STATISTICS IN TRANSITION new series, December 2021
Vol. 22, No. 4, pp. 213–225, DOI 10.21307/stattrans-2021-046
Received – 24.01.2021; accepted – 07.07.2021

Towards a target employment rate within age and gender groups

Stanisław Jaworski[1], **Zofia Zielińska-Kolasińska**[2]

ABSTRACT

Quarterly employment rates in European countries are analysed in terms of the likelihood of achieving a specific employment rate within age and gender groups in a five-year horizon. The German employment rate serves as a benchmark for this research. The likelihood is estimated by a Monte-Carlo simulation based on the class of exponential smoothing models. The research presents a pessimistic prognosis of employment rates in European countries with respect to young and partly to older workers.

Key words: employment rate, exponential smoothing, forecasting, state space approach.

1. Introduction

The European Employment Strategy dates back to 1997, when the Member States of the European Union committed themselves to establishing a set of common goals and tasks in the field of employment policy. Its main goal was to create more and better jobs throughout the European Union. Consequently, national governments have proposed and agreed common employment policy priorities and objectives. Governments have committed to annual reports on the implementation of the Employment Guidelines and an assessment of the Key Employment and Social Indicators.

In 2010, the European Council adopted the Europe 2020 strategy. One of the main targets of this strategy at the European Union level was to raise, by the year 2020, the employment rate of the population aged 20-64 years to at least 75%. The year 2010 was a key milestone in the evolution of the European Employment Strategy because European cooperation on the economic and employment policy had faced the global economic and financial crisis during 2007-09. The crisis has slowed the economic development of many countries until 2013. Despite the global crisis the majority of European countries achieved their targets.

Two age groups in the labour force are of particular interest: people aged 15-24 and 55-64. The population of the European Union is currently experiencing an ageing process, and predictions in this area suggest that this process will accelerate during 2019-2050 (Corselli-Nordblad et al. (2020a)). Demographic ageing means the proportion of people of working age in the EU is shrinking. Hence, the employment rate of older and young people is among

[1]Department of Econometrics and Statistics, Warsaw University of Life Sciences, Poland.
E-mail: stanislaw_jaworski@sggw.edu.pl, ORCID: https://orcid.org/0000-0002-6169-2886.
[2]Department of Mathematics, Siedlce University of Natural Sciences and Humanities, Poland.
E-mail: zofia.zielinska-kolasinska@uph.edu.pl, ORCID: https://orcid.org/0000-0001-8845-758X.

the main policy objectives that European Union has adopted in recent years. A considerable portion of young people aged 15-24 years in the EU is economically inactive. The European Union supports the process of reducing youth unemployment by creating various programs, like *The Youth Guarantee* (European Commission (2018)), *Youth Employment Initiative* (European Commission (2012)), *Skills Agenda for Europe* (European Commission (2020b)) and *Investing in Europe's Youth* (European Commission (2017)). Moreover, the European Commission suggests that the most pressing concern of policy-makers is to encourage older people to remain in the labour market for as long as possible (Corselli-Nordblad et al. (2020a)). A key reason for increasing retirement age is to ensure the financial sustainability of the state pension programme. Moreover, the retirement-aged include workers with extensive experience who can contribute to generating new jobs and make net contribution to GDP. There is also evidence that meaningful and appropriate work benefits older people. Paid work increases their incomes, helping them to achieve higher standards of living. In response, many countries have decided to increase the retirement age. But there is an example of doing the opposite. The topic of the age at which Poles retire returned in the election campaign of 2020. The retirement age was raised in 2012 by the government of Donald Tusk. According to the law then in force, men were to reach the target retirement age of 67 in 2020, and women 20 years later – in 2040. In 2016, the government of Beata Szydło restored the act to its pre-2012 version.

The aim of the work is to estimate the probability of achieving given employment rates within age and gender groups across European countries in a five-year horizon on the basis of employment time series forecasts. German 2019 employment rates reduced proportionally by 5% are taken as the base rates. We compare them accordingly with employment rates of other member states of the European Union. The choice of these base rates is justified to some extent. The applied analysis required comparisons with reasonably high rates. Moreover, the German labour market belongs to the strongest in Europe and experienced robust performance in the financial crisis of 2007-2009. Therefore, the choice seems reasonable as benchmarks of better and satisfactory employment rates for many member states of the European Union. The estimates are based on quarterly employment rates from Eurostat.

