The productivity of the Moroccan industrial sector analysis: Econometric modeling

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Abstract

The purpose of this article is to evaluate the elasticity of Gross domestic product to the added values of seven branches of Moroccan industries during the 1985-2015 period and the productivity of the industrial sector in both general and the seven industrial branches (processing and extractive industries) by using the Ordinary Least Squares (OLS) method, in order to identify sectors which have high growth prospects, and on which Morocco can capitalize to promote its economic emergence, create employment, stimulate growth and enhance its attractiveness on the international scene. To evaluate the productivity of industrial branches, we will refer to the Cobb-Douglas production function.

As a result of this study the labor-intensive branches whose labor productivity exceeds capital productivity are those which contribute most to national economic growth and are therefore more efficient. For the chemical and para-chemical sector, we notice that this last is a promising field, which augurs important prospects for development.

Keywords: Morocco, industrial sector, industrial branches, productivity, economic growth, attractiveness.

1. Introduction

In an international economic environment marked in recent decades by profound changes in favor of the dynamic of globalization. This last one is perceptible through various aspects associated with an increasing economic openness to trade in goods and services, an increasing mobility of factors of production and fierce competition in different markets.

In this context, the adoption and implementation of effective industrial policies were at the origin of developing many countries, considered today as the world’s largest and fastest growing economies.

This new dynamic has affected virtually all industries around the world. Trade in industrial products grew further, reaching more than 80% of total world trade.

In terms of productivity, economists recognize the role of the industrial sector by defining it as the main place of productivity gains. Being at the heart of economic mechanisms, productivity is a measure of the efficiency with which the resources of a company or an economy are transformed into the production of goods and services, since it measures the quantity produced based on the factors labor and capital.

In the case of Morocco, the share of the industrial sector in GDP was highest during the period studied (1980-2015), with a share of 22 per cent in 1984 and 1985, ranking first, followed by those of Agriculture, Trade and Construction and Public Works.

During the last ten years, Morocco is looking for a new industrial strategy. Thus, in 2005, it launched the "Emergence Plan", a strategy to revitalize the Moroccan economy, through the strengthening, revitalization and competitive growth of the Moroccan industrial fabric, as well as the orientation towards new promising
sectors and high value-added products for which Morocco has competitive advantages, namely automotive, aeronautics, electronics, offshoring, textile and leather, agri-food and seafood processing.

Morocco has also initiated the National Pact for Industrial Emergence (PNEI) for 2009-2015, which aims in particular to build a strong industrial sector and create a virtuous circle of growth and to focus industrial recovery efforts on sectors for which Morocco has clear and exploitable competitive advantages, through dedicated development programs.

With a somewhat mixed assessment of the PNEI, the Kingdom has decided to launch the Industrial Acceleration Plan (PAI) for 2014-2020, which aims firstly to change the structure of its economy in the years to come, by capitalizing further on industry and to establish an industrial sector as a source of employment and an accelerator of economic growth.

The plan proposes to address several challenges, including an increase in the absorptive capacity of new assets over the next decade, a 9 percentage point increase in the share of industry in GDP to 23 pc in 2020, creation of 500,000 jobs, boosting export capacity in quantitative and qualitative terms and improving productivity.

The analysis of the indicators, which somehow reflect the performance of a sector of activity, by referring to several empirical studies, shows that the level of performance of an industrial branch differs according to the criterion applied and the adopted time horizon, while the analysis by region showed us that the majority of the industrial activity, production, number of companies, workforce, exports ... is concentrated at the level of the Grand Casablanca region with a trend of the emergence of that of Tangier-Tetouan.

In this respect, the assessment of the productivity of the industrial sectors during the period 1985-2015 seems essential to us in that it will enable us to identify the promising sectors with significant growth prospects and on which Morocco can capitalize on to promote its economic emergence, create employment and growth and enhance its attractiveness on the international scene.

Thus, we will refer to the production function of Cobb-Douglas type which expresses productivity, according to two factors of production, capital (K) and labor (L).

We will try to analyze the productivity of the seven industrial branches studied (processing and extractive industries), referring to the classification adopted in the framework of the Moroccan nomenclature of activities (NMA 2010), which is in perfect accordance with the classification in particular with regard to the branches.

