

# MODELLING INCOME INEQUALITY IN SLOVAKIA USING QUANTILE REGRESSION MODEL

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## Abstract

The reduction of inequalities, both within and between countries, is a prerequisite for achieving the 2030 Agenda for Sustainable Development goals. Most studies on the income modelling consider the lowest incomes to describe poverty. In this paper, we look at both tails of the income distribution. Using Slovak data 2020 from the EU-SILC, we analysed the structure of the household total disposable income and found that while the income of a low-income group is mainly made up of social benefits, the income of a high-income group is mainly labour income. We also looked in detail at inequalities in economic activity, education, gender, etc. In the last part of our work, we performed an analysis of the relationship between the income of the head of the household and selected socio-economic characteristics. Quantile regression model allows us to study the relationship between income levels and individual socio-economic determinants along the entire income distribution and we focused at the lower and upper tail of the distribution.

**Key words:** Slovakia, EU-SILC data, socioeconomic characteristics of households, deprivation, income inequality, quantile regression

**JEL Code:** C51, D31, I32

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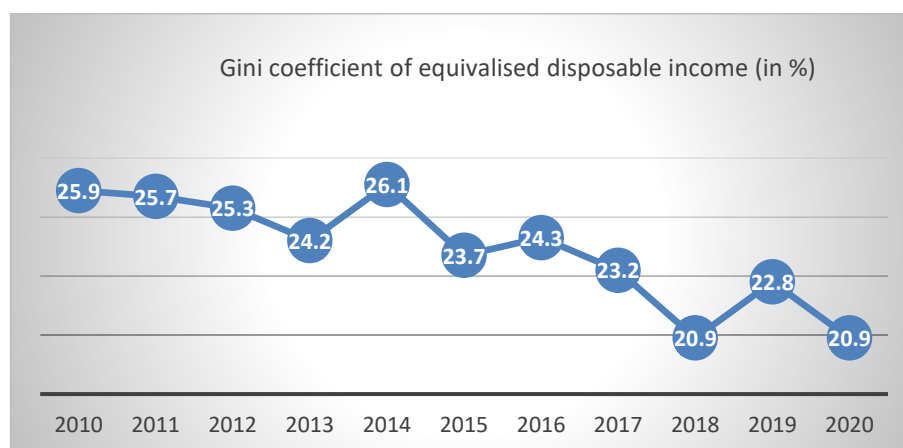
## Introduction

Income inequality has become not only economic, but also social phenomenon. Many economist, sociologist, statistician and even psychologist are interested in the size of such an inequality. Therefore, the income distribution of the society is the subject of the study. The reduction of inequalities, both within and between countries, is a prerequisite for achieving the 2030 Agenda for Sustainable Development. As stated in European Commission “*When inequalities persist, especially in an extreme way, across economic, social, political or environmental dimensions, sustainable development and social cohesion will always be beyond reach*” (European Commission, 2021). OXFAM published a report in 2018 (see Ratcliff, 2018), according to which 1% of the world's population owns up to 82% of the world's wealth, which

was created in 2017. While 3.7 billion people, who make up the poorer half of the world, have not seen any increase in their wealth. This disparity is expected to increase further in the future, as the wealth of the richest people has increased by an average of 13% since 2010. On the other hand, the wages of ordinary workers grew by an average of only 2% per year.

To draw a general picture of the income inequality in Slovakia Fig. 1 illustrates the Gini coefficient.

**Fig. 1: Gini coefficient in the years 2010-2020, Slovakia**



Source: Eurostat, 2022

The Gini coefficient is the most common internationally used measure of income inequality. It measures income distribution by comparing income status of individual households in relation to status of all other households. The coefficient is expressed as a percentage value from 0 up to 100. A zero Gini coefficient would have meant perfect income equality. Gini coefficient at the level of 100 would mean that all income in the economy they would only be attributed by one household, which would result absolute income inequality.