2. Research methodology

The probability of achieving a given employment rate is estimated by Monte-Carlo simulation by the use of exponential smoothing methods. Although the methods have been around since the 1950s, a modelling framework incorporating procedures for model selection was not developed until the nineties. Ord et al. (1997), Hyndman et al. (2002) and Hyndman et al. (2005) have shown that all exponential smoothing methods are optimal forecasts from innovations state space models. The innovations state space approach provides prediction intervals, maximum likelihood estimation and procedures for model selection. The theoretical background of the methods can be found in Hyndman et al. (2008b). Software implementation of the methods is described in Hyndman et al. (2008a), where for each of the fifteen exponential smoothing methods the authors specify two possible innovations state space models, one corresponding to a model with additive errors and the other to a model with multiplicative errors. The models are combinations of components such as the trend,

seasonal, and irregular or error components. The trend component can be additive, additive damped, multiplicative and multiplicative damped. The seasonal component can be additive or multiplicative. The general model involves a state vector $x_t = (l_t, b_t, s_t, s_{t-1}, \ldots, s_{t-m+1})'$ and state space equations of the form

$$y_t = w(x_{t-1}) + r(x_{t-1})\varepsilon_t$$
$$x_t = f(x_{t-1}) + g(x_{t-1})\varepsilon_t,$$

where y_t, $t = 1, \ldots, T$, denote observations, $\{\varepsilon_t\}$ is a Gaussian white noise process with mean zero and variance σ^2. Components l_t, b_t and s_t are unobservable and represent the trend, slope and seasonality respectively. The number of seasons in a period, denoted by m, is a given number. Functions w, r, f, g are known and have a specific form (see Hyndman et al. (2008a)).

As an illustrative example of this class of models let us consider the known Holt's model defined by the equations:

$$\begin{aligned} \text{Level:} \quad & y_t = \alpha y_t + (1-\alpha)(l_t + b_{t-1}) \\ \text{Growth:} \quad & b_t = \beta^\star (l_t - l_{t-1}) + (1-\beta^\star) b_{t-1} \end{aligned}$$

These equations can be rewritten to the following form:

$$y_t = \begin{pmatrix} 1 & 1 \end{pmatrix} x_{t-1} + \varepsilon_t$$
$$x_t = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix} x_{t-1} + \begin{pmatrix} \alpha \\ \beta \end{pmatrix} \varepsilon_t$$

where $\beta = \alpha\beta^\star$, $x_t = (l_t, b_t)'$, $\mu_t = \hat{y}_t = l_{t-1} + b_{t-1}$ and $\varepsilon_t = y_t - \mu_t$ denotes the on-step forecast error at time t. The model is fully specified once we state the distribution of the error term ε_t. Note that in this case

$w_t(x_{t-1}) = \begin{pmatrix} 1 & 1 \end{pmatrix} x_{t-1}$, $r(x_{t-1}) = 1$, $f(x_{t-1}) = \begin{pmatrix} 1 & 1 \\ 0 & 1 \end{pmatrix} x_{t-1}$ and $g(x_{t-1}) = \begin{pmatrix} \alpha \\ \beta \end{pmatrix}$. Generally, a penalised method based on the in-sample fit Akaike's Information Criterion is used in the work to choose appropriate models for the investigated employment series. To estimate the probability of achieving the given target employment rate the set of 1000 sample paths that are future to and conditional on the data is produced. Then, the number of paths crossing the target is calculated. Thus, we estimate probability $P(y_t > \text{target})$ for a given t. The maximum estimate error in this case does not exceed 3%.

3. An example: the Visegrád Group

The Visegrád Group is a cultural and political alliance of four countries of Central Europe (the Czech Republic, Hungary, Poland and Slovakia), all of which are members of the EU and of NATO, with the aim to advance mutual co-operation in military, cultural, economic, climate and energy matters and to further their integration to the EU. All of the countries belonged to the former Eastern Block. The employment rates of these countries and Germany are shown in Figure 1.

