

Long – Term Distribution of the Job Offer in Romania and Job Polarization

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Abstract

In the case study we aim to analyse the long-term distribution of vacancies on the Romanian labour market. This approach allows us to identify one of the long-term consequences of the digitalization of the economy, namely polarization. Polarization can be viewed from several perspectives, but here we are only referring to the polarization of the job supply. The phenomenon implies a significant reduction in interest in mid-level jobs. Thus, to identify the probability that this phenomenon will already manifest itself in Romania, we carried out an analysis with the help of Markov chains. In this way we will identify the occupations that could be the most numerous in the long run in Romania.

Even if Romania does not indicate an obvious polarization of the labour market, in the long run, clues in this regard can be identified. There is a system of vocational training at national level, but it does not cover the prospects of the labour market.

Keywords: Job vacancies, Markov chain, job polarization, digital economy, future occupations

JEL Classifications: J20, J21, J24, J31, J62

DOI: 10.24818/REJ/2023/85/01

1. Introduction

The fourth industrial revolution, or the digital revolution, began in 1960. This led to the automation of processes and the implementation of artificial intelligence in all economic sectors. With the digital transformation of the economy, there is a structural change in the labor market. This change cannot be categorized as positive or negative, but it brings many changes at the level of society.

Like any new thing, society looks with skepticism at the digitalization of the economy. Innovations brought about by the digital economy will restructure employers' need for the workforce. If routine activities are automated or simply find

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much more effective ways to perform them, existing employees will be put in a position to no longer be eligible for their current job. Under these conditions, digital transformation requires employees to develop the ability to continuously adapt to new technologies. This means that in addition to literacy and computational skills, the working population must also possess digital skills. Thus, some polarization of the labor force is observed. More specifically, employees who engage in repetitive activities will no longer be relevant in a digital economy, which is why they will either develop their skills or will have to accept a lower job.

Romania does not enjoy a developed digital economy compared to the rest of the European Union states. However, studies carried out by other researchers have shown a possible polarization of jobs in the space of Central and Eastern Europe. Thus, in the paper we aim to identify indices of the polarization of the labor market, starting from the offer of vacancies in Romania. The first part of the article captures the multiple changes in the labor market because of the digital revolution, and then we focus our case study on the evidence of the polarization phenomenon. We will look at the distribution of jobs in terms of the level of training that the potential candidate must have to fill the vacancy. In this regard, we will use the Markov chains, a mathematical methodology based on probabilities. Thus, we can analyze the probability that the need for job vacancies in a certain category will change from one period to the next. Also, starting from certain premises, we will simulate possible directions of market change. At the end of the case study, we will discuss what are the direct means by which the Romanian workforce is not dramatically affected by this phenomenon.

2. Review of the scientific literature

The main purpose of the digitalization of the economy is the evolution of society, but often the framework in which it is desired to implement it can change the data of the problem. The researchers discussed three possible scenarios in this regard. In the optimistic scenario, the digitalization of the economy is a "land of milk and honey" in which robots work for the long-term well-being of people (Walwei, 2016). The pessimistic scenario describes the "20/80 society", in which 20% of the population will generate high incomes and will own most of the capital (Walwei, 2016). This scenario is about deepening social inequality and people's well-being (Monnig et al., 2019). A study on this pessimistic scenario showed that Romania is among the few European countries where the deepening of income inequality is due to inadequate economic policies, so that the development of technology deepens this inequality (Kharlamova et al., 2018). The third scenario describes the fundamental structural changes in the labor market. In this context, it cannot be said that it is a contraction of labor demand, but rather a structural change of tasks and occupations (Walwei, 2016).

