

## CHANGES OF DISTRIBUTIONS OF PERSONAL INCOMES IN US FROM 1998 TO 2011

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**Abstract:** In this paper the results of studies of personal incomes changes are presented for years 1998 to 2011. The studies were based on the micro-data regarding families and households. Among others it was showed that concentration of individual incomes dropped during the period of 1998 to 2011. The opposite trends of changes of income inequalities for households and individuals were observed.

**Keywords:** income distribution, personal income, income inequalities

### INTRODUCTION

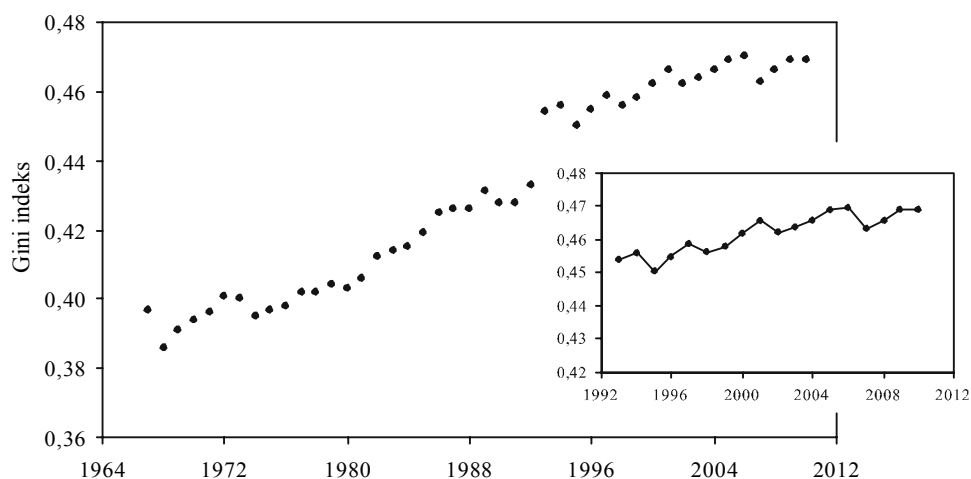
Among developed countries US has the highest spread of incomes, significantly bigger than for neighboring Canada, or UE. Inequalities of incomes greater than for US were observed for some countries in Latin America, Africa, or Russia. One of the consequences of 2007 economic crisis and economic downturn in US was increase of unemployment rate: from 4.6% in 2007 up to 9.0% in 2011. The deterioration in a financial situation of many households and an increase in income inequalities took place. The most important indicator of an incomes concentration in international researches is a Gini Index ( $G$ ), given by the equation:

$$G = \frac{E|X-Y|}{2\mu}, \quad (1)$$

where  $E|X-Y|$  is the average difference between incomes of two ransom units (households, persons) while  $\mu$  denotes the average income. The index assumes values from the range  $[0, 1]$ . It assumes extremely value of 0 in a the case of an

absolutely lack of any concentrations. Intuitively  $G = 1$  corresponds to a fully concentrated incomes. The changes of the Gini Indeks are presented in Fig. 1. The indeks was calculated for households and expresses level of income concentration in 1993 to 2010. As can be seen, the growth in the income inequality over the period 2007-2010 is the part of the long-lasting upward trend, observed since 1967. The periodicity of changes in the several last years has been observed as well. Based on the presented historical data it is not evident that the 2007 crisis caused increase of income inequalities. The reasons of the long-least increase of income inequalities in US could be more complex, related to the economic system itself. Among the most important reasons could be listed: decreasing a redistribution of incomes, flawed system of social transfers, and decreasing the progression of the tax system [CBO 2011, Poślajko 2012].

Figure 1. The growth of the concentration household incomes in US for the period of 1967 to 2010 measured by means of the Gini Index. The inset chart – values of the index for 1993-2010



Source: [DeNavas-Walt et al. 2009, pp. 38-39] and [Noss 2011]

Note: the significant increase of the index in 1993 was due to the changes in study methodology.

