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## ANALYSIS OF THE RELATION BETWEEN THE NUMBER OF EMPLOYEES AND THEIR NET WAGES IN SOME TYPICAL BRANCHES OF PRODUCTION AND THE SERVICE SECTOR IN THE REPUBLIC OF CROATIA

### SUMMARY

*The main task of this work is that of applying some specific statistical and mathematical methods in researching the measures of concentration of the number of employees and their net wages, in other words the incomes in certain economic branches of production and the service sector in the Republic of Croatia.*

*We deal here with the measures of inequality and evenness, and these are the Lorenz curve and the index of concentration. For the purpose of this research, 13 branches, both from production and from the service sectors, have been chosen for examining the measures of concentration according to the indicators.*

*Before concrete realisation and calculation of these measures of concentration can take place, a preliminary very delicate sorting out and modelling of the relevant parameters had to be carried out. This refers especially to adequate compounding of the carriers of the researched phenomena.*

### INTRODUCTION

The primary objective of this work is to research the problems of dispersion or concentration of the working force and its net wages in various branches of production and service sector activities in the Republic of Croatia. We shall try to deal with this problem by using specific mathematical and econometrical methods.

The research objective comprehends 13 branches of economy, service and production sectors included, based on statistical data of the number of people employed and their net wages.

The purpose of this research is not so much to contribute to finding practical solutions, but to attempt to

explain the theoretic application of specific concentration measures being also intended for instructive reasons.

The paper starts with a short comparative analysis of the identified phenomena in various branches of economy. Later on it discusses the application of measures of inequality, i.e. the Lorenz curve and the concentration index.

### 1. EXPLANATION OF THE DEFINED BRANCHES AND INDICATORS OF THE CONCENTRATION RESEARCH

For the purpose of this research we are dealing with 13 branches of production and service sectors of the national economy. We are focusing our attention on the employed personnel and their net wages, as indicators suitable for the application of the measures of inequality.

The chosen branches are systematized in Table 1/1 according to the numbers of employees in 1990, as the first research year. Later the systematization shall be adapted to new requirements.

#### 1.1. Analysis of the defined branches and of their indicators in the framework of the production sector

In the process of defining the branches account has been taken of a wide spectrum of production sectors.

From Table 1/1 it is evident that the number of employees in production branches fluctuates in both preferred periods, and spans from the smallest to the biggest branch in the ratio of 1/20 up to 22 (production of oil and natural gases, production of leather and furs and production of foodstuffs).

**Table 1/1. The number of employees and their net wages in some characteristic production and service sectors of the Croatian economy**

No.	Characteristic sectors	No. of employees		Index	Net wages	Wages × 1000
		Average 1992	I./1995	1995/1992	I./1995	(4x6)
1	2	3	4	5	6	7
<b>A PRODUCTION BRANCHES</b>						
1	Production of oil and natural gases	2300	2200	95.7	2340	5148
2	Production of leather and furs	2300	2000	87.0	1244	2488
3	Production of non-ferrous metals	2800	2600	92.9	1399	3637
4	Production of petroleum products	5400	4900	90.7	2241	10981
5	Production of paper and paper products	7100	5700	80.3	1888	10762
6	Production of beverages	7500	6900	92.0	2170	14973
7	Production of timber products	8800	8100	92.0	1439	11656
8	Production of building materials	13500	11200	83.0	1516	16979
9	Production of chemical products	18600	17100	91.9	2154	36833
10	Product. of electr.machines and appliances	24900	18200	73.1	1784	32469
11	Farming industry	37800	31900	84.4	1595	50881
12	Production of textile products	46200	41700	90.3	1448	60382
13	Production of foodstuffs	46500	44000	94.6	1954	85976
	TOTAL	223700	196500	87.8	1746	343089
<b>B SERVICE SECTOR</b>						
1	Pipeline transport	500	500	100.0	2237	1119
2	River transport	900	600	66.7	1149	689
3	Air transport	2000	2400	120.0	2405	5772
4	Tourism	3200	1900	59.4	1768	3359
5	Personal services	4000	3100	77.5	1241	3847
6	Maritime Transport	7200	4600	63.9	1939	8919
7	City transport	7600	7200	94.7	1922	13838
8	Port transshipment services	7800	6800	87.2	2039	13865
9	Postal, telegraph and telephone services	19900	20600	103.5	1753	36112
10	Tradesmen services and repairs	20200	15500	76.7	1702	26381
11	Road transport	21100	17100	81.0	1509	25804
12	Rail transport	28600	24500	85.7	1686	41307
13	Catering	49300	40700	82.6	1599	65079
	TOTAL	172300	145500	84.4	1691	246041

Source: Monthly statistical data No.3, The Croatian State Institute of Statistics, Zagreb 1995, Tab 3-4 & 3-5

It is further evident that all branches have a number of employees in January 1995, compared with the averages of the year 1992. The fall of employment in all 13 branches amounts to some 12%. The most drastic fall of employment, during the past 2.3 years, happened in the most notable industrial branch, the production of electrical machines and appliances. Here the fall was 27%. The fall of employment in the paper industry was 20% and in the production of building materials 17%.

Interesting to mention, the smallest fall of employment we find in the production of oil and natural gases, a mere 5%. This figure applies also to the production of foodstuffs. The former has the lowest number of employees and the latter the largest.

The reasons for the fall of the employment rate were the war and uncertain political situation in the former Yugoslavia, transition and privatisation. New systems of production require rationalising and economising the working force.