The situation regarding income inequality in Slovakia is gradually improving in a long-term trend, from 2010 to 2013, the value of the Gini coefficient had a decreasing tendency from the value of 25.90% to 24.20%. In 2014, there was a slight increase to the level of 26.10%. This value represents the maximum so far. After this period, the value decreased, in 2019 there was an increase to the level 22.8 %, until the last known value in 2020, at 20.9%. The Gini coefficient is under the EU average by around 10 points (Eurostat, 2022). There is also an assumption that Slovakia as a country does not have such a high growth of income inequality, because it received a relatively good foundation from socialism, the main idea of which was equality. This was also reflected in salaries in socialism, which did not represent extreme fluctuations between individual professions. (Garne & Terrel, 2001)

The goal of this paper is to describe and analyse income distribution of the Slovak households. We will focus on the both tails of the distribution and analyse the lowest and the highest income group, their structure and socio-economic characteristics. Our next goal is using quantile regression model identify determinants which are significant for the both income groups.

The paper is organized as follows. After the introductory section, the first part presents brief literature review and inspiration to our research, the second part of the paper describes data used in the study, their descriptive statistics and quantile regression model. The last section concludes the paper.

## 1 Literature

There are many papers concerning the income inequality and its determinants. Shao LF (2021) describes three sets of variables that robustly and consistently impact income inequality differently. The first includes variables that negatively impact inequality (employment, primary education, etc.); the second includes variables that positively enhance inequality (investment, labor income share, etc.); and the third includes civil liberty and openness, whose roles rely on the development level of a country. Household income is closely related to the socio-economic characteristics of the household's members. Peichl, et al. (2012) found that the growth of the income gap in Germany is strongly related to changes in household structure and employment behavior.

Many empirical studies indicate that education may increase income. More skilled workers (individuals who receive higher hourly wages conditional on their characteristics) are associated with a stronger education-related earnings increment (Pedro & Pedro, 2004). Empirical evidence of the authors Gregorio & Lee (2002) showed that educational factors — higher educational attainment and more equal distribution of education — play a significant role in making income distribution more equal. From the findings in Sylwester, K. (2002), public education expenditures appear to be associated with a subsequent decrease in the level of income inequality.

Furthermore, several studies have attempted to describe the effect of the gender on the income inequality. Šubová & Buleca (2020) studied income gap between men and women in Slovakia based on the HFCS data and found that women's income is 16% lower than men's. Spatial aspects of income inequalities in Slovakia are discussed in Michálek (2020).

Like any survey, the EU-SILC suffers from problems with regard to data collection. Paturot et al. (2013) argue that low-income households are more difficult to contact, are more

likely to refuse to answer and might understate their income. Moreover, they state that high-income households are under-represented in household survey data because they do under-report or refuse to give any information about their income. Because of these restrictions, income inequality tends to be underestimated. Nevertheless, they provide a reliable data source and are also used in between countries comparisons.

## 2 Data and methodology

In this section, we described the income data used in the analysis. The results are based on European Union Statistics on Income and Living Conditions (EU-SILC). To fulfilment our aim, to study relationship between selected determinants and income, we used quantile regression.

### 2.1 Data description and exploratory analysis

The last available wave at the time of the writing was the year 2020, so the data refers to 2019. There are various variables which measures income in EU-SILC data. We will use variable *total household gross income* to study structure of the household income for different income groups. To study income distribution determinants, *equalised disposable income* is used. We divide the whole income distribution into deciles and we will analyse the both tails of the income distribution separately.

The total household gross income is computed as the sum for all household members of gross personal income components (e.g. gross employee cash or near cash income, company car, unemployment benefits, old-age benefits, survivors' benefits, disability benefits, education-related allowances) plus gross income components at household level (income from rental of a property or land, family/children related allowances, social exclusion, housing allowances, regular inter-household cash transfers received, interests, dividends, profit from capital investments in unincorporated business, income received by people aged under 16).

