Potential Job Losses Due to Automation and Its Impact on Poverty Gap in Hungary

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Abstract: - The paper is a first attempt to estimate both the number of potential job losses caused by automation in Hungary and its impact on poverty gap. The job loss is calculated by occupation, while its impact on poverty gap is determined by a static microsimulation model. The unemployment benefit duration in Hungary is the shortest one in the European Union, thus – as expected – the poverty gap will increase even if the present public work program is maintained by the state. It is also determined how much the employment as public workers of those who lose their jobs because of automation costs for the central budget. The estimation of number of job losses and the increase of poverty gap can be considered to be conservative, therefore they can be interpreted as lower bounds.

Key-Words: - automation, job loss, household income survey, microsimulation, poverty threshold, poverty gap

1 Introduction

There seems to be a consensus that the internet will trigger a new industrial revolution generally mentioned briefly as Industry 4.0. The communicating machines, the cyber-physical systems will create a new quality of automation that may significantly increase the productivity in many industries, therefore the computerization can be considered as a driving force of further economic development in the long run. However, such transformation of economic activities may result in problems too: the main concern is that automation will squeeze humans, and several jobs will be lost at least in the short and in the medium term. There are opinions according to which negative social impacts might be persistent, since the ability of adaptation of different social strata can be different, therefore the poverty and the inequalities may further increase due to the Industry 4.0. One thing is certain, the policymaking has to be flexible enough to minimize the possible negative impacts. However, there will be no uniform solutions to treat the problems of the transformation process, since the computerization of activities will depend (amongst others) on economic development level and on the economic structure. The number of automatable tasks are different by industry, and the transformation requires a satisfactory amount of capital at disposal to invest. At the same time the economic level is important from the viewpoint of negative social impacts as well, since the level of social services is obviously lower in relatively underdeveloped countries, and this makes difficult to treat the above mentioned social problems. Thus, country specific analyses are needed to prepare for the transformation, furthermore this requires collaboration of engineers, economists, sociologists, etc. In order to prepare for the transformation, both qualitative and quantitative aspects have to be considered.

Experts and scientists discuss worldwide the possible consequences of the computerization. Surprisingly, it seems that quite a large part of this discussion takes place only in scientific blogs and in popular and professional journals. In spite of the topicality, the number of regular scientific papers is less than one could expect. Several papers discuss the long term positive effects and the necessary steps of adaptation (see e.g. [4], [5], [9], [12], [13], [16] and the references therein). Other papers focus on problems of sustainability including ecological aspects, consequences on employment and on welfare system (see e.g. [1], [2], [6], [8], [10], [11], [15], [17], [18] and [19]). A large part of contributions and papers is restricted to be qualitative, although the discussion on the possible impacts of Industry 4.0 was basically triggered by the quantitative analysis of [10], which suggested that almost half of the human jobs is threatened by the computerization. There are several papers that analyze primarily the employment impacts of Industry 4.0 in a qualitative way, like [2], [6] [15], [16], [17], and [19] (see also the references therein). Unfortunately, a relatively less amount of quantitative estimation of possible effects of computerization has been published so far. This is especially true for such indirect impacts, like the inequality and the poverty. This inspired the authors to make such a first investigation for Hungary, which is a relatively less developed European country. Although the direct impacts, i.e. the possible job losses by occupation has been taken from a recent estimation for the whole European Union, the present paper aims to assess how the job losses caused by automation may affect the main indicators of poverty in Hungary. The microsimulation has been chosen as the tool of this study. The authors are not aware of other applications of microsimulation for this type of problems.

Section 2 presents some recent results directly related to the present paper. Section 3 will formulate the problem, then the methodology and the employed dataset will be presented in Section 4. The main results will be presented in Section 5, and Section 6 concludes the paper.

2 Preliminaries

Certainly, it is a difficult task to assess the future impacts of computerization quantitatively, as these impacts may vary by country and by industry. However, several papers have been published already that have estimated the share of job losses mainly by occupation.

