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MACROECONOMIC DETERMINANTS OF WAGES INEQUALITY IN POLAND

In the paper an attempt has been made to empirically verify the relevance for Poland of the so called Kuznets hypothesis, being the basic fundamental of macroeconomic theories of wage and income inequality. A survey of the existent literature lets the author claim that no research of that type has yet been carried out for the case of Poland.

Presentation of results is preceded by a concise survey of literature, with an emphasis on the outcomes of previous empirical research. Verification of the Kuznets hypothesis – both the simple and the augmented – was done with reference to the models used most frequently while investigating into the Kuznets curve. The outcomes – validated by a solid statistical inference – do not confirm the credibility of the simple hypothesis but suggest the relevance of the augmented Kuznets hypothesis. Thus, it follows from the results that in the long run the economic inequality in Poland is bound to diminish.

Keywords: wages inequality, Kuznets hypothesis, step-wise regression, statistical inference determinants of inequality

1. INTRODUCTION

In the light of modern growth theories, confirmed by empirical research, economic inequality – meant as wage or income diversification – is one of the key factors affecting a lot of weighty socio-economic issues, such as:

a) economic growth (e.g. Barro, 2000),
b) political stability (e.g. Gradstein, Milanovic, 2004),
c) life expectancy (e.g. Deaton [2003]),
d) total fertility rate (e.g. Micevska, Zak, 2002),
e) social coherence (e.g. Kurowska, 2006),
f) crime and violence (e.g. Sztaudynger, 2004),
g) social capital (e.g. Putnam, 1993), etc.

Hence, possible causes of wage and income differentiation are subject of research activities of various socio-economic sciences, both at macro- and micro-level. This is so because it is the effectiveness of macroeconomic

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fiscal policies that depends on the right identification and quantification of factors determining economic inequality.

In the paper an attempt has been made to empirically verify the so-called Kuznets hypothesis, being basic fundamental of macroeconomic theories of economic inequality. A survey of the existent literature lets the author claim that no research of that type has yet been carried out for the case of Poland.

The paper is structured as follows. In section 2 a concise survey of modern theories of income inequality is presented along with a brief description of possible macroeconomic determinants of wage distribution. Section 3 reports specifications of empirical equations, usually used while dealing with the issue under consideration. Section 4 makes the reader acquainted with the data employed in the empirical analysis, whose results are reported and commented on in section 5. Finally, section 6 concludes.

2. KUZNETS HYPOTHESIS – THEORETICAL CONSIDERATIONS

Income distribution is related to the socio-economic development of societies (see Kuznets, 1955; Robinson, 1976). While moving from egalitarian tribe structures to exclusive, centralized structures, inequality tends to grow. The economic fundamental of pre-industrial societies is agriculture, whereas feudalism is the predominant socio-economic basis. Low labour productivity and marginal rates of growth of technological progress result in petrification of existing structures, including income distribution. However, with the advent of the industrial revolution there takes place a transitory increase in economic inequality (see Acemoglu and Robinson, 2002, p. 187). The following processes of deepening democratization and women's emancipation trigger the transition towards more egalitarian socio-economic structures, one manifestation of which is a decline in income inequality (see e.g. Acemoglu i Robinson, 2002).

The mainstream of theoretical considerations on the causes of socio-economic inequality in modern societies – since the beginning of 20th century –rests upon the so-called Kuznets hypothesis/curve (Kuznets, 1955). The primary concept by Kuznets – developed further on by Robinson (1976) and Acemoglu, Robinson (2002) – employs a model of transition from an agricultural economy to an industrial one. In the model agriculture constitutes initially the predominant sector of the economy, characterized by low and hardly increasing labour productivity. *Per capita* income in agriculture is low, whereas its distribution – compared with the other sectors – is relatively equal. The shares of industry and services – attached to urban areas – are slight but their income differentiation and labour productivities are much higher than in agriculture.

Economic growth enforces outflows of capital and labour force from agriculture to industry, the latter being more productive. People employed in industry earn more than in the country, which leads to an increase in wage inequality at national level. This happens because of an expansion of a relatively small sector offering its workers relatively high wages. As a result, at the initial stage of industrialization the relationship between the *per capita* economic growth and income inequality is positive: economic growth leads to an increase in inequality.

However, with the ongoing shrinkage of the agricultural sector, accompanied by the rise in industrial activities, there follows an intensification of urbanization. More and more people find jobs in industry, whereas the labour productivity in agriculture also starts growing significantly, which induces increases in rural wages and, consequently, leads to a decrease in relative differences between farm workers and industrial labourers. In turn, the differentiation of wages within industrial employees is declining too, thanks to decreasing shares of unskilled and low-skilled workers. Consequently, at a later stage of economic growth (sectoral transition) the correlation between *per capita* GDP and income distribution becomes negative: further economic development leads to a decline in economic inequality.

The above-mentioned relationship between economic growth and income/wage inequality – the latter measured by some indicator – is called the *Kuznets hypothesis/Kuznets curve* or *U-inverted Kuznets curve* (see figure 1).

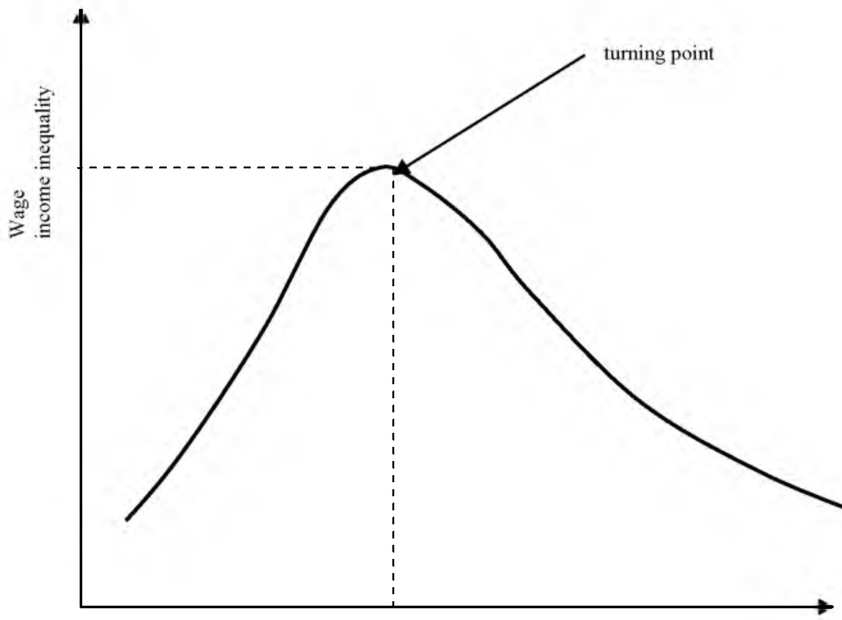


Figure 1. Stylized Kuznets curve

Source: own elaboration

In more modern interpretations of the Kuznets hypothesis some other reasons for the existence of the analyzed relationship are pointed at. And so, Greenwood and Janovic (1990) claim that an initial increase in economic inequality, followed then by a decrease, should be attributed to the transition of economies characterized by poor financial infrastructure towards a more advanced financial system. In general, the transition itself can be explained by the same mechanisms as in the case of the traditional theory. In view of endogenous growth theories (see e.g. Galor, Tsiddon, 1997; or Aghion, Howitt, 1999) – changes in income distribution result from outflows of employees from traditional and less productive sectors to modern and more productive sectors of the economy. Assimilation of new knowledge and skills, necessary to take advantage of advanced technologies, calls for experience and investment in human capital, which by definition is very time-consuming.