The basic descriptive characteristics of income are displayed in the Tab. 1.

**Tab. 1: Descriptive statistics of household gross income in 2020**

Statistic	EU-SILC 2020 (in €)
Minimum	0
10%-quantile	5973
25%-quantile	9416
Median	15265
Mean	17965
75%-quantile	24387
90%-quantile	33471
Maximum	98462
Standard deviation	11385

Source: Author's calculation, data EU-SILC 2020

The minimum gross household income was 0 in the year 2020. On the other hand, the maximum was 98 462 euros, far from the mean and median values. This maximum income represents an average monthly income of approximately 8 205.17 euros for a given household. In the table 1 also arithmetic average income is showed, although it is better to take into account the median. The year average income 17 965 euros corresponds to the average monthly income 1 497.08 euros. In the year 2020 was average wage 1 133 euros and minimum wage 580 euros in Slovakia. Although income inequality has been declining in recent year, it is very important to study the socioeconomic characteristics of households achieving minimum or maximum income. Our researched sample will represent the first decile of the income distribution for the lowest income and the ninth decile for the highest income. Therefore, it is necessary to organize the data in the database and calculate the individual boundaries for both tails of the income distribution. The values of the deciles are as follows:

- 1st decile of income distribution – 5 973 €,
- 9th decile of income distribution – 33 471 €.

After filtering the data, both groups cut by the deciles represent 555 households.

It is important to point out the individual sources of income in households, at both tails of the income distribution. We assumed from the total gross income of households, which includes individual smaller subgroups of income. We chose total gross income in order to examine whether individual households seek to obtain a source of income other than employment, such as investment, rental property, and so on. We take into our calculations values, which corresponds to the head of the household, therefore the percentages in the table below do not result 100% together. We divided the income into three subgroups, namely: labour income, social income and other income. In the Tab.2 below are displayed only selected categories.

**Tab. 2: Structure of gross household income in €**

		<b>10% bottom incomes</b>	<b>10% top incomes</b>
<b>labour incomes</b>	gross employee cash or near cash income	2.13%	27.10%
<b>social incomes</b>	unemployment benefits	0.22%	0.04%
	old-age benefits	70.08%	3.22%
	disability benefits	6.20%	0.44%
	family/children related allowances	2.23%	1.11%
	social exclusion not elsewhere classified	3.86%	0.02%
	housing allowances	0.00%	0.00%
	regular inter-household cash transfers received	1.26%	0.17%

Source: Author's calculation, data EU-SILC 2020

We can assume that at the left tail of the income distribution, representing the lowest incomes in the Slovak Republic, social incomes will prevail. These households have not reached the annual income of 5 972€ per year and are thus in the first decile of the income distribution. On the other hand, a substantial part of the highest income should be made up of work income. We could also assume that the last decile of the income distribution will consist of other income in a larger proportion than in the first decile, as these households could receive more income from other sources, such as rental property or dividends.

In the previous table (Tab. 2), we presented the structure of gross household income, but we know that gross income is not the same as the real income paid to the employee, or the real income from renting property and the like. This revenue is still adjusted for some items. In the EU SILC methodology, three other components are deducted from gross income, namely: regular property taxes, regular money transfers between households and the last group consists of income taxes and social security contributions. The values adjusted for these items are called disposable income. It is therefore the fair value of the income that the household has earned and can use it for its own private purposes.

When observing the structure of income, it is customary to take into account the observation of the equivalent disposable income, which is derived from the disposable income of the household and subsequently dividing by the equivalent size of the household. Subsequently, this income value is assigned to each member of the household.

We analysed the equivalent disposable incomes in both tails of the income distribution, by the different type of household. These results are summarized in the Tab. 3.