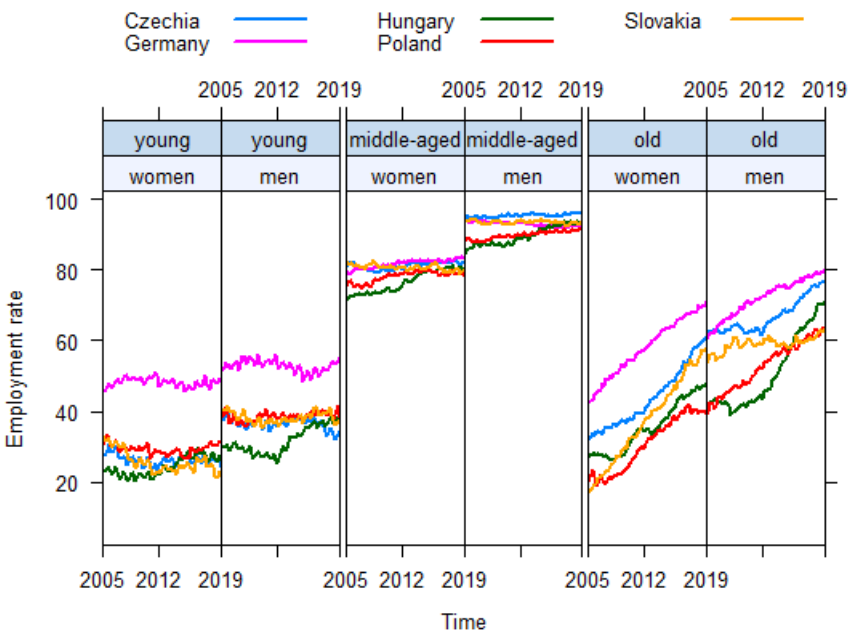

Figure 1: Quarterly time series of employment rates of Germany and the member countries of the Visegrád Group with respect to gender and age groups: 2005-2019

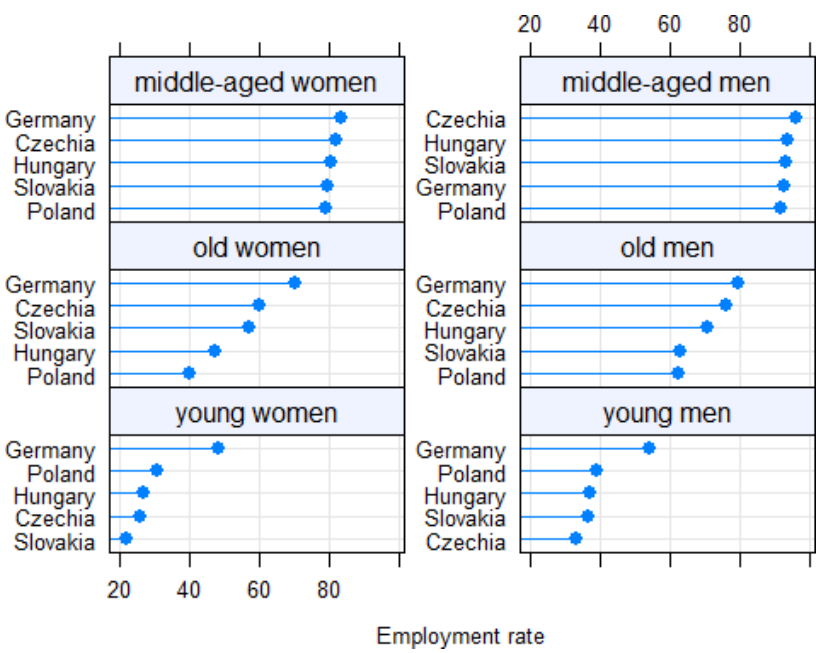

Figure 2: The comparison of the 2019 employment rates of Germany and the member countries of the Visegrád Group with respect to gender and age groups

Note that middle-aged workers (25-54 years old) have similar employment rates. There are much greater differences between the employment rates in the group of young (15-24 years old) and old people (55-64 years old). This can be seen in the comparison of Germany against different countries of the Visegŕad Group. The German employment rate is at least as high as those of other countries. We want to find out the probabilities of the member countries of the Visegrád Group achieving the given level of 95% German employment rate. Figure 2 depicts 2019 employment rates of Germany and the member countries of the Visegrád Group with respect to gender and age groups. It can be taken to mean that differences between probabilities of achieving the given levels will be smaller in young and old workers. For example, the difference in the group of young women between Slovak and German employment rates is relatively large (over 20%). The Slovak employment time series has been well under 30% since 2010 and was declining in the last four years. Thus, the probability of reaching the German employment rate is expected to be low in the case of young Slovak women.

Let us consider the forecast of the Slovak employment rate for this group. The point forecast is given in blue in Figure 3. Three further forecasts were simulated, smoothed and added in red into Figure 3. The forecasts are represented by three smoothed lines starting at 2020. In order to estimate the probability of crossing the given level, there were 1000 such lines generated altogether. The forecasts were smoothed to avoid the short-term influences of seasonal pattern.

