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## STATISTICAL TIME SERIES ANALYSIS OF MACRO INDICATORS OF EDUCATIONAL, PROFESSIONAL AND FAMILY CAREERS OF WOMEN IN POLAND

**Abstract.** Educational, professional and family careers can promote each other, but more often they compete with each other, especially in a case of women. These careers change over time. This article aims to analyze changes over time of selected macro indicators, describing the careers of women in Poland. Analyses of macro indicators' trends and inequality between women and men were performed. Data came from the Polish Central Statistical Office's publications.

**Key words:** educational career, professional career, family career.

### I. INTRODUCTION

Both men and women do educational, professional and family careers in their lives. It is worth noting that educational career competes with a professional career in a short run. People delay beginning the first job if they attend schools or they spend less time on education if they start the first job early. However, educational career promotes professional career in a long run since it increases possibility of undertaking a better job and getting a higher salary. Family career competes with both educational and professional careers, because a problem of time allocation between education, professional work and family occurs. It seems to be of special importance for women who are more predisposed to keeping house and caring for children and old ancestors. These issues are discussed, among others, in such publications as Kotowska (2009) and Kotowska, Sztanderska, Wóycicka (2007). Educational, professional and family careers change over time. This article aims to analyze changes over time of selected macro indicators, describing these careers of women in Poland.

### II. STATISTICAL DATA AND METHODS

In this investigation CSO's aggregated data from: Concise Statistical Yearbook of Poland, Demographic Yearbook of Poland, Statistical Yearbook of

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the Republic of Poland and CSO's Internet web sides were used. Data of professional career were obtained from Labour Force Survey, conducted by CSO every quarter since 1992.

In order to evaluate changes over time of selected macro indicators, describing the careers of women in Poland, analyses of linear and non-linear trends were performed. To compare careers' macro indicators between women and men, relative inequality coefficient ( $I \in <0,1>$ ;  $I=0$  total equality,  $I=1$  total inequality) and absolute inequality coefficient (MSE) were used. Although MSE (mean square error) is usually used to obtain ex post errors of forecasting, estimation or prediction (Welfe, 1998; Kukula, 1999), was adopted to compare indicators between women and men in this investigation.

Absolute inequality coefficient is given by a formula and can be decomposed into 3 components:

$$MSE = \frac{1}{n} \sum_{t=1}^n (y_{t,F} - y_{t,M})^2 = (\bar{y}_F - \bar{y}_M)^2 + (s_F - s_M)^2 + 2s_F s_M (1 - r_{F,M}) \quad (1)$$

where:

$y_{t,F}$  – macro indicator for female in the  $t$ -th time period,  $t=1, 2, \dots, n$ ;

$y_{t,M}$  – the same macro indicator for male in the same  $t$ -th time period;

$\bar{y}_F, \bar{y}_M$  – means of macro indicators of  $n$  time periods for female and male, respectively;

$s_F, s_M$  – standard deviations of macro indicators for female and male, respectively;

$r_{F,M}$  – correlation coefficient between macro indicator for male and female of  $n$  time periods.

Relative inequality coefficient is given by a formula:

$$I = \frac{\sqrt{MSE}}{\sqrt{\frac{1}{n} \sum_{t=1}^n y_{t,F}^2 + \frac{1}{n} \sum_{t=1}^n y_{t,M}^2}} \quad (2)$$

The share of 3 components in MSE is given by formulas:

$$I_1 = \frac{(\bar{y}_F - \bar{y}_M)^2}{MSE} \quad I_2 = \frac{(s_F - s_M)^2}{MSE} \quad I_3 = \frac{2s_F s_M (1 - r_{F,M})}{MSE} \quad (3)$$

### III. POLISH WOMEN'S EDUCATIONAL CAREER

Educational career of women in Poland was described by percentages of population with tertiary, post-secondary or secondary and basic vocational levels of education (Figure 1). Moreover, mentioned above indicators for women were compared with the same indicators for men. Women have been found to have tertiary and post-secondary or secondary educational level more often than men and more rarely – basic vocational.