One of the most well-known quantitative estimations is that of [10]. The authors ranked more than 700 occupations according to probability of computerization using a Gaussian process model with machine learning technique. The model was calibrated using quantified expert opinions and online information on about one tenth of the occupations. The well-known staggering conclusion of the paper was that 47% of employment was related with occupations of probability of computerization greater than 0.7 in the US in 2010, and only 33% of employment was at low risk, where the probability of computerization is less than 0.3. An important feature of this study is that several bottlenecks of computerizability was identified regarding perception manipulation, creative intelligence and social intelligence and scaled for each occupation. The probabilities for each occupation were determined as a function of these data. Several papers were published later indicating that the risk had been significantly overestimated by [10]: one of them was [1]. The authors of this study applied a similar approach examining 21 OECD countries including the US. However, their calculations were task-based taking into consideration that automation displaces tasks and not occupations as a whole. Furthermore, this study used information of ‘Survey of Adult Skills’ conducted by the OECD, which contains a comprehensive list of tasks that workers perform at their workplace. Starting from the results on automatibility of [10], the relationship between automatibility and workplace tasks for the US was quantified. This relationship was considered to be valid for all examined OECD countries. It was found that the high risk employment in the US was only 9% instead of 47% given by [10] (the survey data of 2012 were used here). Although the difference is huge, even the 9% of jobs concern about 13 million workers. The high risk varied between 6% (Korea) and 12% (Austria) in the examined OECD countries. Also the experts’ data of [10] were used by [13] examining the risk of individual jobs for all the 32 OECD countries that participated in the ‘Survey of Adult Skills’ (Hungary was not included). The study assesses that about 14% of jobs is at high risk in the examined countries.

Paper [14] examines probability of automation based on ‘European Skills and Jobs Survey’, in which about 14 000 adult employees (aged 24-65) in the 28 member states of the European Union provided detailed information on their jobs. The author of the paper applied a logistic regression in such a way that the dichotomous dependent variable was 1, if the observed individual worked in a fully automatable occupation according to [10], and 0 otherwise. The set of explanatory variables included age, education level and indicators on labor status, work experience and special skills. The probabilities calculated for each individual were grouped by occupation on 2 digits ISCO[1] level, for which the survey contains information, and the mean values in the groups give the probability of automation of the different occupations. Also the shares of very high risks by occupation were given by calculating the shares of individual with at least 0.7 probability according to the logistic regression. The mean automation risk varies between 42% (personal care workers) and 57% (assemblers), while the very high risk is between 2% (chief executives, senior officials and legislators). The paper calculates the mean and the very high risks also by industry. It should be remarked that this latter paper used some data of the seminal work [10], but followed a different way. The dependent variable was similarly specified, but here individuals and not occupations were the observation units. This logistic regression quantified the relationship between certain skills, job characteristics and probability of automation. Since the employed input database contained information on occupations, the risks of occupations could be estimated in such a way as well. The study [18] estimates the combined impact of technological and socio-economic drivers of change on employment based on an international survey of employees on 9 broad industries and in 15 major developed and emerging economies. The results show that the employment effect is either positive (computer and mathematical job family with +3.2%) or negative (office and administrative job family with -4.9%).

The job losses may cause serious social problems especially in the less developed countries. The above mentioned and several other papers (see e.g. the references therein) do not calculate impacts like the increase of poverty or income inequalities. This paper examines how the potential job loss may change the indicators of poverty in Hungary.

3 Problem Formulation

The strength of impacts and the country-specific impacts of automation depend on many different factors. The social problems caused by job losses may be more serious in the relatively less developed countries with relatively low level of social benefits. This may be true for Hungary, where the rules of unemployment benefit system are relatively strict compared with those of other European Union (EU) member states. The net replacement rate is relatively low, since the initial value of the unemployment benefit is either 60% of the previous gross wage, or the minimum wage, if this 60% would exceed it. According to a European Commission report [8] the net replacement rate at 67% of the average wage after one month of unemployment is just 20%, which is the lowest in the European Union (according to data of 2016). Furthermore, the duration of the unemployment benefit provision is only 3 months, which is the shortest one in the European Union. There is a public work scheme for job-seekers. This means that after the expiration of the unemployment benefit duration, the job-seekers may be employed for short term, i.e. for 2-3 months on average as public workers (called 'fostered workers' in the Hungarian official statistics). The gross wage for public work is however just 60% of the official minimum wage. The purpose of this public works scheme is to support job-seekers to reenter the labor market, but some recent studies show that hardly more than 10% of job-seekers can be brought back to regular employment, and in several cases it works in a counter-productive way, reducing the probability to find a job again (see [11]). It is worth mentioning too that Hungary applies a flat rate on personal income taxes without any opportunity for tax credit in case of the lowest incomes. All this means that the possible social impacts of automation in particular the possible increase of poverty should be examined. The authors are not aware of any study examining both the possible job losses and the development of poverty indicators for Hungary.

The main purposed of this paper is to estimate the automation related job losses in Hungary by occupation on ISCO 2 digits level, and to examine its impact on the poverty gap (see the definition of the poverty gap later). The estimation is based on the results of the above mention literature, especially on those of [14], which has given a relatively conservative estimation concerning the shares of occupation at high risk. The method applied in the present paper is the microsimulation, in which these shares are used as a proxy of possible job losses. In this sense, the results of this microsimulation can be interpreted as an estimation of minimum impact of automation.

