2005' "Emerging Plan", the 2009' "national pact of industrial emergence", the 2014-2020 Industrial Acceleration plan... which all aimed at industrial modernization, technological innovation, and rising competitiveness in global markets, which made Morocco's TFP growth averaged around 1-2% per year over the past two decades, in fact, the country boosted up high added value sectors, like aeronautic and automotive industries, promoted the phosphate sector to become a major international producer of fertilizers, turned to pioneer producers of renewables through The "Noor Ouarzazate" solar complex, being operational at earliest 2016, which is the world's largest concentrated solar power plant, besides several wind farms, such as the "Tarfaya" Wind Farm, operational since December 2014, one of the largest in Africa, contributing both to the country's renewable energy mix. But all these efforts remain insufficients, because high industrialisation which can bring

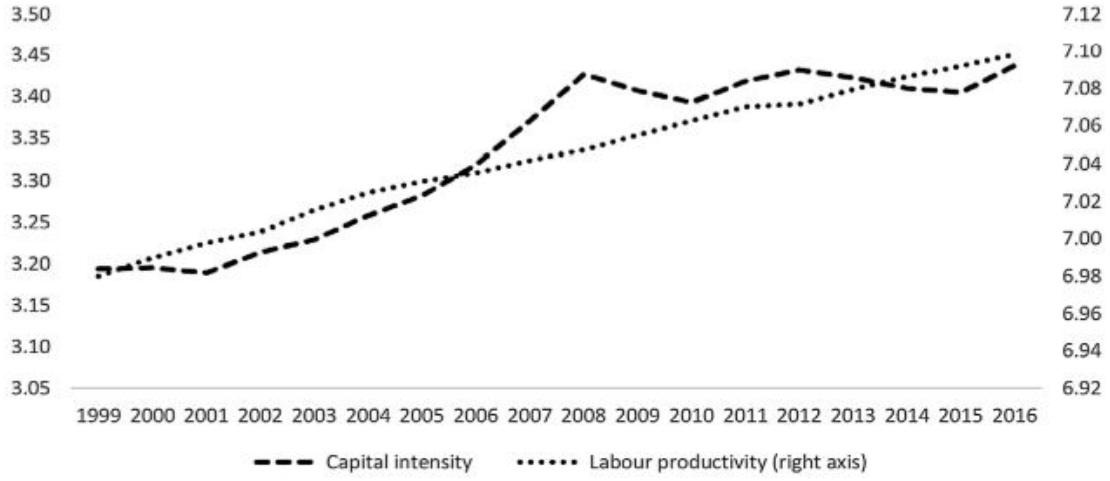
advanced levels of productivity is far away from being achieved to present, especially with the decided shift in earlier stages of 2000's, to the third sector as a strategic national choice. Figure 1 below, retraces the added value in % of GDP by each sector over the period of our study, showing how largely services are dominating at the expense of agriculture and industry, while Figure 2 goes back over the low levels of the capital intensity (in dollar per hour worked) and the labor productivity (unit of GDP per hour of work) over the last two decades in Morocco, which are the two main components of productivity, by illustrating how much they are slowly evolving, they are explaining how productivity in the Moroccan economic context is far away behind the developed countries trends (Feenstra et al., 2015; Bergeaud et al., 2017).

Figure 1: value added (%GDP) by the three economic sectors



Source: Authors own representation based on World Bank data

Figure 2: Capital intensity and Labor productivity in Morocco



Source: HCP (National Moroccan statistics office)

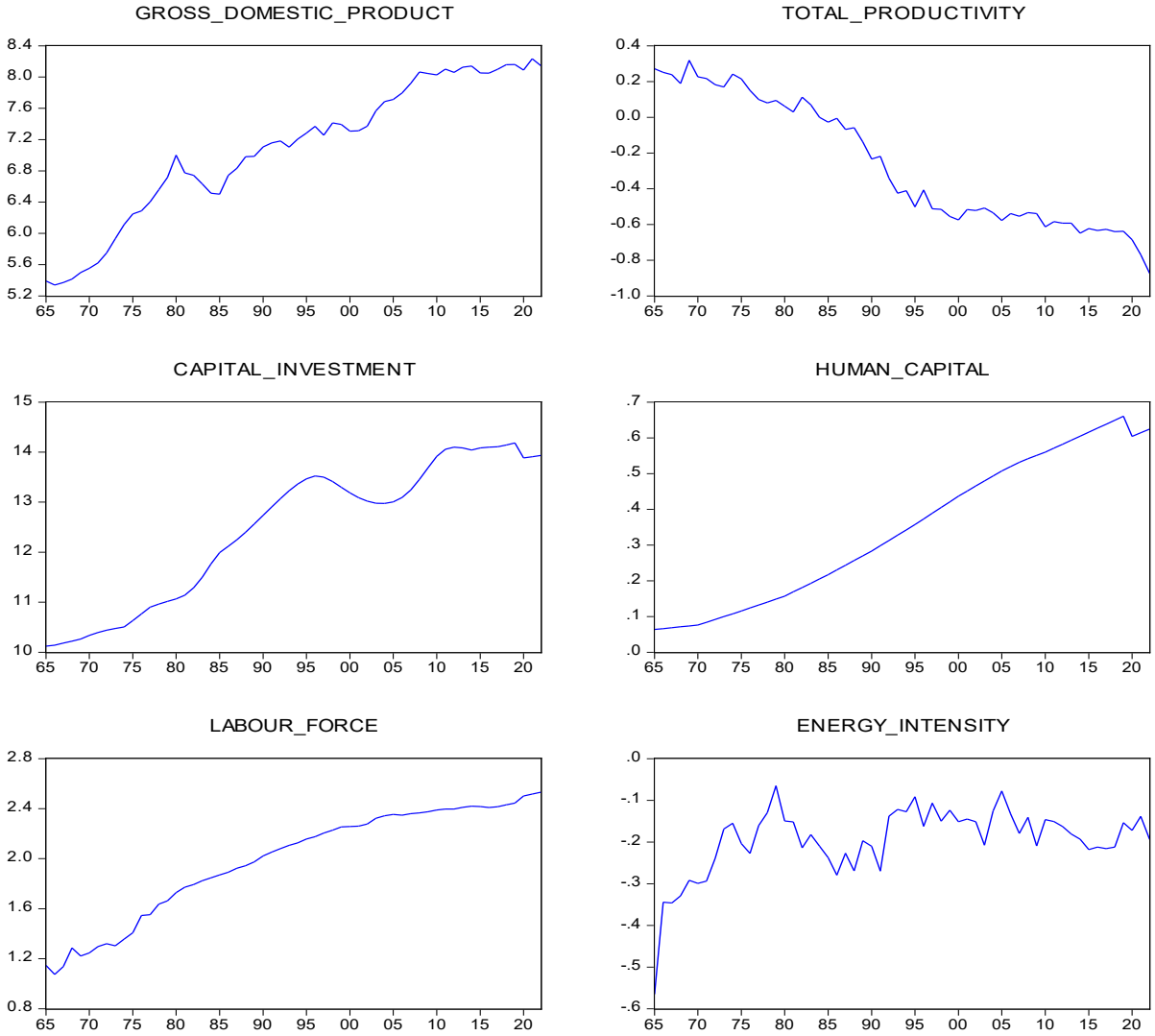
Regarding Capital investment: Morocco experienced high levels of public aggregate investment, in the 1970s and under the structural adjustment program from 1983 to1993, this led to a period of overinvestment in the 1970s then underinvestment from 1982-2004, Morocco has seen another period of overinvestment since the mid-2000s (EZZAHID & NIHOU, 2017) Inclined to a massive public investment including for instance; more than 2000 km highways, high-speed rail "Al Boraq" train connecting Casablanca city in the middle to Tangier city in the north, two tramway networks in the both political and economical capitals, thousands kilometres of roads and railways modernized and expanded, upgrading of existing ports and airports, and building others such as the colossal Tangier Med Port, one of the largest ports in Africa and the Mediterranean, which has significantly boosted Morocco's maritime capabilities, becoming

a major hub for transhipment and trade.

