CONCENTRATION AND SPECIALIZATION OF ECONOMIC ACTIVITIES IN THE KINGDOM OF SAUDI ARABIA

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Abstract

This research presents several indicators for understanding the structure of economic activities in terms of concentration and specialization in the Kingdom of Saudi Arabia. Subsequently to the theoretical description of the different notions of concentration relating to geographical concentration and productive concentration as well as the spatial distribution and specialization of territories, a comparative analysis is presented for all of these indicators. The interpretations in this study are based mainly on statistics of the number of employees and the remuneration paid by economic enterprises. The results obtained are interpreted according to two distinct methods, firstly, geographically, by analyzing the structure of the productive structure of the areas (regions and employment areas), and secondly, sectoral, by studying the spatial distribution of activities in a given sector, which will make possible local comparisons between sectors and areas and with international areas of other countries. Finally, we have proposed approaches and indicators that facilitate the comprehension of specialization and economic concentration.

Introduction:

Knowing the strength and weakness of the productive system is an important challenge for any national economic policy. It would be appropriate to consider the risks of a shock to economic activity at the national or local level, such as a sectoral shock or the cessation of activity of large companies with high employment. The concentration and specialization of activities in a given area are essential elements for the diagnostics of the structure of the productive structure.

The concentration of employment in enterprises permits to measure the dependence of local employment on a limited number of large enterprises. The specialization of economic activity in a few sectors provides information on the risks of a sectoral shock in these sectors. However, high concentration or specialization is a sign of vulnerability of the productive apparatus. They remain in effect as long as the enterprises or sectors concerned have orders, thereby securing their market position. Thus, the territory has a significant role to contribute to the creation of new enterprises, to competitiveness between enterprises, but above all to the choice of localization.

The study of the concentration and specialization of activities in an area helps to respond to questions about the activities of an area or region if they are based on a few large enterprises or several of them dispersed over that
space. It would be evident that through the two indicators of concentration and specialization to know the weight of very big enterprises for the economy of an area or region, to make comparisons between zonal or regional scale activities in terms of similarities with the rest of the territory as well as the specialization of a distinctive sector.

The question of specializations at the local level illustrates that economic activities are not uniformly distributed over the territory, a situation that also requires attention to the localization choices of companies. Several considerations can be advanced to interpret these decisions, which result from natural advantages (such as the availability of a resource or a natural situation like proximity to maritime transport for coastal areas) and externalities of enterprise localization such as the positive effects of agglomeration of enterprises like the exchange of knowledge or know-how (Ellison & Glaeser, 1994, 1997). This problem can be approached by measuring the concentration of the activities of a sector in geographical areas, which helps to explain the spatial dispersion of economic activities in terms of space and the distribution of enterprises of a given sector that obeys randomness over the territory or a convergent rational choice.

Finally, this study relates the various indicators of concentration in order to analyses both the productive structure of an area by comparisons with a reference territory and study the geographical distribution of the activities of a sector in the different areas of a territory.

**Indicators of concentration and specialization:**

1. **The economic concentration and specialization of the territory:** The measures for characterizing areas or sectors of activity are descriptive in scope and are not intended to develop a particular structure of activity that may be based on different economic behavior that depends on the historical or geographical heritage of the regions under consideration. It should be noted that different empirical studies have revealed that the associated effects can be very different depending on the context or area studied. The analysis of the productive sector is based essentially on the number of salaried persons employed by enterprises. It is also possible by using wages, which are an effective indicator of the local economic weight.

2. Thus, for an equivalent number of employees, an enterprise with a high total salary will undoubtedly have a greater impact on the local economy than one with a lower salary. Other economic data could also be relevant, such as value added, investments, exports, etc.... Thus, the notion of concentration is based here on the unequal distribution of activities measured by wage employment. And several types of concentration can be defined:

3. **Productive concentration:** The distribution of employment in a sector among a greater or lesser number of establishments. (Ellison & Glaeser, 1994) empirically defined the gap between the geographical distribution of employment in an industry and the total employment.

4. **Geographical concentration:** The distribution of employment in a geographical area among a greater or lesser number of companies. The geographical concentration is expressed as a unit when there is a spatial configuration of the peripheral center type, this index will take its minimum value for a situation of equitable repartition of all economic activity. Geographical concentration is analyzed in its industrial rather than spatial dimension. The aim is not to study which regions are the most important in terms of industrial employment, but instead to characterize the industries that are the most spatially concentrated.

5. **Spatial distribution:** The distribution of employment of a sector in a greater or lesser number of geographical areas.

6. **Specialization:** The distribution of employment in a geographical area in a greater or lesser number of sectors of activity. Thus, our research is based on the theoretical concepts and takes into account for the practical aspects, the sectors of activities fixed in the nomenclature of activities of the statistical system of the Kingdom of Saudi Arabia.

**The curve of Lorenz:**

The Lorenz curve is an instrument that describes the distribution of a variable evenly (equally) distributed with other variables (several individuals). It compares, on the abscissa, the distribution of cumulative individuals (or sectors or regions) in a given sector or region to the distribution, on the ordinate, of a variable of interest (such as wages) among the different individuals in a given sector or region. The Lorenz curve below (graph 1) is constructed for measuring the distribution of employees (income) according to the different economic sectors, based on the data from Table 1 in Annex 1.

For the workers' data grouped by economic sector, each sector category will be given an $r$ value equal in importance to a relative weight given by the reference variable $Z_r/Z$. In the Lorenz curve, wage $r$ is the fraction $x_r/x$ in
relation to the average wages paid to all employees in the economic sector. Consequently, the slope of the Lorenzon curve is given by the specificity index defined by the following formula: 

\[ S_r = \frac{x_r/x}{z_r/z} = \frac{x_r/z_r}{x/z} \]  

As the Lorenz curve has an increasing slope, the income (wages) paid will be ordered in descending order of specificity. The different points of the curve are given on the abscissa by the accumulation of the weights relative to the number of the given sector \((z_r/z)\), and, on the ordinate, the cumulative relative contribution of the variable under consideration \((x_r/x)\) which corresponds to the average wages paid by sectors to employees in the Kingdom of Saudi Arabia.

**Graph 1:** The curve of Lorenz income (Distribution wages by sector in Saudi Arabia in 2017).

For the different sectors studied, the 30% of employees in the smallest strata cover a total of 10 sectors, i.e. 83% of the entire economic sector. The last 70% of the wages are concentrated alone in the trade and food sector and the industry sector. This curve is increasing, as well as its first derivative (Saporta, 1990 & Jayet, 1993). If the distribution of wages is perfectly uniform between individuals, this Lorenz curve will merge with the main diagonal. On the contrary, it will deviate from this main diagonal for a differentiated distribution of wages between employees according to the different economic sectors. The Lorenzon curve identifies the average wage observed for each employee, representing both locals and foreigners, and male and female. Consequently, the situation for both sectors (industry and trade) should be monitored by the Commercial Registry Centre with regards to the creation and deregistration of enterprises.

In order to measure the spatial distribution of wages (in the different regions) of employment for all sectors, we will use the share of the area in the total income of the reference territory as the relative weight of the area \((z_r/z)\) (in ordinate), and the part of the cumulative area as a relative part of the interest variable \((x_r/x)\) (in abscissa). The Lorenz curve below (graph 2) is constructed to measure the distribution of employees (incomes) according to the different regions, which is established on the basis of the data from table 2 in annex 1 for all employees without distinction of gender.

And it emerges from this curve that employees in 10 out of 13 areas receive 10% of all wages paid. This situation is justified by the presence of 21.06% of employees in these 10 areas, which is essentially caused, spatially, by the vastness of the desert and, on the other, by the occupation of the land according to climatic conditions.
Consequently, employment and salaries paid are concentrated on Eastern region, Makkah El Moukarama and Riyadh. The last two regions divide the 40% of the wages paid.

**Graph 2:** The curve of Lorenz (global wages by region in Saudi Arabia in 2017).

Conversely, if we want to measure the concentration of employment by region in the economic sectors and the wages paid by gender (male and female), we can have the following ordinates (zr/z) the part of all wages paid by all sectors in total employment for the reference territory and in the different areas, and on the abscissa (x/x) the contribution of each sector to employment in the area under consideration. The Lorenz curve below (graph 3) is drawn to measure the distribution of employees (income) according to the different areas, which is established on the basis of the data from table 2 in annex 1 for all employees by gender (male and female).

**Graph 3:** The curve of Lorenz (wages by gender and by region in Saudi Arabia in 2017).

A situation that remains the same in all three areas (North bord, Al-Baha et Al-Jouf) which, as a result of the population level of employment will receive only 3 and 4% of the wages paid by the economic sectors for male and female employees respectively, the situation is improving for female workers compared to male workers in the
regions of Jazza, Tabuk, Aseer, Al-Qaseem and in Al Madinah El-Mounaoura the wages received by women are double those of men (accumulation of regions), and to Estearn region, the wage situation is the same for men and women. For the rest of the areas, employees in Makkah El Moukarama and Riyadh receive 40% of the wages paid by economic sectors to employees. These two cities have the following characteristics, one is the capital of the Kingdom of Saudi Arabia and the other is a saint city, a destination for more than a billion Muslims.

Conversely, if we seek to measure the concentration of employment and income paid by economic sectors by age group, we can have an ordinate of \((zr/z)\) the part of all wages paid by all sectors in total employment by reference age group at the national level, and on the abscissa \((x/r)\) the part of each age group in the employment of the age range under consideration. The Lorenz curve below (graph 4) is constructed to measure the distribution of employees (income) according to the different age groups and which is based on the data from Table 3 in Annex 1.

**Graph 4:** The curve of Lorenz (wages by age group in Saudi Arabia in 2017).

These age groups made up of the following fringes: the under 20 years (15-19 and 20-24) and 55+ (55-59, 60-64 and 65+) receive 11% of the wages paid by the economic sectors. The rest of the age groups receive an almost equitable distribution of wages. Nevertheless, the labor force remains the key element in wages.