In order to simplify the processing of our database and taking into account the availability of data, we opted for the classification by major sector of processing industries adopted by the Moroccan Industry Observatory, under the Ministry of Industry, Trade, Investment and the Digital Economy as part of its annual industry surveys and industry indicators.

Our study will focus on the evaluation of the elasticity of the gross domestic product (GDP) in relation to the added values of the industrial branches studied, and that of the overall industrial value added compared to the variation of the total factors of production. To this, it must be added the evaluation of the productivity of each branch in its own right, in order to try to provide answers to our basic problem.
2. Literature Review

2.1. Theoretical approaches to the growth-productivity relationship

Productivity remains a subjective notion and the method of its apprehension differs according to the point of view adopted and the expected objective of its assessment.

Measuring total factor productivity (TFP) is the simplest and most widely used econometric method for assessing the past and future performance of an economy, the ability to catch up with other economies, and the differences in level of income and growth\(^1\).

The most widely used method in economic analysis is the Cobb-Douglas function, which is written as:

\[
Y = AK^\alpha L^\beta
\]

Or in logarithmic form:

\[
\log Y = \log A + \alpha \log K + \beta \log L
\]

With \(Y\): logarithm of the output (output, added value)

\(L\): logarithm of labor factor

\(K\): logarithm of the capital factor

\(A\): constant term or dimension coefficient characteristic of the economy in question.

\(A, \beta\): Elasticity of output with respect to labor and capital

In our work, we will use value added (output - intermediate consumption) as output. This indicator refers to the real wealth produced by an economy in general and a particular branch of activity and aims to reduce the effect of the interaction between the variables of the economic branches studied.

For the labor factor "L", we chose as a variable the wage bill, because neither the number employed nor the number of hours worked seems to reflect the level of socio-professional qualification of the employees. All the more so as our study focuses on an economic sector that requires well-trained human resources and a highly skilled workforce.

For example, we can have a sector of activity that employs a large volume of labor in relation to another area, whereas its payroll is low because of the predominance of the working class with a low level of qualification, which explains to a large extent the low competitiveness of certain branches studied.

Concerning the capital variable "K", it represents the tangible fixed assets used in the production process of an industry.

However, due to the lack of aggregated data on investment by industrial enterprises provided by the Moroccan Industry Observatory in the annual industrial processing industry surveys, which corresponds to tangible and intangible assets (research and development costs, patents for inventions, etc.) and non-value (preliminary costs to be allocated over several financial years). Several theoretical and empirical studies have

thus revealed the crucial and determining role of research and development investments in improving the performance and efficiency of a sector or an economy.

- In this sense, a study by P. Buigues and A. Jacquemin (1997) showed that there is a significant correlation between technological intensity and the level of industrial competitiveness\(^2\). For the indicators of productivity, demand and wages, the study shows that during the period (1985-1994), higher growth was recorded in the high-tech sectors than in the medium or weak technological intensity sectors.

- Another study by Philippe Cuneo (1984) entitled "The impact of research and development on industrial productivity" reveals that, from a sample of 182 firms followed over the period 1972-1977, the effect of research and development on the productivity of companies appears clearly.

- According to P. Cuneo and J. Mairesse in their econometric study of individual data on "research and development and performance of firms" (1985), we show that in a sample of 390 large and medium-sized companies in the chemical, electronics and mechanics, based on econometric analysis in terms of production function, the results agree with the idea that research and development is a capital comparable to physical capital from the point of view of its productivity and profitability.

- For Jamal Bouoiyour, researcher at the University of Pau et des pays de l’Adour (France), he analyzes, within the framework of a panel data model, the relationship between trade openness, direct investment (FDI) and the productivity growth of North African countries (Algeria, Egypt, Morocco and Tunisia) from 1970 to 2001.

    In this study, entitled "Productivity and openness in North Africa", the results suggest a significant effect of human capital, foreign investment and research and development on North African productivity, but a negative effect of imports.

2.2 / Review of empirical studies on the productivity of processing industries in the Mediterranean countries

In this section, we will review the studies which have dealt with the productivity and performance of the industrial branches in the countries around the Mediterranean in order to provide a relatively exhaustive analysis of the industrial fabric of the Mediterranean and better position Moroccan industry compared with other countries in the region.