The number of employees in various branches of production greatly fluctuates. Not so much the basic wages, whose ratio is 1:1.88. It is interesting to note that the highest and lowest basic wages are to be found in 2 branches with minimum number of employees: the oil and leather industries.

This is due to multiplying the differentiation, in other words the span of indicators of the compound total wages, whose ratio is 1:34.5.

While calculating, later on, the measures of unevenness, this phenomenon will appear as a great concentration of compound income.

### 1.2. Analysis of the defined branches and their indicators, within the scope of the service sector

From Table 1/1 it is evident that 9 of 13 branches of the service sector, belong to the transport industry. The remaining 4 belong to tourism, tradesmen enterprises and personal service. Regarding the number of employees, this group shows a far larger heterogeneity, in other words a differentiation, than that of the production sector. Accordingly, the ratio of the number of employees of the pipeline transport, with the lowest, and that of catering, with the highest, is 1:81.4.

Although we can note that in a few branches of the service sector, namely air transport and postal services, the number of employees increased during 1992-1995, the figures for the whole sector show a fall in employment of some 16%, which is three per cent higher than that of the production sector. The biggest fall in employment was in tourism, some 40% and in the maritime transport industry and the river transport 40% and 36% respectively.

The great fall in employment has to be attributed to the war and adverse political factors in this region. A greater part of the service sector is state owned, where a lot of unessential jobs were filled during the previous regime. The Government is now reducing and rationalising this working force.

The differentiation of net wages in this sector is greater than that in the production sector, and the ratio is 1:2.1, which reflects even larger compound total wages, of 1:9.4.

## 2. THE CONCRETE APPLICATION AND CALCULATION OF THE MEASURES OF CONCENTRATION

The measures of concentration, sometimes also called measures of inequality or unevenness are used for examining the degree of concentration or of relative unevenness of numerous economic statistical phe-

nomena. These are: wages, incomes, riches, various effects, employment, population and similar wider dispersion or distribution dimensions.

Among a greater number of concentration measures, including the methods and procedures of the author of this paper, the biggest value has shown the applicable Lorenz Curve (of the American economist and statistician M. Lorenz) and the index or concentration coefficient (of the Italian mathematician and statistician C. Gini).

The difference between these two measures lies in the way and mode of presenting different phenomena. The Lorenz Curve thus represents the graphic expression, while the Concentration index expresses the quantified mathematical measure.

Lorenz curve is a set of elements  $(F, \phi)$  where  $F$  is the cumulative percentage of the number of income carriers, and  $\phi$  is the cumulative percentage of the income aggregates.

In case of the empirical, discontinued distribution, the coordinates of each element of the Lorenz curve are calculated in the following way:

$$f(x) = \sum_{x_k \leq x} f(x_k) \quad \phi(x) = \frac{1}{m} \sum_{x_k \leq x} x_k \cdot f(x_k)$$

where  $x$  denotes the income rate,  $f(x)$  the percentage of  $x$  income carriers, and  $m$  is an average income.

In the continued case, the Lorenz curve is in the following form:

$$F(x) = \int_{-\infty}^x dF(x) \quad \phi(x) = \frac{1}{m} \int_{-\infty}^x x dF(x)$$

The first part of the equation  $f(x)$  denotes the distribution of the carriers of researched phenomena, on the abscissa. The second part of the equation  $\phi(x)$  denotes the distribution of the phenomena, on the ordinate. We shall explain later in more detail the other elements, while making order of various elements of dispersion and doing calculations. In the meantime we shall look into the theoretical part of the graph. This is the real meaning of the Lorenz Curve, as said by A. Samuelson, which can be noted from Figure 2-1.

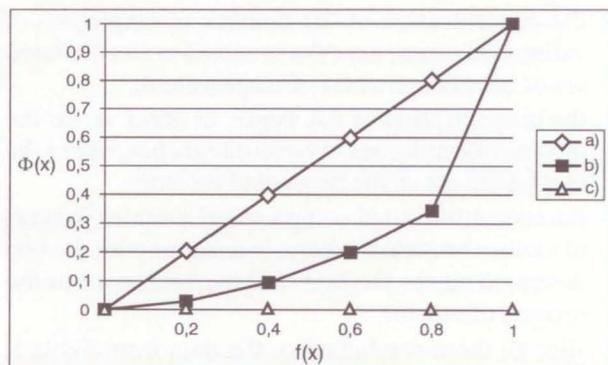


Figure 2.1. Lorenz Curve. A theoretical example of the distribution of income

In the graph in Figure 2-1 we have 3 specimens of income distribution, and these are:

- a) the diagonal line  $\phi = f$  denotes the complete equality, or in other words a distribution evenness. It means that 20% of the income carriers, on the abscissa  $f(x)$  absorb 20% of the income, on the ordinate  $\phi(x)$ , and so on, from 40% to 100%.
- b) the curve between the diagonal and the triangle, denotes the results of the real distribution and this means that 20% of the carriers (markers) absorb merely 3% of the income, that 40% of the carriers receive 10% of the income, that 60% of the carriers receive 20% of the income and that 80% of the carriers receive a mere 35% of income. The rest of 20% of the carriers, at the peak of the concentration (between 80% and 100%) receive 65% of income (the difference between 100% and 35% on the ordinate  $\phi(x)$ ).
- c) The broken line in the form of a rectangle, denotes an extreme hypothetical case, a complete unevenness, in other words a complete concentration. This happens when one carrier owns the whole income, which is indeed only a theoretical possibility.