This type of study is relevant for Hungary since the poverty threshold is the third lowest one in the European Union. Figure 1 shows the poverty threshold in 2017 by country defined as 60% of the equivalized median household income on purchasing power parity[2]. Figure 1 is based on

[1] The author of [14] had first to establish a correspondence between the categories of the US (Standard Occupational Classification – SOC) and the European classification of occupations (International Standard Classification of Occupations – ISCO)

[2] Purchasing Power Standard (PPS) is used in the European Union instead of Purchasing Power Parity (PPP)

Eurostat EU-SILC data (see more details also in subsection 3.2). According to the same data source, the poverty rate of the Hungarian unemployed is around 50%, and the same indicator of less educated (ISCED[3] 3-5) and aged (55-64) people is continuously increasing from 2010. All these data underlines the importance of examining the possible job losses and its social impacts in Hungary.

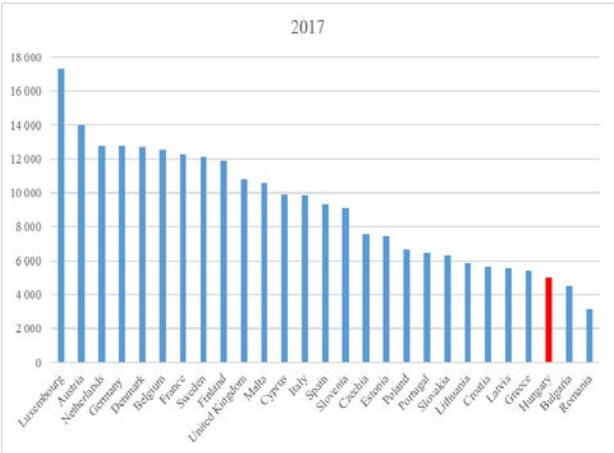

Fig. 1: Poverty threshold in the European Union by country in euro, PPS

Source: Eurostat EU-SILC

4 Methodology

A static microsimulation model has been developed to give an assessment of possible job losses by occupation in Hungary. This assessment can be considered to be conservative: one might interpret it as lower bounds of job losses caused by automation. The microsimulation technique is suitable to outline different scenarios and also to examine the impacts on poverty indicators.

4.1 Static microsimulation

The microsimulation in general is the temporal following of certain processes on micro level, i.e. on the level of persons or households or firms. It is unavoidable in the case of long-term simulation that the changes of the structure of micro units should be modelled (dynamic microsimulation), but for short-term simulation one can omit this (static microsimulation). Since the purpose of the present research is to assess the direct effect of automation in terms of job losses, only a one step simulation is made here, a static model is applied. The micro units are individuals, whose occupation (ISCO 2 digits) and wage is known, if they are actually employed. The sum of all incomes is calculated, then 60% of the median income, i.e. the poverty threshold is determined, below which one is considered to be poor. The poverty gap is defined as the difference between the median of all observations and the median value of the poor. Intuitively, if there are job losses, the poverty gap should increase.

The records belonging to the individuals were ranked first by the ISCO code and the group members were further ranked by education in ascending order. In this way, individuals of lowest education level could be found in the beginning of the list within each occupation. Then the first records in each group corresponding to the shares of very high risk given by [14] were changed, i.e. the calculated unemployment benefit substituted the wage for three months in next period (the database and the model is annual). This solution reflects the experience that primarily workers of low education are more exposed to the risk of dismissing from the job. Three scenarios have been modelled.

- Scenario 1 – Everyone, who lost his/her job was given unemployment benefit in the first scenario.
- Scenario 2 – Only half of the new unemployed is considered to be eligible for unemployment benefit in the second scenario: this share is consistent with the Hungarian experience.
- Scenario 3 – Finally, the new unemployed are supposed to spend three months as public workers receiving the correspondingly calculated wage after the 3 months of unemployment benefit duration.