- According to the study by Jamal Bouoiyour on "Productivity and openness in North Africa" during the period 1970-2001, several conclusions were reached, including the need to take human capital into account in the productivity of the countries of origin, as well as the quality of imported products, while placing great emphasis on the industrial sector (especially as the agricultural sector depends on climate hazards).

- Another study prepared in 2001 by Agnès Chevallier and DenizUnal-Kesenci of the Center for Prospective Studies and International Information (CEPII) on "The productivity of Mediterranean industries" devoted to the comparison of manufacturing industries in five countries of the Euro-Mediterranean area at very different levels of per capita income and integration into the European Union. These are Spain, Portugal, Turkey, Morocco and Egypt which are compared to France.

The results show that in Morocco, during the period 1981-1997, the agro-food industries took the lead, followed by the textile sector. In Egypt, it is in mechanics that labor productivity is closest to the French level.

- As for a study published by Bouttaleb Kouider of Abou Bakr Belkaid University (Algeria) in 2005 under the theme "Efficiency of economic policies and growth: the case of Algeria", it reveals that in Algeria the Total Factor Productivity (TFP) has been negative for at least two decades, as noted in a study by the IMF (2003) that the problem is not the inadequate physical investment nor the human capital which knows fairly high rate.

This situation reveals a serious problem in the allocation of resources and their effectiveness, which means that the resources available to the country are far from negligible and are poorly managed.

- For Romains Bouis (2007) in his study "which sectors to reform to promote employment and growth, it proposes an estimation and a comparison of the intensity of the competition of different sectors in France compared to a set of countries (Belgium, Denmark, Finland, Italy), with the aim of identifying the sectors likely to be the subject of pro-competitive structural reforms.

Three sectors of the French economy appear to be subject to relatively low competition. These are retail trade, hotels and financial intermediation. Increased competition in these sectors, leading to levels of markups close to those observed in the most competitive countries, would ultimately increase the value added of the market sectors by 1.2% and create around 200,000 Employment opportunities.

- Another study on the product portfolio strategies of French industrial firms in the face of competition from low-cost countries by Claire Lelarge and Benjamin Nefussi (2010) proposes an empirical analysis of these strategies, which shows that firms Subject to this type of competition are significantly more diversified. Only the most productive companies associate these strategies with a true innovation effort, which explains their best performance.

- A joint project between the Ministry of Industry, Commerce, Energy and Mines of Morocco and the World Bank, published in 2010 on "the Moroccan manufacturing sector at the dawn of the 21st century", shows that 859 Moroccan manufacturing enterprises, those labor-intensive, labor productivity is about the same as in China, and barely higher than that of India. Morocco's macroeconomic and trade reforms, launched since the mid-1980s, must be supported and complemented by a "second generation" of more institutional reforms at the micro-economic level.

- In his study on "Overall factor productivity" (2002), Karima Zaimi shows that the TFP shows a marked improvement towards the end of the 1990s, due to the improvement in apparent labor productivity. The increase in industrial TFP is marked by two main trends: a slowdown in TFP over the period 1983-1989 followed by an acceleration of its growth rate during the 1990s.

This study also shows that more than 62% of the value added of the industrial sector comes back to work. This result illustrates the preponderance of labor intensive activities in the Moroccan industrial fabric.

- For Alain Henriot in his study entitled "The location of industrial enterprises: how to appreciate the attractiveness of territories?" (2004), he tries to assess the importance of different macroeconomic criteria in determining the location of industrial enterprises. The study points out that the United States and Japan are two polar cases: in the first case, all countries invest more than the potential estimated by the model, whereas the Archipelago suffers from a Deficit of foreign investment.
- Another study by Michel Aglietta and Robert Boyer (CEPII, 1982) entitled "Poles of competitiveness, industrial strategies and macroeconomic policy" shows that the industry's capacity for aggressive transformation depends first and foremost on the presence of competitive clusters, Their strengthening and renewal, and that an overvalued exchange rate too long leads to an industrial disaster.

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3. Methodology

3.1. Modeling the productivity of industrial branches

In the first step, we will try to estimate the elasticity of the gross domestic product (GDP) in relation to the added value of each industrial branch studied, in order to analyze the impact of each branch on the GDP and to determine the branch which created more wealth during the period 1980-2014. Then, we will look at the productivity analysis of the industrial sector in general and each industrial branch in particular, referring to the Cobb-Douglas production function involving labor and capital factors.