**Tab. 3: Descriptive statistics of equivalent disposable income by household size (in €)**

	10% bottom income		10% top income		Population	
	mean	median	mean	median	mean	median
<b>One person household</b>	382.9	409.2	2400.2	2112.4	611.0	553.6
<b>2 adults, no dependent children, both adults under 65 years</b>	192.0	208.0	1649.8	1596.9	886.4	860.3
<b>2 adults, no dependent children, at least one adult above 65 years</b>	272.1	282.9	1861.3	1894.8	680.6	637.4
<b>Other households without dependent children</b>	104.2	121.1	1145.9	1124.5	870.7	870.9
<b>Single parent household</b>	245.5	268.6	X	X	575.0	575.9
<b>2 adults, one dependent child</b>	173.9	181.6	1222.5	1212.7	713.8	698.8
<b>2 adults, two dependent children</b>	153.1	147.6	1113.8	1052.7	691.5	665.2
<b>2 adults, three or more dependent children</b>	85.2	104.9	852.7	890.3	510.0	511.2
<b>Other households with dependent children</b>	113.8	112.8	921.7	897.7	699.1	711.7

Source: Author's calculation, data EU-SILC 2020

The biggest differences are represented by a one-member household, while for the lowest incomes its member is assigned an amount of 382.9 € per month, for the highest it is up to 2 400.2 € per month. It is a very distant value from the results of the entire population of 611 € per month. With the growing number of household members, disposable income also logically decreases. Families with three or more dependent children in the lowest income category are most at risk. Each member of the household is thus allocated an average amount of only 85.2 € per month. On the other hand, for such families earning the highest incomes, each member of this household is allocated € 852.7 / month.

**Tab. 4: Self-defined current economic status, gender and income group**

	Self defined current economic status					
	10% Bottom Incomes			10% Top Incomes		
	Men	Women	Sum	Men	Women	Sum
<b>Employed</b>	0,70%	1,80%	2,50%	50,60%	17,80%	68,50%
<b>Self-employed</b>	1,60%	0,40%	2,00%	9,50%	2,50%	12,10%
<b>Unemployed</b>	9,00%	3,10%	12,10%	1,30%	0,20%	1,40%
<b>Retired</b>	13,70%	63,10%	76,80%	10,60%	5,60%	16,20%
<b>Other</b>	2,70%	4,00%	6,70%	0,50%	1,10%	1,60%
<b>Sum</b>	<b>27,70%</b>	<b>72,30%</b>	<b>100,00%</b>	<b>72,60%</b>	<b>27,40%</b>	<b>100,00%</b>

Source: Author's calculation, data EU-SILC 2020

In the Tab. 4, the income distribution for both genders is presented. Unfortunately, the issue of gender discrimination still resonates. We can often hear that women are paid less than men for the same work. Our results in the table also partially agree with this statement. Women make up more than 72% of those in the lowest income category. It is therefore a far higher percentage than men, of whom only the remaining 27%. At the highest incomes, men dominate. Men make up almost 72.6% of the population and women just over 27.4%. In addition to gender, we can also read the status of basic economic activity from the following table. As we assumed, at the lowest incomes, it is clear that this group consists mainly of pensioners. This is up to 49.4% of people. More about pension system in Slovakia can be found in Špirková et al. (2019). In second place are unemployed (32.5%) and the other inactive people (9.7%). Again, we can say that these are mainly people who are strongly tied to help from others, or to help from the state. Women have a strong presence in them. Retired women account for up to 87.3%. With the highest incomes, the dominant category is working people. It is therefore clear that people who want to live above average must therefore find an adequate job that matches their skills. They do not achieve this above standard from social or other income. It is interesting that people who are unemployed also live in these households. However, they represent a very small

percentage. For example, they may be graduates looking for work, so they are temporarily unemployed, but their parents earn enough to make their households in the decile of the highest-income distribution. Retirees are much under-represented in this part of the division. They can also be multi-generational houses where these people live together with people who earn above-average incomes. Other inactive people are found relatively equally in both divisions.