In the matter of finance, since 2000's, the central bank "Bank Almaghrib" has sustained a stable currency, maintained stable the foreign currency reserves, controled the credit supply, supervise the government's specialized credits establishments, decided recently a relative and progressive liberalisation of the Moroccan Dirham, meanwhile the country reinforced its external liquidities buffers, sustained good access to the global financial markets without being extremely reliable on, and boosted its attractiveness toward foreign direct investment thankfully to various free trade agreements. At the institutional level the new Mohamed VI fund for investment was recently created in 2021 succeeded by the homologation of the new investment charter in order to promote investment, stimulate economic recovery from the Covid-19 effects, support long-term growth by focusing on addressing structural issues and enhancing the competitiveness of the Moroccan economy In summary, while Morocco has seen periods of both under and overinvestment, its capital stock has grown substantially in absolute terms but remains low relative to its labor force and developed economies, limiting consequently productivity and undermining the economic convergence. As regards to human capital, Morocco has done considerable achievements in human development, thankfully to the adoption of national plans such as the National Human Development Initiative (NHDI). Launched in 2005, in order to address critical gaps in Morocco's development trajectory, such as high poverty in rural areas, social exclusion in urban areas, and the lack of opportunities and resources available to vulnerable populations (Benkassmi and Abdelkhalek 2020; World Bank 2017a). A new development model was set in 2021, updating the same main development objectives from other perspectives with new strategies and other keys factors (SCDM, 2021). In the matter of education Morocco has made significant progress in increasing educational attainment rates, with a primary school enrolment nearly universal, but there still challenges in secondary and tertiary education to deal with, particularly in rural areas, where although the expansion in higher education institutions, access remains uneven, adult literacy rate has been promoted, currently three quarters of the adult population is literate. The quality of education remains a concern, with many students not achieving minimum proficiency levels in reading and mathematics as reported the last session of 2023' PISA test, where Moroccan students underperformed. But Efforts are ongoing to reform curricula, teaching methods and promoting relevance to job market needs, to palliate to the mismatch between the skills provided by higher education and the needs of the labor market, leading to high unemployment rates among graduates. Labor itself is a factor of human capital accumulation as in Lucas-Uzawa framework, in which human capital is accumulated endogenously as a result of individual optimal investment decisions on the basis of the expected returns on the labor market (Uzawa, 1965; Lucas, 1988). As for labor work force; on one hand there's a positive aspect of the net increase in the total of persons engaged in the last half century over the two last decades , which is due to multiple key factors related to the evolution of the Moroccan labor market , such as the demographic growth, the continuous decreasing fertility and mortality rates, the growing urbanization , the dynamic female labor force participation, the concentration of specific economic activities in industrial zones and near shore areas which leaded to a significant agglomeration of the labor force in cities, the adoption of positive regulations in matter of preserving workers rights and formalising their activities, the switch of sectoral employment distribution with a progressive migration of workers from agriculture to services over the last sixty years, which is a sector with high potential of employment. On the other hand, the negative aspect would be that the size of the Moroccan economy itself which doesn't permit an occupation rate aliened to international average, which places an additional pressure on the economy to create sufficient jobs for 390,000 entrants in the national workforce every year (Cardarelli & Koranchelian, 2023, p.150), this induces a low Labor absorption, maintains related structural

issues such as, the underemployment, the persistence of the economy of shadow, the irregularities in term of working hours and amount of salaries compared to global averages, the employability discrimination and the pay disparities due to gender gap (Gulvira et al., 2024), the sectoral and territorial discrepancies, besides the mismatch between the skills provided by higher education and the needs of the labor market, leading to high unemployment rates among graduates which increase youth unemployment rate. The energy consumption intensity reflects the country's economic development, population growth, industrialization, Morocco has been historically highly dependent on imported fossil fuels of up to 90%, particularly oil and coal. As the population and the economy grow up, the demand in energy grow up with, which amplified energy consumption, so, to meet its energy needs with the low domestic production, Morocco has undergone significant changes in its energy sector over the past few decades, focusing on diversifying its energy sources, increasing renewable energy capacity, and improving energy efficiency, all backed up by technological and infrastructural advances such as the implementation of smart grid technologies to improve energy distribution and integration of green method and resources. Moreover, Morocco's National Energy Strategy (2009) set a target for renewables to constitute 42% of installed capacity by 2020 and 52% by 2030. Morocco had already exceeded the 42% target. The evolution of the variables keys time series mentioned above and detailed in Table1 below is depicted in the logarithmic form in Figure 3.

Figure 3: the variables keys' time series evolution



Source: Eviews 10 output based on authors' computation

Figure 3 exhibits upward explicit trends and sustained stability in the long run for all variables, except for energy intensity' plot which manifests downward trend and relative instability. The increasing upward trends observed in the plots above can be explained by:

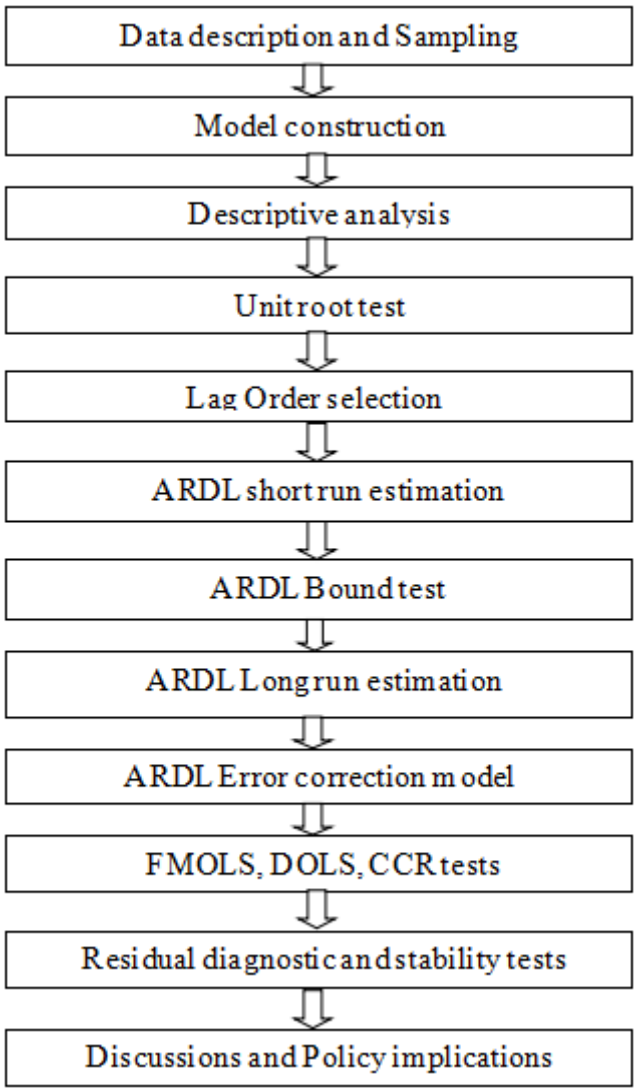
As regards to capital stock, an upsurge in the matter was a key driver of GDP growth in the 1960's, averaging 5.8% annually. However, capital deepening declined significantly in the 1980's-1990's, averaging -1.2% per year, and remained low at 0.2% in the 1990's - 2000's, contributing to the slowdown in GDP growth (Chemingui, 2005), since 2000's, it continues to increase by 6.2% on average, in the time when it never exceeded 4.6% in 80-90 (HCP, 2016). Consequently the net of capital reserve, public as private, was multiplied by 50 within the last sixty years, with a max growth rate of 286 % in 2019 which represented 60 % of GDP, which was much higher than MENAP countries on average (Cardarelli and Koranchelian, 2023). Concerning Human capital, which is tightly correlated to education, the trend is explained by the tremendous updates made in Morocco over the period of our study : primary net school enrolment jumped from 30% in sixties to 100% to present, the secondary rate has doubled to more than 90%, meanwhile the tertiary one was multiplied by 40, all thanks to total public spending on educationwhich raised up by 400%, when passed from barely 200 million USD to more than 8000 million USD, without counting the meaningful contribution of the private sector in the matter (El Asli & Azeroual, 2023a, 2023b). Concerning total labor force, the number of the engaged persons quadrupled from 3.25 million in middle sixties to around 13 million currently, due to continuous demographic growth over the last six decades, in fact, the population of Morocco tripled since the middle of sixties to reach approximately 40 million to present, by extra half a million people every year (HCP, 2017), with an urban rate which has more than doubled from 31% earlier sixties to around 65% nowadays, this structural demographic metamorphose has been accompanied with a significant shift from agriculture employment to industry and services recruitment, thus, sectoral distribution switched from 60% of the workforce engaged in agriculture in middle sixties to more than 45% in favour of services, Agriculture around 33%, industry around 22%. Anent productivity, on one hand, the Moroccan economy was heavily reliant on agriculture at early stages (pre-2000's), well known for its low productivity due to its limited technologies adoption and the modest infrastructure facilities at the expanse of the industrial sector which is, in the Moroccan context, characterized by low levels of innovation and less technological advancement. On the other hand, the switch made to the third sector as the main economic lever since 2000's hasn't succeed yet to raise the level of productivity although the sequence of reforms already mentioned above in introduction . When it comes to commercial openness, only FDI coming from France were statistically significant and had a positive effect on TFP. This is explained in part by the concentration of these investments in the industrial sector, catalyst for knowledge transfer, technological change and economic growth (Azeroual, 2016). Finally, regarding energy intensity plot, the fluctuations observed over time, can be explained by the occurrence of shocks due to well known historical disturbances of international energy prices and supplying chain perturbations such as the successive oil chock crisis and the permanent tensions in middle east where there's the largest oil reserves worldwide. The minor retractions observed at the curves outcome are due to the effects of Covid-19 crisis, but remain slightly tights and ephemerals for two years, then progressively faded away with no real impact.