3.2. Definition and presentation of data

3.2.1 Gross Domestic Product

The gross domestic product (GDP) is the synthetic result of the production activity of all branches operating in Morocco’s economic territory. It represents the total income generated by all industries during their production process.

At current prices, gross domestic product (GDP) grew by an average of 7.5% during the period 1981-2015, reaching its highest growth rate in 1986 (19%) and falling by 2% in 1997.

Over the past decade, the growth rate has progressed from 4.5% in 2005 to about 12% in 2008, the highest value in the decade, to an average of 5% during the period 2009-2015 (figure n°1).

Following the evolution of the ratio for the industrial sector in GDP (figure n°2), we notice that it was highest during the period 1980-1990, with a share of 22 per cent in 1984 and 1985, with the largest share being in agriculture, trade and commerce, construction and Public Works.

During the period studied 1980-2015, it seems clear to us that industry contributes the most to the formation of GDP compared to other sectors with an average of more than 18% compared with 14% for agriculture, 5% for construction and 12% for trade.

3.2.2. The share of value added of industrial branches in overall industrial growth

If we analyze GDP by branch of industrial activity, we will see a divergence in the contribution of each branch and its growth potential (figure n°3).

It is evident from the fluctuating evolution of the industrial branches that the agro-food industries are at the top of the industrial branches in terms of their contribution to national wealth and show an upward trend from 1985 to 2014, whereas in 2015 they showed a slight decline.

The figures also show the remarkable growth potential of the chemical and para-chemical industries, on which Morocco is capitalizing on in its industrial acceleration plan to boost the industrial added value, exports and competitiveness of the industry.

Meanwhile, the textile and leather industries are showing modest growth during the period under review, although the Kingdom has comparative advantages in this area, except that it lacks a strategic vision to enhance its attractiveness and competitiveness.
As for the mechanical, metal and electrical industries, they registered on an upward slope and showed significant growth potential. However, during the period 2003-2013 this sector has almost stagnated, to borrow a relatively upward trend from 2014 onwards, a situation which calls for a new dynamic in this sector, through innovation and transfer of technology.

For the other manufacturing industries excluding petroleum refining, they generally experienced an increase, with the exception of the years 1999, 2000, 2011 and 2013, where they showed slight decline, while the oil refining sector and other energy products saw an increase in upward and downward trends during the period 1985-2015, indicating the weak contribution of this sector to industrial GDP, because the Kingdom imports about 95% of its energy needs, including oil, and the heavy investment required by refineries.

3.3. The characteristics of the sample

We have considered consolidating the branches of the industrial sector into seven major branches in order to simplify our analysis and to be in line with the classification used in national reports and plans.

The table below shows the position occupied by each of these branches in the Moroccan industrial fabric:

**Table 1: The contribution of the seven selected sectors in national industrial growth (1985-2014)**

<table>
<thead>
<tr>
<th>Indicators</th>
<th>extractive Industries</th>
<th>Agrifood</th>
<th>chemical and parachemical</th>
<th>Mecanic, metal and electric</th>
<th>textile and leather</th>
<th>Other industries excluding refining</th>
<th>Petroleum Refining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>-</td>
<td>27%</td>
<td>41%</td>
<td>18%</td>
<td>7%</td>
<td>8%</td>
<td>7%</td>
</tr>
<tr>
<td>Employment</td>
<td>9%</td>
<td>20%</td>
<td>19%</td>
<td>10</td>
<td>36%</td>
<td>-</td>
<td>5%</td>
</tr>
<tr>
<td>Number of companies</td>
<td>-</td>
<td>25%</td>
<td>27%</td>
<td>19%</td>
<td>25%</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>Exports</td>
<td>27%</td>
<td>12%</td>
<td>26%</td>
<td>7%</td>
<td>19%</td>
<td>10%</td>
<td>6%</td>
</tr>
<tr>
<td>Investment</td>
<td>24%</td>
<td>16%</td>
<td>28%</td>
<td>13%</td>
<td>13%</td>
<td>1%</td>
<td>6%</td>
</tr>
<tr>
<td>Level of commitment</td>
<td>0.55</td>
<td>1</td>
<td>0.95</td>
<td>0.50</td>
<td>1.30</td>
<td>0.74</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Source: MCI annual surveys and author's calculations
4. Discussion

4.1. Testing the effectiveness of Moroccan industrial policy

In this section, we analyze the elasticity of GDP with the added values of the seven branches studied during the period 1985-2015 and the productivity of the industrial sector in general and the seven industrial branches (processing and extractive industries) in particular (According to data availability), using the Ordinary Least Squares (OLS) method, to explain the variance of the dependent variable using a combination of explanatory factors (Independent variables).