## 2.2 Quantile regression

The quantile regression classic model has been introduced by Koenker & Bassett (1978) as an extension from the notion of ordinary quantiles (also called "percentiles") in a location model, to a more general class of linear models in which the conditional quantiles have a linear form. Quantile regression is recommended if the dependent variable contains extreme values, which is present in our case of income modelling. The method is robust against extreme values. Moreover, with the quantile regression, we can evaluate the relationship between income and its determinants along the entire distribution (Koenker & Hallock, 2001). This regression examines the relationship between income and its individual determinants for the 10th, 25th, 50th, 75th, 90th percentiles of the distribution. A specific feature of quantile regression is, that the estimated coefficients of the independent variables,  $\beta$ , can be different in quantiles significantly, which may indicate a non-homogeneous conditional distribution of the dependent variable. The 10th and 90th percentiles, which are characterized by the lowest and highest incomes, are particularly interesting to us.

The basic quantile regression model specifies the conditional quantile as a linear function of explanatory variables: Let  $Y$  be a random variable with distribution function  $F(y) = P(Y \leq y)$ ,  $\tau$ -quantile of the variable  $Y$  is defined as an inverse function  $Q(y) = \inf\{y: F(y) \geq \tau\}$ , where  $\tau \in (0,1)$ . Quantile regression model can be presented by equation:

$$y_i = \alpha_\tau + x_i\beta_\tau + z_{\tau i},$$

and  $Q_\tau(y_i|x_i) \equiv \inf\{y_i: F_i(y_i|x_i) \geq \tau\} = \alpha_\tau + x_i\beta_\tau$ , where  $y_i$  is  $i$ -th row of the vector of dependent variable,  $x_i$  is  $i$ -th row of the matrix  $X$  of independent variables,  $\alpha_\tau$ ,  $\beta_\tau$  are parameters to be estimated,  $z_{\tau i}$  is the error term,  $n$  is the number of observations,  $k$  is the number of independent variables.

In this study we analyse relationship between income and its determinants for the 10<sup>th</sup> and 90<sup>th</sup> percentiles of the income distribution in Slovakia.



### 3 Results and discussion

In the last part of our paper, we present the results of the performed quantile regression model. We studied the relationships between the income of the head of the household and selected socioeconomic characteristics. There is no clear theoretical guidance as to which variables should be included in the income model. The factors that are relevant in explaining the income of the poor may not be the same for the rest of the distribution. Following the economic literature, we estimate Mincer equation (see e.g Agovino & Garofalo, 2016). We considered following variables:

- *Household* – type of the household with categories: 1 – One-person household (reference category), 2 – 2 adults, no dependent children, both adults under 65 years, 3 – 2 adults, no dependent children, at least one adult above 65 years, 4 – Other households without dependent children, 5 – Single parent household, 6 – 2 adults, one dependent child, 7 – 2 adults, two dependent children, 8 – 2 adults, three or more dependent children, 9 – Other households with dependent children.
- *Economic activity (EA)* with categories: 1 – employed (reference category), 2 – unemployed, 3 – inactive.
- *Work\_years* represents years spent in paid work.
- *Gender* with categories: 1 – male (reference category), 2 – female.
- *Education* – highest level achieved with categories: 1 – primary (reference category), 2 – secondary, 3 – tertiary.

In the Table 5 are the results of the performed quantile regression. We can see magnitude and intensity of the coefficient and identify the relationship to the income. We used 10<sup>th</sup> and 90<sup>th</sup> percentile which corresponds to the lowest resp. highest income group. We will discuss the most important results. Household head in single parent households in both income groups have lower income (about 27% resp. 6.8%) compared to the reference category, one-person household. For the economic activity, reference category was employed household head. Therefore, negative signs of the estimated coefficient were expected. There is statistically significant relationship between income and economic activity, but the variability is higher for the lowest income group. Unemployed household head has approximately 180% lower income than employed household head. Theory assumes a quadratic relationship between income and the number of experience. For our data, the relationship is not clear, for the highest income group it is not significant, but it can be said that the growth of income accelerates with the number of years spent at paid work. Next, our results show, that if a person live in household

headed by a women, her income is about 11% (for the lowest income group) and about 7.5% (for the highest income group) lower compared to the household headed by a men. The results indicate that education is important and significant factor in income modelling. Especially for the lowest income group are differences notable.