4. THE METHODOLOGY OF THE RESEARCH:

4. 1. THE RESEARCH METHODOLOGY STEPS

The methodological approach followed in this study is schematized step by step in scheme 1:

Scheme 1: the study's methodological Approach



Source: Author's own elaboration

4. 2. ARDL APPROACH PRESENTATION

The ARDL is an econometric model to analyse dynamic relationships with time series data in a single-equation framework where the cointegration techniq is used in determining the long run relationship between series with different order of integration (Pesaran & Shin, 1999; Pesaran et al., 2001), where the current value of the dependent variable is allowed to depend on its own past realisations – the autoregressive terms – as well as current and past values of additional explanatory variables – the distributed lag part (Kripfganz & Schneider, 2018), ARDL cointegration technique is preferable when dealing with variables that are integrated of different order, I(0), I(1) or a combination of both, and, robust when there is a single long run relationship between the underlying variables in a small sample size, The long run relationship of the underlying variables is detected through the F-statistic (Wald test). The reparameterized result gives the short-run dynamics and long run relationship of the considered variables under the Error

Correction Model (ECM), which can be derived from the ARDL model through a simple linear transformation, by integrating short run adjustments with long run equilibrium without losing long run information (Nkoro & Uko, 2016).

The standard ARDL/BTA specification is:

$$\Delta(Y)_t = \alpha_0 + \delta_1 Y_{t-1} + \ldots + \delta_s Y_{t-s} + \beta_1 X_{t-1} + \ldots + \beta_s X_{t-s} + \ldots + \varepsilon_t$$

Where α_0 is the intercept, X_t is the matrix of integrated / co integrated variables, δ are long-run coefficients, ρ are short-term coefficients and ε_t are random disturbances.

4. 3. UNIT ROOT TEST

Before checking any potential relationship between the variables in question, it is primordial to determine if the data are stable. A stationary data is one whose statistical properties do not depend on the time at which the series is observed (Kwiatkowski et al, 1992). data integration, either in level or in the first order, or at them both (cointegration) is fundamental for applying the ARDL bound test (Pesaran et al, 2001). There are many unit root tests to verify if time series are stationary or not, this paper used augmented Dickey-Fuller test (Cheung and Lai, 1995).To tackle problems of autocorrelation related to a non stationary process in time series, Dickey and Fuller (1979) developed a test after their names (ADF) with three specifications:

$\Delta Yt = \beta 1 + ZYt\text{-}1 + \alpha i + \varepsilon t$ (Constant only)

$\Delta Yt = \beta 1 + \beta 2t + Z\ Yt\text{-}1 + \alpha i + \varepsilon t$ (trend and constant)

$\Delta Yt = Z\ Yt\text{-}1 + \alpha i + \varepsilon t$ (without trend and constant)

Two hypotheses are to be tested:

H_0: the variable has unit root

H_1: the variable doesn't

4. 4. GENERAL AND SPECIFIC LAG ORDER SELECTION

When the autoregressive model is subject to restrictions of cointegration there is multiple information criterions for selecting the appropriate lag oder such as Akaike information criterion (AIC), Schwartz-Bayesian Information Criterion (SC), final prediction error (FPE), Hannan-Quinn information criterion (HQIC) (Lütkepohl, 1993)**.** considering the lag length with the lowest value, is fundamental in any auto-regressive modes because it enables to, reduce the robustness of the model, eliminates the statistically insignificant coefficients, avoid the loss of extra degrees of freedom and the multicollinearity phenomenon if there's too many lags, finally, to make sure that the disturbance terms are not serially correlated (Mallik, 2008).

4. 5. ARDL BOUNDS TEST

An ARDL bounds test for cointegration involves an extra *F*-test on the lagged levels of the independent variable in the ARDL equation (Pesaran et al, 2001). Then the calculated F-statistic is compared with critical values: if it exceeds the upper critical bounds value, then the H_0 is rejected. If it falls within the bounds then the test is inconclusive. Lastly, if it falls below the lower critical bounds value; it implies that there is no co-integration (Narayan, 2005).

4. 6. ERROR CORRECTION MODEL (ECM)

Error Correction Model **(ECM)** is the second analytical approach of ARDL model which identifies short-run relationships among the variables and examine the adjustment of the dependent variable by the long term (Engle & Granger, 1987; Hassler & Wolters, 2006). The error correction term (ECT) associated to this adjustment in the Case of an ARDL model, measures the link

between the short-run and the long run, it is developed from the short-run estimators to show how variables quickly converge to equilibrium by the long run (Engle & Granger, 1987). The standard ARDL/ECM model is expressed as:

$$\Delta(Y)_t = \alpha_0 + \delta_1 Y_{t-1} + \delta_2 X_{t-1} + \sum_{i=0}^{p} \rho_1 \Delta Y_{t-i} + \sum_{i=0}^{q} \rho_2 \Delta X_{t-i} + \varepsilon_t$$

Where ρ are short-term coefficients, are the long-term ones, p and q are the lag order for the independent and dependent variables, respectively, are random disturbances.

4. 7. FMOLS, DOLS, CCR TESTS

Besides ARDL, we mobilized the Fully Modified Ordinary Least Squares (FMOLS), Dynamic Ordinary Least Squares (DOLS) estimation techniques and Canonical Cointegrating Regression (CCR). The FMOLS method was pioneered by (Phillips & Perron,1988) for time-series modelling, as a regression approach which amends the least squares method when dealing with cointegration and its impacts on autocorrelation and endogeneity in the explanatory factors, it is particularly noted for its reliability in small sample sizes and its ability to address endogeneity and serial correlation (Hamit-Haggar, 2012). Moreover, the DOLS estimation method initiated by (Stock & Watson, 2003) has been shown to outperform FMOLS in terms of estimation results, specifically by accounting for correlations among regressors, as demonstrated by (Kao & Chiang, 1991). In addition to these two tests, the CCR test is conducted as a robustness check (Pesaran et al., 2001), by transforming numeric info using just the stationary part of an interconnected system, when data are transformed in this way; the cointegrating connection generated by the cointegration model remains unchanged. Error terms in cointegrating models are decoupled from zero-regularity explanatory variables using the CCR modification, this leads to a roughly effective estimation and simultaneously of chi-square tests (Park, 1992; Pattak et al, 2023).