It is worth noting that it follows from the endogenous growth theory findings that income inequality might be characterized by high volatility, and that it can even grow and drop in time many times due to technological breakthroughs, such as: electricity, assembly line, the computer or the Internet, etc. (see Barro, 2000). In the beginning, only a small part of the employed work in a technologically leading sector, in which wages and salaries are much higher than elsewhere. Along with an expansion of the leading sector there follows an inflow of labour force to the sector, which results in a transient increase of aggregate inequality. However, in the course of time the labour force adjusts to the labour demand on high-skilled labourers, which leads to a slowdown in the dynamics of wages and salaries of those employed in the advanced sector and – at the same time – results in a relative rise in earnings of those employed elsewhere. Thus, in the long-run income inequality tends to decline.

The above-presented considerations – constituting theoretical underpinnings of the Kuznets hypothesis – accentuate the role of free market forces for the establishment of income inequality. In general, the initially growing and then declining inequality stems from the existence of a vastly understood dual economy, where technologically leading sector(s) coexist(s) with traditional sector(s). In empirical investigations into the verification of the Kuznets curve a given measure of wage/income inequality is made a function of exclusively *per capita* GDP.

Beside theories ascribing decisive role of economic growth to the explanation of income distribution, both in time and across different countries, there are also other theories accentuating the role of some other macroeconomic, as well as institutional and political factors for the explanation of economic inequality. The number of exogenous variables used while verifying the augmented Kuznets hypothesis is considerable, whereby the augmented Kuznets hypothesis means a relationship in which the dependence of economic inequality on economic growth is investigated while simultaneously controlling for some other variables. One can enumerate the following factors of socio-economic provenance as being determinants of income inequality:

1) Population growth

During demographic transition a decline in mortality rates leads initially to an increase in the number of children, both in poor and in wealthy families. However, the rate of growth is much lower in the latter, which consequently results in the broadening of aggregate income discrepancies. At a later stage of demographic transition there follows a decline in total fertility rates, as even less affluent families decide on investing in their children's education, which leads to an increase in human capital stock, and consequently – to a drop in aggregate income inequality (see e.g. Korzeniewicz, Moran, 2005).

2) Human capital

A rise in the stock of human capital in countries with its low initial levels brings on firstly an increase in aggregate inequality (in line with dual economy theory). However, in the long run, following a continuous increase in the share of well-educated labour force, the opposite tendency prevails. The growing number of people of tertiary education causes an absolute or relative decrease in the number of worse educated labourers, which – under quite a strong assumption about the constancy of demand on low-skilled labour – results in a faster rise in pay of low-educated workers, and consequently in a diminution in wage inequality (see e.g. Teulings, Van Rens, 2003).

3) Unemployment rate

A positive relationship between the unemployment rate and income inequality is obvious: the more people are unemployed, the higher the value of an income inequality measure (see e.g. Schultz, 1969; Bishop et al., 1994; or Weeks, 2005).

4) Inflation

The impact of inflation upon changes in income distribution can be summarized as follows. The earnings of insiders, whose wages and salaries are indexed in line with inflation, hold their purchasing power even in highly-inflationary environment. On the other hand, the earnings of outsiders, whose wages and salaries are contracted in nominal terms, are losing their purchasing power the faster the higher the rate of inflation is. As a result there follows an increase in economic inequality (see e.g. Bulir, 2001).

5) Economic openness (exports' and imports' shares in GDP)

The relationship between the above variable and income distribution is ambiguous and depends upon a given country's economic development. On the one hand, in countries enjoying high human capital stocks and high capital-output ratios an increasing openness contributes to a decline in wages of low-skilled labourers, and thus to a rise in income discrepancies. This is so because such states tend to import low-manufactured commodities, which prevents the prices of analogous, domestically produced goods from rising too fast, and suppresses possible wage pressures in traditional, not technologically advanced sectors. On the other hand, however, in countries with low human capital endowment there takes place the opposite tendency: increasing openness results in a drop of wage inequality because world prices of low-manufactured goods are usually higher than analogous, domestically produced goods in such countries (see e.g. Bourguignon, Morrisson, 1990).

6) Foreign direct investments

This variable is usually positively correlated with income inequality measures. The inequality tends to grow because of higher average wages and salaries earned by those employed by foreign investors (see e.g. Cooper, 2001).

7) Urbanization ratio

This measure approximates simultaneous impact of all the above-discussed factors stemming from the synergic effect (see e.g. Frazer, 2006).

Beside *explicit* economic factors also institutional circumstances, as well as the pursued socio-economic policies, affect income distribution. The government can – at least to some extent – influence income differentiation either directly: through its fiscal policies, transfers or state employment, or indirectly: *via* other instruments that affect income distribution through their impact on the intermediary factors mentioned above. Such factors as:

a) the share of state employment in total employment or

b) the share of social transfers in GDP

diminish disproportions in income distribution, and as such they should be incorporated in the analyses verifying the augmented Kuznets hypothesis (see e.g. Milanovic, 1994; or Iradian, 2005).

To end this section it is worth mentioning that in empirical attempts to verify the Kuznets hypothesis the number of exogenous variables explaining the variability of a given measure of income/wage inequality is usually limited to only a few from among the above-mentioned. In panel data research, apart from the factors reported in the text, some other variables are introduced that account for regional differentiation (e.g. dummies for African or Latin-American countries: Barro, 2000; or Iradian, 2005). It seems that thus far no attempt has been made to allow for a simultaneous impact of all of the possibly significant socio-economic variables upon the income inequality. This is most probably so because of numerical problems caused by strong multicollinearity of regressors. On the other hand, however, due to high correlations between explanatory and explained variables, judgmental restricting the set of relevant exogenous variables to only a few ones results – in most cases – in a full confirmation of their statistically significant impact upon the regressand. Still, the existing theories do not grade individual factors with respect to their possible importance for the explanation of income/wage concentration, the only exception being, of course, *per capita* GDP, which constitutes the essence of the Kuznets hypothesis. Thus, any judgmental inclusion of some variables and exclusion of some others – possibly relevant ones – is not justified and might lead to biased estimates.