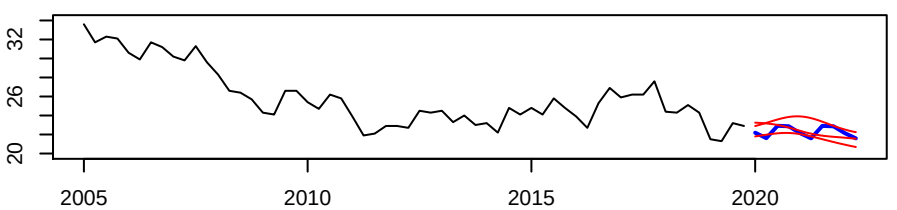

Figure 3: Forecast of the employment rate for young Slovak women

The procedure was repeated for the rest of the member countries of the Visegrád Group. The prognosis for young people is not optimistic: neither probability based on prediction for four countries and years 2020-2024 exceeds 1%. The results for old people are better but not in all of the countries (Table 1). The results for middle-aged people are the best (Table 2). In this case, most estimates are equal to one.

In general, most middle-aged people are employed. The employment rate of older workers increased between 2005 and 2019 but the pace of growth was not uniform in the considered countries. Universally older workers bring a level of experience, critical thinking and sheer knowledge that cannot be taught. In some industries it takes a decade or longer for workers to gain the technical skills necessary to master the job. Despite these advantages, the labour market of many countries does not offer suitable jobs for older people. There are many reasons for this but discussing them is beyond the scope of the work. In fact, not all countries are expected to improve the employment rate of older workers.

Table 1: Forecasts of the probabilities of reaching the 95% German employment rates by the member countries of the Visegrád Group with respect to gender; results for old people

Gender	Country	2020	2021	2022	2023	2024
Female	Czechia	0.13	0.84	0.98	1.00	1.00
	Hungary	0.00	0.00	0.00	0.00	0.00
	Poland	0.00	0.00	0.00	0.00	0.00
	Slovakia	0.02	0.45	0.80	0.93	0.97
Male	Czechia	0.99	0.99	1.00	1.00	1.00
	Hungary	0.51	0.87	0.96	0.98	0.98
	Poland	0.00	0.00	0.00	0.03	0.10
	Slovakia	0.00	0.00	0.00	0.00	0.00

Table 2: Forecasts of the probabilities of reaching the 95% German employment rates by the member countries of the Visegrád Group with respect to gender; results for middle-aged people

Gender	Country	2020	2021	2022	2023	2024
Female	Poland	0.40	0.42	0.44	0.46	0.45
	Slovakia	0.70	0.67	0.64	0.63	0.62
	Other countries	1.00	1.00	1.00	1.00	1.00
Male	All countries	1.00	1.00	1.00	1.00	1.00

Compared to old people, young workers tend to have fewer general work skills and less specific human capital relevant to the particular firm employing them (Bell et al. (2011)). They are faced with wages that provide inadequate compensation for the loss of benefits and with suboptimal commutes. The lack of mobility and limited job search area severely limits their job opportunities.

Many factors influence the employment rate. An interesting discussion may be found in Matthews et al. (2014). Each of the European countries has its own specific factors lowering its employment rate. As the set of common goals and tasks in the field of employment policy is formulated and agreed on, the main goal for every country is to create more and better jobs. This will increase the employment rate. The reasonable measure of the rise should be based on the level itself. The idea of model-based estimate of achieving the specific level representing the one of the strongest labour markets in Europe holds this criterion and takes into account the structure of employment rate time series. The benchmark in this approach is the strong German economy, which is the largest contributor to the EU budget.

4. Employment Rates Forecasts

The following countries were analysed: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Finland, France, Greece, Spain, Ireland, Lithuania, Luxemburg, Latvia, Malta, Netherlands, Germany, Poland, Portugal, Romania, Slovakia, Slovenia,

Sweden, Hungary, the United Kingdom, Italy. The model-based estimates of achieving the 95% German employment rates were calculated as in the previous section. The results are as follows.

Results for young women and men.

1. The estimated probabilities are less than 0.05 for Belgium, Bulgaria, Czechia, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Hungary, Poland, Portugal, Romania, Slovenia, Slovakia.