**The Gini Index in the Kingdom of Saudi Arabia:**
The Gini Index (Gini, 1947; Gini, 1965) is used to summarize the information read on the Lorenz curve. It is twice the area between the curve and the first bisector. This coefficient has values between zero, when there is a uniform distribution of the variable between the different individuals, and the unit (=1), when a single individual has the entire variable under consideration. Between these two extremes, there is a positive value that increases when the Lorenz curve moves downwards and there is an increase in inequality. To be noted that (Silber, 1989) and (Dagum, 1997) have Gini coefficients disaggregated into distinct and defined contributions of total inequality.

From a practical point of view, a first method of calculation is by ordering the \(N\) observations in ascending order and using the formula: 

\[
\text{Gini} = \frac{1}{N(N-1)x} \sum_{i=1}^{N} \sum_{j=i+1}^{N} (x_j - x_i)
\]

or 

\[
\bar{x} = \frac{1}{N} \sum_{i=1}^{N} x_i
\]

is the mean of the variable considered.

A second method is to calculate the surface under the Lorenz curve and to deduct the Gini coefficient accordingly.

\[
\text{Gini} = 1 - \frac{1}{N} \sum_{i=1}^{N} \left( \frac{x_i - 1 - x_j}{c} \right) = 1 + 1 - \frac{2}{N} \sum_{i=1}^{N} \sum_{j=0}^{i} x_j
\]

With: 

\[
x_i^1 = \sum_{j=0}^{i} x_j, x_i^{1-1} = \sum_{j=0}^{i-1} x_j, x_i = x_i^c - x_i, x = \sum_{j=0}^{N} x_j = x_N^c, \text{ and } x_0 = 0
\]
The calculation of the Gini index for the case where individual data have been grouped by areas or sectors, the relative weight of the area or sector is used according to:

\[
\text{Gini} = 1 - 2 \sum_{i=1}^{n} z_i \left( \frac{x_i}{z} \right)^2 + 1 = 1 - \left( \sum_{i=1}^{n} \frac{x_i}{z} \right) \left( \frac{y_i}{z} \right) + \frac{1}{2} \left( \frac{x^2}{z} - \frac{y^2}{z} \right)
\]

For purposes of further comparison, we will adopt the most widely used formula given in the World Bank's explanatory memorandum for the calculation of inequality in the incomes (Brown, 1994), which is as follows:

\[
G = 1 - \frac{\sum_{i=1}^{n} (X_i - X_{i-1}) (Y_i - Y_{i+1})}{\sum_{i=1}^{n} X_i Y_i}
\]

Where \(X\) is the cumulative part of the variable to be studied and \(Y\) is the cumulative part of the mass to be distributed.

The Gini index is an indicator of the distribution of a mass (wages or income, wealth, etc.) within a population in order to get an idea of the more or less egalitarian nature of the distribution of this mass within the population and to compare the results of the distribution with other countries.

It is academically recognized that the Gini coefficient is between 0 and 1, where 0 represents perfect equality (everyone has the same resources) and 100 represents perfect inequality (resources are monopolized by a single person or category). The Gini coefficient is the ratio of the surface area between the diagonal of perfect equality and the Lorenz curve to the total Surface below the line of perfect equality.

Note that China's Gini index stands at 46.9 and Saudi Arabia's at 45.8. Not further behind the United States stands 45.0. The European Union average is 30.9. France is just below at 30.1 and Austria is also below average at 29.2. In Europe, the Gini index for Sweden and Denmark is just under 25, and Slovenia's is the best of all, at 23.7 (Thomsen, 2017), for the emerging countries of Latin America and Central Africa, the Gini coefficient is 0.70 (geoconfluence, 2019), thus, for Brazil the index 59.3 (in 2005) and the world average in 2005 was equivalent to 72.0% (UNDP, 2005).

**According to the calculation method used above, we obtain:**

1. The Gini index of wage distribution by sector = 0.4056 and the graphical equation is: \(y = 0.5085 e^{0.0519 x}\), the coefficient of determination: \(R^2 = 0.9227\) (the equation for the regression line is determined at 92.27% of the point distribution).
2. The Gini index of the distribution of wages by age group = 0.01 and the graphical equation is: \(y = 1.0117 x^{2.6456}\), the coefficient of determination: \(R^2 = 0.9984\) (the equation for the regression line is determined at 99.84% of the point distribution).
3. Gini index of wage distribution by region (total) = 0.5598 and the graphical equation is: \(y = 0.0023 x^{5.7285}\), the coefficient of determination: \(R^2 = 0.9756\) (the equation for the regression line is determined at 97.56% of the point distribution).
4. The Gini index of the distribution of wages by region (male employees) = 0.5693 and the graphical equation is: \(y = 0.0021 x^{5.8395}\), the coefficient of determination: \(R^2 = 0.9732\) (the equation for the regression line is determined at 97.32% of the point distribution).
5. The Gini index of the distribution of wages by region (female employees) = 0.3578 and the graphical equation is: \(y = 0.007 x^{4.781}\), the coefficient of determination: \(R^2 = 0.9833\) (the equation for the regression line is determined at 98.33% of the point distribution).

We deduce that, in terms of the sectoral distribution of wages, the Gini index measures 40.56, a level that can be classified between the European and US levels, in terms of the distribution of wealth. The Gini index for the distribution of wages across age groups is of the order of 1, which makes it possible to attribute a perfect distribution of wages in this respect (a perfect level).

And with regard to the distribution of wages by region, for the overall case of employees (men and women) or only employees (men), the index varies between 55.98 and 56.93, similar to Brazil, but much better than those attributed to the Latin American region and the world average, and therefore, this index represents an appreciable level. And as regards women employees, the distribution as measured by the Gini index is equivalent to 35.78, a level that is comparable to that of the European Union countries, including France.
Concentration measures in the Kingdom of Saudi Arabia:
The purpose of measuring concentration will be to give a summary of the distribution of the size of enterprises in terms of employment or income in a sector or area. The following concentration indicators must satisfy the Lorenz conditions. First, if there is an increase in the dispersion of the distribution with the same mean, this should increase the concentration index. The second condition establishes that if all individuals are of the same size, an increase in the number of individuals must lead to a decrease in the concentration index. The measures of concentration were proposed like (Hall & Tideman, 1967) and the Entropy Concentration Index was proposed by (Jacqueminn, 1975; 1079).

The proportion of the largest enterprises in the Kingdom of Saudi Arabia:
The N firms are ranked in descending order according to the variable in question. We thus note the relative size of enterprise i as measured by employment: \( \varepsilon_i = \frac{x_i}{\sum_{i=1}^{n} x_i} \) such as: \( \varepsilon_1 \geq \varepsilon_2 \geq \cdots \geq \varepsilon_m \geq \varepsilon_N \) and we then define the portion of the m largest enterprises by the formula: \( C_m = \sum_{i=1}^{m} \varepsilon_i \)

We take into account the contribution of the 4 and 10 largest sectors with the largest number of large enterprises referred to respectively as C4 et C10. These indicators allow calculating the concentration of wages in the 4 and 10 largest sectors with large firms with more than 20 employees. These indicators C4 et C10 allow us to determine the proportion of employment in the 4 or 10 sectors (the largest enterprises in the Kingdom of Saudi Arabia) constituting a strategic volume requiring monitoring by a strategic information system. We take the same approach but by taking into account the 4 and 10 areas with the most employment (depending on the sector). These indicators C4 et C10 allow us to consider the geographical areas (regions) and sectors in which the most employees are working.

Note that the ranking in descending order of enterprises by economic sector employing more than 20 employees in 2018 are: Construction of buildings; Education; Retail trade, except of motor vehicles and motorcycles; Food and beverage service activities; Human health activities; Wholesale trade, except of motor vehicles and motorcycles; Wholesale & retail trade and repair of motor vehicles & motorcycles; Manufacture of other non-metallic mineral products; Specialized construction activities et Warehousing and support activities for transportation.

| Enterprises (+ 20 employees) | Number | %     | Mean | Std  | Minimum | Median | Maximum |
|----------------------------|--------|-------|------|------|---------|--------|---------|
| Enterprises                | 85 134 | 2.62  | 34 255 | 97606 | 7       | 1 801  | 610 998 |
| C 4                        | 11 897 | 0.36  | 2 974  | 778  | 2 169   | 2 907  | 3 915   |
| C 10                       | 19 423 | 0.59  | 1 942  | 1 040 | 806     | 1 717  | 3 915   |
| Employment C10             | 111 1619 | 56.4 | 111 161 | 101 807 | 40 045 | 88 019 | 392 368 |
| Employment C4              | 66 4606 | 33.5 | 16 6151 | 152 653 | 63 351 | 104 444 | 392 368 |

Source: Authors

We deduce that the number of enterprises (companies with more than 20 employees) in 2018 is 85 134, or 2.62% of the total number of enterprises. This number varies according to economic sectors, ranging from 7 to around 611,000 enterprises with an average of around 34,000 enterprises. Ranking the number of companies in descending order leads us to conclude that the 10 sectors with more enterprises employing more than 20 employees represent a number 111 1619 and this number rises to 66 4606 for the first 4 sectors employing more than 20 employees for the year 2018. The top 10 as well as the top 4 sectors employing more than 20 employees represent respectively 56.40% and 33.56% of all employment in 2010.

The Herfindahl Index in the Kingdom of Saudi Arabia
Various measures of diversification have been proposed in academic work. The most widely used category, whether for studies in industrial economics (Jacquemin et Berry, 1979) or regional economic studies (Attaran et Zwick, 1987) which is based on the calculation of Herfindahl-Hirschmann concentration index and whose measure is the sum of the squares of the parts of all the individuals: \( IHH = \sum_{i=1}^{N} \varepsilon_i^2 \) (Nutter, 1968).

The HHI results, for a given economic sector group, from the sum of the squared employment shares.
\( \xi_i \) Represents corporate employment i and N represents the total number of enterprises in the economic sector group. This index can be as high as 10000.