The close connection between the measure, according to the Lorenz curve and the index of concentration, can be deduced from the following equation:

$$K = \sum_{i=1}^n (x_{i-1} \cdot y_i - x_i \cdot y_{i-1})^1$$

which means that this coefficient is being calculated by using the same elements as for the Lorenz curve. Regarding the algorithm, we shall return to it later.

## 2.2. Calculation of the measures of concentration in the researched branches of production

The measures of concentration are carried out practically for several indicators and several combinations. These are:

- the concentration of the number of employees of various branches; here the branches act as the carriers of the phenomenon of employment;
- the concentration of net wages, in other words the income of employees in various branches, where the employees act as the carriers of income;
- the concentration of compounded incomes (wages) of various branches, where, in contrast with the one described above, the branches themselves act as the carriers of income.

For all these combinations the data from Table 1. are modelled and adapted, thus obtaining the parameters for the Lorenz curve and the index of concentration in Tables 2.2/1, 2.2/2 & 2.2/3.

### a) The parameters of the Lorenz curve and the index of concentration of the number of employees in various branches of production.

Selecting and modelling these parameters, starts with the formation of elements of the co-ordinate system and subsequent identifying and grouping the carriers of the phenomenon, which in this particular case are the branches of production.

As evident from Table 2.2/1, the title is formed on the basis of symbols used in the equation presented in chapter 2.1. The carriers are being grouped in order to have a minimal difference in the number of employees between different branches. In this process, it is less significant how many branches carriers, there are in every group. More important is, that there is a noticeable quantifying difference between them, in other words, they should be as homogeneous as possible.

From the parameters of Table 2.2/1, it is possible to deduce that in this particular case there is a high concentration of the number of employees, evident by comparing  $f(x_k)$  of column 4 with  $\frac{1}{m} \cdot x \cdot f(x)$  of column 8.

Here we have the following situation: at the start, 23.1% of the carriers (branches) employ a modest 3.5% employees. On the top distribution a total of 15.3% of the carriers employ a total of 43.7% of employees. This phenomena shall be even more evident in further indicators, that is, in the function of the Lorenz Curve and the coefficient of concentration.

For technical reasons it was possible and also justifiable to shorten the process by listing in the same graph of the co-ordinate system, also the phenomenon of concentration of the income of employees. We shall now explicate these parameters.

### b) The parameters of the Lorenz curve and the index of concentration of employees in various branches of production.

When forming these parameters we encountered difficulties in identifying and defining the groups of carriers, because it was necessary to harmonise the branches of production, the average wages in particular branches to the net wages, and the number of employees representing the carriers of income. As it is evident from this model (table 2.2/2) the carriers are made homogenous and later on, compounded in 4 groups, regardless of their mass. This fact is determined indirectly by the span of net wages of the branches of production.

The basic parameters of Table 2.2./2 or  $f(x_k)$  and  $\frac{1}{m} \cdot x \cdot f(x)$  of column 4 & 9, are very much equalized. It is already possible to see, in this initial phase, that the concentration of this distribution is very small, in

Table 2.2/1: Parameters of the Lorenz curve and the index of concentration of the number of employees in various branches of production, during I./1995.

No	Branches of production (carriers of employees)	No. of employees	Compounded carriers	Percentage of the number of carriers	Summed up percentage of carriers	Transformed $f(x)$ into coefficients	Compounded employees	$\frac{1}{m} \cdot x_k \cdot f(x_k)$	Summed up percentage of employees	Transformed F(x) into coefficients
			$x$	$f(x_k)$	$f(x)$	0-1	$f(x_k)$	%	$\phi(x)$	0-1
			3	4	5	6	7	8	9	10
1	Production of leather and furs	2000								
2	Production of oil and natural gases	2200	3	23,1	23,1	0,23	6800	3,5	3,5	0,04
3	Production of non-ferrous metals	2600								
4	Production of petroleum products	4900								
5	Production of paper and paper products	5700	3	23,1	46,2	0,45	17500	8,9	12,4	0,12
6	Production of beverages	6900								
7	Production of timber products	8100								
8	Production of building materials	11200	2	15,4	61,6	0,62	19300	9,8	22,2	0,22
9	Production of chemical products	17100								
10	Production of electrical machines and appliances	18200	2	15,4	77,0	0,77	35300	17,9	40,1	0,40
11	Farming industry	31900	1	7,7	84,7	0,85	31900	16,2	56,3	0,56
12	Production of textile products	41700								
13	Production of foodstuffs	44000	2	15,3	100,0	1,00	85700	43,7	100,0	1,00
	TOTAL		13	100,0			196500	100,0		

Source: No. from Table 1/1

other words, that a very high degree of evenness is being achieved in the distribution of incomes.

This will appear even more evident in the graph, in other words, in the form of the Lorenz curve. The logic of it can be even now deduced from the compensating influence of the relative smaller net wages and the relative greater mass of the employed. This leads to well equalized relative shares of carriers and compounded incomes.

After sorting and modelling indispensable parameters, we can approach the process of drawing the Lorenz curve and the calculation of coefficients, or index of concentration, for the 2 distributions submitted.