4. 8. RESIDUAL DIAGNOSTIC AND STABILITY TESTS

Residuals are critical data at the model's diagnostic check point, where one seeks indications that either assesses the capability of the model, or provides directions along which it might be modified (Mauricio & Alberto, 2008). In this study, the residuals normal distribution test was conducted by jarque-bera normality test (Bera & Jarque,1981), the heteroscedasticity was checked with the Breusch-Pagan-Godfrey test (Breusch & Pagan, 1979), and the serial correlation was evaluated with the Breusch-Godfrey-Lagrange Multiplier test (Godfrey, 1978), while the regression specification errors was verified with the Ramsey RESET test (Ramsey, 1969). The consistency of the regression relationship is checked by the cumulative sum CUSUM and the cumulative sum of squares CUSUMSQ tests (Brown et al., 1975).

4. 9. MODEL ASSUMPTIONS, ENDOGENEITY CONCERNS AND LIMITATIONS

4. 9. 1. MODEL ASSUMPTIONS

Based on the literature provided by the study, the following hypothesis has been formulated: – H_0: productivity, capital investment, employment, human capital and energy intensity, impact economic growth.

The above hypothesis is further explained by the following sub-hypothesis

H_{0a}: Productivity negatively impacts economic growth

H_{0b}: Capital investment negatively impacts economic growth

H_{0c}: Employment negatively impacts economic growth

H_{0d}: Human capital negatively impacts economic growth

H_{0e}: Energy intensity negatively impacts economic growth

We assume a constant return on scale in the specification of the augmented energy CDPF for the Moroccan economy in order to simplify calculations , which means that the sum of the inputs elasticities is $\alpha + \beta + \chi = 1$, in fact this is not really the case because the variables keys doesn't have a constant trend the long of our study.

4. 9. 2. ENDOGENEITY CONCERNS

- Endogeneity is a significant concern when using the ARDL model, as it can lead to biased and inconsistent parameter estimates, it occurs when an explanatory variable is correlated with the error term in a regression model. This correlation can arise due to omitted variable bias, measurement error, or simultaneous causality.
- Lag structure: one way to mitigate endogeneity is by appropriately specifying the lag structure of the ARDL model. Increasing the number of lags can help in addressing endogeneity concerns, especially when the regressors are integrated of order one (I(1)) but not cointegrated among themselves (Gemmell et al., 2014)
- Cointegration Tests: Before applying the ARDL model, it is essential to test for cointegration among the variables. If cointegration is established, OLS estimators can be consistent even in the presence of endogeneity, provided that the model is correctly specified.
- Checking Robustness, by using different lag lengths or alternative specifications, can help validate the findings and ensure that the results are not driven by endogeneity
- Checking results reliability by using complementary tests such as FMOLS, DOLS, CCR.

4. 9. 3. MODEL LIMITATIONS

While being useful in econometric analysis, the ARDL, FMOLS, DOLS, and CCR have several limitations such as:

- Stationarity requirements: The ARDL model requires that the variables be stationary at levels I(0) or at first difference I(1). If any variable is stationary at I(2) or higher, the ARDL model cannot be applied. This can restrict its applicability in certain datasets where such conditions are not met (Chetty P, 2018)
- Sensitivity to model specification: The results from ARDL and FMOLS can be highly sensitive to the choice of lags and the specification of the model. This means that different choices can lead to significantly different results, which may affect the reliability of the conclusions drawn from the analysis (Pahlavni et al., 2005)
- Complexity in interpretation: The interpretation of the coefficients in an ARDL model can be complex, especially when distinguishing between long-run and short-run effects. This complexity may lead to misinterpretations if not handled carefully.
- Potential for Overfitting: due to the flexibility in lag selection, there is a risk of overfitting the model to the data. This can result in a model that performs well on historical data but poorly on out-of-sample predictions (Chetty P, 2018; Božanić et al., 2023).
- Assumption of exogeneity: These methods assume that the regressors are exogenous, which may not always be the case in practice, this can limit the model's ability to account for external influences that are important in certain contexts, subconsequenlty, the estimates from these methods may be inconsistent (Bansal et al., 2021).
- Assumption of Linear Relationships: ARDL typically assumes linear relationships among variables. If the true relationship is nonlinear, the model may fail to capture the dynamics accurately, leading to biased estimates (Kripfganz & Schneider, 2022).

- Modelling unreal dynamics: if there is a stochastic (random) trend present in the data, the dynamics in an ARDL model will be approximating this trend rather than modelling real dynamics (MVA Consultancy, 2008).
- Sensitivity to small samples sizes and potential for multicollinearity: these methods may produce biased results when the sample size is small, as they rely on asymptotic properties that may not hold in finite samples. If there is high multicollinearity among the regressors, the estimates from these methods may be imprecise with large standard errors (Hardi et al., 2023).
- Difficulty in handling structural breaks: while FMOLS, DOLS, and CCR do not explicitly account for structural breaks in the data, which can lead to biased estimates if such breaks are present., ARDL can take them into consideration thanks to the Dummy variables method.
- Lack of hypothesis testing: Unlike ARDL, FMOLS, DOLS, and CCR do not provide a direct way to test hypotheses about the coefficients, such as testing for the significance of individual coefficients or joint restrictions (Bansal et al., 2021).

4. 10. DATA DESCRIPTION AND SAMPLING

4. 10. 1. THE ANALYTICAL APPROACH OF THE DATA COLLECTION PROCESS

The collected data is quantitative in nature, secondary in category, since it has already been published, some time series have nominal values, some others are expressed at percentage, all available online under free common licences from certified sources such as the Word Bank data platform. The variables in question have been chosen on the basis of their availability for the period of the study (1965-2022), for their homogeneity in terms of unit of measurement with the exogenous variable and for their compatibility with the theoretical model. Monetary variables such as Gross domestic Product (GDP), Total Factors of Productivity (TFP) and capital stock are expressed at Current PPP for Morocco in international USD to allow standard comparisons of real prices of goods and services for each year in order to avoid potential random fluctuations of local currency for statistical considerations. Missing values, in case if they existed, have been estimated by the mean of the two adjacent values.

4. 10. 2. DATA PRESENTATION

In the table 1 below, are presented the adopted variables which corresponds to the CDPF determinants, their respective, acronyms, descriptions, unit of measurement, and their sources.

Table 1. Variables and Data presentation

CDPF Determinant	Adopted Variable And its Acronym		Description	Unit of measure	Data source
Production	Gross Domestic Product per capita	GDP	The sum of gross value added by all resident producers + any product taxes - any subsidies not included in the value of the products, divided by midyear population	Current U.S. Dollars at purchaser's prices	World-Development-Indicators
Productivity	Total factor productivity	TFP	the proportion of output not explained by the amount of inputs used into, it reflects the efficiency and effectiveness of production as a result of an optimised combination of TFP including institutional, and policy-keys	Level at Current PPP for Morocco Index USA = 1	Penn world Table 10.01
Capital	Capital stock	CLS	consists of resident producers' investments, deducting disposals, in fixed assets by the government, business sectors, and householders	Current PPP for Morocco at Millions of U.S. Dollars	Penn world Table 10.01
Human Capital	Human capital per person	HCI	based on years of schooling and rate return to education	Index	PWT 10.01
Labor	Total labor force	TLF	persons aged 15 and older engaged for the production of goods and services even for an hour per week	Millions of persons	Penn world Table 10.01
Energy	Energy intensity	ENY	Primary energy consumption per unit of GDP output	kilowatt-hours per $	U.S-EIA

Source: Authors own construction

4. 11. MODEL CONSTRUCTION

By applying the CDPF, the standard one and the energy-augmented one, on the variables identified below, we get the following ARDL/BTA equations, expressed at first as:

$$GDP_t = TFP_t * CLS_t^{\alpha} (HCI_t * TLF_t)^{\beta} \quad (1)$$

$$GDP_t = TFP_t * CLS_t^{\alpha} * TLF_t^{\beta} * ENC^{\chi} \quad (2)$$

Generating eq (1) and eq (2) in logarithmic form with the adopted mentioned variables which express the growth rate of each one simultaneously yields to the following specifications:

$$LnGDP_t = LnTFP_t + \alpha\, LnCLS_t + \beta\, LnHCI_t + \beta\, LnTLF_t + c + \varepsilon_t \quad (1')$$

$$LnGDP_t = LnTFP_t + \alpha\, LnCLS_t + \beta\, LnTLF_t + \chi\, LnENC_t + c + \varepsilon_t \quad (2')$$