4.2 Database of the microsimulation

The European Union Statistics on Income and Living Conditions (EU-SILC) is a product of the Eurostat, i.e. of the statistical service of the European Union. It contains microdata on income, poverty, social exclusion and living conditions. Social exclusion and housing condition information is given for households, while labour, education and health information is given for adult household members (aged 16 and over). The income is mainly collected at personal level. The EU-SILC integrates surveys conducted by the statistical services of the member states based on statistical samples of households. The EU-SILC is based on common concepts and definitions, therefore data are suitable for cross-country comparisons and also to monitor the fulfilment of the Europe 2020 strategy

[3] International Standard Classification of Education (UNESCO)

concerning in particular the poverty and social inclusion targets[4]. Specially, Hungary applies a stratified sampling according to different design by rotational group. There are at least 4750 households and 10250 persons in the cross-sectional, while 3500 households and 7750 persons in the longitudinal component representing Hungary's population of almost 10 million. We remark that ad hoc modules are developed every year within the EU-SILC beyond the permanently collected data. This module contains supplementary data of special areas. For example, the ad hoc module in 2018 is the 'Material deprivation, well-being and housing difficulties', which underlines the importance of examining the risk of poverty. Table 1 shows that Hungary is above the EU average regarding the number of people at risk of poverty, i.e. of share of those who are below 60% of the median income. We remark that this statistics is based on equalized household disposable income, but the micro-simulation reported in this paper was based on individual data. Table 1 shows that the at-risk-of-poverty indicator is worse in Hungary in every category of education level than the corresponding EU average. The difference is especially apparent in case of the lowest ISCED classes: this risk is especially high among ethnic Romani people.

Table 1: People at risk of poverty in Hungary and in the EU (%)

	Hungary	**EU28**
ISCED 0-8 (all)	*24.0*	*22.0*
ISCED 0-2 (primary)	41.9	34.2
ISCED 3-4 (secondary)	21.4	21.0
ISCED 5-8 (tertiary)	12.0	10.9

Source: Eurostat, EU-SILC

5 Main results

The three scenarios have been simulated as described in Section 3. The shares of very high risks of automation by occupation (ISCO sub-major groups, 2 digits) taken from [14] are shown by Table 3 given in Appendix A. It is apparent how the risk values increase together with the ISCO number of major groups (1 digit). This means that the manual, physical work is more exposed to the risk (6: Skilled agricultural, forestry and fishery workers, 7: Craft and related trade workers, 8: Plant and machine operators and assemblers, 9: Elementary occupations). The risk is relatively the lowest in management (1: Managers).

The main results of the three scenarios are summarized by Figures 2, 3, 4 and by Table 2. About 3.4 million individuals' record has been aged in one step in the microsimulation. In every scenarios 334,613 workers lose his/her job (see the table in Appendix A). As expected in all the scenarios the average monthly income is less than in the baseline (with no change). The median does not change, because typically the individuals with the lowest education level were supposed to lose their jobs in every occupation, and these individuals have typically low wages. Correspondingly, the poverty threshold remains the same. However, the median of the poor is relevantly different in the examined scenarios, which changes the poverty gap. Table 2 shows that even if government maintains the present public work system the poverty gap may increase. The increase of poverty gap may be sharp without the opportunity of public work. We emphasize once again that the supposed shares of job losses is only a conservative estimation: the poverty impact of automation may be stronger in real life. The histograms show significant differences among the low earners. If only half of those who lose their jobs is eligible for unemployment benefit (Scenario 2), the left hand side of the diagram shows higher frequencies than in the case when everyone is eligible (Scenario 1). There is a significant change again on the left hand side, when every second unemployed may take part in the public work program with a supposed 3 months contract.

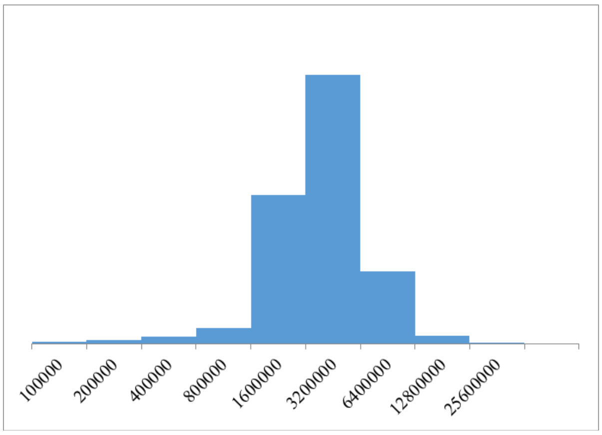

Fig. 2: Normalized histogram of average annual income, Scenario 1

Source: own calculation

[4] The anonymized microdata are available for scientific purposes under specific conditions.