The inverse of this HHI index can be interpreted as the equivalent number of firms of equal size that would share the employment equally. The current guidelines suggest that a market with HHI less than 1,500 is “unconcentrated” while an HHI of greater than 2,500 is highly concentrated (Bruce and al, 2014).

We opt for the case where \( \text{IHH} < 1000 \), that the distribution of wages according to the chosen parameter (regions, economic sectors or age groups) is uniform; the N parameters are of similar size and no risk of dependency or dominance is presented. And under this condition, employment is not at all concentrated in the area (or economic sector or at the level of an age group).

Thus, from Table 1 in Annex 1, after calculating the percentage share of each sector in employment, we deduce from that the value of:

\[
\text{IHH}_{\text{by sector for 2017}} = (4.98)^2 + (19.01)^2 + (16.41)^2 + (34.75)^2 + (5.57)^2 + (3.65)^2 + (1.73)^2 + (4.30)^2 + (2.97)^2 + (2.97)^2 + (0.52)^2 + (3.14)^2 = 1957
\]

For \( \text{IHH}_{\text{by sector for 2017}} = 1957 \), a value ranging between 1000 and 2000, it indicates that employment is not highly concentrated in one economic sector compared to other sectors. Nevertheless, a predominance of the sector (Trade, Accommodation and Food) over overall employment, the regulator (legislation and regulations currently applicable on trade, taxation, immigration and vocational training) must ensure that a more favorable business environment is provided for this employment sector, particularly for enterprises employing between 1 and 5.

Using the same estimation method, the HHI index by age group is calculated from Annex 1, Table 3, which equals:

\[
\text{IHH}_{\text{by age group in 2017}} = (0.14)^2 + (1.00)^2 + (2.99)^2 + (29.77)^2 + (17.45)^2 + (54.12)^2 + (221.13)^2 + (147.11)^2 + (272.88)^2 + (291.54)^2 + (372.94)^2 = 1411
\]

For \( \text{IHH}_{\text{by age group in 2017}} = 1411 \), a value ranging between 1000 and 2000 which indicates that employment is low concentrated in one age group in comparison to other groups. Employment by age category is more equal for 6 out of 12 categories. However, the 34–44 age group alone represents 52.91% of the total employment, which is distributed around 17% for each of the 30–34 and 40–45 age groups. While the age group from 35 to 39 years old stands out with the higher employment rate which is equal to 19.31%. However, we recommended that \( \text{IHH}_{\text{by age group in 2017}} \) does not increase more than 250 (equivalent to 16% in overall employment) so that the situation will not be concentrated from one category to another, with the exception of a favor granted to the 20–29 age group for better para-tax participation (more contributions from this category to the pension and insurance fund) which makes it possible to ensure the financial equilibrium of the fund and long-term sustainability.

After calculating the percentage rates of each area’s contribution to employment, the HHI employment index for the areas is derived from Table 2 in Annex 1 as follows:

\[
\text{IHH}_{\text{by region in 2017}} = (0.41)^2 + (0.52)^2 + (0.89)^2 + (1.85)^2 + (2.51)^2 + (2.69)^2 + (3.03)^2 + (16.11)^2 + (16.17)^2 + (19.43)^2 + (385.19)^2 + (485.76)^2 + (1388.71)^2 = 2323
\]

Three areas (region) are the most job-seeking regions and these concerns Eastern Region with 19.63% followed by Makkah with 22.04% and Riyadh with 37.27%.

Thus, the Herfindahl-Hirschmann index by area \( \text{IHH}_{\text{by region in 2017}} = 2323 \) denotes a concentration of employment in the capital Riyadh. In order to ensure a balance of concentration, the regulators must ensure that this index does not increase more than 150 (about 12.2% of total employment).

In conclusion, independently of the parameter chosen (sector, area, or age group), there is no distinction between a borderline case and a deregulation of concentration (all employees working) in a sector or area or age group haven’t a dominance that presents a risk concentration.
The Herfindahl index normalized in the Kingdom of Saudi Arabia:

There is also a standardized HHI index. While the HHI varies between 1/n and 1, the normalized HHI index varies between 0 and 1. Its formula is:

\[ \text{IHH}_{\text{Normalized}} = \frac{(\text{IHH} - 1)}{N - 1} \]

From this formula, the Herfindahl-Hirschmann concentration index normalized for sector, area, and age category parameters is calculated, resulting in the following values:

\[ \text{IHH}_{\text{Normalized by sector}} = \left( \frac{(1956.78 - 1)}{12} \right) = 2135 \]

\[ \text{IHH}_{\text{Normalized by area}} = \left( \frac{(2323.26 - 1)}{13} \right) = 2517 \]

\[ \text{IHH}_{\text{Standardized by age group}} = \left( \frac{(1411.05 - 1)}{11} \right) = 1552 \]

As a deduction to these calculations, the sector-standardized Herfindahl index is the only one that lagged above 2000 and is joined to the same analysis attributed to the regions.

The table below shows the analysis according to Herfindahl-Hirschmann Index (HHI) and Herfindahl-Hirschmann Normalized Index (HHI*). These indices remain sensitive to high \( \theta \).

**Table 2:** Matrix for analysis by the Herfindahl-Hirschmann Index (HHI) and Herfindahl-Hirschmann normalized index (HHI*).

| Designations | Parameter (sector, area, age group) | IHH < 1000 | 1000 < IHH < 2000 | 2000 < IHH < 1000 | IHH= 10000 |
|--------------|-----------------------------------|------------|-------------------|-------------------|------------|
|              | Distribution uniform: the N parameters are the same size | The N parameters are of distinct size | Distribution uniform: the N parameters are all singular in size | Every employees are working in the only parameter object of the study |
| IHH par      | Sector                            | -          | 1956.78           | -                 | -          |
|              | Region                            | -          | -                 | 2323.26           | -          |
|              | Age Group                         | -          | 1411.05           | -                 | -          |
| IHH* par     | Sector                            | -          | -                 | 2134.57           | -          |
|              | Region                            | -          | -                 | 2516.78           | -          |
|              | Age Group                         | -          | 1552.06           | -                 | -          |
| Comments     | The employment is not concentrated in the area or sector or age group. | Employment is low Concentrated in area or sector or age group. | The job is concentrated in area or sector or age group. | Maximum concentration In area or sector or age group. |

**Source:** Auteurs

Theil Entropy Index in the Kingdom of Saudi Arabia:

The entropy index, proposed by (Theil, 1967), is equal to the sum of the portions weighted by their logarithm:

\[ E = \sum_{i=1}^{N} \xi_i \ln \xi_i \]

or simply:

\[ T = \sum x_i \ln(x_i n) \]

or in the other way, as indicated by the following formula:

\[ T = \frac{1}{n} \sum_{i} \left( \frac{y_i}{y} \right) \ln \left( \frac{y_i}{y} \right) \]

from Where:

\[ x_i = \text{Each individual's participation of total income} \]

\[ n = \text{total number of individuals} \]
\( y_i = \text{Income of individual } i \)

\( \bar{y} = \text{average personal income} \)

The calculations are shown in the tables in Annex 1:

1. \( T \text{ by sector in 2017} = 0.5241 \) (refer to Table No. 4 in Annex 1)
2. \( T \text{ by age group in 2017} = 0.3369 \) (refer to Table No. 5 in Annex 1)
3. \( T \text{ by region} = 1.0374 \) (refer to Table No. 6 in Annex 1 with average wages)

This Theil entropy index also has a decomposition property. When the population is divided into several groups \((j = 1..n)\), the general entropy index is subdivided into two elements: intra-group entropy, measuring inequalities within each group, and inter-group entropy, measuring inequalities between different groups. We will use this peculiarity in the calculations of the Theil index by region by decomposing employees by gender (male and female), which indicates the relative importance of gaps in the degree of income concentration for each category (decomposition) is expressed according to the following formulas:

\[
T = T_1 + T_2 \quad \text{or} \quad T = T_{\text{intra}} + T_{\text{inter}}
\]

Where:

\[
T_{\text{intra}} = T_1 = \sum_j v_j \sum_i z_{ij} \ln(z_{ij} n_j) \quad \text{and} \quad T_{\text{inter}} = T_2 = \sum_j v_j \ln \left( \frac{v_j n_j}{n} \right)
\]

With:

\( v_j = \text{participation of group } j \text{ in total income} \)

\( z_{ij} = \text{participation of individual } i \text{ in the income of group } j \)

\( n_j = \text{number of individuals in group } j \)

\( n = \text{total number of individuals} \).

Thus:

\( T \text{ by region} = 1.2770 \) (see Table No. 7 in Annex 1 with salaries corresponding to each "male and female" gender and decomposed)

The first of the two addenda in the penultimate column (of Table 7 in Annex 1) represents the contribution of inequality between male employees to the total Theil index. The second is the inequality resulting from the distribution among female employees. For its own part, the last column calculates the contribution to the total inequality of inequality between the two categories of female employees by region. The total Theil is the sum of the previous components.

Finally, the result of the sum of \( T_1 \) and \( T_2 \) is equal to \( 1.277 \) which does not correspond exactly to the value of the total inequality coefficient calculated previously \( 1.0374 \) because of the values used. For the first result, the average wages between the male and female category for each region (group), for the second result, the use in the calculations of the wages relating to each category (male and female) for each region (group).

Thus, the results of \( T_1 = 1.02109 \) and \( T_2 = 0.25597 \), reveal that inequality between the two groups (male and female) of wage is more important in total inequality than inequality between regions.

As in the case of the Herfindahl index, a minimum and maximum value of this entropy index can be calculated. Thus, if all the parameters are of equal size with the same size \( 1/N \) ratio, the entropy index will be equal to \( \log(N) \), whereas the maximum value (0) is obtained if only one parameter holds all the employment (all incomes are equal zero except one).