3. SPECIFICATIONS OF EMPIRICAL MODELS OF THE KUZNETS CURVE

In the vast majority of empirical investigations into the (unconditional) Kuznets hypothesis, polynomials of second degree are used with respect to levels or logarithms in *per capita* GDP. Moreover, variants with or without intercept are analyzed (see the dispute between Ram and Ravallion: Ram, 1995; Ravallion, 1997; Ram, 1997), the argument against inclusion of intercept resting on an observation that under a hypothetical society, in which there is no private property, income differentiation would have to equal zero. Some aggregate measure of income/wage inequality is made dependent upon one of the after-mentioned functions:

$$INQ_t = \alpha_0 + \alpha_1 YC_t + \alpha_2 YC_t^2 + \varepsilon_t \tag{1}$$

$$INQ_t = \alpha_1 YC_t + \alpha_2 YC_t^2 + \varepsilon_t \tag{2}$$

$$INQ_t = \alpha_0 + \alpha_1 \ln YC_t + \alpha_2 (\ln YC_t)^2 + \varepsilon_t \tag{3}$$

$$INQ_t = \alpha_1 \ln YC_t + \alpha_2 (\ln YC_t)^2 + \varepsilon_t \tag{4}$$

where:

INQ_t – income/wage inequality measure in period t (or for the t-th object/country in the case of cross-sectional data),

YC_t – *per capita* GDP

$\alpha_0, \alpha_1, \alpha_2$ – structural parameters,

ε_t – disturbance term,

ln – natural logarithm.

Other researchers (e.g. Anand, Kanbur, 1993; or Deutsch, Silber, 2004) advocate the usage of a reciprocal function in *per capita* GDP instead of a squared function. A respective formula is then as follows:

$$INQ_t = \alpha_0 + \alpha_1 YC_t + \alpha_2 \frac{1}{YC_t} + \varepsilon_t \qquad (5)$$

Another functional modification consists in introducing rates of growth of *per capita* GDP into the regression equation (see e.g. Chang, Ram, 2000), which does not undermine the essence of the simple Kuznets hypothesis, as the only explanatory variable still remains *per capita* GDP. Justification for the presence of the rates of growth of GDP in the analyzed relationship rests upon an observation that in the short run changes in income inequality may result not only from changes in levels but also from the dynamics of *per capita* GDP. One cannot, however, on *a priori* grounds take for granted the direction of the relationship between the rates of growth and the inequality (see e.g. Barro, 2000). A modified function takes the following form:

$$INQ_t = \alpha_0 + \alpha_1 \ln YC_t + \alpha_2 (\ln YC_t)^2 + \alpha_3 \Delta \ln YC_t + \varepsilon_t \qquad (6)$$

$$INQ_t = \alpha_1 \ln YC_t + \alpha_2 (\ln YC_t)^2 + \alpha_3 \Delta \ln YC_t + \varepsilon_t \qquad (7)$$

where:

Δ – first increments ($\Delta \ln YC_t = \ln YC_t - \ln YC_{t-1}$).

In all functions (1)-(7) the estimates of α_1 should be positive, whereas those of α_2 – negative. Turning points – i.e. levels of *per capita* GDP, YC^*, over which the inequality starts declining, are as follows:

a) for functions (1) and (2): $YC^* = -\frac{1}{2} \cdot \frac{\alpha_1}{\alpha_2}$

b) for functions (3) and (4): $YC^* = \exp(-\frac{1}{2} \cdot \frac{\alpha_1}{\alpha_2})$

c) for function (5): $YC^* = \sqrt{\alpha_2 / \alpha_1}$

d) for functions (6) and (7): $YC^* = \exp[-\frac{1}{2} \cdot \frac{(\alpha_1 + \alpha_3)}{\alpha_2}]$

Beside research into the simple Kuznets hypothesis there are a lot of empirical analyses verifying the augmented Kuznets hypothesis. The number of additional variables in such investigations is – as already mentioned – substantial, whereas the functional forms are usually extensions of the functions presented above. Thus, typical regression equations are then as follows:

$$INQ_t = \alpha_0 + \alpha_1 YC_t + \alpha_2 YC_t^2 + \sum_{i=1}^{K} \beta_i X_{it} + \varepsilon_t \tag{8}$$

$$INQ_t = \alpha_1 YC_t + \alpha_2 YC_t^2 + \sum_{i=1}^{K} \beta_i X_{it} + \varepsilon_t \tag{9}$$

$$INQ_t = \alpha_0 + \alpha_1 \ln YC_t + \alpha_2 (\ln YC_t)^2 + \sum_{i=1}^{K} \beta_i X_{it} + \varepsilon_t \tag{10}$$

$$INQ_t = \alpha_1 \ln YC_t + \alpha_2 (\ln YC_t)^2 + \sum_{i=1}^{K} \beta_i X_{it} + \varepsilon_t \tag{11}$$

where:

X_{it} – the i-th explanatory variable (see section 2) in the t-th period/country,

β_i – structural parameters,

K – number of explanatory variables (exclusive of *per capita* GDP).

Formulae (1)-(7) mark general framework of specification of equations applied to verify the simple Kuznets hypothesis, whereas formulae (8)-(11) – to verify the augmented Kuznets hypothesis.

It is worth mentioning that confirmation of the simple Kuznets hypothesis brings on some weighty normative conclusions. If the hypothesis holds, then macroeconomic policies should be focused on economic growth rather than on income redistribution issues. It follows from the hypothesis that in the long run a decline in income inequality is a foregone conclusion, providing the country is on a long term growth trajectory. Thus, any attempts to intervene into the existent income distribution are ineffective (see Atkinson, 1999). However, if the simple Kuznets hypothesis does not hold, then it is crucial to identify other – apart from *per capita* GDP – macroeconomic determinants of inequality. Quantification of their impact – by means of estimating the augmented Kuznets curve – enables identification of the most effective instruments/variables, from among statistically significant ones, to affect income concentration.

The outcomes of empirical investigations into the Kuznets hypothesis are not univocal, and the conclusions drawn depend, to a large degree, upon the following elements:

1) Type of data used: time series, cross-sectional, panel

Research based on time series data are relatively scarce and confirm the credibility of the simple Kuznets hypothesis only for a few countries (see e.g. Ahluwalia, 1976; or Papanek and Kyn, 1986). In turn, investigations based on cross-sectional or panel data usually confirm the legitimacy of the simple Kuznets hypothesis, providing some observations are treated by dummies, especially some Latin American, African or Asian countries (Campano and Salvatore, 1988).

2) Selection of research objects (countries) and quality of data

The more homogenous and reliable the sample and the data are, the more conclusive the final results are (see e.g. Deininger and Squire, 1996; or Thornton, 2001).

3) Sample period

Earlier investigations – from the 1960s and 1970s – confirm the relevance of the simple Kuznets hypothesis, whereas the conclusions drawn on the basis of the analyses carried out in the 1990s are less univocal (see e.g. Polak and Williamson, 1991; Anand and Kanbur, 1993; or Li, Squire and Zou, 1998).

4) Type of hypothesis: simple *versus* augmented

The vast majority of research into the augmented Kuznets hypothesis confirm its credibility, although sets of variables used in such investigations are very diversified (see e.g. Milanovic, 1994; Barro, 2000; Bulir, 2001; or Iradian, 2005).