4.1.1. Estimation of the elasticity of the GDP to the added values

\[(LVA \text{ agro}) + \alpha_3 (LVA \text{ extractive industries}) + \alpha_4 (LVA \text{ mechanical and metallic industries}) + \alpha_5 (LVA \text{ textile and leather}) + \alpha_6 (LVA \text{ other manufacturing industries}) + \alpha_7 (LVA \text{ petroleum refining}) + \varepsilon_i\]

With: LPIB: log of GDP during the period 1985-2015

LVA of branches: logarithm of value added of industrial branches

\[\varepsilon: \text{ Error term}\]

The results clearly show the positive and significant link between the GDP (output) and the added values of the seven industrial branches studied (the parameters are highly significant and generally show a positive sign with the exception for oil refining).

The explanatory variables used account for more than 99% of the dependent variable. And for error independence, the Durbin-Watson statistic is around 2, which means that there is no positive correlation between residual values and individuals.

The elasticity of the GDP to the added value of the branches studied is 0.04 for the chemical and para-chemical industries, 0.16 for the agro-food industries, 0.10 for the extractive industries, 0.20 for the mechanical, metal and electrical industries, 0.22 for the textile and leather industries, 0.38 for the other manufacturing industries and -0.01 for oil refining.

This means that other industries, such as "textiles and leather", agri-food and "mechanical, metal and electrical" industries, are the industries that have the greatest impact on GDP growth over the period 1985-2014, chemical and para-chemical effects have only a minimal effect on GDP growth. An observation that contradicts what we observed in our descriptive analysis of data through several indicators, that the chemistry and parchment industry occupies the first position in relation to the other industrial branches in terms of production, enterprises, exports and investment.

In this context, we will divide our database by three periods to try to see the correlation between the added value of chemical and parachemical industries and economic growth.

The results show that the link between the GDP (output) and the value added of the chemical and parachemical industries was negative and not significant during the period 1980-2000, whereas the
relationship became positive is significant during the period 2000 -2015, due to the fact that the chemicals and parachemicals sector underwent a restructuring during the last ten years with a significant change in investments, given its promising growth potential and Morocco's willingness to make it a catalyst industrial growth and employment, alongside other industrial sectors, including aeronautics, automotive, electrical and electronics, and textiles and leather.

4.1.2. Estimation of Cobb-Douglas function

We analyze in this section the determinants of the productivity of the global industrial sector (manufacturing and extraction industries) and the seven branches studied.

\[-1 / \text{Global industrial } LVA = C + \alpha \text{ Global LMS} + \beta LINV \text{ global} + \varepsilon\]

The results clearly show the positive and significant relationship between the industrial value added (output) and the inputs in factors of production, to have the stock of capital (investment) and labor (wage bill), because the parameters are highly significant and have a positive sign.

The elasticity of total industrial value added to the capital stock is 0.44, while that of labor is 0.35. This means that an increase in investment of 1% leads to a 0.44% increase in the industrial VA, and that an additional 1% of the wage bill leads to an increase of 0.35% of output.

Thus, industrial added value reacts more strongly to changes in capital than to labor, as the nature of industrial activity is highly capital-intensive and requires heavy investment, especially in terms of innovation and new technologies, in order to be competitive on the international scene and bringing added value to the economy.

Regarding the labor factor, it is clear that the industrial sector requires a highly skilled workforce, especially with the Kingdom's commitment to new global businesses, including automotive, aeronautics, mechanics and electronics. These require the development of training programs capable of supporting the current momentum of the industrial sector and the promotion of the industrial emergence of the Kingdom.