As mentioned, this is being carried out on the basis of the parameter in Table 2.2/1, for the distribution of the number of employees and also from Table 2.2/2, for the distribution of incomes of employees. All this is shown also in the graph in Figure No.2.2./1. Tab.2.2/1

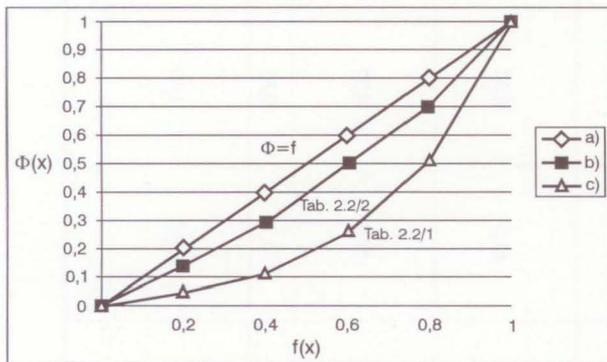


Figure No.2.2./1.

The results, in other words the distribution of these Lorenz curves, because there are two of them, are expounded in similar fashion as in the tables, from which they were derived. It is important to note the deviation of the real curve of distribution in comparison with the diagonal, in other words, the direction of the completely relative equality  $\phi = f$ .

It is therefore evident that we have here a very high degree of concentration, in other words, unevenness of the number of employees in the researched branches of production. It should be reiterated that a scarce 23% of all the branches of production employ 60% of the working force.

On the other hand the Lorenz curve, when showing the income of employees, and when systemized by the span of average wages, implying a relatively high evenness of small concentration, of the phenomenon, follows very closely the direction (line) of complete equality.

As mentioned previously, in the theoretical part of this paragraph, a more precise measure of concentra-

tion than that of the Lorenz curve, is the coefficient or index of concentration, which is expressed as one absolutely quantified measure. The basis for the calculations of these coefficients is to be found in Tables 2.2/1 & 2.2/2 and these are coefficients  $f(x_i)$  and  $\phi(x_i)$  making the Lorenz curve.

Due to the fact that in the previously exposed theoretical part of this article, a complete equation for calculating this coefficient has been presented, we started concretising the process, calculating the particular elements, firstly for the concentration of employees in branches of production (Table 2.2/1).

$f(x_i)$	$\phi(x_i)$	$f(x_{i-1})$	$\phi(x_i)$	$f(x_i)$	$\phi(x_{i-1})$
0,23	0,04	0,23 x 0,12	0,0276	0,46 x 0,04	0,0184
0,46	0,12	0,46 x 0,22	0,1012	0,62 x 0,12	0,0744
0,62	0,22	0,62 x 0,40	0,2480	0,77 x 0,22	0,1694
0,77	0,40	0,77 x 0,56	0,4312	0,85 x 0,40	0,3400
0,85	0,56	0,85 x 1,00	0,8500	1,00 x 0,56	0,5600
1,00	1,00		1,6580		1,1622

$$K_{zap} = 1,6580 - 1,1622 = 0,4958$$

It is here essential to point out the process of calculation. It is important to put the values  $F(x_i)$  and  $\phi(x_i)$  into the proper place, and thereafter to multiply exactly in the way as indicated by little crosses, the first one above, with second value in the second column and so on until the end. In this way we automatically created the situation that in the first part of the equation  $f(x_{i-1}) \phi(x_{i-1})$  shall be missing the multiplication by 1.00 (-1), which is valid also for the second part of the equation i.e.  $f(x_{i-1}) \phi(x_{i-1})$ , which is multiplied diagonally, from down below upwards.

$f(x_i)$	$\phi(x_i)$	$f(x_{i-1})$	$\phi(x_i)$	$f(x_i)$	$\phi(x_{i-1})$
0,28	0,23	0,28 x 0,52	0,1456	0,59 x 0,23	0,1357
0,59	0,52	0,59 x 0,80	0,4720	0,84 x 0,52	0,4368
0,84	0,80	0,84 x 1,00	0,8400	1,00 x 0,80	0,8000
1,00	1,00		1,4576		1,3725

$$K_{dpr} = 1,4576 - 1,3725 = 0,0851$$

In contrast with the previously described coefficient of concentration this particular one, with the obtained value of 0,0851, is very small. Out of the surface of the triangle mentioned in the previous chapter, it occupies only 8.5% of the area and the similarity between the quantitative measure taken and the graphic one, can be clearly noticed.

**Table 2.2/2: Parameters of the Lorenz curve and the index of concentration of income of employees in regard to the span of wages in branches of production, during I./1995.**

	Branches of production (span of wages in Kunas)	No. of employees (carriers)	Compounded carriers	Percentage of the number of carriers	Summed up percentage of compounded incomes	Transformed $f(x)$ into coefficients	Distribution of income	Compounded income	$\frac{1}{m} \cdot x_k \cdot f(x_k)$	Summed up percentage of carriers	Transformed $\phi(x_k)$ into coefficient
			$x_k$	$f(x_k)$	$f(x)$	0-1		$x_k$	%	$\phi(x_k)$	0-1
	1	2	3	4	5	6	7	8	9	10	11
– span of wages 1200-1500											
1	Production of leather and furs	2000	54400	27,7	27,7	0,28	2448	78163	22,8	22,8	0,23
2	Production of non-ferrous metal	2600					3637				
3	Production of timber products	8100					11656				
4	Production of textile products	41700					60382				
– span of wages 1500-1800											
5	Production of building materials	11200	61300	31,2	58,9	0,59	16979	100329	29,2	52,	0,52
6	Farming industry	31900					50881				
7	Production of electrical machines and appliances	18200					32469				
– span of wages 1800-2100											
8	Production of paper and paper products	5700	49700	25,3	84,2	0,84	10762	96738	28,2	80,2	0,80
9	Production of foodstuffs	44000					85976				
– span of wages 2100-2400											
10	Production of chemical products	17100	31100	15,8	100,0	1,00	36833	67935	19,8	100,0	1,00
11	Production of beverages	6900					14973				
12	Production of petroleum products	4900					10981				
13	Production of oil and natural gases	2200					5148				
TOTAL			196500	100,0				343165	100,0		