**Table 3:** Theil Entropy Index analysis Matrix (\( T \)).

| Designations | Limit case \( T = 0 \) | \( 0 < T \leq 1.24 \) | \( T > 1.2424 \) | Limit case \( T = \log(1/12) = 2.48 \) |
|--------------|------------------------|--------------------------|-----------------|-----------------------------|
| **For each parameter** | All employees are works in one area | | | Uniform distribution and all employees by (sector, region and age group) are on the same size |
| **T=** | | | | |
| Sector | - | 0.5241 | - | - |
| area | - | 1.0374 | - | - |
| Age group | - | 0.3369 | - | - |
| **Comments** | Concentration | Employment is | The employment is | The employment is not |

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maximum in the area (or the Sector). | low concentrated in sector, area, region or age group | concentrated in some sectors, areas or age groups | flatly concentrated in one parameter (economic sector, area or age group)
---|---|---|---

Source: Authors

As a result, no classification admits any concentration of wages or employment, a satisfactory situation; nevertheless, it is advisable to improve the wages of the women's category by tax moderation.

The Gini employment index by sector and region:
For (Davezies & Pech, 2014), Spatial concentration is measured by considering the totality of the spatial structure(s), i.e. using a synthetic indicator. The synthetic indicator most often used is arguably the Herfindahl index for absolute spatial concentration and the Gini index for relative concentration.

The distribution coefficient is also a measure of the concentration of sectors in geographical areas, i.e. the distribution of employment in a sector among the different areas of the territory. It is a Gini index for each geographical area weighted according to its contribution to total employment in the territory. It takes into account the weight of the areas in total employment. From Table No. 8 in Annex 1, the relative Gini coefficients of employment by area and by sector are calculated according to the method formulated above and represented in the following graph:

Graph 5: Gini coefficients by area (all sectors combined) and by sector (all areas combined) for employment.

The coefficients of variation in employment defined by the formula: \( CV = \frac{\sigma}{\mu} \times 100 \) by area (all sectors combined) and by sector (all regions combined) are all above 100% and they vary respectively from 111% to 150 and 133% to 358%, which indicates that they do not have the same dispersion and they remain heterogeneous, but it should be noted that it would be easier to reach a consensus (more repeatability in the data) by area than by sector and the area remains the most representative is the East Province. An area can take on the character of a pilot area where any observation reported on a sector is significant for the whole of the Kingdom of Saudi Arabia and from which; it is recommended that an observatory on employment, productivity and competitiveness be established.)
Economic density

Economic density is used to evaluate the potential of an area to attract employment and expresses productive character than residential. Hence the economic density, noted $D_j^E$ and with based on the hypothesis developed by (Dreier et al., 2001) and that where we live influences, the quality of life and the manner in which that place operates impacts the quality of our society. Economic density is a measure of the importance of economic activity in an area. Economic density $D_j^E$ of an area j is calculated in a manner analogous to the population density $D_j^P$ such as the number of employees per km$^2$.

$$D_j^E = \frac{\text{Employment}_j}{\text{Surface}_j} \text{ et } D_j^P = \frac{\text{Population}_j}{\text{Surface}_j}.$$ 

These two densities are highly correlated.

The economic density in the analysis also provides an estimate of the benefits and constraints resulting from the relative concentration of actors. And for greater visibility; an employment rate for the area can also be constructed. $(TE_j)$, i.e. the ratio of employment to population. It is also the ratio of economic density to population density. So,

$$TE_j = \frac{\text{Employment}_j}{\text{Population}_j} = \frac{D_j^E}{D_j^P}.$$

Graph 6: Economic density and employment & population densities by area.

Source: Authors

Development increases density which in its turn enhances attractiveness and stimulates expansion, which further improves attractiveness (Ciccone et Hall, 1996). We can note that areas with a high economic density offer greater support for the competitiveness of businesses. Nevertheless, work on French territories (Binet et al., 2010) Point up the statistical problems involved in measuring economic density, given its very uneven distribution, which leads to its abandonment. There remains a direct relationship between the territorial context and entrepreneurial activity. And it goes in the same direction as most of the work concerning the local determinants of business creation (Keeble et al., 1993; Reynolds and Storey, 1993; Reynolds et al., 1994; Audretsch and Fritsch, 1994; Keeble and Walker, 1994; Johnson and Parker, 1996).

Measures of specialization and specificity:

We note that all calculations relating to specialization and specificity measures are based on the data in Table 8 in Annex 1.
The specialization coefficient by area:
The notion of specialization applies to a spatial unit. Specialization is relative in nature. The concept of specialization is based on the comparison of two sectoral structures. Thus, the specialization of the production or employment of an area in relation to the country is understood by comparing the sectoral structure of production or employment of the area with the sectoral structure of production of the country, and by using the production or employment of the country as a reference element (Vermaut, 2003). Specialization indicates whether an area's production or employment is more or less oriented towards a particular activity. It is also an indicator of diversification. The employment specialization coefficient measures the concentration of an area's employment in a greater or lesser number of sectors. It is a relative Gini index, i.e. each sector is weighted by its proportion of total employment. Thus, this coefficient reflects the importance of each of the sectors at the aggregate level of the reference territory.

Each relative specialization coefficient is the expression of the ratio of the weight of sectors $i$ in the total economic activity of a specific employment area $j$ in relation to the relative weight of the same activity at national level $\frac{x_{ij}}{\sum x_i}$. (Aiginger, 1999). It is obtained from the following report: $S_{ij} = \frac{x_{ij}}{\sum x_i}$ That is to say:

\[
\text{Specialization index noted } S_{ij} = \frac{\text{Sector employment in the territory } X_{ij}}{\text{Total employment in the territory } X_i}
\]

The results of sectoral specialization measure the ratio between the sectoral structure of the employment area under study and that of the entire Kingdom of Saudi Arabia. Three classes were defined: over-representation (specialization index >1.25), in the average (between 0.75 and 1.25) and under-representation <0.75. The following table is derived after the calculations according to the above formula.

| Specialization | Areas | Under-representation $S_{ij} < 0.75$ | The average $0.75 \leq S_{ij} \leq 1.25$ | Over-representation $S_{ij} > 1.25$ |
|---------------|-------|----------------------------------|---------------------------------|----------------|
| **North.Bord.** | Other service activities, Agriculture & forestry and fishing, Electricity, gas and Water, Mining & quarrying, Transportation & communication, Financial and insurance activities | Other collective and social services, Manufacturing, Trade, Construction. |  |  |
| **AL – Baha** | Other service activities, Agriculture, forestry & fishing, Electricity, gas & Water, Mining & quarrying, Financial and insurance activities. | Other collective and social services, Manufacturing, Construction. | Transportation & communication, Trade |  |
| **AL – Juf** | Other service activities, Electricity, gas & Water, Mining & quarrying, Financial & insurance activities. | Manufacturing, Construction. | Agriculture, forestry & fishing, Transportation & communication, Trade, Other collective & social services |  |
| **Tabuk** | Other service activities, Electricity, gas & Water, Mining & quarrying, Manufacturing, Financial & insurance activities. | Transportation & communication, Other collective & social services, Trade, Construction. | Agriculture, forestry & fishing |  |
| **Hail** | Other service activities, Electricity, gas & Water, | Transportation & communication, Other collective | Agriculture, forestry & fishing |  |
| Region      | Other service activities, Mining & quarrying, Financial & insurance activities, Agriculture, forestry & fishing, Trade, Construction. | Other service activities, Mining & quarrying, Financial & insurance activities, Agriculture, forestry & fishing, Trade, Construction. | Other service activities, Mining & quarrying, Financial & insurance activities, Agriculture, forestry & fishing, Trade, Construction. |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| Najran      | Other service activities, Electricity, gas & Water, Mining & quarrying, Transportation & communication, Financial & insurance activities. | Other collective and social services, Manufacturing, Trade, Construction. | Agriculture, forestry & fishing |
| Jazan       | Other service activities, Electricity gas & Water, Mining & quarrying, Financial & insurance activities. | Manufacturing. | Agriculture forestry & fishing, Transportation & communication, Trade, Other collective & social services, Construction. |
| Asir        | Other service activities, Electricity gas & Water, Mining & quarrying, Financial & insurance activities. | Agriculture, forestry & fishing, Transportation & communication, Other collective & social services, Manufacturing, Trade, Construction. | Agriculture, forestry & fishing |
| Madinah     | Other service activities, Electricity gas & Water, Mining & quarrying, Financial & insurance activities. | Transportation & communication, Other collective & social services, Manufacturing, Trade, Construction. | Agriculture, forestry & fishing |
| Qassim      | Other service activities, Mining & quarrying. | Transportation & communication, Other collective & social services, Manufacturing, Financial & insurance activities, Trade. | Agriculture, forestry & fishing, Electricity gas & Water, Construction. |
| Makkah      | Other service activities, Agriculture forestry & fishing, Mining & quarrying, Financial & insurance activities. | Electricity gas & Water, Transportation & communication, Other collective & social services, Manufacturing, Trade, Construction. | |
| Riyadh      | Other service activities, Agriculture forestry & fishing, Mining & quarrying. | Electricity gas & Water, Transportation & communication, Other collective & social services, Manufacturing, Financial & insurance activities, Trade, Construction. | |
| Easte. Prov. | | | Other service activities, Mining & quarrying. |

**Source:** Authors

**Krugman Specificity Index**

The disadvantage of the indices of sectoral specificity of areas stems from the fact that there are as many of them as there are sectors considered for each area of the territory. These can be analysed in order to find the sectoral specialities of the area, but this does not provide an indication of the overall specificity of the area. In order to
The Krugman index is therefore the sum of the differences in absolute value between the industrial structure of the area and that of the rest of the reference territory defined according to the following formula: $K_i = \sum_k \frac{|x^k_1 - x^k_i|}{X - x^k_i} = \sum |S^k_1 - S^k_i|$

For our case study, the economic activities or industrial sector (structure) is measured across its employment base, consequently, $S^k_i$ is the proportion of employment in sector $i$ of administrative area $k$ and $S^k$ is the proportion of employment in sector $i$ of the reference group (the whole country). It measures the absolute distance between the relative importance of a sector (between $k$ and the reference group) and then adds all sectors together to generate an index.