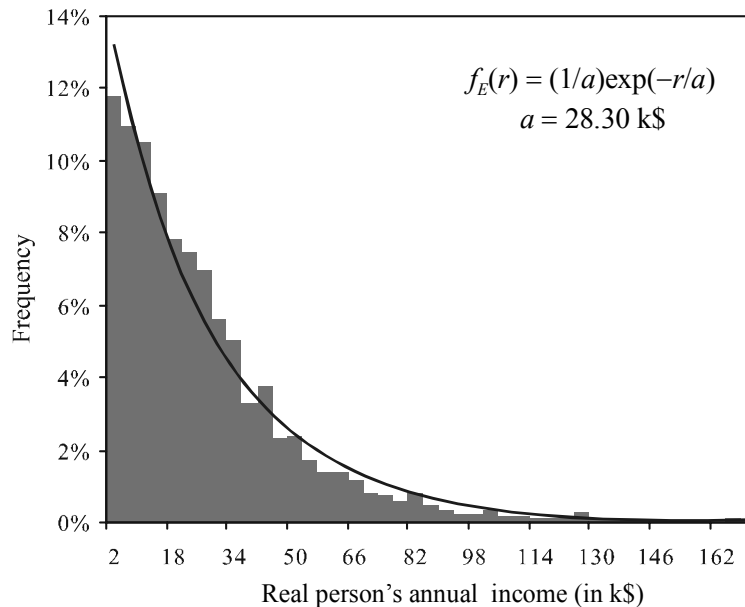
This paper concerns changes of a distributions of personal incomes in the US and follows-up our earlier studies [Łukasiewicz et al. 2004, Łukasiewicz et al. 2012]. The majority of the studies of incomes changes regards households or families incomes. However, it is worthy to note, that those incomes are the sum of personal incomes of household or family members. So it could be interesting to investigate personal incomes. They are more likely to change as a result of changes on the labor market in comparison with household or family ones.

The personal incomes distribution in the US has a high number of individuals in the range of the lowest incomes. Sample shape of the distribution has been presented in Fig. 2. In [Drăgulescu et al. 2000] authors approximated personal incomes distribution in the US with one-parametric exponential function given by the equation:

$$f_E(x) = \frac{1}{a} \exp\left(-\frac{x}{a}\right), \quad (2)$$

where  $x$  indicates personal income, whereas  $a$  parameter is equal to an average income. In [Łukasiewicz et al. 2012] authors investigated fit quality for other income models. They also showed that the distribution of personal incomes in the US is zero-modal.

Figure 2. The personal income distribution in 2005 and exponential fit (2)



Source: own preparation

## INCOME DATA

Data analyzed in this paper contain information, among others, about personal incomes in USA in 1998 to 2011. Files with data have been collected within the project Current Population Survey (CPS). Additionally, for comparison, the data from Survey of Income and Program Participation (SIPP) project for 2001, 2004, 2008 were used.

The CPS is a monthly survey of about 50,000 households conducted by the Bureau of the Census on behalf of the Bureau of Labor Statistics. The CPS is the primary source of labor force statistics in the US. It is the source of numerous high-profile economic statistics regarding unemployment, incomes, earnings, etc. The CPS also collects extensive demographic data that complement and enhance our understanding of labor market conditions in the nation overall, among various population groups and geography.

SIPP is a statistical survey conducted by the United States Census Bureau. The main objective of the SIPP is to provide accurate and comprehensive information about the income of American individuals and households. The SIPP is designed as a continuous series of panels, with a sample size from approximately 14,000 to 37,000 households.

The variable studied was „total persons income”. Incomes are after-tax and they are expressed in k\$ (thousand of dollars). Data undergone preliminary selection: zero values (lack of data) have been eliminated, monthly incomes have been recalculated into an annual ones. The final number of items analyzed, depending on year, was about 90,000 – 145,000 for CPS and about 200,000 – 290,000 for SIPP. Personal income is a combination of some components. This is a sum of persons earnings and other incomes. Earnings are wages, salaries as well as profits coming from own business and farm self-employment. The other incomes are coming from social benefits, alimony, allowances, etc.