4.1.3 Evaluation of the productivity of each branch

\[- \text{LVA agro } = c + \text{LMS agro } + \text{LINV agro} + \varepsilon\]

With:

- LVA agro, chemical, textile .... : Logarithm of the added values of the industrial branches studied
- LMS agro, chemical, textile ...: logarithm of the payroll of each branch
- LINV agro, chemical, textile ....: logarithm of investment committed in each branch

The results show a positive and very significant link between the added values of the seven industrial branches studied and the factors of production (labor and capital), insofar as the parameters are highly significant and have a positive sign.

The elasticity of the value added to the capital stock is 0.16 for the agri-food industries, and that of labor is 1.05. This means that the agri-food sector reacts more than proportionally to wage bill than to investment, because this economic activity is linked to the agricultural sector, which employs more than 40% of the working population.
This leads us to wonder about the future of the sector and its competitiveness, which now requires more than ever to use new technologies to promote its productive performance and enable the Kingdom to take advantage of its comparative advantages in this field.

For the chemical and para-chemical industries, the figures show that the elasticity of their value added to investments is 0.64 and 0.09 at work. This corresponds perfectly to what has been mentioned earlier in economic theory, which reveals that the chemical and para-chemical sector is highly capital-intensive and requires heavy investments for its development.

Morocco spared no efforts to stimulate a new momentum in this field, as it ranks first in terms of investment in the industrial sector during the period 1985-2014 with a share of more than 28%, which justifies its contribution with 41% to national industrial production in 2014.

Concerning the "textile and leather" sector, the figures show that the elasticity of their added value to the wage bill is 0.82 and 0.06 for investments. This means that this branch is strongly linked to the labor force, which contributes to its added value, as it remains the main employer of labor with more than 26% of the total workforce Industries in 2014.

This positive impact proves to be important that the sector has long been successful in placing Morocco in an advanced position in international markets.

However, the data show that the textile and leather sector has declined by 61% in the number of its enterprises, from 2171 in 2003 to only 839 in 2014. In addition, the share of exports of this sector in relation to total exports, from 30% in 2005 to 12% in 2014, which threatens the future productivity of the sector and requires measures to new dynamic, in order to resume its position in the national economic fabric.

For the "mechanical, metal and electrical" industries, the figures show that the elasticity of their value added to the wage bill is 0.65 and 0.12 for investments. This means that the "mechanical, metal and electrical" branch is strongly linked to the labor force, which contributes to its added value, even though this branch only holds 11% of the workforce employed by the global industrial sector.

However, over the past few years, these industries have almost stagnated, an indicator that aims to give new momentum to this sector, through innovation and transfer of technology, all the more so because this branch is largely dependent on new technologies to promote production processes and further contribute to enhancing national economic growth and boosting the competitiveness of domestic industry.

For the mining extractive industries, the figures show that the elasticity of their value added to the wage bill is 0.87 and 0.35 for investments.

It is clear that the labor factor contributes to raising the added value of the sector, more significantly in relation to the allocation of capital, which confirms that the field of mining remains labor-dependent, rather than on sophisticated machines and developed technology that will undoubtedly have a remarkable effect on the development of the sector and the improvement of its performance especially in export.

Regarding the petroleum refining sector, the figures show that there is no significant relationship between value added and the labor and capital factors linked to this branch.
For their part, other manufacturing industries, including electronics, woodworking and wood products manufacturing, publishing, printing and reproduction ..., the results show that the elasticity of value added to the payroll is 0.51 and 0.06 to investments. This means that any 1% increase in payroll leads to a 0.51% increase in output, and that a 1% increase in investments implies a 0.06% increase in value added.

This branch is linked to the labor force, which contributes remarkably to enhancing its added value, while the productivity of capital is low.

**Conclusion**

By means of the equations of economic growth and productivity of both the industrial sector in general and the seven industrial branches in particular, it appears that "other manufacturing industries", "textiles and leather", "agri-food" and the "mechanical, metal and electrical industries" are the sectors that have the greatest impact on GDP growth during the period 1985-2015, while the chemical and para-chemical sector only began to have a significant effect from the 2000s onwards the increase in investment flows, which shows promising prospects, all the more so as investment in a capital-intensive sector is paying off only in the medium and long term.

Extractive industries contribute weakly to national growth, while there is a negative link between the added value of the "oil refining" industries and GDP.