The Krugman index will be equal to zero when the area in terms of employment is perfectly similar to the rest of the territory (country); the area has no specificity because it perfectly reflects the structure of the territory. However, if the area is entirely specialized in activities not found elsewhere (employment dominance), the Krugman index will be equal to the number 2, and we will have a perfectly specific area. Following the above formula, the Krugman specialization index is obtained from Table 8 in Annex 1.

### Table 5: Krugman Specialization Index (%).

| Administrative area | Other services activities | Agriculture forestry and fishing | Electricity gas and Water | Mining and quarrying | Transport and communication | Other collective and social services | Manufacturing | Financ and insurance activities | Trade | Construction |
|---------------------|--------------------------|---------------------------------|--------------------------|---------------------|----------------------------|------------------------------------|--------------|-------------------------------|-------|---------------|
| North.Bord | 0.46 | 0.32 | 0.39 | 0.42 | 0.21 | 0.04 | 0.04 | 0.24 | 0.07 | 0.13 |
| AL - Baha | 0.48 | 0.33 | 0.39 | 0.42 | 0.19 | 0.001 | 0.03 | 0.22 | 0.18 | 0.06 |
| AL - Jouf | 0.67 | 0.22 | 0.54 | 0.56 | 0.22 | 0.18 | 0.01 | 0.40 | 0.28 | 0.03 |
| Tabuk | 1.05 | 0.68 | 0.91 | 0.83 | 0.10 | 0.06 | 0.32 | 0.76 | 0.05 | 0.05 |
| Hail | 1.27 | 1.34 | 1.10 | 1.01 | 0.31 | 0.21 | 0.07 | 0.97 | 0.22 | 0.22 |
| Najran | 1.36 | 1.45 | 1.09 | 1.05 | 0.35 | 0.32 | 0.08 | 0.54 | 0.20 | 0.31 |
| Jazan | 1.40 | 1.70 | 1.10 | 1.07 | 0.37 | 0.42 | 0.22 | 0.57 | 0.72 | 0.59 |
| Asir | 3.34 | 0.69 | 2.93 | 2.84 | 0.58 | 0.58 | 0.11 | 2.43 | 0.33 | 0.21 |
| Madinah | 3.55 | 2.81 | 2.72 | 2.62 | 0.49 | 0.29 | 0.28 | 2.64 | 0.33 | 0.24 |
| Qassim | 3.72 | 8.13 | 2.96 | 2.32 | 0.09 | 0.54 | 0.50 | 0.87 | 0.89 | 1.53 |
| Makkah | 21.17 | 8.42 | 1.70 | 16.54 | 2.28 | 4.74 | 3.14 | 6.73 | 5.02 | 0.97 |
| Riyadh | 22.28 | 6.36 | 1.78 | 15.46 | 0.27 | 1.24 | 2.23 | 2.82 | 4.96 | 1.00 |
| Easte. Prov | 60.75 | 1.59 | 8.14 | 45.13 | 3.91 | 2.82 | 5.17 | 19.18 | 0.81 | 2.62 |

**Source:** Authors

**Legends of table n° 5**

- $K_i = 0$ ⇒ No specialization of the administrative area
- $0\% < K_i < 20\%$ ⇒ The administrative area is relatively specialized
- $20\% \leq K_i < 100\%$ ⇒ The administrative area is very specialized
- $K_i = 100\%$ ⇒ Perfect specialization of the administrative area

**Specificity indexes:**
The specificity considers the nature of sectoral activities by comparing the structure of the area with that of the territory as a whole. The specificity of the area in terms of employment is confirmed by (Dissart et al., 2011) which shows the influence of market potential, propensity to consume locally, as well as local attractiveness and access to specific equipments. The specificity helps to compare the production or employment structure of an area in relation to a reference territory.

Indices of sector specificity:
The sector specificity index allows a comparison of the importance of a sector of economic activity in the study area and in the territory as a whole. The specificity index of a territory or an economic sector corresponds to the ratio between the number of employees in a sector in the total number of employees in a given territory and that of the reference territory. It is generally defined by:

\[ r_{i}^{k} = \frac{\omega_{i}^{k}}{S_{k}} = \frac{X_{i}^{k}}{X_{i}} \]

Specificity index noted \( r_{i}^{k} \) = \( \frac{\text{Size of the sector in the territory } P_{i}^{k}}{\text{National size of the sector } P_{k}} \)

This index is equal to 200 if sector \( k \) has the same importance in area \( i \) and in the territory as a whole; it is equal to zero if no activity of sector \( k \) is located in area \( i \). When all employment in sector \( k \) is located in area \( i \), it equals \( X/X_{i} \). If the result is superior to 100 then the sector is over-represented locally. But if this index is inferior to 100 then the sector is under-represented locally. The maximum value therefore depends on the size of the area, which can be annoying when we study an area that is large in relation to the reference territory.

We define four classes: sector \( k \), is not represented at all when \( r_{i}^{k} = 0 \), a strong representation when \( r_{i}^{k} \geq 100 \), of average representation for \( 20 \leq r_{i}^{k} < 100 \) and weak representation for the \( 0 < r_{i}^{k} < 20 \).

**Graph 7:- Specificity index.**

**Source:** Authors
The Krugman Specificity Index

The Krugman index is therefore the sum of the differences in absolute value between the industrial structure of the area and that of the rest of the reference territory defined according to the following formula:

\[
K_i = \sum_k \frac{|x^k - \bar{x}^k|}{\bar{x}_i - \bar{x}_k} = \sum_k \left| \frac{x^k_i}{x_i} - \frac{\bar{x}^k_i}{\bar{x}_k} \right| = \sum_k \left| \frac{\omega^k_i}{\bar{\omega}_i} - \frac{\bar{\omega}^k_i}{\bar{\omega}_k} \right| - 1 = \sum_k \bar{\omega}_i^k |\bar{\tau}_i^k - 1|
\]

Thus its value is between zero and two. The Krugman index can be interpreted as the sum of the divergences, taken in absolute value, of the specificity index of the area in relation to 2, i.e. a situation where the area has the same proportion of employment as the whole territory. This sum is adjusted by the importance of sector \( k \), measured by the relative share of employment in sector \( k \) in the rest of the territory. As a result, a synthetic index of the specificity of the area in relation to the rest of the territory is obtained (Krugman, 1991).

From the above, if the area is similar in all sectors to the rest of the territory, we will have for all \( k \): \( \bar{\tau}_i^k = 2 \) because \( \omega_i^k = \bar{\omega}_i^k \) or else \( \omega_i^k = \frac{x^k_i}{x_i} = \frac{x^k}{x} = s_k \). As a result, the Krugman index will be equal to zero and it can be said that the area is perfectly similar to the rest of the territory: it has no specificity as it reflects perfectly the sectoral structure of this territory. However, if the zone is entirely specialized in activities that cannot be found elsewhere, the Krugman index will be equal to 2 and the area will be perfectly specific.

This index can also be interpreted as the percentage of sectoral reallocation that should take place in the area in order for it to be perfectly similar to the rest of the territory in terms of productive structure or employment. In fact, this Krugman index is the sum of the differences in percentage between the productive or employment structure of the area and the rest of the territory.

Therefore, in order to resemble the rest of the territory perfectly and to have zero specificity, all the specificity indices must be units (\( \bar{\tau}_i^k = 1 \)) what occurs through a redistribution of productive activities or employments between sectors (Kubrak, 2013).

**Table 6:** Krugman Specificity Index.

| Administrative area | Other service activities | Agriculture forestry and fishing | Electricity gas and Water | Mining and quarrying | Transport and communication | Other collective and social services | Manufacturing | Financial and insurance activities | Trade | Construction |
|---------------------|--------------------------|---------------------------------|---------------------------|----------------------|----------------------------|-----------------------------------|--------------|-----------------------------------|-------|--------------|
| North. Bord.        | 0.000                    | 0.0073                          | 0.0096                    | 0.0191               | 0.0189                    | 0.0071                            | 0.0082       | 0.0540                           | 0.0381 | 0.1097       |
| AL - Baha           | 0.000                    | 0.0070                          | 0.0090                    | 0.0178               | 0.0202                    | 0.0044                            | 0.0002       | 0.0429                           | 0.1184 | 0.0703       |
| AL - Jouf           | 0.000                    | 0.0098                          | 0.0081                    | 0.0156               | 0.0401                    | 0.0658                            | 0.0490       | 0.0421                           | 0.2758 | 0.2034       |
| Tabuk               | 0.000                    | 0.0294                          | 0.0078                    | 0.0107               | 0.0455                    | 0.0895                            | 0.0609       | 0.0364                           | 0.3063 | 0.4548       |
| Hail                | 0.000                    | 0.0496                          | 0.0070                    | 0.0089               | 0.0465                    | 0.1704                            | 0.1623       | 0.0348                           | 0.3289 | 0.4923       |
| Najran              | 0.000                    | 0.0541                          | 0.0048                    | 0.0066               | 0.0504                    | 0.2039                            | 0.1813       | 0.0805                           | 0.3883 | 1.0063       |
| Jazan               | 0.000                    | 0.0607                          | 0.0038                    | 0.0058               | 0.1203                    | 0.228                            | 0.2549       | 0.0840                           | 0.9272 | 1.2719       |
The prevalence index between specialization and specificity:
The Krugman Specialization Index ($K_i$) as a measure of specialization that is broadly used. We propose the calculation of the global specialization index, which can be considered as a relative specialization that could be compared to another country or a reference country group. This Global Specialization Index expressed as a percentage is calculated according to the following formula: 

$$\text{IS}_G = \frac{\sum \left| X_i^k - \bar{X}_i \right|}{\sum \left| X_i - \bar{X}_i \right|} = \frac{10765426}{266818027} = 75\%$$

(See calculations in Tables 8.1 and 8.2 of Annex 2).