We would like at this point to draw attention to the fact that the analyzed data were derived from statistical representative household surveys, however, they do not contain sufficient information about extremely high incomes. The full information can be yielded from tax statements which are not openly accessible [see CBO 2011].

Based on the personal incomes the basic statistical indicators (mean, median, percentiles, concentration indices) of incomes distributions were calculated. The results are presented in Tables 1, 2, and 3. Data regarding price index were taken from publications of Bureau of Labor Statistics (<http://www.bls.gov>).

The following symbols were used:

$x_j$  – nominal income,  $\bar{x}$  – average nominal income,

$r_j$  – real income,  $\bar{r}$  – average real income,

$m_r$  – median of real incomes,

$p_i$  – percentile of  $i/100$  - rank, where  $i = 5, 10, 90, 95$  (real income). Symbols  $p_{10}$  and  $p_{90}$  denote a first and a last decile of income distribution.

$k_i$  – percentage of a total income for a  $i$ -th percentile group. The  $k_i$  index denotes positional index of incomes concentration. If we denote by  $n$  the sample size, then  $k_i$  can be calculated by one of the equations:

$$k_i = \sum_{r_j < p_i} r_j \bigg/ \sum_{j=1}^n r_j, \text{ where } i = 5, 10 \quad (3)$$

$$k_i = \sum_{r_j > p_i} r_j / \sum_{j=1}^n r_j, \text{ where } i = 90, 95 \quad (4)$$

$d_i$  – percentage of total number of persons in the extreme groups defined by the percentiles of income distribution in 1998 (see Table 1, row 2).

Explicitly:  $d_i = m / n$ , where  $m$  denotes a number of objects (persons) with real incomes

- less than 1.10 k\$ for  $d_5$ ,
- less than 3.21 k\$ for  $d_{10}$ ,
- less than 54.81 k\$ for  $d_{90}$ ,
- less than 73.95 k\$ for  $d_{95}$ .

$d_i$  indices „movement of objects” on opposite ends of an income distribution in relation to the income limits, set for the entire period.

$G$  – Gini Index. In this studies it has been calculated using the formula

$$G = \frac{2}{n^2 \bar{r}} \sum_{i=1}^n i \cdot r_i - \frac{n+1}{n}, \quad (5)$$

where incomes series  $r_1, r_2, \dots, r_n$  is ordered non-decreasing.

Table 1. Characteristics of personal incomes distributions in the US

Year	$\bar{x}$	$\bar{r}$	$m_r$	$p_5$	$p_{10}$	$p_{90}$	$p_{95}$
1998	26.71	26.71	18.20	1.10	3.21	54.81	73.95
1999	28.01	27.41	19.10	1.14	3.33	56.75	75.44
2000	28.59	27.05	18.92	1.14	3.40	56.95	76.32
2001	30.39	27.96	19.14	1.20	3.62	57.13	76.25
2002	31.88	28.88	19.93	0.94	3.04	59.02	79.84
2003	32.11	28.44	19.50	0.89	3.02	58.46	79.48
2004	32.92	28.40	19.83	0.86	3.00	59.26	80.28
2005	33.90	28.30	19.67	0.88	3.09	58.64	79.52
2006	35.56	28.75	19.68	0.97	3.23	59.60	80.91
2007	37.61	29.57	19.84	1.18	3.62	60.53	80.90
2008	38.38	29.05	20.24	1.35	3.79	60.56	80.33
2009	38.77	29.44	20.27	1.17	3.64	60.77	80.87
2010	38.45	28.72	19.42	1.27	3.73	59.75	79.36
2011	38.59	27.94	18.83	1.23	3.62	58.18	79.25