According to CSO's data, 1.2% of women and 3.1% of men had tertiary educational level in 1960. Both indicators were increasing on average 0.32 percentage point for men and faster for women on average 0.59 p.p. every year. 20.0% of women and 15.3% of men had tertiary educational level in 2010. Linear trends of percentages of population with tertiary educational level are given by: for women  $\hat{y}_{t,F} = 1.62 + 0.59t$ ,  $R^2 = 0.964$ ; for men  $\hat{y}_{t,M} = 4.35 + 0.32t$ ,  $R^2 = 0.878$ .

9.9% of women and 10.7% of men had post-secondary or secondary educational level in 1960. 35.3% of women and 31.8% of men had post-secondary or secondary educational level in 2010. This indicator for men was increasing on average 0.59 p.p. every year, but the indicator for women change non-linearly (it increased until year 1999, then decreases). The trends of percentages of population with post-secondary or secondary educational level are given by: for women  $\hat{y}_{t,F} = -0.09t^2 + 3.44t + 9.77$ ,  $R^2 = 0.875$ ; for men  $\hat{y}_{t,M} = 0.59t + 15.81$ ,  $R^2 = 0.867$ .

1.5% of women and 5.1% of men had basic vocational level of education in 1960. Both indicators change non-linearly: increased until year 1998, then decreases. 16.4% of women and 28.3% of men had basic vocational level of education in 2010. Non-linear trends are given by: for women  $\hat{y}_{t,F} = -0.07t^2 + 2.51t + 2.16$ ,  $R^2 = 0.832$ ; for men  $\hat{y}_{t,M} = -0.11t^2 + 3.85t + 9.13$ ,  $R^2 = 0.821$ .

The largest difference between women and men was observed in percentage of basic vocational level of education ( $I=0.28$ ), then post-secondary or secondary ( $I=0.17$ ) and the smallest difference – tertiary (0.14), (Table 1). All pairs of percentages (for women and men) were strongly positively correlated. Percentages of women and men with tertiary educational level had the largest share of the second components in MSE. It means that the difference between women and men in these percentages were caused mainly by differences in relative variation. Percentages of women and men with post-secondary or secondary and basic vocational levels of education had the largest share of the first components in MSE. It means that the difference between women and men in these percentages were caused mainly by differences in average values of these percentages.

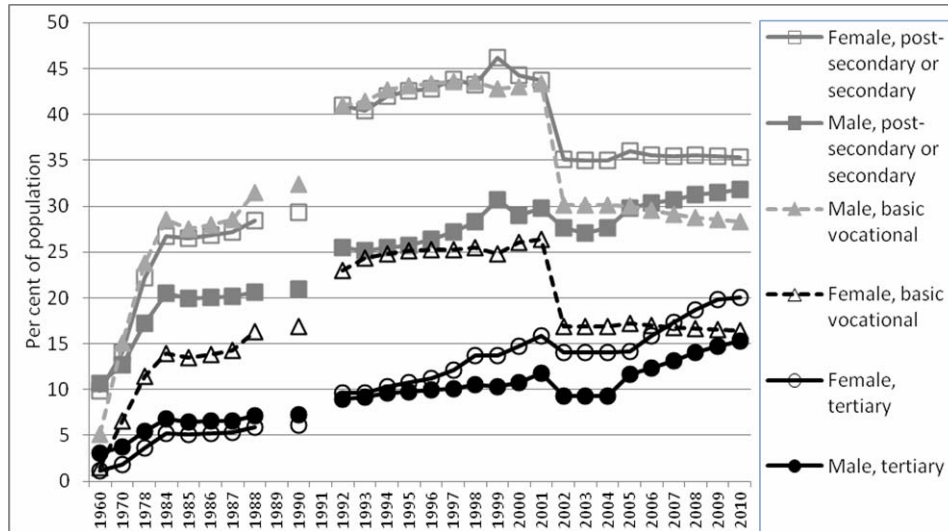


Figure 1. Educational level structure by gender in Poland in 1960–2010

Source: own analysis based on CSO's data.