Similarly, the global specificity index calculated as a percentage obtained according to the following formula applies: 

$$\text{IS}_C = \frac{\sum \left| X_i - \bar{X}_i \right|}{\sum \left| X_i - \bar{X}_i \right|} = \frac{77376897}{1005899661} = 7.69\%$$

As a result, the prevalence index between specialty and specificity noted $\text{IPsG}$ is obtained as a result of the following ratio: 

$$\text{IPsG} = \frac{\text{IS}_G}{\text{IS}_C}$$

In case this prevalence index is greater than 1, the preference for bilateral comparison between regions based on the specialization index is the best option, otherwise, or if $\text{IPsG}$ is less than 1, the preference for bilateral comparison by region established on the specificity index would be preferred.

For our case study on the index in the Kingdom of Saudi Arabia, the prevalence index between specialty and specificity is $\text{IPsG} = \frac{\text{IS}_G}{\text{IS}_C} = \frac{75.00\%}{7.69\%} = 9.75$. In from this index, we will use the bilateral specialization index for our calculations.

Bilateral specialization indexes by administrative area
We can also propose a bilateral specificity index between two areas to search for areas that most resemble the study area or areas that are the furthest away from it in terms of industrial structure or employment. For this aim, the Krugman index is adjusted in such a manner that the comparison of employment by economic sector is no longer made with the rest of the territory, but with another zone $j$ of the territory: 

$$K_i = \sum_k \left| \frac{X_i^k}{X_i} - \frac{\bar{X}_i^k}{\bar{X}_i} \right| = \sum_k \left| \frac{X_i^k}{X_i} - \frac{\bar{X}_i^k}{\bar{X}_i} \right| = \sum_i |S_i^k - \bar{S}_i^k|$$

Thus we construct a square (symmetrical) table of these bilateral indices which are interpreted in the same way as the Krugman index: if the index is near zero, the two zones will be very similar in their industrial structure, otherwise the index will indicate the percentage of reallocation of activities that would have to be implemented in zone $i$ in order for this zone to have the same employment structure as zone $j$. 

Source: Authors
It should be noted that we exclude from our evaluation the sector «Other service activities» for its negligible values.

Table 7: Bilateral Specialty Indices by Region (%).

| Administrative area | North. Bord. | AL - Baha | AL - Jouf | Tabuk | Ha'il | Najran | Jazan | Asir | Madinah | Qassim | Makkah | Riyadh | East Prov |
|---------------------|-------------|-----------|-----------|-------|------|--------|------|-----|---------|-------|--------|--------|----------|
| North. B'nd        | 13.1        | 16.7      | 15.4      | 16.6  | 18.7 | 21.7   | 13.2 | 17.4| 36.8    | 18.5  | 22.7   | 48.0   |          |
| AL - Baha          | 13.1        | 12.4      | 11.8      | 13.1  | 14.7 | 16.7   | 10.1 | 13.3| 28.8    | 13.6  | 16.6   | 32.3   |          |
| AL - Jouf          | 16.7        | 12.4      | 7.5       | 7.9   | 9.6  | 11.2   | 7.0  | 8.7 | 20.9    | 12.2  | 14.8   | 27.6   |          |
| Tabuk              | 15.4        | 11.8      | 7.5       | 9.3   | 11.6 | 13.7   | 8.6  | 10.3| 26.7    | 16.1  | 19.4   | 31.0   |          |
| Hail               | 16.6        | 13.1      | 7.9       | 9.3   | 11.6 | 13.9   | 8.6  | 10.2| 26.5    | 16.2  | 19.6   | 31.8   |          |
| Najran             | 18.7        | 14.7      | 9.6       | 11.6  | 11.1 | 11.1   | 7.1  | 8.5 | 19.8    | 11.9  | 14.4   | 23.9   |          |
| Jazan              | 21.7        | 16.7      | 11.2      | 13.7  | 13.9 | 11.1   | 5.2  | 6.2 | 15.8    | 9.9   | 12.0   | 21.2   |          |
| Asir               | 13.2        | 10.1      | 7.0       | 8.6   | 8.6  | 7.1    | 5.2  | 11.2| 29.0    | 17.0  | 20.7   | 36.1   |          |
| Madinah            | 17.4        | 13.3      | 8.7       | 10.3  | 10.2 | 8.5    | 6.2  | 11.2| 20.2    | 12.6  | 15.4   | 25.1   |          |
| Qassim             | 36.8        | 28.8      | 20.9      | 26.7  | 26.5 | 19.8   | 15.8| 29.0| 20.2    | 6.1   | 7.4    | 13.0   |          |
| Makkah             | 18.5        | 13.6      | 12.2      | 16.1  | 16.2 | 11.9   | 9.9  | 17.0| 12.6    | 6.1   | 11.2   | 20.4   |          |
| Riyadh             | 22.7        | 16.6      | 14.8      | 19.4  | 19.6 | 14.4   | 12.0| 20.7| 15.4    | 7.4   | 11.2   | 15.5   |          |
| East. Prov         | 48.0        | 32.3      | 27.6      | 31.0  | 31.8 | 23.9   | 21.2| 36.1| 25.1    | 13.0  | 20.4   | 15.5   |          |

Source: Authors

The numbers colored in Azure blue correspond to a bilateral specificity index between two areas that most similar to the study area in terms of employment, and the numbers written in red correspond to the areas that are most distant from it in terms of employment and industrial structure.

Conclusion:

Indeed, in a context of international competitiveness, territories are the source of many of the diversity, specialization and concentration factors that determine the success of business creation: infrastructure (transport, energy, and telecommunications), employment areas, the presence of research and training centers, and the quality of the pool of outsourcers and suppliers. In addition, the era of the knowledge-based economy, marked by the predominance of tertiary activities, innovation and dematerialization, and the ability to attract and retain foreign direct investment are the conditions that make the area attractive to businesses, considering factors such as a pleasant quality of life and a positive image as a consequence of local development.

These material and immaterial factors, whose control requires specialization or concentration in order to concretize a strategic alliance between the enterprises and the territory. Therefore, the analysis of local determinants implies identifying the distinctive characteristics of territories through the estimation of concentration and specialization that can contribute to the understanding of the trajectories of enterprises (creation, disappearance, increase and foreign direct investment). In addition, this estimation constitutes a warning factor regarding the trends of the sectors of activity and their impacts on employment, the distribution of the wealth and the growth at the level of each administrative area.

The fact remains that the specialization of a territory favors the flow of information, innovation and, more generally, agglomeration economies (Maurel, 1996) related to Marshall-Arrow-Romer (Scitovsky, 1954) and, to which the spatial concentration of enterprises in the same sector of activity established on a network of links that promotes local growth. For (Jacobs, 1969), the diversity of activities is a favorable factor for growth insofar as
complementarities of knowledge, technologies or products could emerge. And therefore, inter-sectoral agglomeration economies according to the sectoral diversity of an area must be the issue at stake.

Specialization refers to the mastering by the territory of a number of knowhow related to a sector of activity or a product. It corresponds in a certain manner to industrial districts and, more broadly, to localized production systems. Thus, we propose a method to calculate the intermediate Krugman specialization index of a country’s $K_T = \frac{\sum_{i=1}^{n} K_i}{N}$. This index helps a priori to make a differentiation reading between specialization and concentration (the dominance of one over the other) and to make international comparisons in view of the divergence of classifications of economic activities in the statistical system of every country. We reiterate the

Krugman formula: $K_1 = \sum_{k} \left| \frac{x_k^i}{x_i^k} - \frac{x_k^i - x_i^k}{x_i^k} \right| = \frac{1}{2} \sum_{k} \left| \frac{x_k^i}{x_i^k} - \frac{x_i^k}{x_k^i} \right|$. And in regard to the sectors of activity in the Kingdom of Saudi Arabia; $N= 13$ and for the regions $N= 10$ and that $(\sum_{i=1}^{n} K_i= 364.95\%$, value obtained from the sums of the values in Table 5 above). Then we obtain the specialty index of the Kingdom of Saudi Arabia by activity sector ($K_{T/R}$) and by region ($K_{T/S}$):

$K_{T/R} = \frac{\sum_{i=1}^{n} 364.95\%}{10} = 36.50\% \quad \text{Et} \quad K_{T/S} = \frac{\sum_{i=1}^{n} 364.95\%}{13} = 28.07\%$

We express the value of the intermediate specialization index by region and by sector of activity with the confidence domain as follows (expressed in %):

$K_T = \left[ \frac{K_{T/R} + K_{T/R}}{2} \pm \left( \frac{\sigma_1}{2} + \frac{\sigma_2}{2} \right) \right] = \frac{36.50 + 28.07}{2} + \left( \frac{\sigma_1}{2} + \frac{\sigma_2}{2} \right) = 32.28 + \left( \frac{\sigma_1 + \sigma_2}{2} \right)$

$\sigma_1 :$ The variance between the different values (totals) of the Krugman specialty indexes by region.

$\sigma_2 :$ The variance between the different values (totals) of the Krugman specialty indexes according to activity sectors. Thus, $\sigma_1$ or $\sigma_2$ are then given by the following formula: $\sigma_{region or sector}^2 = \sum_{i=1}^{N} X_i^2 \sigma_i^2 + \sum_{i=1}^{N} \sum_{j=1}^{N} X_i Y_j \text{Cov}(i,j)$

$\sigma_1 = 2.35\%$ (See Tables 9 and 10 in Annex 2) and in the similar manner we calculate $\sigma_2$ and we obtain $\sigma_2 = 3.75\%$.

So, $K_T = \left[ 32.28 \pm \left( \frac{2.35}{2} + \frac{3.75}{2} \right) \right] = (32.28 \pm 3.05\%)$

Thus, the range of the intermediate specialty index for the Kingdom of Saudi Arabia is $K_T = [29.23; 35.33\%]$

Finally, the concentration reflects a situation of dependence on a small number of economic agents and makes the economy vulnerable to the decisions of large firms which contribute to the production or distribution of goods and services. By contrast, specialization makes the territory dependent on a given sector and extremely vulnerable in case of sectoral crises.