4. THE DATA

The present investigation into the Kuznets hypothesis for Poland is based on annual macroeconomic data covering the years 1974-2005. In particular:

a) As a measure of inequality the Lorenz wage concentration ratio is utilized, whose values for the years 1980-2005 are taken from an investigation by Kumor (2006). For the 1970s appropriate values of the ratio under consideration are derived by means of own computations based on decile distribution of wages contained in the official Statistical Yearbooks of

Poland. The principles of construction of the Lorenz wage concentration ratio are the same as in the case of the Gini index as both the measures rest on the Lorenz concentration curve. The Gini coefficient is the most frequently used measure of income – but not wage inequality. However, long enough series of the Gini index are not available for Poland. Still, between both indicators there is a high correlation. Besides, income differentiation is in the first place caused by wage differentiation (e.g. Milanovic, 1999), which fully justifies usage of the wage concentration ratio while verifying the Kuznets hypothesis.

b) GDP, imports and exports – in constant prices of 1995 – are taken from databases of W8 models for Poland, elaborated at the Chair of Econometric Models and Forecasts, University of Lodz, Poland (see Florczak, 2003).

c) Demographic data (population, population growth) is taken from the Demographic Yearbooks of Poland.

d) Foreign direct investments (balance) are derived from the balance of payments for Poland.

e) Inflation rate, unemployment rate, urbanization ratios – on the basis of the Statistical Yearbooks of Poland.

f) Share of people with tertiary education in the total population stands for a proxy of human capital: Statistical Yearbooks of Poland.

g) Share of state employment in total employment: Statistical Yearbooks of Poland.

Trajectories of growth of all the variables used in the present research are depicted in figure 2, whereas in table 1 are shown their coefficients of correlation. Moreover, the last column of table 1 reports outcomes of an integration analysis, obtained by means of apparently the most popular analytical tool being the augmented Dickey-Fuller test (due to the space limits of the paper, methodological details were deliberately excluded. The reader can find them in virtually every contemporary handbook of econometrics).

Symbols of variables denote respectively:

GINI – the Lorenz wage concentration ratio,
YC, *YC2* – *per capita* GDP and its square,
LYC, *LYC2* – logarithm of *per capita* GDP and its square,
PNAT – population growth (in %),
HCAP – share of people with tertiary education (in %),
UNR – unemployment rate (in %),

OPEN – share of exports in GDP (in %),
INF – inflation rate (in %),
FDI – share of foreign direct investments (balance) in GDP (in %),
URB – urbanization ratio (in %),
RELN – share of state employment in total employment (in %),
TRAN – share of social transfers in GDP (in %),
U86 – dummy variable taking value of 1 in year 1986 and 0 in the other years.

Table 1

Coefficients of linear correlation within the years 1974-2005 between the variables used in the research, and order of integration of the variables, obtained by means of the augmented Dickey-Fuller test (ADF)

Variable	*GINI*	*YC*	*LYC*	*YC2*	*LYC2*	*1/YC*	*PNAT*	*HCAP*	*UNR*	*OPEN*	*INF*	*FDI*	*URB*	*RELN*	*TRAN*	**ADF**
GINI	1.000	0.806	0.788	0.818	0.797	-0.764	-0.649	0.879	0.872	0.703	-0.358	0.760	0.488	-0.907	-0.746	*I(1)*
YC	0.806	1.000	0.997	0.997	0.999	-0.986	-0.508	0.799	0.545	0.822	-0.298	0.802	0.201	-0.622	-0.499	*I(2)*
LYC	0.788	0.997	1.000	0.986	0.999	-0.997	-0.497	0.759	0.513	0.810	-0.304	0.765	0.176	-0.595	-0.481	*I(1)*
YC2	0.818	0.997	0.986	1.000	0.992	-0.969	-0.512	0.833	0.571	0.828	-0.289	0.834	0.222	-0.642	-0.511	*I(2)*
LYC2	0.797	0.999	0.999	0.992	1.000	-0.993	-0.503	0.777	0.528	0.816	-0.302	0.781	0.187	-0.608	-0.490	*I(2)*
1/YC	-0.764	-0.986	-0.997	-0.969	-0.993	1.000	0.481	-0.713	-0.475	-0.793	0.308	-0.724	-0.148	0.562	0.458	*I(1)*
PNAT	-0.649	-0.508	-0.497	-0.512	-0.503	0.481	1.000	-0.656	-0.703	-0.284	-0.077	-0.498	-0.696	0.756	0.768	*I(0)*
HCAP	0.879	0.799	0.759	0.833	0.777	-0.713	-0.656	1.000	0.823	0.613	-0.123	0.838	0.632	-0.862	-0.753	*I(2)*
UNR	0.872	0.545	0.513	0.571	0.528	-0.475	-0.703	0.823	1.000	0.522	-0.205	0.577	0.666	-0.966	-0.795	*I(1)*
OPEN	0.703	0.822	0.810	0.828	0.816	-0.793	-0.284	0.613	0.522	1.000	-0.319	0.704	-0.081	-0.536	-0.248	*I(1)*
INF	-0.358	-0.298	-0.304	-0.289	-0.302	0.308	-0.077	-0.123	-0.205	-0.319	1.000	-0.197	0.212	0.141	-0.040	*I(0)*
FDI	0.760	0.802	0.765	0.834	0.781	-0.724	-0.498	0.838	0.577	0.704	-0.197	1.000	0.309	-0.641	-0.532	*I(1)*
URB	0.488	0.201	0.176	0.222	0.187	-0.148	-0.696	0.632	0.666	-0.081	0.212	0.309	1.000	-0.709	-0.779	*I(0)*
RELN	-0.907	-0.622	-0.595	-0.642	-0.608	0.562	0.756	-0.862	-0.966	-0.536	0.141	-0.641	-0.709	1.000	0.866	*I(1)*
TRAN	-0.746	-0.499	-0.481	-0.511	-0.490	0.458	0.768	-0.753	-0.795	-0.248	-0.040	-0.532	-0.779	0.866	1.000	*I(1)*