Table 1. Comparison of educational level structure by gender

Educational level	$RMSE$	$I$	$\bar{y}_F - \bar{y}_M$	$S_F - S_M$	$r_{F,M}$	$I_1$ (%)	$I_2$ (%)	$I_3$ (%)
Tertiary (%)	3.02	0.14	1.63	2.37	0.97	29.18	61.85	11.59
Post-secondary or secondary (%)	10.57	0.17	9.16	3.43	0.83	75.08	10.54	15.31
Basic vocational (%)	14.77	0.28	-14.39	-3.17	0.99	95.02	4.62	0.55

Source: own analysis based on CSO's data.

#### IV. POLISH WOMEN'S PROFESSIONAL CAREER

Professional career of women in Poland was described by: activity rate, employment rate and unemployment rate (Figure 2).

Activity rate was estimated at 52.2% for women and 70.0% for men in 1992. It decreases both for women (on average 0.33 p.p., 0.7% every year) and for men (on average 0.30 p.p., 0.5% every year). It can be described as linear or exponential trend (with the similar values of determination coefficients) both for women:  $\hat{y}_{t,F} = 52.70 - 0.33t$ ,  $R^2 = 0.774$  or  $\hat{y}_{t,F} = 52.73 * 0.993^t$ ,  $R^2 = 0.778$ ; for men

$\hat{y}_{t,M} = 67.70 - 0.30t$ ,  $R^2 = 0.585$  or  $\hat{y}_{t,M} = 67.68 * 0.995^t$ ,  $R^2 = 0.545$ . Activity rate was estimated at 48.3% for women and 64.5% for men in the second quarter 2011.

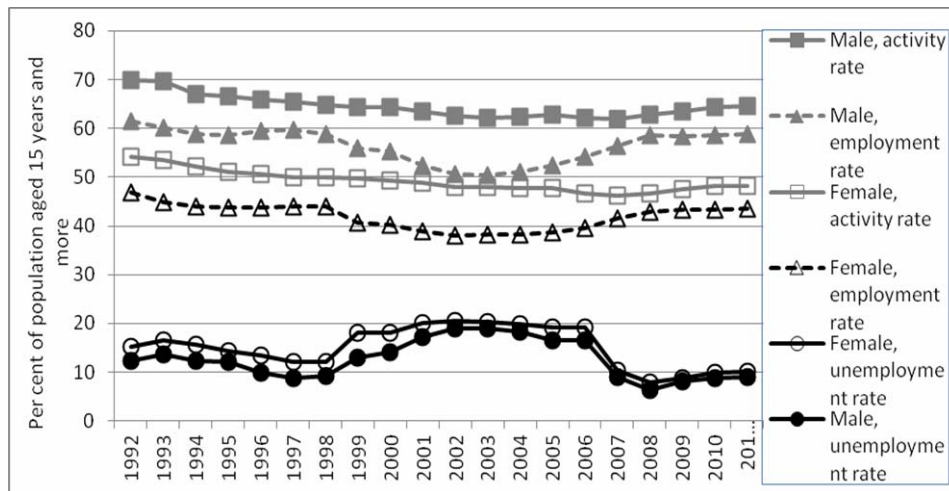


Figure 2. Professional career’s indicators by gender in Poland in 1992–2<sup>nd</sup> quarter 2011  
 Source: own analysis based on CSO’s data.

Employment rate was estimated at 46.8% for women and 61.4% for men in 1992. It changes non-linearly, decreased until 2003, then increased both for women and men. Employment rate was estimated at 43.5% for women and 58.8% for men in the second quarter 2011. It can be described as non-linear trend: for women:  $\hat{y}_{t,F} = -0.0008t^4 + 0.04t^3 - 0.51t^2 + 1.67t + 56.47$ ,  $R^2 = 0.868$ ; for men  $\hat{y}_{t,M} = -0.0014t^4 + 0.06t^3 - 0.94t^2 + 3.81t + 56.47$ ,  $R^2 = 0.823$ .