All in all, for our case study, we consider a tolerable level or acceptable threshold when $K_{T/R} or K_{T/R} or K_T \leq 33\%$ considering the margin of error (the variances) and for the case of the Kingdom of Saudi Arabia, no predominance is defined between specialization and concentration. And we consider a situation of dependence or vulnerability to economic cycles when $K_{T/R} or K_{T/R} or K_T \geq 50\%$.

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Annex 1:-
Table 1:- Distribution of wages by sector in Arabia Saudi Kingdom 2017.

| Total employees by Size of enterprises and economic Activity 2017 | Average wage for workers, by nationality and economic activity, 2017 |
|---------------------------------------------------------------|---------------------------------------------------------------|
| 5-1 | 49-6 | 249-6 | 250+ | Total | Sectors | Saudi | Non-Saudi | AVG |
| 233 004 | 57 963 | 15 279 | 41 945 | 348 191 | Agriculture, forestry and fishing | 623 453 982 | 3 776 | 1 399 | 1 791 |
| 267 978 | 236 829 | 262 658 | 561 043 | 1 328 508 | Industrial Sector | 16 789 251 197 | 16 989 | 6 292 | 12 638 |
| 72 112 | 189 368 | 176 671 | 709 043 | 1 147 194 | Construction | 3 387 380 572 | 8 860 | 3 281 | 2 953 |
| 1 379 744 | 713 518 | 197 571 | 138 513 | 2 429 347 | Trade, Accommodation and Food | 8 685 216 920 | 4 707 | 1 744 | 3 575 |
| 43 854 | 97 603 | 76 045 | 171 804 | 389 307 | Transportation, Information & communication | 1 353 777 984 | 6 347 | 2 351 | 3 477 |
| 81 728 | 79 305 | 30 127 | 64 318 | 255 479 | Financial, Insurance & Real estate | 1 514 836 684 | 9 845 | 3 647 | 5 929 |
| 28 204 | 43 744 | 25 231 | 23 495 | 120 674 | Professional, scientific and technical activities | 537 605 623 | 7 944 | 2 942 | 4 455 |
| 48 951 | 54 792 | 52 319 | 144 463 | 300 526 | Administrative and support service activities | 857 513 114 | 5 014 | 1 857 | 2 853 |
| 10 341 | 128 278 | 61 153 | 7 876 | 207 648 | Education | 683 939 988 | 4 585 | 1 698 | 3 294 |
| 5 084 | 66 053 | 55 830 | 80 747 | 207 715 | Human health and social work activities | 715 033 626 | 6 042 | 2 238 | 3 442 |
| 7 447 | 20 662 | 7 908 | 0 | 36 017 | Arts, entertainment and recreation | 88 256 330 | 4 780 | 1 770 | 2 450 |
| 160 451 | 40 086 | 12 317 | 6 767 | 219 622 | Other service | 433 934 905 | 3 835 | 1 420 | 1 976 |

Source: https://www.stats.gov.sa (visited in October 2019)

Table 2:- Global wages by region in 2017.
Table 3: wages by age group in Saudi Arabia in 2017.

| Group | Population | Wages per individual | Wages by age group | % of group | % of cumulative | Group | % of group | % of cumulative |
|-------|------------|----------------------|--------------------|------------|----------------|-------|------------|----------------|
| 15-19 | 52 493     | 3 117                | 163 620 681       | 0.20       | 0              | 1     | 0.09       | 9              |
| 65+   | 138 600    | 5 799                | 803 741 400       | 0.96       | 1              | 2     | 0.09       | 18             |
| 64-60 | 240 078    | 5 628                | 1 351 158 984     | 1.61       | 3              | 3     | 0.09       | 27             |
| 20-24 | 757 362    | 4 326                | 3 276 348 012     | 3.91       | 7              | 4     | 0.09       | 36             |
| 55-59 | 579 778    | 6 849                | 3 970 899 522     | 4.74       | 11             | 5     | 0.09       | 45             |
| 50-54 | 1 021 164  | 6 783                | 6 926 555 412     | 8.27       | 20             | 6     | 0.09       | 55             |
| 25-29 | 2 064 126  | 5 129                | 10 586 902 254    | 12.63      | 32             | 7     | 0.09       | 64             |
| 45-49 | 1 683 572  | 7 248                | 12 202 529 856    | 14.56      | 47             | 8     | 0.09       | 73             |
| 30-34 | 2 292 994  | 5 859                | 13 434 651 846    | 16.03      | 63             | 9     | 0.09       | 82             |
| 40-44 | 2 370 084  | 6 458                | 15 306 002 472    | 18.26      | 81             | 10    | 0.09       | 91             |
| 35-39 | 2 680 607  | 5 888                | 15 783 414 016    | 18.83      | 100            | 11    | 0.09       | 100            |
| Total | 13 880 858 | 63 084               | 83 805 824 455    | 100        | 100            | 11    | 1.00       | 100            |

Table 4: Calculation of the Theil index of wages paid in 2017 by activity sector.

| Sector                            | No. | Revenues Paid by Sector | x_i | x_i * Ln(x_i * n) | y_i / y | Ln(y_i / y) | y_i LN(y_i / y) |
|-----------------------------------|-----|-------------------------|-----|-------------------|---------|-------------|----------------|
| Agriculture, forestry and fishing | 1   | 348191                  | 0.0498 | -0.0256           | 0.5977  | -0.5146     | -0.3076        |
| Industrial Sector                 | 2   | 1328508                 | 0.1901 | 0.1567            | 2.2806  | 0.8244      | 1.8803         |
| Administrative Area | Total employed | Mean Wages (male & female) | Wages by region | \( x_i \) | \( x_i \cdot \ln(x_i \cdot n) \) | \( y_i \) | \( \frac{\ln(y_i)}{\ln(\overline{y})} \) | \( y_i \cdot \ln(y_i) \) | \( \frac{\ln(y_i)}{\ln(\overline{y})} \) |
|---------------------|----------------|---------------------------|----------------|----------|-----------------|--------|----------------|----------------|----------------|
| North.Bord.         | 71102          | 1444                      | 102687919      | 0.003036 | -0.009812       | 0.039  | -3.232         | -0.12756        |
| AL - Baha           | 80272          | 1499                      | 120310260      | 0.003557 | -0.010933       | 0.046  | -3.074         | -0.14213         |
| AL - Jouf           | 105263         | 1305                      | 137317807      | 0.000459 | -0.011942       | 0.053  | -2.942         | -0.15524         |
| Tabuk               | 152046         | 1897                      | 288464640      | 0.008528 | -0.018756       | 0.111  | -2.200         | -0.24383         |
| Hail                | 177062         | 1299                      | 229998460      | 0.007999 | -0.016495       | 0.088  | -2.426         | -0.21443         |
| Najran              | 183081         | 1289                      | 236009182      | 0.006977 | -0.016746       | 0.091  | -2.400         | -0.2177          |
| Jazan               | 194215         | 1439                      | 279386307      | 0.008259 | -0.01843        | 0.107  | -2.231         | -0.23959         |
| Aseer               | 448201         | 1751                      | 784911632      | 0.023032 | -0.027809       | 0.302  | -1.199         | -0.36152         |
| Madinah             | 448990         | 2306                      | 1035265805     | 0.030604 | -0.028207       | 0.398  | -0.922         | -0.36699         |
| Al-Qaseem           | 492135         | 1360                      | 669431676      | 0.01979  | -0.026867       | 0.257  | -1.358         | -0.34928         |
| Eastern Region       | 2191336        | 3876                      | 8493854250     | 0.251093 | 0.2970472       | 3.264  | 1.183          | 3.861613         |

Source: Authors
Table 7: Calculation of the Theil index of wages paid to employees by gender category (male and female) in 2017 by region.

| Individus | Wages male | v_i | z_i | z_i ln(\theta) | ln(z_i ln(\theta)) | T1 | T2 |
|-----------|------------|-----|-----|---------------|------------------|----|----|
| 1         | 79 748 922 | 0.002762483 | 0.036 | -3.327 | -0.009 |
| 2         | 91 172 439 | 0.003158191 | 0.041 | -3.193 | -0.010 |
| 3         | 108 988 409 | 0.003775331 | 0.049 | -3.014 | -0.011 |
| 4         | 216 552 892 | 0.007501338 | 0.098 | -2.328 | -0.017 |
| 5         | 171 335 588 | 0.005935022 | 0.077 | -2.562 | -0.015 |
| 6         | 190 805 234 | 0.006609446 | 0.086 | -2.454 | -0.016 |
| 7         | 201 721 042 | 0.006987567 | 0.091 | -2.399 | -0.017 |
| 8         | 612 348 710 | 0.021211606 | 0.276 | -1.288 | -0.027 |
| 9         | 848 514 844 | 0.029392342 | 0.382 | -0.962 | -0.028 |
| 10        | 535 171 041 | 0.018538191 | 0.241 | -1.423 | -0.026 |
| 11        | 7 689 614 332 | 0.266366321 | 3.463 | 1.242 | 0.331 |
| 12        | 6 378 914 875 | 0.220964019 | 2.873 | 1.055 | 0.233 |
| 13        | 117 43679 948 | 0.406798142 | 5.288 | 1.666 | 0.678 |
| **Subtotal** | **28868568 276** | **0.841498** | | | 1.063246 | **0.894720** | **0.438063** |