Source: own calculation

Table 2. The indices of concentrations of personal incomes in the US

Year	$G$	$k_5$	$k_{10}$	$k_{90}$	$k_{95}$	$k_{95}/k_5$	$k_{90}/k_{10}$
1998	0.509	0.07%	0.48%	36.7%	24.9%	76.9	345.2
1999	0.497	0.07%	0.47%	36.0%	24.3%	76.1	334.8
2000	0.497	0.07%	0.50%	35.2%	23.1%	71.0	327.0
2001	0.504	0.08%	0.50%	36.4%	24.6%	73.0	313.1
2002	0.512	0.06%	0.40%	37.0%	25.2%	93.1	448.3
2003	0.510	0.05%	0.39%	36.7%	24.9%	94.9	463.1
2004	0.509	0.05%	0.38%	36.6%	24.6%	96.4	478.0
2005	0.506	0.05%	0.40%	36.5%	24.6%	91.6	485.2
2006	0.509	0.05%	0.44%	37.0%	25.1%	84.3	466.5
2007	0.511	0.06%	0.46%	36.9%	25.1%	79.7	385.7
2008	0.502	0.08%	0.50%	36.1%	23.9%	72.4	291.0
2009	0.507	0.07%	0.47%	36.2%	24.3%	76.5	367.4
2010	0.507	0.08%	0.49%	36.8%	24.5%	74.8	323.7
2011	0.504	0.07%	0.54%	36.1%	24.0%	66.3	324.0

Source: own calculation

Table 3. Percentages of the populations in the income groups defined by the income percentiles in 1998 year (real incomes)

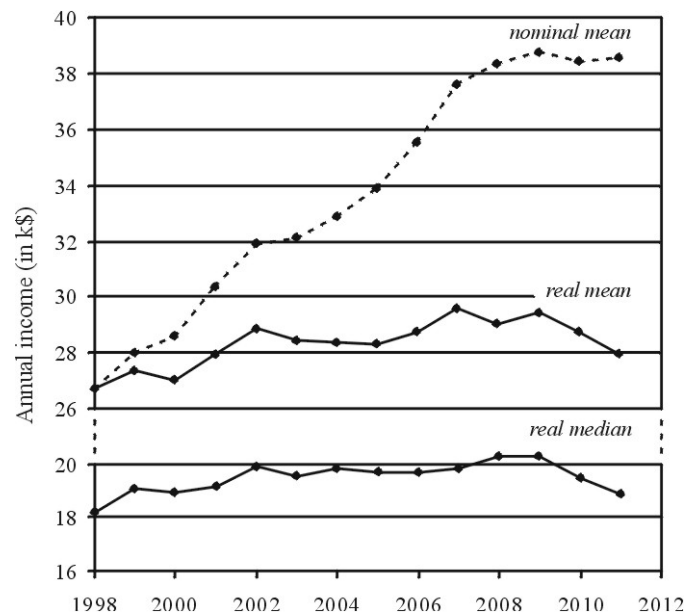
Year	$d_5$ $r < 1.10$ k\$	$d_{10}$ $r < 3.21$ k\$	$d_{90}$ $r > 54.81$ k\$	$d_{95}$ $r > 73.95$ k\$
1998	5.0%	10.0%	10.0%	5.0%
1999	4.9%	9.8%	10.6%	5.3%
2000	4.8%	9.6%	11.0%	5.5%
2001	4.7%	9.2%	11.4%	5.4%
2002	5.5%	10.3%	11.7%	5.9%
2003	5.6%	10.4%	11.4%	5.8%
2004	5.7%	10.5%	11.6%	6.0%
2005	5.5%	10.2%	11.4%	6.0%
2006	5.3%	9.9%	11.9%	6.2%
2007	4.8%	9.4%	12.7%	6.6%
2008	4.4%	9.0%	12.3%	6.5%
2009	4.8%	9.4%	12.5%	6.6%
2010	4.5%	9.2%	11.9%	6.4%
2011	4.8%	9.2%	11.4%	5.7%

Source: own calculation

## RESULTS

The changes of the mean personal income in 1998 to 2011 are presented in the Fig. 3. During the 13 years mean nominal income significantly. However, it seems to stabilize during the last 3 years. The relative increase of the mean reached 45% in 2009. Using annual price index incomes were corrected for the changes of prices and in this way real incomes were incorporated. The median and mean values of real incomes are presented in the Fig. 3. We can observe slow rise of the real incomes in the period of time studied, up to the year 2007 (by about 11%), while, after 2007 the drop of the mean income by about 5% took place. The median was increasing up to the year 2009 (one more time, by about 11%), whereas its drop took place during the last 2 years (by about 7%). The 2007 crisis was marked by the decrease of the mean real income; the decrease of the median occurred two years later. That was resulting from the changes in the ranges of low and high incomes.