2. The estimated probabilities are equal to at least 0.98 for Denmark, Malta, Netherlands, Austria, Finland, Sweden, the United Kingdom.

3. For other countries the estimates are in Table 3. With the exception of Ireland, the estimates are increasing.

Table 3: Model-based estimates of achieving the 95% German employment rates; results for young workers from countries with estimates greater or equal to 0.05 and less than 0.98

Gender	Country	2020	2021	2022	2023	2024
Female	Estonia	0.53	0.63	0.69	0.72	0.75
	Ireland	0.39	0.30	0.24	0.19	0.21
	Lithuania	0.00	0.00	0.02	0.10	0.23
Male	Estonia	0.38	0.46	0.51	0.58	0.61
	Ireland	0.12	0.10	0.06	0.06	0.06
	Lithuania	0.00	0.00	0.03	0.06	0.09

Most of the calculated estimates do not exceed 5%. Only 25% of European countries have the estimates greater than 98%. Three countries are between these two extreme cases. This shows that the European countries are highly differentiated.

Results for middle-aged women and men.

Estimates for middle-aged people are shown in Figure 4. In this case, estimates for most countries are very close to one, therefore only those that are less than 0.9 are displayed. Generally, most middle-aged people in Europe are employed. Employment rates are as high as in Germany and in some cases they are slightly greater. Therefore, the estimates are close to one.

Results for old-aged women and men.

The case of old workers is rather complex. For some of the countries the probabilities of reaching the 95% of the appropriate German employment rates levels are very low (e.g. for Poland, Romania and Greece) (Table 4). On the other hand, there are countries with a high probability of achieving it (Table 4). Some countries show the probability steeply increasing in the group of women or men (Figure 5).

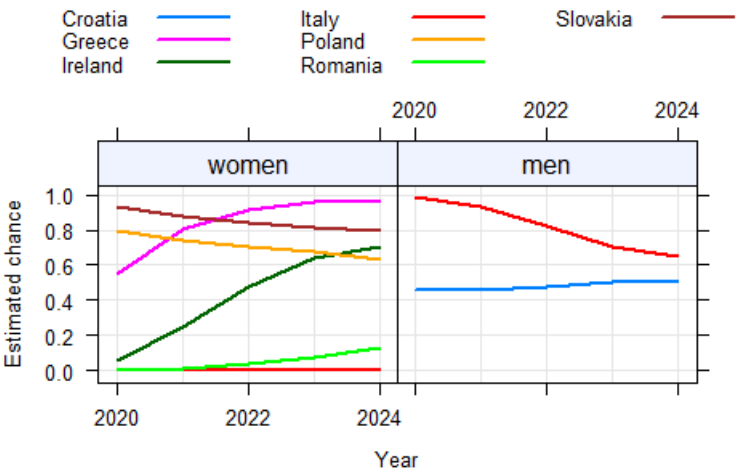

Figure 4: Model-based estimates of achieving the 95% German employment rates; results for middle-aged people from countries with estimates less than 0.9

Table 4: Countries with the investigated probabilities less than 0.3 are marked with $\times$ and greater than 0.8 are marked with $\otimes$

Country	Women	Men	Country	Women	Men
Greece	$\times$	$\times$	Czechia	$\otimes$	$\otimes$
Croatia	$\times$	$\times$	Denmark	$\otimes$	$\otimes$
Italy	$\times$		Estonia	$\otimes$	
Hungary	$\times$	$\times$	Latvia	$\otimes$	
Malta	$\times$		Lithuania	$\otimes$	$\otimes$
Austria	$\times$		Netherlands	$\otimes$	$\otimes$
Poland	$\times$	$\times$	Finland	$\otimes$	$\otimes$
Romania	$\times$	$\times$	Sweden	$\otimes$	
Belgium		$\times$	United	$\otimes$	
Spain		$\times$	Cyprus		$\otimes$
France		$\times$	Hungary		$\otimes$
Slovenia		$\times$			
Slovakia		$\times$			

An interesting case is France. The country is one of the largest contributors to the EU budget, like Germany, but its employment rate is less than in Germany and the investigated probability is very low in both gender groups (mostly less than 2%). This shows how difficult it is to resolve the dispute about the reasons for the given employment levels to differ. Differences in German and French labour-market institutions are significant. The two countries have different economic strategies that affect employment rate and level. Application

of collective bargaining at the firm level allows for more flexibility in Germany (Herzog-Stein et al. (2013), Möller (2010)). However, the higher resilience and flexibility of the German labour market comes at the price of higher market-income inequality and poverty across individuals and age groups (Hartung et al. (2018), Cléaud et al. (2019)).