**Second**

| Individus | Wages female | v_i | z_i | z_i ln(\theta) | ln(z_i ln(\theta)) | T1 | T2 |
|-----------|--------------|-----|-----|---------------|------------------|----|----|
| 1         | 36 634 895  | 0.00673733 | 0.088 | -2.435 | -0.016 |
| 2         | 52 614 962  | 0.009676139 | 0.126 | -2.073 | -0.020 |
| 3         | 48 712 346  | 0.00895843 | 0.116 | -2.150 | -0.019 |
| 4         | 99 897 981  | 0.01837171 | 0.239 | -1.432 | -0.026 |
| 5         | 82 618 100  | 0.015193858 | 0.198 | -1.622 | -0.025 |
| 6         | 64 692 396  | 0.011897237 | 0.155 | -1.866 | -0.022 |
| 7         | 122 404 938 | 0.022510845 | 0.293 | -1.229 | -0.028 |
| 8         | 242 611 215 | 0.044617346 | 0.580 | -0.545 | -0.024 |
| 9         | 222 312 216 | 0.040884264 | 0.531 | -0.632 | -0.026 |
| 10        | 184 623 676 | 0.033953164 | 0.441 | -0.818 | -0.028 |
| 11        | 823 814 744 | 0.151503414 | 1.970 | 0.678 | 0.103 |
| 12        | 1 226 816 054 | 0.225617254 | 2.933 | 1.076 | 0.243 |
| 13        | 2 229 845 023 | 0.410079009 | 5.331 | 1.674 | 0.686 |
| **Subtotal** | **5 437 598 546** | **0.158502** | | | 0.797 | 0.12637167 | **-0.18209** |
| **Total** | **34 306 166 822** | | | | 1.02109 | **0.25597** |
| **Theil total** | | | | | 1.27706 |

Source: Authors

Table 8: Number of Employees by administrative area and main groups of economic activities, 2018.

| Administrative area | Transport and communication | Trade | Construction | Mining and quarrying | Other collective and social services | Agriculture, forestry and fishing | Manufacturing | Electricity, gas and Water | Financial and insurance activities | Other service activities | Total |
|---------------------|-----------------------------|-------|--------------|----------------------|-------------------------------------|-----------------------------|---------------|---------------------------|----------------------------------|------------------------|-------|
| Riyadh              | 154 222                     | 830 977 | 1176 111 | 8 512                | 273 192                            | 33 558                      | 289 873       | 45 158                    | 511 885                           | 7                      | 3323 495          |
| Makkah              | 81 426                      | 608 136 | 663 649 | 12 994               | 158 002                            | 14 833                      | 216 198       | 23 664                    | 176 281                           | 2                      | 1955 185          |
Table 9:

| Administrative area | Other service activities | Agriculture forestry and fishing | Electricity gas and Water | Mining and quarrying | Transport and communication | Other collective and social services | Manufacturing | Financiers and insurers activities | Trade | Construction | Total |
|---------------------|-------------------------|---------------------------------|--------------------------|----------------------|-----------------------------|------------------------------------|--------------|-------------------------------|-------|-------------|-------|
| Madinah             | 9 975                   | 101 193                         | 115 889                  | 2 490                | 28 036                      | 2 543                              | 36 472       | 802                           | 8 114 | 0           | 305 514 |
| Qassim              | 11 113                  | 70 806                          | 171 539                  | 555                  | 18 152                      | 11 664                             | 28 314       | 253                           | 7 351 | 0           | 319 567 |
| Eastern Prov.       | 68 928                  | 357 445                         | 774 863                  | 149 555              | 109 090                     | 10 725                             | 211 623      | 18 919                        | 128 982| 1 500       | 1 831 630 |
| Assir               | 13 125                  | 65 947                          | 123 655                  | 1 667                | 21 466                      | 1 571                              | 27 910       | 6 446                         | 25 165 | 0           | 286 952 |
| Tabuk               | 3 639                   | 25 309                          | 32 807                   | 118                  | 11 986                      | 3 643                               | 10 341       | 166                           | 2 618 | 0           | 90 627 |
| Hail                | 3 233                   | 22 084                          | 54 496                   | 394                  | 9 712                       | 5 759                               | 11 090       | 395                           | 1 924 | 0           | 109 087 |
| North. Bor.         | 2 453                   | 8 542                           | 17 690                   | 892                  | 3 184                       | 126                                 | 3 952        | 123                           | 2 360 | 0           | 39 322 |
| Jazan               | 3 485                   | 46 526                          | 34 282                   | 589                  | 11 029                      | 2 802                               | 13 983       | 290                           | 7 214 | 0           | 120 200 |
| Najran              | 6 389                   | 22 975                          | 64 937                   | 467                  | 6 532                       | 801                                 | 6 352        | 135                           | 8 089 | 0           | 116 677 |
| AL - Baha           | 913                    | 20 884                          | 10 610                   | 204                  | 2 734                       | 1 400                               | 3 637        | 89                            | 2 394 | 0           | 41 605 |
| AL - Jouf           | 5 447                   | 14 543                          | 22 924                   | 66                   | 5 600                       | 2 366                               | 5 884        | 64                            | 2 678 | 0           | 57 572 |
| **Total**           | **362,348**             | **219,5367**                    | **326,272**              | **178,503**          | **685,175**                 | **90,531**                           | **865,629**  | **96,504**                    | **885,555** | **1509**   | **859,743** |

Source: https://www.stats.gov.sa/ar/64 (visited in December, 2019)

Annex 2:-

**Table 8.1:-** (part 1 of the calculation ISSG).

**Table 8.2:-** (part 1 of the calculation ISSG).

**Table 9:-** Variance-covariance matrix resulting from Krugman's specialization by industry sector (C= covariance and σ= Standard deviation).
| Other service activities (1) | Agriculture, forestry and fishing (2) | Electricity, gas and Water (3) | Minin and quarrying (4) | Transport and communication (5) | Other collective and social services (6) | Manufacturing (7) | Financial and insurance activities (8) | Financial and insurance activities (9) | Construction (10) |
|-----------------------------|-------------------------------------|-------------------------------|------------------------|-------------------------------|-------------------------------------|----------------|---------------------------------|---------------------------------|---------------|
| 2.6* C<sub>1,2</sub>       | 18.4* C<sub>2,3</sub>              | 6.5* C<sub>3,4</sub>         | 4.7* C<sub>4,5</sub>   | 12.5* C<sub>5,6</sub>        | 13.6* C<sub>6,7</sub>              | 12.7* C<sub>7,8</sub> | 7.5* C<sub>8,9</sub> | 13.7* C<sub>9,10</sub> | 13.7* C<sub>10,11</sub> |
| 2.6* σ<sub>1</sub>         | 18.4* σ<sub>2</sub>                | 6.5* σ<sub>3</sub>           | 4.7* σ<sub>4</sub>     | 12.5* σ<sub>5</sub>          | 13.6* σ<sub>6</sub>               | 12.7* σ<sub>7</sub> | 7.5* σ<sub>8</sub> | 13.7* σ<sub>9</sub> | 13.7* σ<sub>10</sub> |
| 2.6*                        | 18.4* σ<sub>2</sub>                | 6.5* σ<sub>3</sub>           | 4.7* σ<sub>4</sub>     | 12.5* σ<sub>5</sub>          | 13.6* σ<sub>6</sub>               | 12.7* σ<sub>7</sub> | 7.5* σ<sub>8</sub> | 13.7* σ<sub>9</sub> | 13.7* σ<sub>10</sub> |

### Table 10: Variance-covariance matrix (calculated from Table 9 above).

| Sectors | Other service activities | Agriculture, forestry and fishing | Electricity, gas and Water | Mining and quarrying | Transport and communication | Other collective and social services | Manufacturing | Financial and insurance activities | Trade | Construction | Sous-totaux |
|---------|-------------------------|----------------------------------|---------------------------|---------------------|-----------------------------|----------------------------------|--------------|----------------------------------|-------|--------------|-------------|
| Other service activities | 3.16                    | -4.75                            | 2.60                      | 4.78                | 0.93                        | 0.19                            | -0.80        | 3.85                             | -0.62 | -0.99        | 8.34        |
| Agriculture, forestry and fishing | -4.75                   | 225.33                           | 12.34                     | -2.91               | -2.32                       | 19.50                           | 4.26         | -6.17                            | 7.88  | 28.16        | 281.31      |
| Electricity, gas and Water | 2.60                    | 12.34                            | 12.17                     | 4.54                | 1.06                        | 0.13                            | 2.65         | 6.69                             | 1.29  | 2.92         | 46.38       |
| Mining and quarrying | 4.78                    | -2.91                            | 4.54                      | 6.26                | 1.39                        | 0.51                            | -0.87        | 5.63                             | -0.64 | -0.78        | 17.92       |
| Transport and communication | 0.93                    | -2.32                            | 1.06                      | 1.39                | 8.95                        | 2.90                            | 1.24         | 2.02                             | 9.33  | 4.09         | 29.57       |
| Other | 0.19                    | 19.50                            | 0.13                      | 0.51                | 2.90                        | 4.90                            | 0.87         | 0.87                             | 4.80  | 3.29         | 37.98       |
| collective and social services | Manufacturing |  |  |  |  |  |  |  |
|-------------------------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|
|                               | -0.80         | 4.26          | 2.65          | -0.87         | 1.24          | 0.87          | 2.53          | 0.81          |
|                               | 2.32          | 2.41          | 15.41         |               |               |               |               |               |
| Financial and insurance activities | 3.85         | -6.17         | 6.69          | -5.63         | 2.02          | 0.87          | 0.81          | 6.13          |
|                               | 1.18          | 0.74          | 21.75         |               |               |               |               |               |
| Trade                         | -0.62         | 7.88          | 1.29          | -0.64         | 9.33          | 4.80          | 2.32          | 1.18          |
|                               | 11.53         | 6.09          | 43.15         |               |               |               |               |               |
| Construction                  | -0.99         | 28.16         | 2.92          | -0.78         | 4.09          | 3.29          | 2.41          | 0.74          |
|                               | 6.09          | 7.37          | 53.29         |               |               |               |               |               |
| Total Variance                |               |               |               |               |               |               |               | 555.11        |
| Standard deviation (%)        |               |               |               |               |               |               |               | 23.56         |