Source: own computations

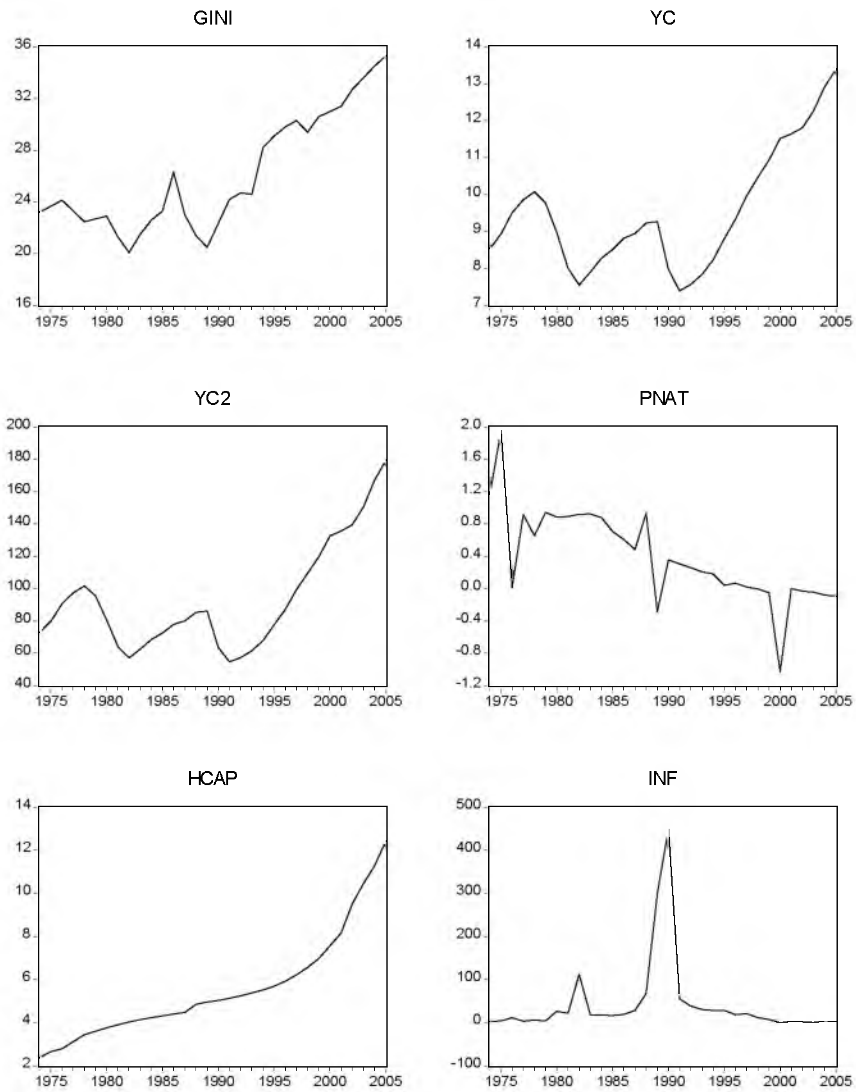


Figure 2. continued on the next page

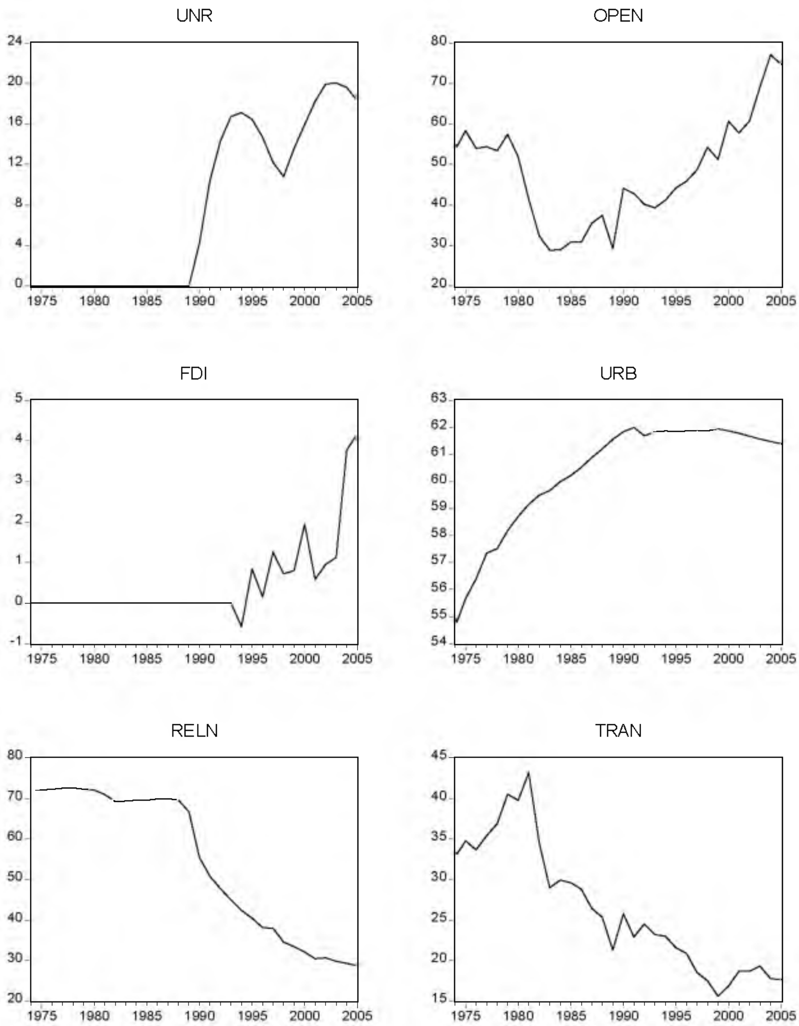


Figure 2. Trajectories of growth of the variables used in the analysis

Source: own elaboration

Conclusions one can draw on the basis of the correlation, integration, and graphical analyses can be summarized as follows:

a) Except for *INF* and *URB* all the other variables exhibit – with respect to the explained variable – correlations that are consistent – in signs – with theoretical postulates (see section 2).

b) Correlation coefficients between explanatory variables are high and many a time even higher than correlation coefficients between these variables and the regressand, which might lead to multicollinearity problems in the regression analysis.

c) Variances of all the variables are quite high.

d) The explained variable, *GINI,* exhibits not quite explainable jump in the year 1986. Graphical analysis of the growth trajectories of the other variables does not, however, identify any abrupt changes in that year, which prompts us to regard that observation as an outlier.

e) Variables *PNAT*, *INF* and *URB* are integrated in order 0, which makes us regard these variables as short-term determinants of inequality only because *GINI* is integrated in order 1.

f) The integration analysis shows that verification of the simple Kuznets hypothesis, using formulae 3-7, must lead to spurious regressions. This is so because in equations 3-4 and 6-7 variable *YC2* is integrated of order 2 (*YC2~I(2)*), whereas the explained variable is integrated of order 1 (*GINI~I(1)*), which – under the lack of other regressors integrated of order 2 (ln*YC~I(1)* – then by definition: Δln*YC~I(0)*) – must result in spurious regression (see e.g. Welfe, Majsterek, Florczak, 1994). By the same token, in equation 5 we have *YC~I(2)* and *1/YC~I(1)*, whereas *GINI~I(1)*.

g) For the reasons outlined above, for the augmented Kuznets hypothesis to hold it is necessary for variable *HCAP* to be present in the regression equation since it is the only variable – apart from *per capita* GDP and its square – integrated of order 2 (*HCAP~I(2)*).

5. THE RESULTS

Table 2 reports the outcomes of estimation of equations 1-7 verifying the simple Kuznets hypothesis. In the parentheses are given absolute values of Student's *t*-statistics, whereas the last three lines contain respectively:

- $\bar{R}^2$ – adjusted coefficient of determination: measure of goodness of fit,
- D-W – Durbin-Watson statistics: verification of possible autocorrelation of disturbance term,
- ADF – augmented Dickey-Fuller test: verification of stationarity of disturbance term.