Unemployment rate was estimated at 15.2% for women and 12.4% for men in 1992. It changes non-linearly both for women and men, it increased until 1993, then decreased until 1998, then increased until 2002, then decreased until 2009, now is growing up. Unemployment rate was estimated at 10.1% for women and 8.9% for men in the second quarter 2011. It can be described as non-linear trend: for women:  $\hat{y}_{t,F} = 0.0025t^4 - 0.11t^3 + 1.63t^2 - 7.88t + 24.62$ ,  $R^2 = 0.733$ ; for men  $\hat{y}_{t,M} = 0.0025t^4 - 0.11t^3 + 1.66t^2 - 8.28t + 22.37$ ,  $R^2 = 0.684$ .

Women have lower activity and employment rates than men and higher unemployment rate (Table 2). The largest difference between women and men was observed in employment rates (I=0.15), then activity rates (I=0.13) and the smallest difference in unemployment rates (0.09). All pairs of rates (for women and men) were strongly positively correlated. All professional careers’ rates had

the largest share of the first components in MSE. It means that the difference between women and men in these rates were caused mainly by differences in average values of these rates.

Table 2. Comparison of professional career's indicators by gender

Indicator	<i>RMSE</i>	<i>I</i>	$\bar{y}_F - \bar{y}_M$	$s_F - s_M$	$r_{F,M}$	$I_1$ (%)	$I_2$ (%)	$I_3$ (%)
Activity rate (%)	15.31	0.13	-15.30	-0.12	0.96	99.84	0.01	0.15
Employment rate (%)	14.61	0.15	-14.58	-0.86	0.98	99.50	0.34	0.16
Unemployment rate (%)	2.65	0.09	+242	+0.26	0.97	82.23	0.96	16.81

Source: own analysis based on CSO's data.

## V. POLISH WOMEN'S FAMILY CAREER

Family career of women in Poland was described by: illegitimate births, average woman's age at the first birth (Figure 3), total fertility rate, percentages of marriages and divorces in population (Figure 4). The first three indicators were described by linear trends, the last two indicators – by non-linear trends, as following formulas:

illegitimate births  $\hat{y}_t = 0.48t - 1.11$ ,  $R^2 = 0.829$ ;

average woman's age at the first birth  $\hat{y}_t = 0.065t + 22.50$ ,  $R^2 = 0.737$ ;

total fertility rate  $\hat{y}_t = -0.0391t + 3.3943$ ,  $R^2 = 0.890$ ;

percentages of marriages  $\hat{y}_t = 0.00001t^4 - 0.0016t^3 + 0.0628t^2 - 0.9699t + 13.231$ ,  $R^2 = 0.883$ ;

percentages of divorces  $\hat{y}_t = 0.00002t^3 + 0.0021t^2 + 0.0817t - 0.0686$ ,  $R^2 = 0.761$ ;

Percentage of illegitimate births was 5.5% in 1970, increasing on average about half percentage point every year, it was 20.6% in 2010. Average woman's age at the first birth was 22.8 in 1970, increasing on average about one month every year, it was 26.0% in 2010. Total fertility rate was 3.7 children per woman in 1970, decreasing on average about 0.04 child per woman every year, it was 1.4 children per woman in 2010. Percentages of marriages was 11.9 in 1946 and 7.0 in 2010, divorces 0.3 and 1.6 respectively.