The third hypothesis presented in Walwei's research, I consider to be closer to contemporary reality. The substantial reduction in the price of technology has made employees who perform routine tasks increasingly poorly paid. Basically, the change in the structure of tasks corresponding to an occupation influences the evolution of income inequality (Atalay et al., 2018). Thus, the job offer has been oriented towards occupations in the service area, which are difficult to automate (Autor & , 2013). The McKinsey company did a study for Central and Eastern Europe in which it estimated that 49-51% of work activities could be automated, the equivalent of approximately 21 million jobs (Novak, et al., 2018). Many of these lost jobs are mid-level ones, which involve routine activities. Demand for technology-skilled employees will increase due to technologies that will replace human jobs (Chinoracký & Čorejová, 2019). Highly qualified employees will be complementary to technology and thus will involuntarily deepen social inequality (Prettner & Strulik, 2020). This change could exacerbate social inequalities if those affected are not supported by VET programs (OECD, 2019). Research on the digitalization of the labor market has shown that information and communication technology help highly trained employees to perform abstract tasks, replacing mid-level workers (Atalay, et al., 2018). Thus, in addition to basic literacy and numeracy skills, an adult must also have digital skills (OECD, 2017).

In other words, what this structural change in the labor market entails is a change in the concentration of demand for certain categories of occupations and the replacement of redundant ones with technology. The increase in interest in high-level and basic occupations and the simultaneous reduction of interest in mid-level occupations is named after it in the polarization literature (Autor, 2014) (Goos et al., 2014) (Asplund et al., 2011). Some previous studies have indicated that this polarization of jobs manifests itself both within industries and between industries (Goos, et al., 2014), having a different manifestation depending on the nature of the industry. Surely, technology could be one of the reasons why mid-level occupations are becoming redundant, but this is the most widely debated in the literature. A study shows a directly reduced impact of technology on jobs, in the sense that it will reduce the number of employments for unskilled people, but it will not produce mass unemployment, as the contribution of technology to productivity has proven not to be far superior to the human workforce (Graetz & Michaels, 2018). There is research carried out at European level about the polarization of occupations that also argues that an increase in world trade could be one of the reasons for polarization (Author, et al., 2006) (Goos, et al., 2009). There is also talk of a peculiarity in technology that would rather explain the reduction in interest in mid-level jobs, namely, offshoring (Acemoglu & Autor, 2011) (Goos, et al., 2014) (AKÇOMAK, et al., n.d.). Other researchers support the hypothesis that increasing education is a more prominent factor in changing the structure of demand in the

labor market, rather than the influence of technology. Specifically, the increase in the number of graduates has led to a thinning of the middle class by relocating the middle workforce to top positions (Salvatori, 2018). However, there are researchers who consider this hypothesis to be slightly generalized, since at the microeconomic level, polarization can be influenced by the choices of the organization (Heyman, 2016).

3. Research methodology

In the case study, we used data from the website of the National Institute of Statistics. The indicator of interest was the number of vacancies, classified by occupation groups. The indicator is measured in the period 2005-2020. The data was aggregated according to the level of education required by the occupation. Thus, out of the nine groups of occupations analyzed, we obtained three groups of jobs.

Table 1. The level of education specific to each group of occupations

| International Standard Classification of Occupations 2008 | Level of education | Occupations |
|---|---|--|
| 1 | Higher education | Managers |
| 2 | Higher education | Professionals |
| 3 | Higher education | Technicians and associate professionals |
| 4 | Secondary, high school and post-high school education | Clerical support workers |
| 5 | Secondary, high school and post-high school education | Service and sales workers |
| 6 | Secondary, high school and post-high school education | Skilled agricultural, forestry and fishery workers |
| 7 | Secondary, high school and post-high school education | Craft and related trades workers |
| 8 | Secondary, high school and post-high school education | Plant and machine operators, and assemblers |
| 9 | Primary education | Elementary occupations |

Source: Own production

The category of higher-level jobs includes managers, professionals, technicians, and associate professionals (Rubinian, 2020). The mid-level job group consists of the following occupations: clerical support workers, service and sales workers, skilled agricultural, forestry and fishery workers, craft and related trades workers, plant and

machine operators, and assemblers (Rubinian, 2020). Elementary occupations form the category of lower-level jobs (Rubinian, 2020). For the case study, it is necessary to calculate the chain-based index of the chosen indicator. The application itself uses the Markov chain methodology.