For its part, industrial added value reacts more strongly to changes in capital than to labor, as the nature of industrial activity is highly capital-intensive and requires heavy investment, especially in terms of innovation and new technologies, in order to be competitive on the international scene and bringing added value to the economy.

Regarding the labor factor, it is clear that the industrial sector requires a highly skilled workforce, especially with the Kingdom's commitment to new global businesses, including automotive, aeronautics, mechanics and electronics. This requires the development of training programs, capable of supporting the current dynamics of the industrial sector and encouraging the industrial emergence of the Kingdom.

In this respect, and after an assessment of the productivity of the industrial branches, it is clear to us that labor-intensive branches whose labor productivity exceeds that of capital are those which contribute most to national economic growth and are more efficient.

This does not mean that the chemical and para-chemical sector remains at the top of the list in terms of investment in the industrial sector during the period 1985-2014, and is a promising area, the impact of which is already beginning to be felt during the last ten years on economic growth, which bodes well for important development prospects.

These results should in no case lead to too clear conclusions. They refer to the need to deepen the analysis of the links between the productivity of the industrial branches studied and other external variables, such as the rate of trade openness, human capital and training and research and development.
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Appendix

Figure n°1: Trends in the GDP growth rate over the period 1980-2015

Source: HCP

Figure n°2: Share of industry in the national economy

Source: HCP
Figure n°3 The share of value added of industrial branches in overall industrial growth

![Graph showing the share of value added of industrial branches in overall industrial growth]

Source: HCP

- The estimation of the elasticity of the GDP to the added values

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LCHIMICAL_PARACH</td>
<td>0.045364</td>
<td>0.043065</td>
<td>1.053393</td>
<td>0.0301</td>
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<tr>
<td>LINDU_AGRO</td>
<td>0.161546</td>
<td>0.061011</td>
<td>2.647808</td>
<td>0.0007</td>
</tr>
<tr>
<td>LINDU_EXTRACTIVE</td>
<td>0.104684</td>
<td>0.022122</td>
<td>4.732124</td>
<td>0.0001</td>
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<tr>
<td>LINDU_MECANIC</td>
<td>0.200610</td>
<td>0.061124</td>
<td>3.282039</td>
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<tr>
<td>LINDU_TEXTILE</td>
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<td>0.058432</td>
<td>3.848253</td>
<td>0.0055</td>
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<tr>
<td>LMANUFACTURER</td>
<td>0.387845</td>
<td>0.101795</td>
<td>3.842823</td>
<td>0.0007</td>
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<tr>
<td>OIL RAFFINING</td>
<td>-0.015494</td>
<td>0.021101</td>
<td>-0.734265</td>
<td>0.0164</td>
</tr>
<tr>
<td>C</td>
<td>2.589315</td>
<td>0.190494</td>
<td>13.59262</td>
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</table>

R-squared              0.997711  Meandependent var  12.70546
Adjusted R-squared     0.997118  S.D. dependent var  0.695179
S.E. of regression     0.037320  Akaike info criterion -3.540921
Sumsquaredresid        0.037606  Schwarz criterion  -3.185413
Log likelihood         69.96613  Hannan-Quinn criter. -3.418200
F-statistic            1681.458  Durbin-Watson stat  1.901496
The following table presents the results for the estimated equation per period:

<table>
<thead>
<tr>
<th>Period</th>
<th>Variable</th>
<th>Coefficient</th>
<th>Std.Error</th>
<th>t-Statistic</th>
<th>Prob</th>
</tr>
</thead>
<tbody>
<tr>
<td>1980-1990</td>
<td>VA Chemical &amp; parachemical industries</td>
<td>-0.006042</td>
<td>0.116093</td>
<td>-0.052047</td>
<td>0.9618</td>
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<tr>
<td>1990-2000</td>
<td></td>
<td>-0.267466</td>
<td>0.862540</td>
<td>-0.310091</td>
<td>0.7768</td>
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<tr>
<td>2000-2015</td>
<td></td>
<td>0.140712</td>
<td>0.065179</td>
<td>2.158865</td>
<td>0.0529</td>
</tr>
<tr>
<td>R-squared</td>
<td></td>
<td>0.998188</td>
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</table>