Source: No. from Table 1/1

**c) Parameters of the Lorenz curve and the index of concentration of wages (incomes) in various branches of production.**

We are dealing in this case with compounded incomes in branches of production; this means that the branches are carriers of income, which is a product of the number of employees and average net wages. The corresponding parameters are selected and modelled for the drawing of the Lorenz curve and for the calculation of the coefficient of concentration, as presented in Table 2.2/3.

The distribution of income, in particular of branches of production, denotes a noticeable quantitative difference, so that it has been easy to form the compounded groups of carriers. The results obtained in Table 2.2/3., especially in column 4 (the percentage of carriers  $f(x_k)$  and column 8 (compounded income), show a high degree of income concentration, because the decisive factor is the number of employees in particular branches.

The above is confirmed by the following indications: at the start of the distribution of income 23.1% of the carriers obtain a scarce 3.3% of the total earnings within the 13 branches observed. At the top of the distribution, only 7.7% of the carriers obtain 25.1% of the total amount of income. The Lorenz curve here below, speaks for itself (Figure 2.2/2):

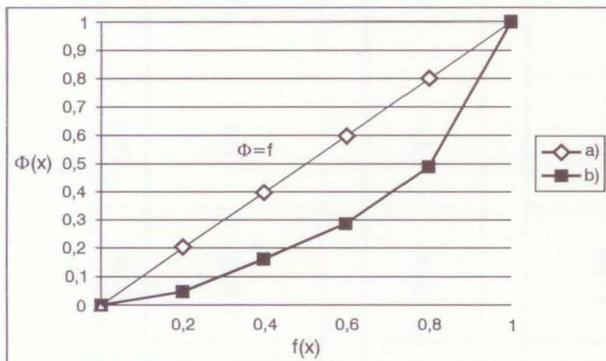


Figure No.2.2./2.

In view of the fact of considerable deviation from the real function of the diagonal of complete evenness, it can be said that the concentration of incomes within several branches of production is considerably articulated. At the top of the distribution we have 23% carriers, in possession of 57.5% of incomes.

More precise measure takers about the degree of concentration of the referred phenomena, are obtained from the mentioned calculation of the index of concentration, which is calculated on the basis of data in column 6 of Table 2.2./3.

The absolute values of the index of concentration of 0.4858, obtained in this way, confirm the previous indications about the considerable concentration or

$f(x_i)$	$\phi(x_i)$	$f(x_{i-1})$	$\phi(x_i)$	$f(x_i)$	$\phi(x_{i-1})$
0,23	0,03	0,23 x 0,13	0,0299	0,46 x 0,03	0,0138
0,46	0,13	0,46 x 0,22	0,1012	0,62 x 0,13	0,0806
0,62	0,22	0,62 x 0,43	0,2666	0,77 x 0,22	0,1694
0,77	0,43	0,77 x 0,75	0,5775	0,92 x 0,43	0,3956
0,92	0,75	0,92 x 1,00	0,9200	1,00 x 0,75	0,7500
1,00	1,00		1,8952		1,4094

$$K_{zap} = 1,8952 - 1,4094 = 0,4858$$

unevenness of compounded incomes in branches of production. This is due to the decisive impact of the number of employees in the food processing industry and in the industry of textile products, regardless of their low net wages.

Linked with the graphic expression of the Lorenz function, the calculated coefficient shows that in one right - angled triangle, the deviation of the real curve from the line of unevenness ( $\phi=f$ ) occupies somewhat less than 50% of the total surface area of the triangle.

**2.3. Calculation of the measures of concentration in the branches of the service sector**

The measures of concentration in the branches of the service sector are researched in similar fashion as the ones in the branches of production. These are the same indicators and combinations:

- measures of unevenness of employees in branches of the service sector, where the branches have the function of the carriers of the phenomena researched, and these are the number of employees,
- measures of unevenness or concentration of wages of employees in particular branches, where the employees are the carriers of incomes,
- measures of concentration of the compounded incomes (wages) in the branches of the service sector, where these branches are the carriers of the incomes.

For each of those research variants regarding the degree of concentration of the mentioned indicators, appropriate indicators are being modelled, on the basis of data in Table 1/1 (service sector), and so we obtain the parameter of the Lorenz curve and the index of concentration, in Tables 2.2/3 - 2.3/3.

**a) Parameters of the Lorenz curve and the index of concentration of the number of employees in the service sector**

In order not to repeat the common procedure about the concept of the title of the said model and of other relevant elements on the basis of equation in Chapter 2.1. and of Table 1/1, we here explain the

Table 2.2/3: Parameters of the Lorenz curve and the index of concentration of compounded incomes (wages) in branches of production for I./1995.