A Markov chain is a stochastic process that has its origins in the name of the Russian mathematician Andrei Andreevich Markov. His motivation started from the desire to prove that two of the classical theorems of probability theory, namely the Law of Large Numbers and the Central Limit Theorem, can be extended to sums of dependent random variables. By definition, a Markov chain is a sequence of random variables, with the property that future states of the process are independent of past states. At any time, the system may remain in the state it is in or may transition to another state. Therefore, in most applications, Markov chains are represented by transition matrices. Another way of presenting them is the graphical method, in which the states of the chain constitute nodes in a graph and, depending on the probabilities of passing from one state to another, the connections between the nodes of the graph are outlined, in which there may be chains or loops as well.

Both in the data processing stage and in the data analysis stage, we used the RStudio statistical software. The entire application is based on author-defined scripts and not predefined packages.

4. Results and discussion

According to Markov chain theory, the simulation of the probability of occurrence of an event is justified to highlight the transition of an individual / process from one state to another. This state can be either discrete or continuous. Thus, the targeted entity is the labor market, and the states in which it may be are low, medium, high. The states were defined according to the type of job group previously defined. In this case, the defined states are of the discrete type, so we will build a Markov chain of the discrete type.

The data will not be used as such, but for the 3 types of jobs will be calculated chain-based indices. Thus, we will see on the three categories of jobs, if from one quarter to another we have an increase or decrease in the number of vacancies. To determine exactly what state the labor market is in a specific quarter, I will choose the state for which I will identify the highest growth.

The calculation method is not a difficult one, but is based on the classical theory of probabilities. Using a script made in RStudio, we will calculate the probabilities of passing from one state to another. The algorithm begins by determining the frequencies of all possible combinations of the three states. Subsequently, the probability of the occurrence of each pair is calculated as follows: $P_{i,j} = \frac{n_{i,j}}{\sum_j n_{i,j}}$.

Figure 1. One step transition matrix

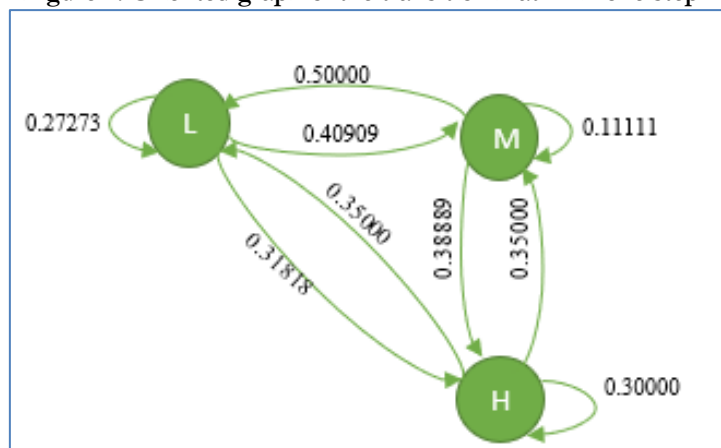
| | L | M | H |
|---|---------|---------|---------|
| L | 0.27273 | 0.40909 | 0.31818 |
| M | 0.50000 | 0.11111 | 0.38889 |
| H | 0.35000 | 0.35000 | 0.30000 |

Source: Own production in RStudio

Considering that the series is a homogeneous Markov chain, the one-step transition matrix is:

$$P = \begin{pmatrix} 0.27273 & 0.40909 & 0.31818 \\ 0.50000 & 0.11111 & 0.38889 \\ 0.35000 & 0.35000 & 0.30000 \end{pmatrix}$$

Figure 2. Oriented graph of the transition matrix in one step



Source: Own production

The probability that in the next quarter on the Romanian labor market the biggest increase compared to the previous quarter will be the jobs that require general education is 27,273%, knowing that in the current quarter most vacancies were those that require a level of general education. If low-level jobs had the highest growth in this quarter, the probability that medium-level jobs will have the highest increase in the next quarter is 40.909%, and the probability that in the next quarter the highest high growth will have high-level jobs is 31.818%. Also, if in the current quarter the highest increase compared to the previous period was the number of medium-level jobs, the probability that the next quarter the highest increase will be registered by low-level jobs is 50%, the probability that the next quarter the highest growth will be recorded by medium-level jobs is 11,111%, and the probability that the next quarter the highest growth will be recorded by high-level jobs is 38,889%.