Figure 3. The mean nominal incomes (dashed line) and the mean and median real incomes (solid lines)

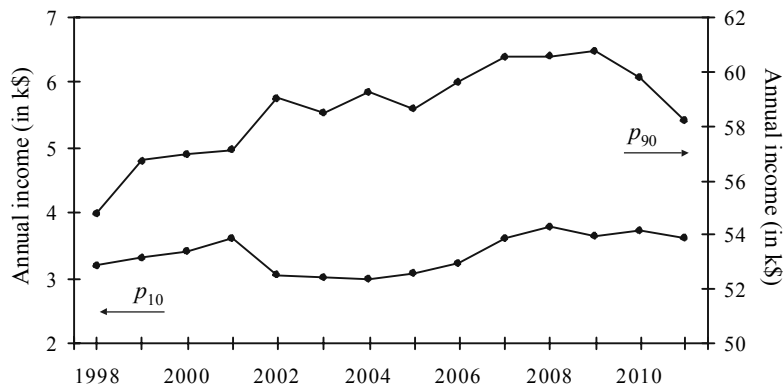


Source: own preparation

The values of the extreme deciles of the income distributions ( $p_{10}$  and  $p_{90}$ ) are presented in the Fig. 4. In the case of the poorest people after the year 2001 we can observe the sudden and big drop of the incomes by about 16% to the level of 3.0k\$ in the year 2003 and the 2-3 years of stabilization took place afterwards.

We can also observe the return of the incomes to the previous level which stabilized on the average level of about 3.7k\$ in the period 2008-2011. In the case of people belonging to the last decile group we observe the other tendency: the upward trend of incomes during 1998 to 2009 (increase by about 11%) and big drop of incomes in the last 2 years. The similar changes can be observed in the narrower, 5% - groups of people ( $p_5$  and  $p_{95}$ ).

Figure 4. Tenth and ninetieth percentile of real incomes



Source: own preparation

Changes of extreme percentiles provide some information about income inequalities. In order to perform deeper analysis Gini Index values, the typical positional indices of concentrations:  $k_5$ ,  $k_{10}$ ,  $k_{90}$ ,  $k_{95}$  and quotients  $k_{90} / k_{10}$ ,  $k_{95} / k_5$  were calculated. The quotients give us information about mutual relation between extreme income groups. The values of the indices were presented in Fig. 5 and 6.

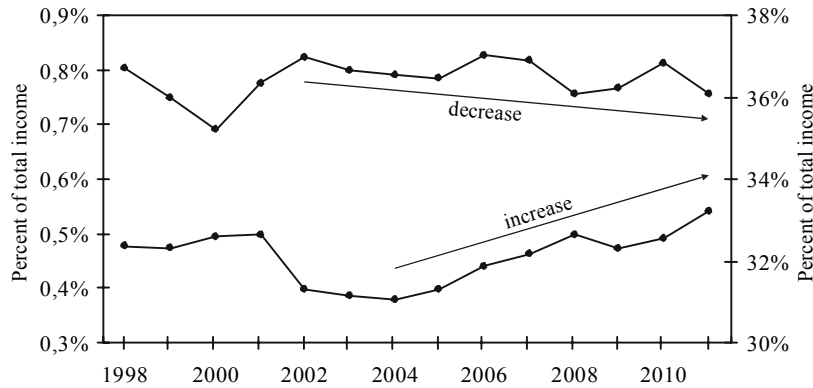
The changes of the percentage of the total income in the range of the first and the last percentile were opposite in the whole 1998 to 2011 range. Approximately an increase of  $k_{10}$  index corresponds to a decrease of  $k_{90}$  index and vice versa (similarly, in the case of  $k_5$  and  $k_{95}$ ). Fluctuations seen in the Fig. 5 are reflected in the changes in the concentration indices shown in Fig. 6. In 1998 to 2000 the decrease of income inequalities took place, in 2002 – significant increase and in successive years – drop again. Gini index exhibits some fluctuations but its value dropped from the level of 0.512 in 2002 to the level of 0.504 in 2011. The values of the positional concentration indices indicate on the decrease of income inequalities since 2004. We observe the increase of income percentage belonging to the first decile group and downward trend income percentage in tenth decile group (Fig. 5), and consequently big decrease of quotients  $k_{90} / k_{10}$  and  $k_{95} / k_5$ , even below the level for 1998.