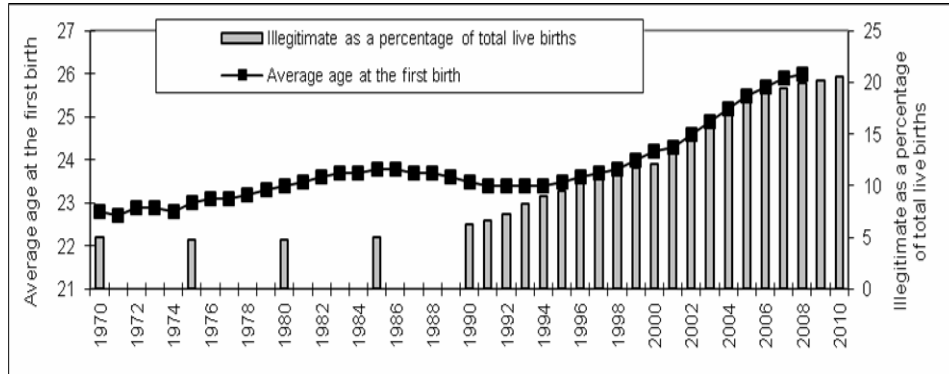


Figure 3. Illegitimate births and average age at the first birth in Poland in 1970–2010  
 Source: own analysis based on CSO’s data.

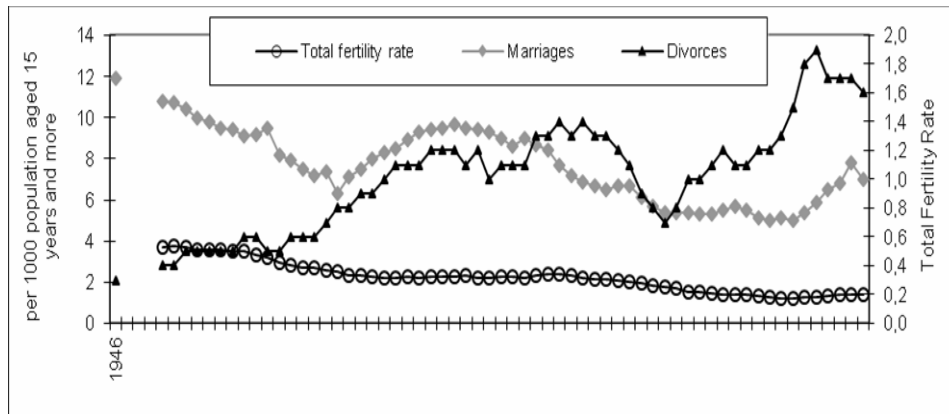


Figure 4. Total fertility rate, marriages and divorces indicators in Poland in 1946–2010  
 Source: own analysis based on CSO’s data.

### VI. CONCLUSIONS

1) Increasing level of education and labor force participation of both women and men, decreasing fertility, the percentage of marriages and increasing women’s average age at the first birth, percentage of divorces and illegitimate births are actually observed in Poland.

2) The difference between percentages of basic vocational educated women and such men was positive and relatively larger whereas the difference between percentages of tertiary and post-secondary or secondary educated women and such men was negative and relatively smaller.

3) The difference between unemployment rates of women and men was positive and relatively smaller whereas the differences between activity rates of women and men and employment rates of women and men was negative and relatively larger.

4) Inequality coefficient is usually used in order to obtain ex post errors of forecasting, prediction and estimation. This coefficient was used to compare educational and professional careers' indicators between women and men. The advantages of this coefficient are: it can be used to measure the relative differences in time and space, between different variables and expressed in different units, as well as it can be divided into three components that show the relative expressed reasons of these differences.

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#### STATYSTYCZNA ANALIZA DYNAMIKI MAKRO-WSKAŹNIKÓW KARIER: EDUKACYJNEJ, ZAWODOWEJ I RODZINNEJ KOBIET W POLSCE

Człowiek w swoim życiu realizuje kariery: edukacyjną, zawodową i rodzinną, które mogą sprzyjać sobie, ale częściej konkurują ze sobą, szczególnie w przypadku kobiet. Kariery te bardzo zmieniają się w czasie. Celem artykułu jest analiza zmian w czasie wybranych makro wskaźników, opisujących te kariery kobiet w Polsce. Na podstawie danych Głównego Urzędu Statystycznego w Polsce przeprowadzono analizę liniowych i nieliniowych trendów tych makro wskaźników oraz analizę rozbieżności w tych makro wskaźnikach między kobietami a mężczyznami.