**Tab. 5: Estimated coefficient of quantile regression model for lowest and highest incomes in EU SILC 2020**

	Variable	Coefficient	Standard Error	significance
Lowest Incomes	2 adults <65 , no children	0.259	0.0398	***
	2 adults, no children	0.290	0.0208	***
	Household without dep.children	0.340	0.0408	***
	Single parent	-0.270	0.0313	***
	2 adults, one child	0.100	0.06188	0.105
	2 adults, 2 children	0.134	0.5292	0.011
	2 adults, 3 or more children	-0.358	0.13974	0.015
	Other household with children	0.004	0.08351	0.955
	Unemployed	-1.807	0.24309	***
	Inactive(incl. Retired)	-0.193	0.2036	***
	Work_years	0.033	0.00635	***
	Work_years^2	-0.0003	0.00010	***
	Gender (female)	-0.113	0.02303	***
	Secondary education	0.578	0.03491	***
Tertiary education	0.788	0.04030	***	
Highest Incomes	2 adults <65 , no children	0.335	0.02564	***
	2 adults, no children	-0.023	0.02605	0.371
	Household without dep.children	0.236	0.02520	***
	Single parent	-0.068	0.02992	*
	2 adults, one child	0.112	0.02986	***
	2 adults, 2 children	0.036	0.03247	0.266
	2 adults, 3 or more children	-0.247	0.05320	***
	Other household with children	0.465	0.03003	0.122
	Unemployed	-0.286	0.07762	***
	Inactive(incl. Retired)	-0.299	0.01755	***
	Work_years	-0.00247	0.00305	0.419
	Work_years^2	0.02	0.0006	0.830
	Gender (female)	-0.07533	0.02037	***
	Secondary education	0.272	0.02796	***
Tertiary education	0.503	0.03228	***	

Source: Author's calculation, data EU-SILC 2020, significance codes: 0 \*\*\* 0.01 \*\* 0.05 \* 0.1 ·

## **Conclusion**

Among the underlying causes of income inequality are differences between individuals in general, which are long-term and impossible to prevent. They are often based on innate differences (ability, education, various discrimination, wealth, etc.). However, there are also causes that can be influenced. We are talking about different degrees of distribution of ownership of production factors (i.e. distribution of wealth).

In this paper we focused on the income inequality in Slovakia. We analysed income inequality by dividing the income distribution into two parts. By analysing descriptive statistics that while households with the lowest incomes depend almost exclusively on social benefits, for the opposite part of the distribution, social benefits represent only a tenth of total annual income. Also, based on the results of the analyses, we can claim the following about the representation of people: at the lowest incomes, there is a greater representation of women than men; basic economic activity has a significant impact on which part of the distribution people find themselves in. Examination of quantile estimates show that income is determined by economic activity, work years, gender and education. Using quantile regression model we saw, that education and economic activity had greater weight in the lowest income group. Number of years spent at work was not significant for the highest income group and being a single parent or living in household with three or more dependent children is associated with the lower income for both income groups.

It is widely believed that some inequality can motivate investment in human capital, promote mobility and stimulate innovation. Economic incentives important to growth rely on the possibility that the individual will achieve better results through hard work. However, if inequality widens too much, it can threaten growth. This is especially true if the cause is increased poverty in the lowest income group. If individuals in the lowest income bracket (or wealth bracket) lack the resources to invest in their skills and education, they may not be able to reach their full potential, and this hurts overall growth. In addition, income redistribution can also help stimulate demand in the economy, as low-income households tend to spend more (see European Commission, 2021).

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