Gini index is characterized by a low sensitivity to changes of income distributions. Fluctuations: 0.497 (1999), 0.512 (2002), 0.504 (2011) indicate significant changes of income inequalities. It is worthy to mention that income distribution in US is characterized by the level of concentration close to 0.5. The



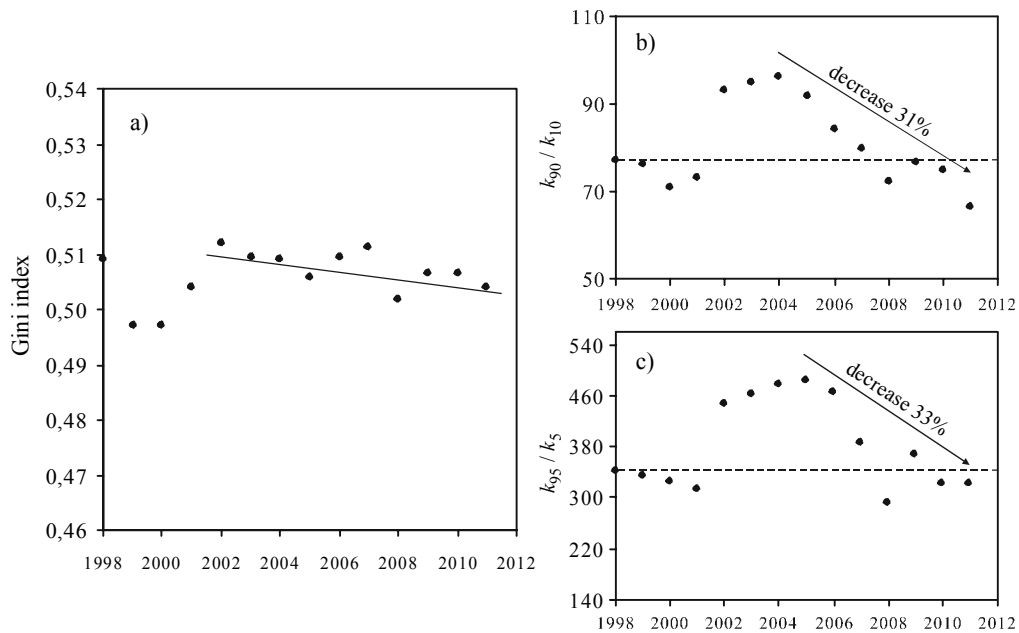
values of Gini index were calculated for SIPP data. They were: 0.500, 0.510, 0.508 for 2001, 2004, 2008 respectively, what has been proofed by the increase of income inequalities after 2001.