By combining the equations (1') and (2'), and making the necessary simplifications, we get the following specification which is the adopted equation serving to our ARDL model:

$$LnGDP_t = LnTFP_t + \alpha\, LnCLS_t + \beta/2\, LnHCI_t + \beta\, LnTLF_t + \chi/2\, LnENC_t + c + \varepsilon_t$$

The stoichiometric coefficients are unified in a one final equation expressed as following:

$$LnGDP_t = \lambda 1 LnTFP_t + \lambda 2 LnCLS_t + \lambda 3 LnHCI_t + \lambda 4 LnTLF_t + \lambda 5 LnENC_t + c + \varepsilon_t \quad (3)$$

Consequently, the ARDL/BTA specification is expressed as:

$$LnGDP_t = \sum_{i=1}^{p} \mu_i LnGDP_{t-i} + \sum_{i=1}^{q} \mu_{1i} LnTFP_{t-i} + \sum_{i=1}^{q} \mu_{2i} LnCLS_{t-i} + \sum_{i=1}^{q} \mu_{3i} LnHCI_{t-i} + \sum_{i=1}^{q} \mu_{4i} LnTLF_{t-}$$

$$+ \sum_{i=1}^{q} \mu_{5i} LnENY_{t-i} + \lambda_0 LnGDP_{t-i} + \lambda_1 LnTFP_{t-i} + \lambda_2 LnCLS_{t-i} + \lambda_3 LnHCI_{t-i} + \lambda_4 LnTLF_{t-i} + \lambda_5 LnENY_{ti} + c + \varepsilon_t$$

At the fist difference as:

$$\Delta LnGDP_t = \sum_{i=1}^{p} \mu_i \Delta LnGDP_{t-i} + \sum_{i=1}^{q} \mu_{1i} \Delta LnTFP_{t-i} + \sum_{i=1}^{q} \mu_{2i} \Delta LnCLS_{t-i} + \sum_{i=1}^{q} \mu_{3i} \Delta LnHCI_{t-i} + \sum_{i=1}^{q} \mu_{4i} \Delta LnTLF_{t-i} + \sum_{i=1}^{q} \mu_{5i} \Delta LnENY_{t-i} + \lambda_0 LnGDP_{t-i} + \lambda_1 LnTFPt-i + \lambda_2 LnCLS_{t-i} + \lambda_3 LnHCI_{t-i} + \lambda_4 LnTLF_{t-i} + \lambda_5 LnENY_{t-i} + c + \varepsilon_t \quad (4)$$

Where t represents the current period, t − i represents the previous period, Δ is the first difference operator, p and q are respectively the adequate lags length for both dependent and independents variables, , coefficients of short and long run are shown through and λ respectively, while t represents the error notation. We construct two hypotheses from eq(4): The first of which is the null hypothesis (H0: $\lambda 1 = \lambda 2 = \lambda 3 = \lambda 4 = \lambda 5 = \lambda 6 = 0$) if no cointegration and the 2nd in the Case of the alternative one (H1: $\lambda 1 \neq \lambda 2 \neq \lambda 3 \neq \lambda 4 \neq \lambda 5 \neq \lambda 6 \neq 0$). If there is cointegration, then, the error correction model (ECM) representation is specified as:

$$\Delta LnGDP_t = \sum_{i=1}^{p} \mu_i \Delta LnGDP_{t-i} + \sum_{i=1}^{q} \mu_{1i} \Delta LnTFP_{t-i} + \sum_{i=1}^{q} \mu_{2i} \Delta LnCLS_{t-i} + \sum_{i=1}^{q} \mu_{3i} \Delta LnHCI_{t-i} + \sum_{i=1}^{q} \mu_{4i} \Delta LnTLF_{t-i} + \sum_{i=1}^{q} \mu_{5i} \Delta LnENY_{t-i} + \gamma ECT_{t-1} + \mu_t \quad (5)$$

Where, γ represents adjustment pace, t symbolizes time, and μt represents the relative error term, while ECT represents the error correction term.

The terms of adjustment, the constant and the random disturbances in the specifications below won't be considered in the rest of this paper since we are exclusively concerned about the nexus between the main variables more than the respective share of each one of them.

4. 12. DESCRIPTIVE ANALYSIS

Descriptive analysis is conducted through Descriptive analysis, Multivariate Correlation analysis (MCA), and Principal Component Analysis (PCA).

4. 12. 1. DESCRIPTIVE STATISTICS

Descriptive analysis is conducted to ascertain the statistical properties of the variables. Table 2 presents the descriptive statistics of the variables of the estimation model:

Table 2. Descriptive Statistics

	LNGDP	LNTFP	LNCLS	LNHCI	LNTLF	LNENY
Mean	7.079463	-0.260872	12.45185	0.345008	1.984606	-0.195030
Median	7.195070	-0.409163	12.99265	0.334866	2.116125	-0.180076
Maximum	8.234174	0.318933	14.18219	0.660518	2.532088	-0.065172
Minimum	5.340049	-0.873282	10.12099	0.063623	1.074467	-0.565177
Std. Dev.	0.884330	0.354294	1.398427	0.201663	0.438736	0.080407
Skewness	-0.492540	0.207566	-0.415479	0.065945	-0.645414	-1.891951
Kurtosis	2.184073	1.463422	1.660857	1.533924	2.084198	9.137694
Sum	410.6088	-15.13059	722.2073	20.01045	115.1071	-11.31173
Sum Sq. Dev.	44.57623	7.154878	111.4692	2.318078	10.97189	0.368525
Observations	58	58	58	58	58	58

Source: Eviews10 output based on authors' computation

As shown in table 2, based on Skewness, all variables have almost symmetrical distributions except for LnENY which has uneven distribution highly skewed to the left, based on kurtosis, all variables' distributions tend to be relatively platykurtic except for LnENY which sound to be too peaked than normal. Overall, it can be concluded that there are no outliers in these time series causing the data sets to become relatively symmetrical and normally distributed.

4. 12. 2. MULTIVARIATE CORRELATION ANALYSIS (MCA):

MCA is based on Pearson's correlation coefficients applied to a dataset in order to enable the measure of the strength of each two variables linear relationship (Bonett and Wright, 2000).

Table 3 summarizes the variables pair-wise correlations as displayed in the correlation matrix:

Table 3. Pair-wise correlations matrice

	LNGDP	LNTFP	LNCLS	LNHCI	LNTLF	LNENY
LNGDP	1.000000					
LNTFP	-0.938536	1.000000				
LNCLS	0.950068	-0.964939	1.000000			
LNHCI	0.955626	-0.967382	0.948712	1.000000		
LNTLF	0.978376	-0.963268	0.971488	0.949516	1.000000	
LNENY	0.575833	-0.512640	0.490252	0.430940	0.565872	1.000000

Source: Eviews10 output based on authors' computation

Results from Table 3 show that LnGDP is positively correlated with LnCLS, LnHCI, LnENC and negatively correlated with LnLTFP and LnTLF, this sounds logic because intuitively, intensive capital investments associated to considerable human capital stock contribute positively in economic growth especially through strategic sectors with a potential high added value where production is assisted by large qualified workforce in a state of economy of scale. Meanwhile the strong correlation between growth and energy intensity can be explained by the fact that energy is the most important supplier of the entire economic activity itself (Puška et al., 2018).

The same reasoning as GDP can be adopted to explain the positive correlations where capital stock is part of since it represents a component of the expenditure on GDP.

The negative correlation between growth and total productivity can be explained by the low levels of capital intensity and labor productivity in Morocco as shown in Figure 2 above.

The strong correlation between human capital and total workforce can be explained by the fact that the more an individual requires knowledge, skills and technicity, the more employable he becomes, and the more chances he got to be productive and well remunerated. Moreover, since there's no direct link between energy and the energy-augmented CDPF inputs as discussed above, their corresponding correlations are ambiguously dispersed. Moreover, these measures suggest that the problems due to multicollinearity are not supposed to emerge.