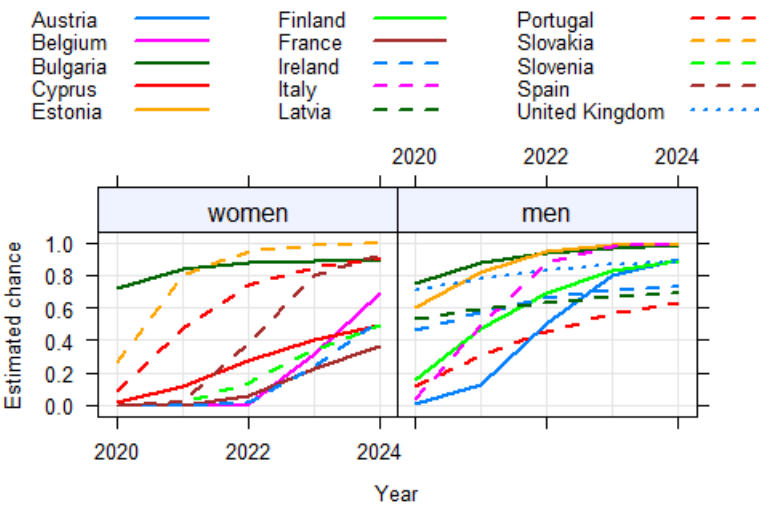

Figure 5: Model-based estimates of achieving the 95% German employment rates; results for old-aged people from countries with estimates between 0.3 and 0.8

Although Germany's growth model has allowed it to benefit from the strong post-2008 financial crisis recovery in the global economy, it also makes it more exposed to swings in the global cycle. France's growth model has relied more on domestic demand. Together with a larger public sector, this has helped to smooth out economic cycles, but has also implied some losses in cost competitiveness and a significantly higher tax burden (Cléaud et al. (2019)).

5. Summary

The idea of model-based probability estimate of reaching the specified employment rate level represented by one of the strongest labour markets in Europe and at the same time one of the largest contributors to the EU budget, i.e. Germany, was applied. This approach takes into account the structure of employment rate time series and allows to forecasting the probability of achieving the given level. The research comprises groups by age and gender. The prognosis is based on the data from 2005 to 2019. The data embracing the year 2020 are not included in the analysis. The one-year series relate to the global spread of a new disease and appear too short to be included into a statistical model. According to the knowledge of the authors no similar approach to the issue has been proposed.

The obtained results are not optimistic for young people. Low probability of reaching

the German employment rates levels results from the past covering of 2005-2019 time period. It means that the time series consist of low rates (for example in the case of Bulgaria, Italy or Greece) or are not expected to increase fast enough as in the case of Cyprus, Latvia, Slovenia and other countries with relatively high employment rates. This is true for Belgium, Bulgaria, Czechia, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Hungary, Poland, Portugal, Romania, Slovenia and Slovakia. The 2019 employment rates of these countries are shown in Figure 6.

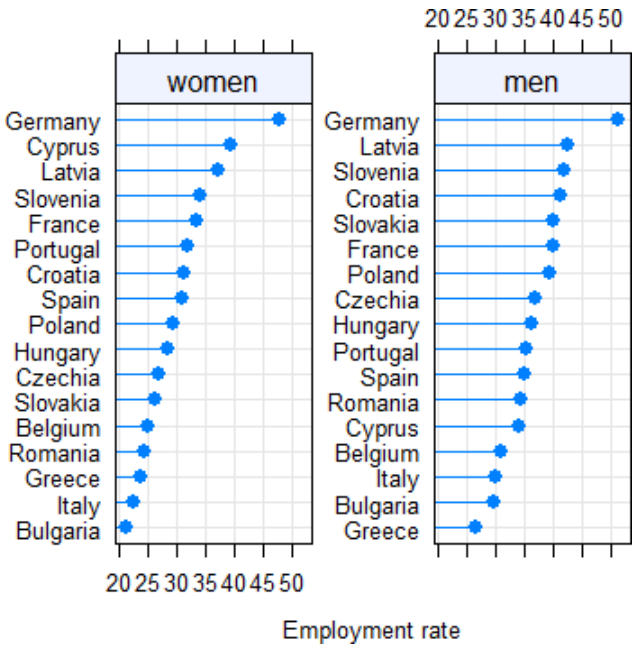

Figure 6: The 2019 employment rates for young people

The employment rates for old people are more optimistic. The rates are increasing and that is reflected by the increasing probability of approaching the levels of German employment rates. Slovakia, Portugal, Spain and Belgium show high growth rates among women. Their probabilities of approaching the 95% German employment rates levels are expected to rise above 80% no later than in 2024. Among men it includes Estonia, Italy, Finland and Austria (see Figure 5).