The research outcomes do not confirm the relevance of the simple Kuznets hypothesis for Poland (using a dummy for 1986 as an additional regressor in the variants reported in table 2 does not qualitatively change the obtained results). Instead of the *U*-inverted curve, meant to describe the apparent relation between *per capita* GDP and wage inequality, the results seem to indicate quite the opposite: inequality is increasing in line with economic growth. Still, even such an unexpected conclusion is not fully justified in the light of the outcomes. Even a cursory statistical inference indicates an absolute rejection of the assumed hypothesis: low coefficients of determination, autocorrelation of error term and its non-stationarity in the first place make any further statistical inference useless. In the period under investigation there was no simple relationship between aggregate economic inequality and *per capita* GDP growth. Any possible causal link between these variables must allow for the impact of other factors, which leads directly to the formulation and verification of the augmented Kuznets hypothesis.

Table 2

Estimates of equations 1-7 of the simple Kuznets hypothesis

Equation	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Constant	33.809 (1.87)		195.52 (2.14)		-57.596 (1.63)	255.37 (2.86)	
YC	-3.648 (1.01)	3.11 (10.19)			5.354 (3.00)		
YC2	0.290 (1.63)	-0.038 (1.28)					
LYC			-170.37 (2.13)	1.299 (0.42)		-220.97 (2.83)	2.516 (0.78)
LYC2			42.08 (2.40)	4.595 (3.36)		52.614 (3.09)	4.013 (2.82)
1/YC					303.62 (1.77)		
$\Delta \ln YC$						20.209 (2.25)	12.574 (1.29)
$\overline{R}^2$	0.646	0.602	0.652	0.595	0.652	0.696	0.604
D-W	0.37	0.39	0.38	0.38	0.38	0.62	0.48
ADF	-1.66	-1.77	-1.70	-1.73	-1.69	-2.34	-2.04

Source: own computations

Table 3 reports the estimates of the augmented Kuznets curve. While establishing the set of diagnostic checks, we aimed at taking into account the realization of the Gauss-Markov theorems (see e.g. Welfe, 2004, pp. 64-66). Due to the space limits of the paper, methodological details were deliberately excluded. The reader can find them in virtually every contemporary handbook of econometrics (see e.g. Greene, 1993; or Welfe, 2004). Eventually, the following set of diagnostic tests and measures was employed:

- Wh – White test: to verify the homogeneity of the disturbance term,
- J-B – Jarque-Bera test: to verify the normality of the error term distribution,
- RES – test RESET: to verify possible specification errors,
- H-C – Harvey-Collier test: to verify the stability of structural parameters.

In appropriate columns of table 3, for $\overline{R}^2$, D-W, H-C and ADF, test values are reported, whereas in columns for J-B, Wh and RES *p*-values are given.

Table 3. Estimates of the augmented Kuznets hypothesis

No	*Const*	*YC*	*YC2*	*LYC*	*LYC2*	*PNAT*	*HCAP*	*UNR*	*INF*	*OPEN*	*FDI*	*URB*	*RELN*	*TRAN*	*U86*	$\overline{R}^2$	D-W	J-B	Wh	RES	H-C	ADF
1	25.91 (1.47)	9.412 (2.96)	-0.512 (2.76)			-0.144 (0.25)	1.419 (2.43)	0.024 (0.23)	-0.006 (2.42)	0.029 (0.65)	0.655 (1.65)	-0.716 (2.67)	-0.144 (2.63)	-0.012 (0.22)	4.058 (4.43)	0.965	2.05	0.88	0.52	0.67	2.20	-5.68
2	-	11.606 (4.01)	-0.634 (3.70)			-0.004 (0.01)	1.538 (2.60)	0.067 (0.65)	-0.006 (2.48)	0.056 (1.36)	0.845 (2.19)	-0.526 (2.17)	-0.098 (2.11)	-0.015 (0.27)	3.966 (4.22)	0.963	2.06	0.84	0.70	0.43	0.60	-5.57
3	-187.0 (2.67)			232.40 (3.41)	-52.90 (3.32)	-0.295 (0.56)	1.396 (2.96)	-0.013 (0.13)	-0.007 (2.90)	0.039 (0.94)	0.415 (1.20)	-0.681 (2.94)	-0.164 (3.33)	-0.011 (0.21)	3.970 (4.70)	0.971	2.08	0.50	0.72	0.53	1.94	-5.85
4	-			54.57 (3.38)	-11.39 (2.80)	0.057 (0.10)	0.460 (1.28)	0.021 (0.19)	-0.005 (2.15)	-0.000 (0.00)	0.294 (0.75)	-0.512 (2.01)	-0.190 (3.44)	-0.013 (0.22)	4.134 (4.30)	0.962	1.72	0.71	0.76	0.04	1.15	-4.79
5	35.665 (3.23)	8.788 (3.11)	-0.471 (2.91)				1.323 (2.91)		-0.006 (3.18)		0.653 (1.99)	-0.785 (3.88)	-0.178 (8.57)		3.956 (4.72)	0.970	1.98	0.82	0.32	0.37	1.96	-5.50
6	-	11.814 (4.59)	-0.650 (4.37)				1.642 (3.58)		-0.007 (3.77)	0.063 (2.72)	0.794 (2.39)	-0.518 (2.43)	-0.128 (7.56)		3.970 (4.47)	0.967	1.97	0.95	0.61	0.31	2.32	-5.27
7	-154.4 (2.62)			206.82 (3.54)	-46.546 (3.45)		1.216 (3.48)		-0.006 (3.49)		0.497 (1.77)	-0.744 (4.47)	-0.187 (10.40)		3.853 (4.93)	0.974	2.04	0.66	0.53	0.13	1.71	-5.68
8	-			56.822 (5.98)	-11.924 (4.86)		0.616 (3.19)		-0.006 (3.08)			-0.556 (3.64)	-0.200 (10.65)		4.140 (4.81)	0.968	1.63	0.58	0.30	0.01	1.65	-4.54
9	30.172 (1.99)	9.824 (3.03)	-0.517 (2.79)				1.222 (2.32)	0.138 (1.53)	-		0.845 (2.15)	-0.847 (3.63)	-0.126 (2.53)		4.352 (4.60)	0.961	1.90	0.73	0.15	0.94	2.60	-5.29
10	-	13.284 (4.57)	-0.697 (4.06)				1.376 (2.49)	0.243 (3.14)	-		1.222 (3.34)	-0.712 (3.00)	-0.052 (1.48)		3.974 (4.05)	0.956	1.98	0.08	0.17	0.31	1.57	-5.32
11	-159.2 (2.26)			209.52 (3.02)	-46.72 (2.92)		1.048 (2.44)	0.122 (1.40)	-		0.636 (1.82)	-0.791 (3.85)	-0.145 (3.11)		4.278 (4.67)	0.964	1.85	0.32	0.17	0.33	2.38	-5.22
12	-			45.067 (4.68)	-8.492 (3.48)			0.151 (1.86)	-		0.616 (2.19)	-0.420 (3.22)	-0.153 (3.31)		4.552 (4.63)	0.957	1.58	0.87	0.42	0.13	1.60	-4.39

Source: own calculations

The first 4 rows of table 3 contain the estimates of equations 8-11 (see section 3), obtained by incorporating all the variables described in section 2. Let us notice that the working hypothesis about the outlying value of *GINI* in the year 1986 has been statistically proved (variable *U86* is significant in all the variants). It is also worth emphasizing that – unlike the simple Kuznets hypothesis – in initial specifications the hypothesis already seems to hold: signs of the estimates at *YC*(*LYC*) and *YC2*(*LYC2*) are in line with the theory and the variables themselves turn out to be statistically significant. Besides – except for variant [4] (specification errors signaled by RESET) – all the diagnostic checks indicate the acceptance of the obtained results. However, in variants 8-11 some explanatory variables are statistically insignificant and some estimates have even signs inconsistent with theoretical findings. The cause of such a state of affairs is multicollinearity, and thus any attempts to arrive at credible results must allow for this fact.