		Distribution of income	Compounded carriers	Percentage of the number of carriers	Summed up percentage of compounded incomes	Transformed $f(x)$ into coefficients	Compounded income	$\frac{1}{m} \cdot x_k \cdot f(x_k)$	Summed up percentage of carriers	Transformed $\phi(x_k)$ into coefficient
			$x_k$	$f(x_k)$	$f(x)$	0-1	$x_k$	%	$\phi(x_k)$	0-1
	1	2	3	4	5	6	7	8	9	10
1	Production of leather and furs	2488	3	23,1	23,1	0,23	11273	3,3	3,3	0,03
2	Production of non-ferrous metal	3637								
3	Production of oil and natural gases	5148								
4	Production of paper and paper products	10762	3	23,1	46,2	0,46	33399	9,7	13,7	0,13
5	Production of petroleum products	10981								
6	Production of timber products	11656								
7	Production of beverages	14973	2	15,4	61,6	0,62	31952	9,3	22,3	0,22
8	Production of building materials	16979								
9	Production of electrical machines and appliances	32469	2	15,4	77,0	0,77	69302	20,2	42,5	0,43
10	Production of chemical products	36833								
11	Farming industry	50881	2	15,3	92,3	0,92	111263	32,4	74,9	0,75
12	Production of textile products	60382								
13	Production of foodstuffs	85976	1	7,7	100,0	1,00	85976	25,1	100,0	1,00
	TOTAL		13	100,0			343165	100,0		

Source: No. from Table 1/1

mode of selecting and putting in order the carriers of the phenomena, as one of the most delicate questions. The question is delicate because there is a great span of employees in the researched branches. There have been lots of difficulties in compounding them into groups, under condition that inside the groups there should be the smallest possible span and that, at the same time, the groups should be as numerous as possible.

As evident from Table 2.3./1, the carriers, the branches of the service sector are compounded in 6 groups, to which fact all the parameters are adapted.

The degree of concentration of the employees is evident from the relation at the beginning of the distribution of this phenomenon: 15.4% of the carriers (or branches) of column 4 absorb only 0.8% of the employed (column 8), and in the meantime, at the top of the distribution, about 8% carriers employ about 28% employees.

For the purpose of shortening the operations, we draw in the same graph also the function of concentration of incomes of employees in the service sector. We have therefore to switch to the model type presentation of the said parameters.

#### b) Parameters of the Lorenz curve and the index of concentration of incomes of employees in the service sector branches

Here the carriers (employees) are compounded by the span of their net wages, in the particular service activities, in a way that within the defined wages span various branches with their number of employees are being placed.

In this way the carriers are compounded in 5 groups. The compounded incomes, as a researched phenomenon, are deduced out of the net wages and the real number of the employed in these particular groups of carriers.

Thus we came to a certain compensation between the lower average wages and the numerous employees in these branches, from where very balanced relative relations between various groups of carriers and of compounded incomes are deduced.

The parameters modelled in this way are shown in Table 2.2/3 and evident is a very homogenous and balanced distribution of incomes of employees in the branches of the service sector. Because of the fact that we identified the carriers and their incomes, by firstly using the average wages in particular branches, this example has a rather more theoretical and hypothetical value. Having in mind this fact, it is very important remembering it in the process of interpretation of any so obtained results, and also when realising the algorithm for any element of the model.

After the analysis of the parameters of Tables 2.3./1 & 2.3./2, we draw the Lorenz curve of the said

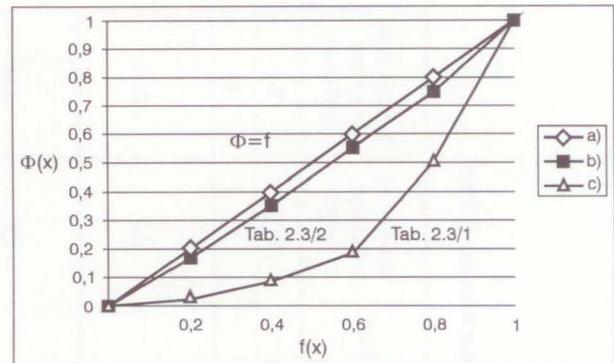


Figure No.2.3./1.

phenomena i.e. the concentration of the number of employees in various branches and the concentration of income of employees.

Both of these functions are interpreted in a similar fashion as are the parameters of Tables from which they are derived. It is important to note the deviation of the real curve of distribution from the line of complete relative equality or evenness  $\phi = f$ .

This means that when following the function of distribution of the number of employees in the service sector branches, we can notice a considerable deviation of the Lorenz curve from the line of equality, which speaks of a high degree of concentration of employees in several branches. So we can find that at the top of the distribution, only 23% branches in question absorb 50% of the total number of employees in these branches.

On the other hand, the function of distribution of incomes of the employees is showing a small almost neglectable deviation of the Lorenz curve from the line of complete relative equality, which proves an almost ideal evenness of this phenomenon. So we can find at the top of the scale of wages, by the span of 2100-2500 kn., that 2% of the working force in the service sector absorbs an almost identical percentage (2.8%) of the total incomes. We should here remember the previously mentioned mode of combining and modelling the compounded carriers, by using the average net wages of employees.

However, a more precise and quantitatively more absolute measures of unevenness (concentration) are derived, as we said in the theoretical part of this work, firstly on the basis of the parameters of Table 2.3/1 for the coefficient of concentration of the number of employees in various branches of the service sector. Because of the fact that the basic equation and its part are already known, we approach the concrete calculation on the basis of coefficients  $f(x_1)$  &  $\phi(x_1)$ , as well as the Lorenz curve.

All remarks given for the calculating algorithm of this coefficient of the branches of production, are also valid here, so we are not going to repeat them. We shall therefore only comment the results obtained: the

Table 2.3/1: Parameters of the Lorenz curve and the index of concentration of the number of employees in various branches of production, during I./1995.