The employment rates for old people may be strongly influenced by the pandemic. A large body of research has established health as a significant factor affecting the labour market participation of older people, with those in poorer health more likely not to be employed (van den Berg et al. (2008), van Rijn et al. (2014)). Figure 7 shows the distribution of difference between employment rates of 2020:Q2 and of 2019:Q2. About half of the European countries show a decrease in employment rates among old-aged people since the beginning of the pandemic. The distribution is shifted to the left compared to the corresponding data of a previous year. Differences in employment levels are more varied for women, as can be seen from the different scale of distributions.

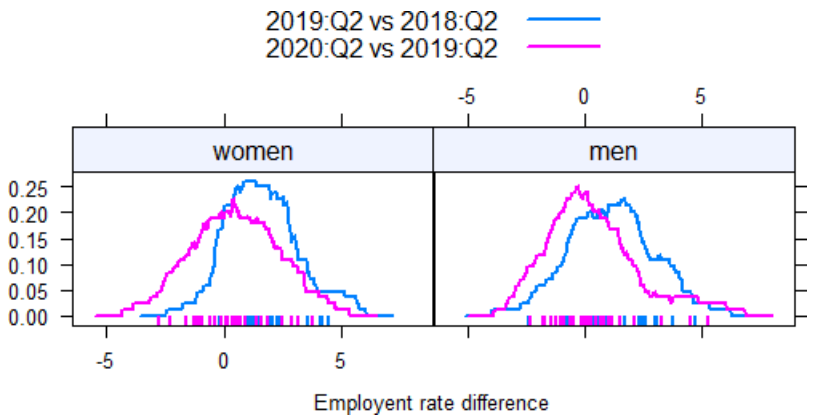

Figure 7: Employment rate difference distribution 2020:Q2 vs 2019:Q2 and 2019:Q2 vs 2018:Q2 for old people across European countries.

The German Institute for Economic Research (DIW Berlin) said that Germany's economic output could return to pre-crisis levels toward the end of 2021. The prognosis for Europe is less optimistic. Autumn 2020 Economic Forecast of European Commission claims that output in both the euro area and the EU is not expected to recover its pre-pandemic level in 2022. Hence, the forecasts contained in this article should be postponed by at least two years.

The low employment rate of young people is very disadvantageous from a social point of view. Already in the nineteenth century, Gustav Le Bon wrote: *The conditions of success in life are the possession of judgment, experience, initiative, and character – qualities which are not bestowed by books* (Le Bon (2015)). This message is still relevant today (compare with Bell et al. (2011) and Standing (2016)).

The increasing employment rate of older people is implied by demographic ageing. The European Commission suggests that policy makers should have incentivized older workers to remain longer in the labour market. Good health is for many an imperative for working beyond the pensionable age. The employment rate for old people depends strongly on the quality of health, quality of work, benefit system and other factors.

Low employment rates of young and old workers are connected with the phenomenon of a growing number of people with transient roles in the labour market, short spells of employment interspersed with unemployment spells of varied length that do not make life meaningful. Standing (2016) argues that this class of workers, called Precariat, will cause instability in society. Presence of a large Precariat raises the spectre of populist movements to restrict the movement of labour and to promote disenfranchisement of various vulnerable groups. The populist movements go against the mainstream media, universities, the political class, banks, and also against widely accepted truisms such as global warming and the benefits of free trade (Dustmann et. al (2017)).

Some implications of low employment were outlined. The issue is complex and requires detailed research. The aim of the article is not to explain the complexity of the labour market, but to state the pessimistic prognosis about employment rates in European countries. It

seems that governments of many countries should revise their economic strategies affecting labour market if they want to achieve satisfactory employment rates

References

Baumol, W. J., (2015). *Macroeconomics: Principles and policy*, Cengage Learning, Inc.

Bell, D. N., Blanchflower, D. G., (2011). Young people and the Greater Recession,*Oxford Review of Economic Policy*, Vol 27 (2), pp. 241–267.