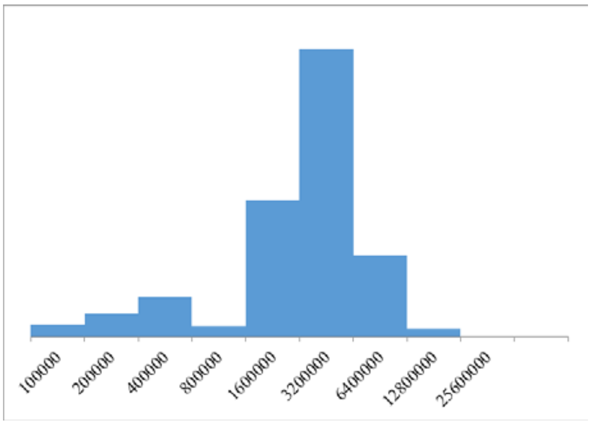

Fig. 3: Normalized histogram of average annual income, Scenario 2
Source: own calculation

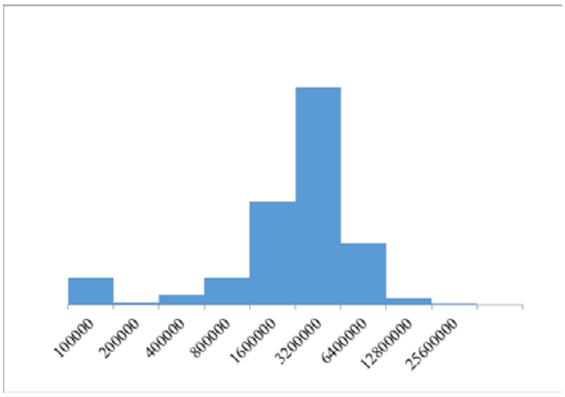

Fig. 4: Normalized histogram of average annual income, Scenario 3
Source: own calculation

Certainly, the public work program is financed by the central budget. If one calculates with the public work wages of 2018, the additional cost in Scenario 3 would be cca. 45 billion HUF for the central budget, which is hardly greater than 0.1% of the present annual GDP.

6 Conclusion

The paper presented the results of a static microsimulation, which gave a conservative estimation on the possible number of job losses by occupation (ISCO 2 digits level) caused by automation in Hungary in the future. Also the impact on poverty gap was calculated. Results show that the automation may lead to a deterioration of the labor market in Hungary without additional governmental measures. The poverty gap calculated on the basis of individual earnings is quite high even in the baseline scenario: it is 62%. This gap would increase up to 83% due to job losses without any governmental interference. If the government would extend the unemployment benefit scheme for all new unemployed (Scenario 1), the gap would be still as high as 79%. The other intervention option is that the government would provide additional public work opportunities. Scenario 3 shows that this solution would be more effective since although the poverty rate increases even in this case, but increase of the poverty gap is not significant compared to the baseline scenario. Based on the calculations, the budgetary effects of the additional public employment would not exceed 0.1% of the annual GDP.

This means that governments should be prepared for elimination of negative effects of the expected transformation. Results show that governments should rather support endangered employees to stay in the labor market instead of trying to avoid the harmful impacts of huge increase in unemployment.

Table 2: Summary of simulation results[5]

	Number of observations, head	Mean of income/year, HUF	Median of income/year, HUF	Poverty threshold
	(a)	(b)	(c)	(d)=(c)*0.6
Baseline	3,403,684	2,373,440	2,035,767	1,221,460
Scenario 1	3,403,684	2,255,520	1,994,496	1,196,698
Scenario 2	3,403,684	2,245,975	1,994,496	1,196,698
Scenario 3	3,403,684	2,259,180	1,994,496	1,196,698

	Number of people under poverty threshold, head	Poverty rate	Median of the poor, HUF	Poverty gap
	(d)	(e)=(d)/(a)	(f)	(g)=((c)-(f))/(f)
Baseline	334,742	9.8%	774,369	0.62
Scenario 1	536,617	15.8%	252,267	0.79
Scenario 2	536,617	15.8%	207,000	0.83
Scenario 3	536,617	15.8%	433,884	0.64

Source: Eurostat, EU-SILC, own calculation

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Appendix A

Table 3: Very high risks of automation by occupation

ISCO'08 2 digits	Risk (%)	Number of job losses	ISCO'08 2 digits	Risk (%)	Number of job losses
11	2	361	52	9	17258
12	3	924	53	4	2385
13	3	1202	54	10	11519
14	4	406	61	13	10961
21	8	8022	62	8	814
22	5	1789	63	18	
23	3	5585	71	16	24302
24	5	3327	72	15	25242
25	6	3932	73	18	2626
26	5	5293	74	11	8753
31	8	6364	75	18	15249
32	7	7554	81	17	29193
33	7	13914	82	17	22735
34	5	2652	83	13	24524
35	6	1018	91	13	14939
41	6	5433	92	12	6806
42	5	2212	93	13	13931
43	6	6662	94	10	4471
44	5	1968	95	4	
51	8	9030	96	12	11257

Source: [14] and own calculation
Remark: Sub-major groups 63 and 95 are not represented in the Hungarian sample