No	Branches of production (carriers of employees)	No. of employees	Compounded carriers	Percentage of the number of carriers	Summed up percentage of carriers	Transformed $f(x)$ into coefficients	Compounded employees	$\frac{1}{m} \cdot x_k \cdot f(x_k)$	Summed up percentage of employees	Transformed F(x) into coefficients
			$x$	$f(x_k)$	$f(x)$	0-1	$x_k$	%	$\phi(x)$	0-1
	1	2	3	4	5	6	7	8	9	10
1	Pipeline transport	500	2	15,4	15,4	0,15	1100	0,8	0,8	0,01
2	River transport	600								
3	Tourism	1900	3	23,1	38,5	0,39	7400	5,1	5,9	0,06
4	Air transport	2400								
5	Personal services	3100								
6	Maritime transport	4600	3	23,1	61,6	0,62	18600	12,8	18,7	0,19
7	Port transhipment services	6800								
8	City transport	7200								
9	Tradesmen's services and repairs	15500	2	15,4	77,0	0,77	32600	22,4	41,1	0,41
10	Road transport	17100								
11	Postal telegraph and tele- phone serv.	20600	2	15,3	92,3	0,92	45100	31,0	72,1	0,72
12	Rail transport	24500								
13	Catering	40700	1	7,7	100,0	1,00	40700	27,9	100,0	1,00
	TOTAL		13	100,0			145500	100,0		

Source: No. from Table 1/1

**Table 2.3/2: The parameters of the Lorenz curve and the index of concentration of the compounded incomes (wages) of the branches of the service sector, for 1/1995.**

No	Branches of production (carriers of employees)	No. of employees	Compounded carriers	Percentage of the number of carriers	Summed up percentage of carriers	Transformed $f(x)$ into coefficients	Compounded employees	$\frac{1}{m} \cdot x_k \cdot f(x_k)$	Summed up percentage of employees	Transformed $F(x)$ into coefficients
			$x$	$f(x_k)$	$f(x)$	0-1	$x_k$	%	$\phi(x)$	0-1
	1	2	3	4	5	6	7	8	9	10
1	River transport	689	2	15,4	15,4	0,15	1808	0,7		0,01
2	Pipeline transport	1119								
3	Tourism	3359	3	23,1	38,5	0,39	12978	5,3	6,0	0,06
4	Personal services	3847								
5	Air transport	5772								
6	Maritime transport	8919	3	23,1	61,6	0,62	36622	14,9	20,9	0,21
7	City transport	13838								
8	Port transshipment services	13865								
9	Road transport	25804	2	15,4	77,0	0,77	69185	21,2	42,1	0,42
10	Tradesmen's services and repairs	26381								
11	Postal telegraph and tele- phone serv.	36112	2	15,3	92,3	0,92	77419	31,5	73,6	0,74
12	Rail transport	41307								
13	Catering	65079	1	7,7	100,0	1,00	65079	26,4	100,0	1,00
	TOTAL		13	100,0			246091	100,0		

Source: No. from Table 1/1

$f(x_i)$	$\phi(x_i)$	$f(x_{i-1})$	$\phi(x_i)$	$f(x_i)$	$\phi(x_{i-1})$
0,03	0,02	0,03 x 0,56	0,0168	0,59 x 0,02	0,0118
0,59	0,56	0,59 x 0,82	0,4836	0,85 x 0,56	0,4760
0,85	0,82	0,85 x 0,97	0,8245	0,98 x 0,82	0,8036
0,98	0,97	0,98 x 1,00	0,9800	1,00 x 0,97	0,9700
1,00	1,00		2,3051		2,2614

$$K_{znp} = 2,3051 - 2,2614 = 0,0437$$

value of coefficients as from 0.5271. Confirmed are all previous assertions about the high degree of concentration, which means the unevenness of employment in the branches of the service sector. The interpretation of the obtained index of concentration, on the context of the Lorenz function, in the co-ordinate system, show that the real deviation of the curve, from the diagonal of complete equality  $\phi = f$ , is taking 53% of the surface area of the said triangle.

The same method of calculating coefficients of concentration is used also for the phenomenon of concentration of incomes of the employees, which are compounded within the established span of average net wages, and not on the basis of coefficients  $f(x)$  and  $\phi(x_i)$  of Table 2.3/2.

The value of the obtained index of concentration is 0.0437, which confirms a high degree of evenness or relative equality in the distribution of incomes of employees, which number is compounded within the branches of the service sector, according to the span of the average net wages, which again is, in accordance with the form of the Lorenz curve. This coefficient confirms that the real direction of the curve, with its deviation from the diagonal of complete equality, occupies only 4% of the total surface area of the right-angled triangle, of the said co-ordinate system.

**c) Parameters of the Lorenz curve of the compounded incomes (wages) in branches of the service sector**

From the title it is evident that here the carriers of income in the branches of the service sector, and their compounded incomes, are being derived from the product of net wages and the number of employees in the said branches.

Sorting out the relevant parameters for the purpose of drawing the Lorenz curve and the calculation of the index of concentration is shown in Table 2.3/3.

As it is evident from this Table, that the branches of the service sector, as carriers of incomes, are compounded in 6 groups, and accordingly, the other relevant parameters are also adapted. From parameters in columns 4 & 8, it is possible to conclude that there is in question a very large concentration of incomes of branches, because here the decisive role has the

number of employees, which is by this program dispersed in a wide span, while the differences of net wages are much smaller.