Cléaud, G., De Castro Fernández, F., Durán Laguna, J., Granelli, L., Hallet, M., Jaubertie, A., Maravall Rodriguez, C., Ognyanova, D., Palvolgyi, B., Tsalinski, T., Weißschädel, K., Ziemendorff, J., (2019). *Cruising at different speeds: similarities and divergences between the German and the French economies*, European Commission. Directorate General for Economic and Financial Affairs, Discussion Paper 103. https://doi.org/10.2765/756955

Corselli-Nordblad, L., Strandell, H., (2020). *Ageing Europe: Looking at the lives of older people in the EU: 2020 Edition*, Eurostat. https://doi.org/10.2785/628105.

Dustmann, Ch., Eichengreen, B., Otten, S., Sapir, A., Tabellini, G., Zoega, G., (2017). *Europe's trust deficit: Causes and remedies*, CEPRR PRESS. Retrieved from http://voxeu.org/system/files/epublication/Europes_Trust_Deficit_MII1.pdf

European Commission, (2020). *European Skills Agenda for Sustainable Competitiveness, Social Fairness and Resilience*, Retrieved from https://ec.europa.eu/social/main.jsp?catId=89&newsId=9723

European Commission, (2018). *The Youth Guarantee*. Retrieved from https://ec.europa.eu/social/main.jsp?catId=1079

European Commission, (2017). *Investing in Europe's Youth*. Retrieved from https://ec.europa.eu/social/BlobServlet?docId=16923.

European Commission, (2012). Youth Employment Initiative. Retrieved from https://ec.europa.eu/social/main.jsp?catId=1176.

Hartung, B., Jung, P., Kuhn, M., (2018). *What hides behind the German labour market miracle? Unemployment insurance reforms and labor market dynamics*, CESifo Working Paper Series 7379. Retrieved from https://ideas.repec.org/p/ces/ceswps/_7379.html

Herzog-Stein, A., Lindner, F., Sturn, S., (2013). *Explaining the German employment miracle in the Great Recession – The crucial role of temporary working time reductions*, IMK Working Paper 114–2013, IMK at the Hans Boeckler Foundation, Macroeconomic Policy Institute. Retrieved from http://www.boeckler.de/pdf/p_imk_wp_114_2013.pdf

Hyndman R. J., Koehler, A. B., Snyder, R., D., Grose, S., (2002). *A state space framework for automatic forecasting using exponential smoothing methods*, International Journal of Forecasting, 18(3), pp. 439–454.

Hyndman R., J., Koehler, A., B., Ord, J., K., Snyder, R., D., (2005). *Prediction intervals for exponential smoothing using two new classes of state space models*, Journal of Forecasting, 24, pp. 17–37.

Hyndman R., Khadakar, Y., (2008a). *Automatic time series forecasting: The forecast package for R*, Journal of Statistical Software, 27(3).

Hyndman R., J., Koehler, A. B., Ord, J. K., Snyder, R. D., (2008b). *Forecasting with exponential smoothing – the state space approach*, Springer-Verlag Berlin Heidelberg.

Le Bon, G., (2015). *The Crowd and The Psychology of Revolution*, CreateSpace Independent Publishing Platform.

Matthews, P., Besemer, K., (2014). *Poverty and social networks evidence review, Joseph Rowntree Foundation.* Retrieved from http://www.storre.stir.ac.uk/bitstream/1893/21042/1/JRF%20final%20published%20report.pdf.

Möller, J., (2010). *The German labour market response in the World Recession – de-mystifying a miracle*, Zeitschrift Für ArbeitsmarktForschung, 42(4), 325–336. https://doi.org/10.1007/s12651-009-0026-6

Ord, J. K., Koehler, A. B., Snyder, R. D., (1997). *Estimation and prediction for a class of dynamic nonlinear statistical models*, Journal of the American Statistical Association, 92, pp. 1621–1629.

Standing, G., (2016). *The Precariat: The new dangerous class*, London, UK and New York, USA: Bloomsbury Academic.

van den Berg, T., Elders, L., de Zwart, B., Burdorf, A., (2008). *The effects of work-related and individual factors on the Work Ability Index: A systematic review*, Occupational and Environmental Medicine, 66(4), pp. 211–220.

Van Rijn R. M, Robroek S. J. , Brouwer, S. Burdorf, A., (2014). *Influence of poor health on exit from paid employment: A systematic review*, Occupational and Environmental Medicine, 71(4), pp. 295–301.