- Estimation of Cobb-Douglas function

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>Prob.</th>
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</thead>
<tbody>
<tr>
<td>LINVESTMENT_GLOBAL</td>
<td>0.445949</td>
<td>0.075666</td>
<td>0.0000</td>
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<tr>
<td>LMS_GLOBALE</td>
<td>0.355196</td>
<td>0.100906</td>
<td>0.0016</td>
</tr>
<tr>
<td>C</td>
<td>3.340777</td>
<td>0.475533</td>
<td>0.0000</td>
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</tbody>
</table>

| R-squared            | 0.947206    | Meandependent var | 11.19943|
| Adjusted R-squared   | 0.943295    | S.D. dependent var | 0.496373|
| S.E. of regression   | 0.118200    | Akaike info criterion | -1.338237|
| Sumsquaredresid      | 0.377224    | Schwarz criterion  | -1.198117|
| Log likelihood       |             | Hannan-Quinn criter. | -1.293411|
| F-statistic          |             | Durbin-Watson stat | 1.833002|
| Prob(F-statistic)    |             |               |       |
## Evaluation of the productivity of each branch

<table>
<thead>
<tr>
<th>Branches</th>
<th>Explicative Variables</th>
<th>Explained Variable</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Production</td>
</tr>
<tr>
<td>Agri-food Industries</td>
<td>Constante</td>
<td>0.380232 (prob : 0.5256)</td>
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<tr>
<td></td>
<td>LINV</td>
<td>0.162035 (prob : 0.0200)</td>
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<tr>
<td></td>
<td>LMS</td>
<td>1.050293 (prob : 0.0000)</td>
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<tr>
<td></td>
<td>R2</td>
<td>0.938762</td>
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<tr>
<td></td>
<td>R2 adjusted</td>
<td>0.934226</td>
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<tr>
<td></td>
<td>Durbin-Watson stat</td>
<td>1.755307</td>
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<tr>
<td>Chemical and parachemical</td>
<td>Constant</td>
<td>2.889484 (prob : 0.0000)</td>
</tr>
<tr>
<td>Industries</td>
<td>LINV</td>
<td>0.643911(prob : 0.0000)</td>
</tr>
<tr>
<td></td>
<td>LMS</td>
<td>0.093051(prob : 0.0030)</td>
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<tr>
<td></td>
<td>R2</td>
<td>0.858660</td>
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<td></td>
<td>R2 adjusted</td>
<td>0.848190</td>
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<td></td>
<td>Durbin-Watson stat</td>
<td>1.910841</td>
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<tr>
<td>Textile and leather</td>
<td>Constant</td>
<td>1.775328 (prob : 0.0114)</td>
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<td>LINV</td>
<td>0.069061 (prob : 0.0000)</td>
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<td>LMS</td>
<td>0.824976 (prob : 0.0122)</td>
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<td>R2</td>
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<td>R2 adjusted</td>
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<td>Durbin-Watson stat</td>
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<td>Industry Type</td>
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<tr>
<td>--------------------------------------------</td>
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<tr>
<td>&quot;mechanical, metal and electrical&quot; Industries</td>
<td>2.980612 (prob : 0.0000)</td>
<td>0.126831 (prob : 0.0177)</td>
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<td>R2</td>
<td>0.966239</td>
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<td>R2 adjusted</td>
<td>0.963739</td>
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<td>Durbin-Watson stat</td>
<td>1.702791</td>
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<tr>
<td>Extractive Industries</td>
<td>-0.448730 (prob : 0.7788)</td>
<td>0.358881 (prob : 0.0015)</td>
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<tr>
<td>R2</td>
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<td>R2 adjusted</td>
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<td>Durbin-Watson stat</td>
<td>1.817534</td>
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<tr>
<td>Oil Refining</td>
<td>7.010148 (prob : 0.0000)</td>
<td>-0.148544 (prob : 0.0059)</td>
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<tr>
<td>R2</td>
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<td>R2 adjusted</td>
<td>0.044865</td>
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<td>Durbin-Watson stat</td>
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<tr>
<td>Other manufacturing industries</td>
<td>4.962329 (prob : 0.0000)</td>
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<td>R2</td>
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<td>R2 adjusted</td>
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<td>Durbin-Watson stat</td>
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</table>