4. 12. 3. PRINCIPAL COMPONENT ANALYSIS (PCA)

PCA is a multivariate analyzing technique in which observations are described by inter-correlated quantitative dependent variables represented into a set of new orthogonal variables called principal components; the observations are displayed as points in map (Pearson, 1901).

Table 4: Principale component matrice

Number	Value	Difference	Proportion	Cumulative Value	Cumulative Proportion
1	5.154817	4.454652	0.8591	5.154817	0.8591
2	0.700164	0.638270	0.1167	5.854981	0.9758
3	0.061894	0.007796	0.0103	5.916875	0.9861
4	0.054098	0.033232	0.0090	5.970973	0.9952
5	0.020866	0.012705	0.0035	5.991839	0.9986
6	0.008161	---	0.0014	6.000000	1.0000

Source: Eviews10 based on authors' computation

Results from Table 4 show that the first principal direction which corresponds to economic growth explains roughly 85% of the information contained in the correlation matrix below, the second corresponding to productivity 11%, the third corresponding to capital 1%, and so on. As discussed above, energy impact on growth is quite neglected when it's compared to the other economic factors, which is reflected by its parsimonious proportion in PCA. Furthermore, the gap between each two successive cumulative proportions corresponding to the endogenous variables represented from directions 3 to 6, is not exceeding 1% and keep decreasing continuously, which is making these variables respective weights relatively close, and their repartitions almost equiproportional but far away behind the first principal direction.

5. EMPIRICAL RESULTS

5. 1. UNIT ROOT TEST

Except for energy intensity, it's obvious that the adopted other time-series don't have any constant means or consistent variances and their trends seem to have a long memory, the overall implication is that our variables have to be differenced in order to remove their linear trends which persist in original data, and to generate an integrated data less correlated.

Results from Table 5 below, show that time series are conjointly integrated, some at level, some others at the first difference, considering both constant / constant and trend criterions at 5% level of significance. Accordingly, it can be said, that the series in question are related and therefore their variables can be combined in a linear fashion in the long-run. These results guided us to apply ARDL/BTA, based on the presence of con-integration between time-series since there's a mixture between I(0) and I(1), thus, we proceed for an ARDL parameters estimation at both short-run and long-run, then, an error correction model is warranted.

Table 5. Augmented Dickey Fuller Unit root test

At Level							
		LNGDP	LNTFP	LNCLS	LNHCI	LNTLF	LNENY
With Constant	t-Statistic	-1.7917	-0.2005	-1.5708	-0.2169	-3.7589	-5.8178
	Prob.	0.3809	0.9320	0.4907	0.9298	0.0061	0.0000
		n0	n0	n0	n0	***	***
With Constant & Trend	t-Statistic	-1.4288	-2.1455	-1.8791	-1.4502	-0.5590	-5.5358
	Prob.	0.8417	0.5099	0.6520	0.8349	0.9774	0.0001
		n0	n0	n0	n0	n0	***
Without Constant & Trend	t-Statistic	3.3775	1.4885	1.4029	-2.1666	0.3004	-1.7511
	Prob.	0.9997	0.9648	0.9584	0.0303	0.7687	0.0759
		n0	n0	n0	**	n0	*
At First Difference							
		d(LNGDP)	d(LNTFP)	d(LNCLS)	d(LNHCI)	d(LNTLF)	d(LNENY)
With Constant	t-Statistic	-6.3647	-9.4052	-2.9303	-6.5451	-5.6911	-10.8948
	Prob.	0.0000	0.0000	0.0482	0.0000	0.0000	0.0000
		***	***	**	***	***	***
With Constant & Trend	t-Statistic	-6.6394	-9.3295	-3.1071	-6.4886	-7.3699	-10.9881
	Prob.	0.0000	0.0000	0.1147	0.0000	0.0000	0.0000
		***	***	n0	***	***	***
Without Constant & Trend	t-Statistic	-5.3242	-7.9733	-2.4066	-0.8062	-3.2982	-10.9490
	Prob.	0.0000	0.0000	0.0168	0.3621	0.0014	0.0000
		***	***	**	n0	***	***

Notes:

a: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1% and (no) Not Significant

b: Lag Length based on SIC

c: Probability based on MacKinnon (1996) one-sided p-values.

Source: Eviews10 output based on authors computations

5. 2. OPTIMAL LAG ORDER SELECTION

5. 2. 1. ARDL GENERAL LAG ORDER SELECTION

As shown in table 6, based on multiple lag order criterions such as LR (sequential modified LR test statistic), FPE (Final prediction error), AIC (Akaike information criterion), SC (Schwarz information criterion), HQ (Hannan-Quinn information criterion), since there's no contentment between criterions on the optimal lag, we let Eviews10 choose it automatically.

Table 6. General ARDL Lag order selection

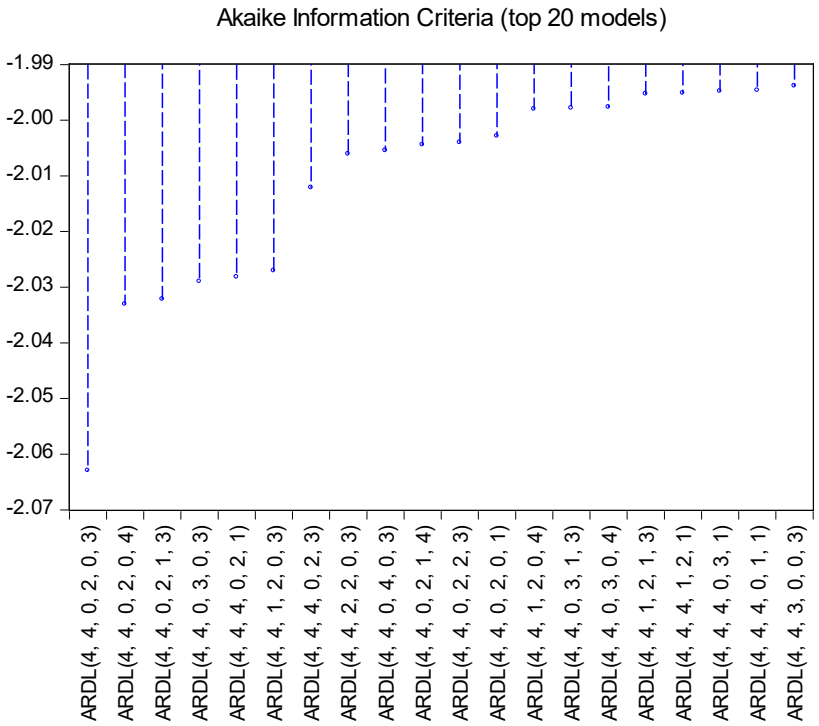
Lag	LogL	LR	FPE	AIC	SC	HQ
0	234.9219	NA	7.14e-12	-8.638563	-8.415511	-8.552788
1	632.1345	689.5011	8.67e-18	-22.26923	-20.70786*	-21.66880
2	697.3434	98.42848	3.03e-18	-23.37145	-20.47177	-22.25637*
3	741.4391	56.57564	2.57e-18	-23.67695	-19.43896	-22.04722
4	783.8454	44.80666	2.68e-18	-23.91869	-18.34240	-21.77432
5	846.2499	51.80754*	1.69e-18*	-24.91509*	-18.00048	-22.25607
* indicates lag order selected by the criterion						

Source: Eviews10 Output based on authors computations

5. 2. 2. ARDL SPECIFIC LAG ORDER SELECTION

Figure 4 show the ARDL specific Lag order selection for each variable based on (AIC)

Figure 1. Specific ARDL lag order selection



Source: Eviews 10 output based on authors computations

As shown in Figure 4, based on (AIC), under the rule of Thumb, the specific lag order is ARDL (4,4,0,2,0,3). this means that the lag lengths (p) corresponding to each variable, such as LnGDP, LnTFP, LnCLS, LnHCI, LnTLF and lnENY are 4,4,0,2,0 and 3 respectively.