Econometrics postulates some ways to ameliorate the problem, for which, however, the satisfactory, final solution cannot be found. From among the existing proposals the most frequently employed seems to be a heuristic method of data mining. There are a few specific approaches to the problem.

The first one – of very limited practical value – boils down to estimating all the possible combinations of exogenous variables under consideration, and selecting afterwards the most promising variant, from the viewpoint of some criteria. In the case of equations 7 and 9 this would mean the necessity to estimate $2^{13} = 8192$ variants, whereas in the case of models 8 and 10: $2^{12} = 4096$ variants. Little wonder then that practical implementations of this technique are scarce and can be found rather in more theoretical analyses than in purely empirical research (e.g. Sala-i-Martin, 1997).

The second approach – *specific to general* – consists in a sequential addition of successive variables to an initial one-variable model, with the variable being the one with the highest coefficient of correlation with the regressand. New regressors are introduced into the gradually swelling model in order of their significance in explaining the variance of the endogenous variable (measured by means of the Student's *t*-statistic). The search algorithm stops if none of the remaining candidate variables, when introduced to already fixed model, shows appropriate statistical significance.

The third approach – *general to specific* – starts with the most general (unrestricted) model. Then, variables with the lowest *t*-values are, one by one, excluded from the specification until all the variables that remain in the model are statistically significant.

Finally, the fourth approach is a combination of approach 2 and 3: a variable with the lowest *t*-value is replaced by a variable with the highest correlation with the regressand.

All the above-outlined techniques constitute the essence of the data mining procedure, when a researcher aims at arriving at an acceptable final version of a model. Due to quantifiability of the entry/exit rules the procedure can be easily algorithmized. There are a lot of computer packages (e.g. RATS that has been used in the present research) with an in-built block of step-wise regression, which is just another name for the techniques described above. Its usage saves the researcher's time and efforts while searching for the best model. One should, however, bear in mind that a sensible use of the step-wise regression requires an assistance on the side of the researcher. This is so because one might end up in nonsensical final results while uncritically implementing the method. The necessity to interfere with the algorithm may stem from the fact that the program might "regard" a given variant of the model as the best one (on the basis of goodness of fit or statistical significance of regressors), even if such a variant is inconsistent with theoretical prerequisites (e.g. parameter signs contradict the theory).

In rows [5]-[8] of table 3 are presented the outcomes of estimation of equations (8)-(11) by means of step-wise regression in *general to specific* manner. Just as expected through step-wise regression functions, all the explanatory variables that remain in the model are now statistically significant either at 10% or – more often – at 5% significance level. Except for variant [8] (specification errors signaled by RESET and possible autocorrelation indicated by D-W) – all the diagnostic checks suggest acceptance of the results.

In the variants under consideration – except for [6] – the set of explanatory variables is the same. Variables rejected – due to their statistical insignificance – are: *PNAT*, *UNR OPEN* (present in variant [6]) and *TRAN*. Their lack in the considered variants, except for *UNR*, can be easily justified on logical grounds. Statistically significant impact of *PNAT* upon economic inequality is, in principle, confirmed only by panel data investigations due to underdeveloped countries – typified by high population growth – that are present in such samples. In turn, variable *OPEN* is a clear alternative to *FDI*, both in economic and statistical (see table 1) aspects. Finally, variable *TRAN* does not seem necessary, bearing in mind the fact that the explained variable is the Lorenz wage, not income, concentration ratio and that *TRANS* might be regarded as an alternative to *RELN* (see correlation coefficient between those variables).

Hitherto the present reasoning prompts us to claim that among variants [5] or [7]-[8] one should appoint the best one. Unfortunately, this is not the case. In all those variants signs at the variable *INF* contradict theoretical findings. Moreover, the variable itself is statistically significant even at 1% significance level and is robust to changes in specifications. It remains so even in the variants – not reported here – in which the impact of a few years of hyperinflation was neutralized by means of appropriate dummies. One must not then find this occurrence incidental. On the other hand, however, one is not allowed to take such perverse results for granted, either. That is why for the purpose of further inference we have decided to exclude this variable from the set of explanatory variables and to re-run the step-wise regression.

Rows [9]-[12] of table 3 report the outcomes obtained by means of step-wise regression under zero restriction imposed on *INF*. Due to the reasons described in section 4g) variant [12] should be found unacceptable. From among variants [9]-[11] the most promising seems variant [10] (see figure 3). The following arguments can be said for it:

a) Unlike variants [9] and [11] the Harvey-Collier test indicates its structural stability within the whole sample period,

b) Variant [10] sustains Ram's critique: the intercept in variant [9] is 30.172, which suggests occurrence of exceptionally high economic inequality even in primary, non-market societies,

c) The number of explanatory variables that are significant at significance level lower than 5% is greater in variant [10] than in variants [9] and [11] (see absolute *t*-values).

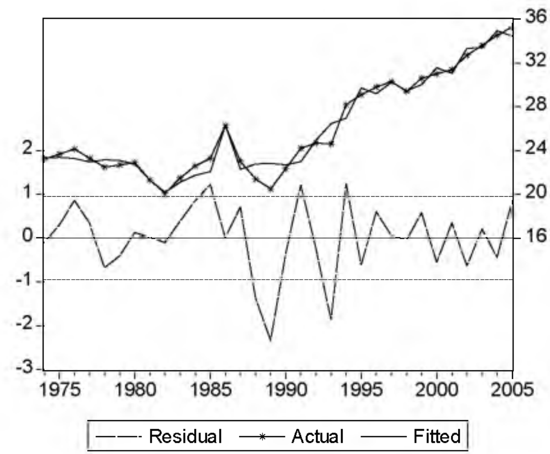


Figure 3. Actual and fitted values of the estimation of variant [10] and estimation residuals

Source: own computations

In order to fully legitimize equation [10] one should verify a hypothesis about the impact insignificance of the variables present in the initial version of the model, i.e. in variant [1] (unrestricted model), but excluded from the final version of the model, i.e. in variant [10] (restricted model). The set of respective hypotheses is as follows:

$H_0 : \alpha_0 = \beta_1 = \beta_4 = \beta_5 = \beta_9 = 0$

against:

H_1 : at least one of the above parameters is not zero,

where:

α_0 and β_i are structural parameters present in equation [1] but excluded from equation [10], i.e. parameters standing at the following variables: intercept, *PNAT*, *INF*, *OPEN* and *TRAN*.