About the doubtless high concentration of income of the branches speaks the indication that, at the start of the distribution, 15.4% of the carriers absorb only 0.7% of incomes, and meanwhile, at the top of the distribution, about 8% of carriers absorb 26.4% of incomes.

This is far better noticeable in the form of the Lorenz curve, in Figure 2.3./2. This form has a great deviation from the diagonal of the line of equality, which indicates a high degree of concentration of the compounded incomes in a lesser number of branches of the service sector. In favour of this fact we should mention that the said 23% of branches absorb 58% of income.

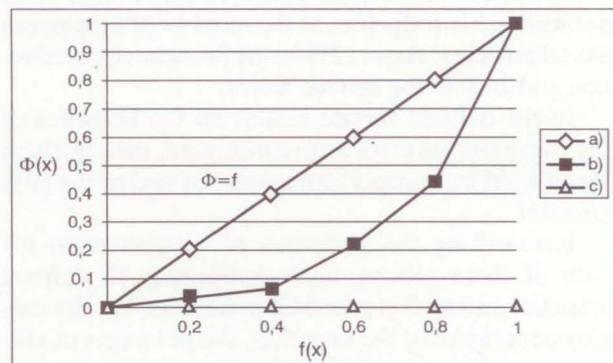


Figure No.2.3./2.

A more precise and quantitatively absolute measure of concentration, the index of concentration, is being calculated on the basis of partial coefficients  $f(X_i)$  and  $\phi(X_i)$  in Table 2.3/3, in the following way:

$f(x_i)$	$\phi(x_i)$	$f(x_{i-1})$	$\phi(x_i)$	$f(x_i)$	$\phi(x_{i-1})$
0,15	0,01	0,15 x 0,06	0,0090	0,39 x 0,01	0,0039
0,39	0,06	0,39 x 0,21	0,0819	0,62 x 0,06	0,0372
0,62	0,21	0,62 x 0,42	0,2604	0,77 x 0,21	0,1617
0,77	0,42	0,77 x 0,74	0,5698	0,92 x 0,42	0,3864
0,92	0,74	0,92 x 1,00	0,9200	1,00 x 0,74	0,7400
1,00	1,00		1,8411		1,3292

$$K_{dpg} = 1,8411 - 1,3292 = 0,5119$$

The so obtained coefficient of 0.5119 confirms all the previous indications about the great concentration of the compounded incomes of the branches of the service sector. In the context of the Lorenz curve, this coefficient shows that the deviation of the curve from the diagonal of equality  $\phi = f$  occupies over 52% of the surface area of the right - angled triangle of the co-ordinate system.

Table 2.4.

Concentration measure for the indicators	Symbol	Production activities	Service activities
Concentration coefficient of employees according to branches	$K_{zap}$	0,4958	0,5271
Concentration coefficient of net income per employee	$K_{ppz}$	0,0851	0,0437
Concentration coefficient of incomes per branch	$K_{dpg}$	0,4858	0,5119

## CONCLUSION

Although researching the concentration of the number of employees and their net wages in a defined number of branches of production and the service sector was a precise task, it proved impossible to avoid mentioning also the conventional considerations of this problem. This is first of all related to the observation that from the year 1992 till the beginning of 1995, a considerable reduction of the number of employees has taken place: about 12% in the branches of production and 16% in the service sector.

In the defined service sector, all the branches of the transport industry are represented, among them also the public transport companies owned by the government.

Researching the measures of concentration for both of these groups, each comprising 13 defined branches and all 3 researched indicators, i.e. the employment figure of the branches, the net wages of employees and the compounded incomes of branches, indicate to a considerable degree concentration or underdevelopment. This can be seen, for example, in the results obtained from the quantitative absolute measure (the coefficient of concentration), which has the following values for various sectors (Table 2.4.).

Except for the concrete results obtained by the research, a very important goal of this work was also to explain the procedure of modelling the relevant parameters and carrying out the measures of unevenness, whether that of the Lorenz curve, or that of the index of concentration. A very delicate and creatively difficult task was that of identifying and systematising the carriers of the researched phenomena. All these cognitions determine the possibilities and the range of application of the measures of unevenness.

## SAŽETAK

### ANALIZA ODNOSA ZAPOSLENIH I NETO PLAĆA PO KARAKTERISTIČNIM GRANAMA USLUŽNIH I PROIZVODNIH DJELATNOSTI U REPUBLICI HRVATSKOJ

Glavna okosnica rada sastoji se u aplikaciji specifičnih statističko-matematičkih metoda u ispitivanju mjera koncentracije broja zaposlenih i neto plaća, odnosno dohodaka po određenim gospodarskim granama u okviru proizvodnih i uslužnih djelatnosti u Republici Hrvatskoj.

Konkretno, radi se o mjerama nejednakosti, odnosno ravnomyernosti, a to su Lorenzova krivulja i indeks koncentracije. U svrhu ovog ispitivanja definirano je po 13 grana u okviru proizvodnih i uslužnih djelatnosti za koje su ispitivane mjere koncentracije po spomenutim pokazateljima.

Postupku konkretnog izvođenja i izračunavanja dotičnih mjera koncentracije, prethodi vrlo delikatno sređivanje i modeliranje relevantnih parametara, pogotovo se to odnosi na identifikaciju i adekvatno agregiranje nositelja ispitivanih pojava.

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