Figure 5. Percentage of the total income belonging to the first and the last decile group



Source: own preparation

Figure 6. Indices of income concentration: a) Gini index, b)  $k_{90} / k_{10}$  quotient, c)  $k_{95} / k_5$  quotient



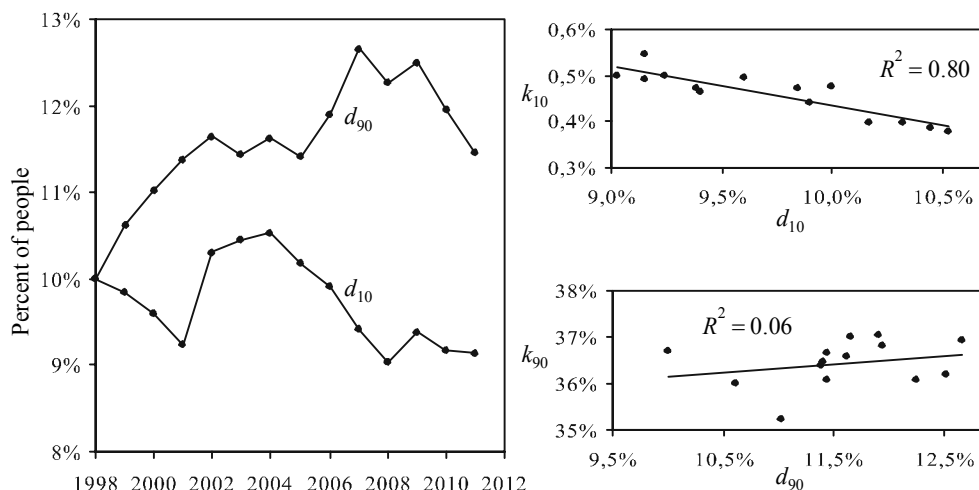
Source: own preparation

Changes of the percentage of the total income in the ends of the income distribution may have strict relation with the change of the people percentage in the

defined ranges of incomes. The changes of  $d_{10}$  and  $d_{90}$  and correlations with  $k_{10}$  and  $k_{90}$  are shown in Fig. 7.

The strong relation between  $d_{10}$  and  $k_{10}$  indices exists in the range of low incomes. The increase of relative incomes in the range of the lowest decile, e.g. in 2004 to 2011 (Fig. 5), is strictly related to the decrease of people percentage below the bottom limit of income (Fig. 7). This indicates the increase of mean income for the lowest decile – the decrease of the depth of a poverty. In the case of the highest incomes such relation is not observed. The increase of the  $d_{90}$  indicator in 1998 to 2000 comes together with the decrease of the last decile group participation in the distribution of the total income (similarly, in 2005 to 2007). This phenomena indicates the decrease of the most wealthy people number. The decrease of the  $d_{90}$  indicator in 2000 to 2002 corresponds to the increase of the percentage of the income in the last decile group.

Figure 7. a) Changes of  $d_{10}$  and  $d_{90}$ , b) relation between  $d_{10}$  and  $k_{10}$ , c) relation between  $d_{90}$  and  $k_{90}$



Source: own preparation

## DISCUSSION AND SUMMARY

The level of concentration of personal incomes in the US is very high. The Gini index for that income category is about 0.5. Some increase of the income inequalities in 2000 to 2002 existed. The participation of the last decile group in the income distribution increased significantly in 2002, and at the same time participation the first decile group decreased. Gini index reached its highest level of 0.512. At the same time these changes were accompanied by the increase in the average real income. We observe the decrease of the Gini index in 2002 and its downward trend till 2011. We have observed the significant decrease of the

positional indices since 2004. There was the increase of participation of the first decile in people incomes in 2004 to 2011 and simultaneously the participation of the people in the last decile was getting smaller. At the same time we observed the decrease of percentage of people with the lowest incomes, and since 2007 also the significant decrease of percentage in the opposite end of the income distribution. The decrease of the real personal incomes took place in 2007 to 2011 but the decrease was mainly for most wealthy part of the population. The increase of income inequality that occurred in the household (Fig. 1) was accompanied by the decline of personal income inequality.

Obtained results point to some events in the history which incline to set two hypotheses regarding the influences of economic crises on personal incomes. First, the 2001 crisis (attack on WTC and the beginning of the war with a terrorism) results in the decrease of personal incomes of the poorest part of the population in the next year, at the same time does not limiting an increase of the richest. This is the source of the increase of the income inequalities. Second, the 2007 crisis hits mainly the personal incomes of the richest, not causing bigger changes in incomes of the poorest people. This leads to the decline of the income inequalities.

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