If in the current quarter the highest growth in the labor market is registered by the jobs that require higher education, the probability that the next quarter the highest growth will have the low or medium level jobs is 35%, and the probability of the highest growth of high-level jobs is 30%.

All states are interconnected, which is why we can say that we have an irreducible finite Markov chain. In this case, all states are recurrent and belong to the same communication class. Thus, the periodicity of each state is equal to 1, which is why the Markov chain is aperiodic. An irreducible and aperiodic Markov chain, for which the return time corresponding to each state is a finite medium, is an ergodic chain. This is also the case for the Markov chain presented in the present study. The fundamental theorem of ergodic Markov chains states that there is a single positive stationary distribution of the chain, which is the limit distribution of the chain.

To determine the long-term distribution of the analyzed states, we will initially check if the Markov chain crossing matrix is a regular one. According to the theorem, there is a non-zero natural power for which the matrix raised to this power has all non-zero elements, for which the matrix is regular. If the transition matrix in a step P is regular, then the Markov chain has a limit distribution, which is the only stationary distribution of the chain. The unique stationary distribution of a

transition matrix is the solution of the system:
$$\begin{cases} \boldsymbol{\pi} = \boldsymbol{\pi} \cdot \mathbf{P} \\ \boldsymbol{\pi} = (\pi_1, \pi_2, \pi_3) \\ \pi_1 + \pi_2 + \pi_3 = 1 \\ \pi_1, \pi_2, \pi_3 > 0 \end{cases} \Rightarrow$$

$$\begin{cases} (\pi_1, \pi_2, \pi_3) \cdot \begin{pmatrix} 0.27273 & 0.40909 & 0.31818 \\ 0.50000 & 0.11111 & 0.38889 \\ 0.35000 & 0.35000 & 0.30000 \end{pmatrix} = (\pi_1, \pi_2, \pi_3) \\ \pi_1 + \pi_2 + \pi_3 = 1 \\ \pi_1, \pi_2, \pi_3 > 0 \end{cases}$$

Using an algorithm written in RStudio, we calculated the minimum power of the matrix from which the matrix no longer changes, and its lines are equal. In this case the minimum power is 9. Thus, the unique stationary distribution is $\boldsymbol{\pi} = (0.3667, 0.3000, 0.3333)$.

$$\lim_{n \rightarrow \infty} P^{(n)} = \boldsymbol{\pi} = \begin{pmatrix} 0.3667 & 0.3000 & 0.3333 \\ 0.3667 & 0.3000 & 0.3333 \\ 0.3667 & 0.3000 & 0.3333 \end{pmatrix}$$

At the limit, the least likely state of the labor market is state M, and the most likely state is state L. This indicates that in the long run the phenomenon of polarization of the labor market is outlined, meaning that a decrease in the probability of increasing the number mid-level jobs.

Knowing that the irreducible Markov chain has only recurring states, we can calculate the average number of steps in which the chain returns to the state from which it left.

$$\mu_j = M(T_j | X_0 = j)$$

Because the stationary distribution is the only long-term distribution, then $\mu_j = \frac{1}{\pi_j}$.

We obtained: $\mu = (2.73, 3.33, 3)$. According to the model, if in the current quarter the largest increase is registered by the number of vacancies that require a level of general education, meaning that the market is in the L state, then such a state will reach on average after about 2.73 quarters. If in the current quarter the Romanian labor market is in state M, then the market will reach this state in about 3.33 quarters. Similarly, if the market is in the H quarter in the current quarter, then this state can be reached in about 3 quarters.

To simulate a path of the Markov chain used in this analysis, it is necessary to use an initial distribution. The proposed distribution is $\alpha = (0.4176, 0.0330, 0.5494)$ and represents the share of jobs grouped by occupation and level of education designed by the European Center for the Development of Vocational Training for the period 2020-2030.