To verify the above hypotheses one can use the *F*-statistic (see e.g. Gujarati, 1995, p. 260):

$$F = \frac{(R_{UR}^2 - R_R^2)/m}{(1 - R_{UR}^2)/(n-k)} \qquad (12)$$

where:

R_{UR}^2 – coefficient of determination in the unrestricted model (variant [1]),

R_R^2 – coefficient of determination in the restricted model (variant [10]),

m – number of restrictions,

n – number of observations,

k – number of structural parameters in the unrestricted model.

Statistic (12) is *F*-distributed with *m* and *n-k* degrees of freedom.

In our case:

$F = \frac{(0.999403 - 0.999048)/5}{(1 - 0.999403)/(32 - 13)} = 2.259631$, which corresponds to *p*-value of 0.0897. One is then allowed to state that it is the following variables that influenced the wage inequality in Poland in the years 1974-2005: *YC*, *YC2*, *HCAP*, *UNR*, *FDI*, *URB* and *RELN*.

Significance of explanatory variables, right signs of structural parameters as well as the exhaustive statistical inference, all of it speaks for the existence of the augmented Kuznets curve in Poland. An increase in *per capita* GDP leads initially to a rise in wage inequality but after having exceeded the level of PLN 9.5 thousand (in constant 1995 prices) any further increase should result in a diminution in wage concentration. Interpretation of the other estimates is straightforward: an increase by one percentage point in the value of a given explanatory variable leads – *ceteris paribus* – to an increase (in the case of *HCAP*, *UNR*, *FDI*) or to a decrease (*URB* and *RELN*) in the explained variable by a value equal to the appropriate estimate, expressed in percentage points, too. It is worth mentioning that the turning point value of the *per capita* GDP – after which *ceteris paribus* economic inequalities should be declining – is relatively robust to any of the specifications analyzed, oscillating around PLN 9.5 thousand.

It follows from historical data that the hypothetical value of PLN 9.5 thousand, over which one should expect a decline in wage discrepancies, was reached at the turn of 1996. However, ever since then the wage inequality has been growing. Yet it is not difficult to identify the reasons behind such a state of affairs using our model.

Figures 4a-4d present a decomposition of all the factors influencing wage inequality by the following layout:

a) Changes in *per capita* GDP (figure 4a).

It's worth noticing that – had it not been for the other factors – the actual inequality would be much higher than in reality. It is only over the last five years that one can observe an increasing role of *per capita* GDP in diminishing the inequality.

b) Stimulants of inequality (figure 4b).

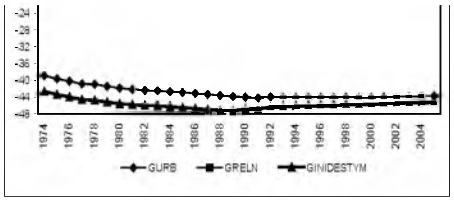
The stimulants are typified by high dynamics. Human capital has exhibited an exponential growth since the mid 1990s. Unemployment – an adverse and conspicuous sign of transformation – affects the inequality in considerable way, whereas the impact of foreign direct investments also intensifies at the end of the sample.

c) Destimulants of inequality (figure 4c).

Among the destimulants the key role plays the urbanization ratio, although – unlike the other destimulant – its variance is relatively low. Despite a considerable drop in the share of state employment, this factor's impact upon the wage concentration is negligible due to the small absolute value of the estimate at that variable.

d) Composition of factors' groups (figure 4d).

It follows from figure 4d that the main reason why economic inequality has been growing ever since the beginning of the transformation are the inequality stimulants. Although since the mid 1990s one can observe an ameliorating impact of the *per capita* GDP growth upon the wage concentration, this factor by itself is not able to counterbalance the increases in the stimulants of the economic inequality, all the more so as at the same time the destimulants show signs of abating.



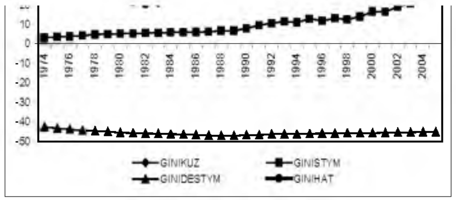


Figure 4a. Decomposition of changes in *per capita* GDP upon wage concentration ratio

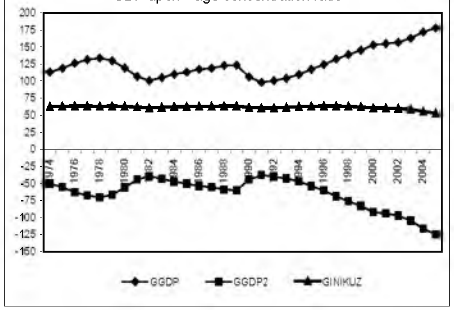


Figure 4b. Decomposition of the impact of stimulants of wage concentration ratio

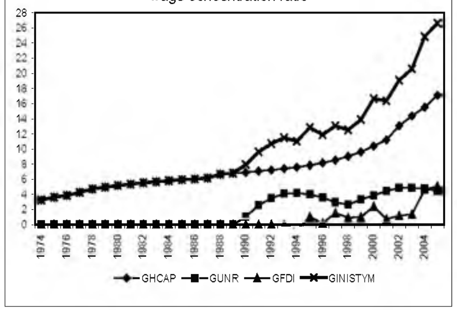


Figure 4c. Decomposition of the impact of destimulants of wage concentration ratio

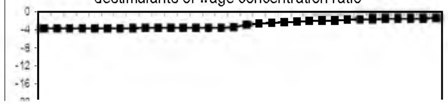
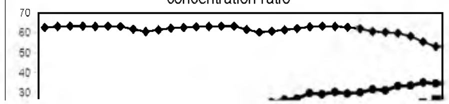


Figure 4d. Decomposition of factor groups on wage concentration ratio



Source: own elaboration

6. FINAL REMARKS

Once the process of identification and quantification of the macroeconomic determinants of the economic inequality is over, it seems natural to ask about the possible changes of this category in the future. As already mentioned, an answer to such a question has a crucial bearing on a lot of weighty socio-economic issues.

Yet it is by no means easy to find a right answer, especially if short- and medium-term forecasts are concerned. As for the long run a decline in the inequality seems a foregone conclusion because long term perspectives of growth for the inequality stimulants are limited, whereas the Kuznets effect, strengthened by the ongoing urbanization, will – sooner or later – prevail. Still, in the short run one might expect a further rise in the inequality, mainly due to increases in human capital, continuation of privatization, intensification of FDI inflows, and a diminution in administration employment. On the other hand, however, these tendencies might be counterbalanced by a considerable drop in unemployment and quick economic growth, so that the final effect will be a resultant of the signaled processes. In general, it seems that a quantifiable answer to the question about the possible short-term changes in the economic inequality would require a construction of a multi-equation model, in which thus far explanatory variables would be an *explicit* subject of investigation in their mutual interlinks.

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