Consequently eq (4) is specified as:

$$\Delta LnRGDP_t=\lambda_1 LnGDP_{t-i}+\lambda_2 LnTFPt-i+\lambda_3 LnCLS_{t-i}+\lambda_4 LnHCI_{t-i}+\lambda_5 LnTLF_{t-i}+\lambda_6 LnENY_{t-i}$$
$$+\sum_{i=1}^{4}\mu_i\Delta LnGDP_{t-i}+\sum_{i=1}^{4}\mu_{1i}\Delta LnTFP_{t-i}+\sum_{i=1}^{2}\mu_{3i}\Delta LnHCI_{t-i}+\sum_{i=1}^{3}\mu_{5i}\Delta LnENY_{t-i}+c+\varepsilon \quad (4')$$

5. 3. ARDL GENERAL PARAMETERS ESTIMATIONS

Table 7 captures the ARDL general parameters estimations, based on ARDL (4,4,0,2,0,3).

Table 7. ARDL general parameters estimations

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNGDP(-1)	0.656017	0.151102	4.341549	0.0001
LNGDP(-2)	-0.240941	0.191559	-1.257792	0.2168
LNGDP(-3)	-0.047213	0.189205	-0.249531	0.8044
LNGDP(-4)	-0.282287	0.138112	-2.043902	0.0485
LNTFP	0.735842	0.265884	2.767527	0.0090
LNTFP(-1)	-0.128411	0.312067	-0.411486	0.6832
LNTFP(-2)	-0.032111	0.320980	-0.100039	0.9209
LNTFP(-3)	0.433795	0.315489	1.374992	0.1779
LNTFP(-4)	0.705632	0.288415	2.446588	0.0196
LNCLS	0.116988	0.053323	2.193942	0.0350
LNHCI	3.175440	1.314908	2.414953	0.0211
LNHCI(-1)	-2.995604	1.709226	-1.752609	0.0884
LNHCI(-2)	3.654814	1.276394	2.863390	0.0070
LNTLF	0.899993	0.223798	4.021459	0.0003
LNENY	0.342357	0.307686	1.112681	0.2734
LNENY(-1)	1.088625	0.355366	3.063388	0.0042
LNENY(-2)	0.129040	0.374493	0.344572	0.7325
LNENY(-3)	0.746915	0.356384	2.095814	0.0434
C	2.721133	0.602910	4.513335	0.0001
R-squared	0.993818	Mean dependent var		7.205407
Adjusted R-squared	0.990638	S.D. dependent var		0.778887
S.E. of regression	0.075362	Akaike info criterion		-2.062966
Sum squared resid	0.198779	Schwarz criterion		-1.363139
Log likelihood	74.70009	Hannan-Quinn criter.		-1.793070
F-statistic	312.5774	Durbin-Watson stat		2.173209
Prob(F-statistic)	0.000000			

Source: Eviews10 output based on authors computations

Table 7 show that the coefficient of determination R^2 and the adjusted R2 are significantly too strong which implies that the explanatory variables explain more than 99% of the variability in GDP, the interpretation of correspondent observations are gathered at the following table 8.

Table 8. interpretation of ARDL parameters estimations

Variables	Impact at level	Impact at lags
LnGDP	…….....	Positive at the first, negative at the fourth
LnTFP	Positive	Positive at the first and the fourth
LnCLS	Positive	.....
LnHCI	Positive	Positive at the second
LnTLF	Positive	.....
LnENY	Positive	Positive at the first and the fourth

Source: Author's own elaboration based on authors computations

5. 4. ARDL BOUNDS TEST

Table 9 represents the ARDL bounds test results, in which the calculated F-statistic=4.90 is widely above both the upper and the lower critical value bounds at their respective levels of significance; this means that the null hypothesis of no cointegration is rejected in the favour of the existence of cointegration relationship between variables in the long run.

Table 9. ARDL Bounds test

Test Statistic	Value	K
F-statistic	4.900622	5
Critical Value Bounds	I0 Bound	I1 Bound
10%	2.26	3.35
5%	2.62	3.79
2.5%	2.96	4.18
1%	3.41	4.68

Source: Eviews10 output based on authors computations

5. 5. ARDL ERROR CORRECTION MODEL (ARDL/ECM)

Table 10 show the ARDL/ECM long run estimations, based on ARDL (4,4,0,2,0,3).

Table 10. ARDL short run and long run estimations

Long Run Coefficients				
LNTFP	1.875222	0.214987	8.722472	0.0000
LNCLS	0.127937	0.051625	2.478175	0.0182
LNHCI	4.193515	0.398243	10.530031	0.0000
LNTLF	0.984218	0.196087	5.019305	0.0000
LNENY	2.522830	0.425164	5.933776	0.0000
C	2.975789	0.444295	6.697775	0.0000

Source: Eviews10 output based on authors computations

Results from table 10 show that, in the long run, the explicative variables progress all together significantly and proportionally in the same positive direction to generate economic growth, this implicates that an extra unit of GDP is associated in terms of units, to; 1.87 of increase in productivity level, 0.12 of amplification in capital investment, 4.19 of gradation in human capital stock, 0.98 of augmentation in labor force and 2.52 intensification of energy. The error correction term (ECT) has a negative and significant value of $-1 \leq -0.914424 \leq 0$, suggesting a rapid annual speed of adjustment of about 91.44% to the long-term equilibrium.

5. 6. ROBUSTNESS CHECK: FMOLS, DOLS, CCR TESTS

Table 11 below regroups the FMOLS, DOLS and CCR respective tests results:

Table 11. FMOLS, DOLS, CCR tests results

Variables	FMOLS		DOLS		CCR	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
LNTFP	1.456932	0.0003	1.914208	0.0003	1.410869	0.0015
LNCLS	0.090343	0.3065	0.228150	0.0392	0.083174	0.3570
LNHCI	3.238067	0.0000	4.042355	0.0000	3.235938	0.0000
LNTLF	1.250423	0.0001	0.804869	0.0193	1.226229	0.0002
LNENY	1.968195	0.0006	3.185037	0.0000	1.823668	0.0007
R-squared	0.979516		0.990780		0.979370	
Adjusted R-squared	0.977508		0.985357		0.977347	

Source: authors own construction based on Eviews10 outputs

Results from table 11 show that in the FMOLS model, a 1% increment in, LnTFP, LnHCI, LnTLF, LnENY, uplifts, respectively, by 1.456%, 3.23%, 1.25%, 1.96% of GDP average. Here, all the coefficients are significant at 5%, except for LnCLS.

Following the DOLS model, if LnTFP, LnCLS, LnHCI, LnTLF, LnEny upsurges by 1% , then on average, GDP upsurges by 1.91%, 0.22%, 4.04%, 0.80%, 3.18% respectively.

The CCR mode also show a similar pattern, where, a 1% increase in, LnTFP, LnHCI, LnTLF, LnENY, rise GDP on average, by 1.41%, 3.23%, 1,22%, 1,82% respectively , Here, all the coefficients are significant at 5%, except for LnCLS.

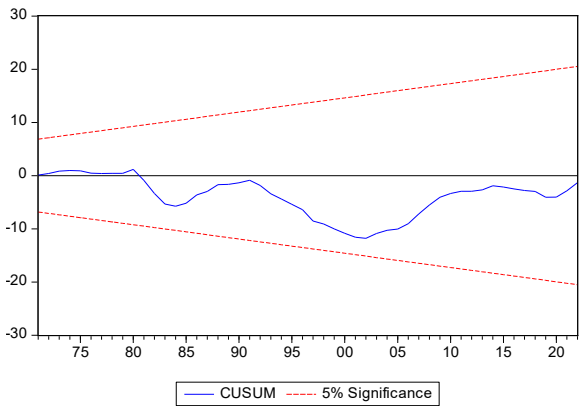
The coefficient of determination and its adjusted value in the three models are too strong which implies that the exogenous variable is strongly explained by the endogenous variables. These investigations converge with the long-run ARDL outputs in table 10 above, in terms of the sense of progression and the rate of proportionality of each explicative variable.