For 10.000 states we obtain an absolute frequency distribution of

| | | |
|----------|----------|----------|
| <i>L</i> | <i>M</i> | <i>H</i> |
| 4141 | 304 | 5555 |
| <i>L</i> | <i>M</i> | <i>H</i> |
| 0.4141 | 0.0304 | 0.5555 |

as well as the corresponding relative frequency distribution

Comparing the results obtained from the simulation with the stationary distribution of the chain, we find that the probability that in the next quarter the highest increase will be the low-level jobs is 5 percentage points higher than that obtained by determining the long-term distribution. Also, the probability that the high-level jobs obtained by the simulation will have the highest increase in the next quarter is higher than the long-term probability by 22 percentage points. The trend is not maintained in the case of state M, where the simulated probability is lower than the long-term probability by about 27 percentage points. There is an accentuation of the polarization phenomenon, when we start from the expected distribution in the future.

Using the same simulation, for a period of 8 quarters, the labor market can be in the states: "L", "M", "H", "H", "L", "H", "M", "L". The most common states are L and H. The first state is related to the third quarter of 2020. If we do a simulation of 1000 chains composed of 8 states related to 8 quarters, we obtain a relative

distribution $\begin{matrix} L & M & H \\ 0.3686 & 0.2704 & 0.3610 \end{matrix}$. Comparing the results obtained from the simulation with the stationary distribution of the chain, we find that all three states have approximately equal probabilities in both simulation and long-term distribution.

Conclusions

We have chosen to analyze the phenomenon of polarization of the job supply from the perspective of the level of training, because education is an important factor in maintaining relevance in the labor market. For employees to acquire new skills, they will have to learn throughout their lives. In this context, a very important role could be played by the vocational education and training vocational education and training system. But for it to fulfill its purpose, it must follow the trends of the economy. Thus, depending on the dynamics of the market, the education system must adapt its policies. As we have noticed, in the long run, low-level occupations are the most wanted, followed by higher-level ones. In December 2020, the National Agency for Employment published 77 training courses. The maximum number of participants in these courses is 1,063 (Agenția Națională pentru Ocuparea Forței de Muncă, 2020), a rather small number. Of these, 63% are courses that prepare participants for medium-level occupations, 25% for higher-level jobs, and 1% for low-level jobs. Here, I think it is a problem because this system of training the active population does not train the skills of the workforce but prepares them for a certain occupation. Only 10% of the courses are dedicated to digital skills, foreign language communication skills, and entrepreneurial skills. Another disadvantage of the vocational education and training system is that it is not uniformly distributed nationally. Only 25 of the counties benefited in December 2020 from these courses.

As we are in strong technological progress, it is necessary that the government institutions dealing with the education system need to be updated and prepared for new challenges. It is true that the basic needs must first be largely met to bring education to the next level. In the case of the vocational system of education and vocational training, the number of participants must be increased, but also the number of courses. A valid alternative to long-term learning would also be the training provided by the private sector, but it is often for a fee. In addition to these, a retraining program is also needed for people with higher education whose occupations will disappear in the future.

Most studies indicate a polarizing trend in Central and Eastern Europe. Forecasts show that this trend will intensify in Romania as well. If we look at the data of the last years, in Romania, there is no categorical polarization. This was largely due to the lack of digitalization of the Romanian economy, although the European trend

was different. Thus, based on the accessed data, we described the probable dynamics of the Romanian labor market. In the long run, there is a polarization of jobs, if we look at the probabilities calculated previously. It seems that the supply of jobs for elementary occupations is ahead of the supply of high-level jobs. As expected, the middle class of the labor market has a more attenuated probability, even with 3 percentage points. Using the structure of the built chain, we performed various simulations, starting from a series of probabilities calculated based on future projections made by other researchers. The result is not different, but after enough simulations it indicates the same polarization highlighted by the limit distribution. We are not saying that medium-level jobs will disappear completely in the coming years, but there will be fewer. Given the simulations performed, but also the events of 2020, it is appropriate to consider new strategies in the education system involving technology. Moreover, the main recommendation is for the decision-making institutions on the labor market to build strategies in the direction of developing soft skills.

Until now, the labor market was influenced by the digitalization of the economy, which was not obvious in Romania. Now, in 2020, Romania is facing a forced digitalization imposed by the conditions of the global pandemic. Obviously, the research will be slightly affected, but not enough so that we cannot draw a general trend.

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