5. 7. POST ESTIMATION DIAGNOSTICS AND STABILITY TESTS

5. 7. 1. CUSUM AND CUSUMSQ TESTS

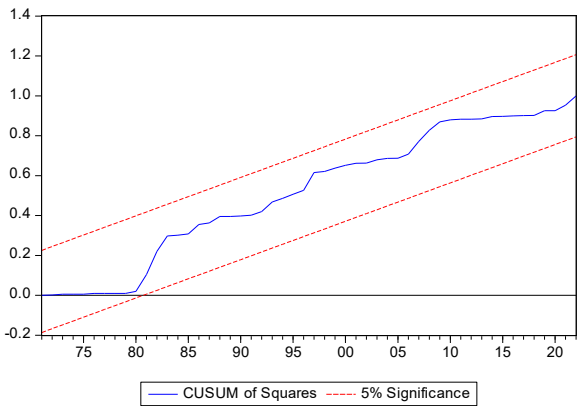
The figure 7 and the figure 8 are showing the respective plots of (CUSUM) and (CUSUMSQ) under the following decision rule : If the plots of the (CUSUM) and (CUSUMSQ) graphs fall within the critical limits of a 5% significance value, then the null hypothesis of all coefficients in the given regression are stable and cannot be rejected (Edgerton & Wells, 1994).

Figure 2: Cumulative sum (CUSUM) plot



Source: Eviews10 output based on authors computations

Figure 3: Cumulative sum of squares (CUSUMSQ) plot



Source: Eviews10 output based on authors computations

5. 7. 2. POST ESTIMATION DIAGNOSTICS AND STABILITY TESTS SUMMARY

The results of Post estimation diagnostics and stability tests are regrouped in Table 15.

Table 15. Post diagnostic tests results

Items	Test	F-Statistic	p-value	Interpretation	Conclusion
Serial correlation	Breusch–Godfrey serial Correlation LM test	1.964268	0.1247	Fail to Reject H_0	There's no serial autocorrelation
Normality	Jarque–Bera	2.542770	0.280443	Fail to reject H_0	Residual are normally distributed
Heteroscedasticity	Breusch–Pagan–Godfrey	0.962214	0.5194	Rejection of H_0	Data is homoscedastic
Functional form (test of specific error)	Ramsey RESET Test	0.481316	0.4925	Fail to reject H_0	No residuals misspecification in the model
CUSUM	Stable				
CUSUMSQ	Stable				

Source: authors own construction based on Eviews10 outputs

6. DISCUSSIONS AND POLICY IMPLICATIONS

In summary, we scrutinized the consequences of productivity, capital investment, human capital employment and energy intensity on economic growth in Morocco under the theoretical framework of Energy-augmented CDPF, using extended data from 1965 to 2022. We applied ARDL BTA/ECM based on the existence of cointegration between variables. We engaged FMOLS, DOLS and CCR tests for more reliability. The investigations proved the existence of long-term relationship, in which the explanatory variables progress all together positively and proportionally to generate economic growth, just as stipulate the standard CDPF. Findings led to the rejection of all formulated hypothesis above H_{0A}, H_{0B}, H_{0C}, H_{0D} and H_{0E} in the favour of the alternative hypothesis. Results implies that an additional unit of GDP corresponds, to a jointed increase in terms of units of, 1.87 in productivity level, 0.12 in capital investment, 4.19 in accumulation of human capital, 0.98 in labor force and 2.52 intensification in energy consumption. That Moroccan economy is human capital intensive unlike when it comes to physical capital. Our findings are to be compared with similar regions and countries to Morocco regarding the size of economy and the appurtenance to the same upper middle income group. From Asia, Khatun, T. & Afroze, S. (2016) explored the relationship between RGDP and Labor and Capital showed that there is growing of returns in the production process in all remarkable countries for the selected Countries and revealed that, there is a strong positive and significant relationship between real GDP. From Africa, Kilishi et al. (2013) explored the relevance of Augmented Solow Model for Africa's economic growth and found out that human capital had a positive and statistical meaning on the GDP per capita while increasing in population had not. In line with Ugwunna et al. (2023) who examined the determinants of economic growth specifically for Sub Saharan Africa from 23 countries in SSA from 1996 to 2020 using Fixed effect and random effect method and discovered that GFCF, Population growth, exchange rate and FDI have positive and significant effects on the economic growth. In a similar study from Egypt, Mohamed Kamal et al. (2023) investigated the sources of Egypt's economic growth over the course of four generations of reforms from 1991 to 2019 by examining the contribution of input factors to economic growth under the augmented Solow model, they found that economic growth is closely linked to trends in human capital, productivity, and capital, all of which are heavily influenced by savings volatility and population growth rates. From middle east, Oryani et al. (2020) examined the impact of energy consumption on the economic growth of Iran in

the framework of the extended CDPF from 1970 to 2017 using a ARDL approach, in which results supported a positive impact of energy consumption and capital stock on GDP in both the short and long terms, and a negative one for labor force. From south east Asia, Hamizah et al. (2020) investigated the effects of capital, labor and energy consumption on economic growth in Malaysia using data period of 1982-2017, they found that there's a significant effects of capital and energy consumption on economic growth both in the short runs and the long unlike Labor. In fine, and from Algeria, a neighbour country sharing with Morocco a lot of common characteristics, a relevant paper examined the sources of economic growth in Algeria, studying the key drivers of their slow and weak economic performance, during the period of 1979–2019 from the perspective of the augmented growth accounting framework and the growth regression method, showed that Algeria's growth performance has been weak and modest for decades, this finding is mainly explained by labor growth going with weak gain in capital accumulation and to sharp losses in the TFP growth (Haouas et al., 2024). As regards to other drivers of economic growth, let's take the example of Kazakhstan, in which Omir et al. (2024) checked the assessment of the impact of financial factors on economic growth in the short term for twenty years and founded that the capital market influences economic growth in Kazakhstan and the CIS countries, while Serikkyzy et al. (2024) examined the patterns of foreign direct investment (FDI) in Kazakhstan and draws comparisons with global trends based on statistical data spanning from 2000 to 2022 which revealed that is FDI strongly associated with global FDI inflows and the growth of GDP. When it comes to policy implications recommendations, we think that Morocco, should accelerate its industrial transition to transform its economy into a diversified, competitive, and sustainable industrial model, we think that this can be achieved by increasing the industrial sector's contribution to GDP from 15% to 25% by 2035, through generating 1.5 million new industrial jobs and achieving significant technological advancements and sustainable industrial practices. For this purpose; it must rely on strategic key industrial sectors such as automotive and aerospace, renewable energy, agro-processing, phosphate and mining industries, textiles and apparel, digital and high tech manufacturing, through installing effective policies and regulatory reforms in order to improve the investment climate to attract both domestic and foreign investment through tax incentives, grants, and subsidies, streamlining regulations, reducing bureaucratic hurdles, and ensuring a transparent legal environment., reforming labor laws to balance workers protection with business flexibility; Providing financial support and investment mechanisms by improving access to financing for SMEs through low-interest loans, venture capital, and other financial instruments, encouraging joint ventures and partnerships to leverage private investment in industrial projects; Enhancing integration into global value chains by strengthening export promotion agencies and initiatives to enhance market access for Moroccan products, branding the made in Morocco by a large communication and advertising campaign, leveraging existing trade agreements and negotiating new ones to open up additional markets; Innovation and digital Transformation via promoting the adoption of Industry 4.0 technologies such as IoT, AI, robotics, and big data, supporting start-ups and innovative enterprises through incubation programs and financial incentives; Monitoring and evaluation by establishing key performance indicators to measure progress and impact, conducting periodic reviews to assess progress, identify challenges, and make necessary adjustments, and involving all stakeholders, including government agencies, industry players, and civil society, in the monitoring process; Proceed to a large modernization and mechanisation of the agriculture in order to inspire more productivity and complementarization with industry, share out the public spending equitably following two dimensions, physical by upgrading local infrastructure to attract more investments, and human by promoting human capital through education and social protection for the good benefit of next generations' employment and labors productivity. Finally, we allow ourselves to propose further avenues such as measuring the impact of our proposed

industrialization plan on economic productivity and/or growth of Morocco, investigating the long-term sustainability of the proposed industrial and structural reforms, testing renewable intensity, cloning our same research methodology on similar neighbours such as Mauritania or Libya, or even generalizing it for entire regions such as the Maghreb or the ECOWAS.

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