THE ROLE OF PHARMACISTS IN THE AGE OF AUTOMATION

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Abstract

In this paper, we examine the role of pharmacists in the age of automation. Advances in the use of automation technologies replace many tasks previously performed by human workers. At the same time, new tasks in which labour has a comparative advantage have been created. Pharmacists as healthcare professionals can benefit from these advances, but their main tasks will shift away from retail to professional services complementing new technologies. We compare three different estimations of future automation probabilities for pharmacists based on the tasks they perform. We relate those probabilities to healthcare specialists, retailers and other services. Finally, we provide empirical evidence on the size of the effects in Slovakia based on detailed microdata on employment by occupation. Between 2014 and 2019, there was a relative shift of employment from pharmaceutical technicians to pharmacists in the Slovak labour market. This result is in line with predictions on automation probabilities for these occupations but identifying the role of automation in this process calls for further research.

Keywords

Automation, Pharmacy Market, Pharmacists, Healthcare

I. Introduction

Recent advances in automation technologies, digitalisation, and the use of machine learning and artificial intelligence are expected to contribute to increasing productivity and social welfare. On the other hand, new technologies replace human labour in tasks that were considered to be the main domain of human activity and there is increasing anxiety related to technologies that are seen as a threat to humans, labour, employability and related socio-economic consequences.

In this paper, we explore the changing role of pharmacists in the age of automation. The workforce structure in the pharmacy sector has been relatively static for many years. However, due to technological changes in almost all industries, healthcare is not an exception and has been also exposed to automation. Since some of the pharmacists' roles may become redundant soon, concerns about the future of jobs occur in pharmacy. On the contrary, new tasks and roles are expected to be created, while pharmacists may be released from the dispensing and supplying processes. We can already meet with the automated dispensing systems or machines (ADM) which have been used to a wide range of repetitive tasks at risk of error like record keeping, item selection, labelling or dose packing (Spinks et al., 2017). We compare the probabilities of automation of pharmacists based on the tasks that they perform using estimates by Frey and Osborne (2017), Dengler and Matthes (2018) and Mihaylov and Tijdens (2019). Then, we relate those probabilities to other healthcare professionals and specialists, as well as to retailers and other professional services. In this way, we can reveal the range of tasks performed by pharmacists. Many tasks that they perform are far away from the capabilities of machines for their replacement but there are other tasks that could be automated in the near future. One of our aims is to provide empirical evidence on the size of the expected effects for Slovakia.

The paper is structured as follows. First, the literature on the future of labour and the impact of automation technologies is reviewed in general and with a special focus on the pharmacy market and pharmacists. Second, differences in the estimates of automation probabilities and methodology are explained. Finally, empirical evidence on the impact of the Slovak labour market and pharmacists is

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presented. The analysis revealed that between 2014 and 2019, there was a relative shift of employment from pharmaceutical technicians to pharmacists in the Slovak labour market. The only region where pharmaceutical technicians and assistants keep outnumbering pharmacists is Banská Bystrica. Predictions on automation probabilities for pharmacists and pharmaceutical technicians and assistants suggest that the relative importance of pharmacists should increase over time. But there are many other factors other than automation that could be behind the observed development in Slovakia in this specific period. Thus, a better understanding of the role of automation in this process would require further research.

II. Literature review

Questions and concerns about the future of work have quite naturally arisen in the current period. Although computerisation has been historically affecting mostly routine tasks (Autor et al., 2003; Autor and Dorn, 2013), some authors (Frey and Osborne, 2017; McAfee and Brynjolfsson, 2011, among others) suggest that recent technological development allows computers to substitute an increasing amount of non-routine tasks, as well. Therefore, several studies deal with the potential impacts of technological progress and estimate the susceptibility of individual tasks or even whole occupations to automation in the near future. Literature already offers a wide spectrum of estimates ranging from positive and neutral to strongly negative effects on the overall employment. Frey and Osborne (2017) examined how current jobs are susceptible to technological developments. To assess this, they implemented a novel methodology to estimate the probability of computerisation for 702 occupations. They distinguished between high, medium, and low risk occupations considering their probability of computerisation. As the authors highlight, they do not attempt to estimate the number of jobs being actually automated, they rather focus on potential jobs automatability in the upcoming decades. Their estimates suggest a relatively high percentage of U.S. jobs facing a high risk of computerisation, more precisely 47%. They refer to these as jobs at risk, which mostly include transportation and logistics occupations, office and administrative support workers and other workers in production occupations. However, a substantial share of jobs in services has been becoming highly susceptible to computerisation in the past years as well. This finding can be supported by the increasing number of service robots over the past decades (Manyika et al., 2013).

Inspired by the study by Frey and Osborne (2017) mentioned previously, many authors followed this path and used either occupation-based or a task-based approach to predict the risk of automation for the jobs in other countries. However, both approaches have their drawbacks. For instance, occupation-based approach does not consider task heterogeneity within occupations and task-based approach depends mostly on the quality of detailed national data regarding information on corresponding occupations. Using the occupation-based approach, assuming that the risk of automation for a certain occupation is comparable across countries, Pajarinen and Rouvinen (2014) estimated the share of jobs susceptible to automation to be around 35% in Finland while Brzeski and Burk (2015) estimated the share of jobs at risk of automation to be as high as 59 % in Germany. Bowles (2014) working with more aggregated employment data finds that the share of jobs susceptible to automation in Europe ranges between 45% to more than 60%, with the highest exposure to a potential automation in southern Europe. For Slovakia, the author estimates that roughly 55% of jobs are at a high risk of automation. This is almost identical with the average for all EU member states (54%).

The findings of Arntz et al. (2016) suggest that using a task-based approach results in a much lower susceptibility to automation compared to occupation-based approach. When allowing for workplace heterogeneity, they find that the automation risk of U.S. jobs drops to 9 %. In their study from 2016, they estimate that in 21 OECD countries, 9% of jobs on average are highly automatable. Workers face the lowest risk of automation in South Korea (6%) and the highest risk in Austria (12%). The share for Slovakia is 11%. At the same time, their study indicates that groups at the highest risk of automation include low-income population groups and workers with primary and lower secondary education. In this analysis, Slovakia's labour market is in the fourth place in terms of risk, right after Austria, Germany and Spain. A similar, but also somewhat modified approach is used by Nedelkoska and Quintini (2018), who extended their analysis to 32 OECD countries, where they predict about the average share of jobs at a high risk of automation to be 14%. On country level, the shares range from 6% to 33%, while the country at the highest risk of automation is Slovakia. The average job in Slovakia is associated with a 57% automatability. In the case of EU countries, Pouliakas (2018) reached the same conclusion as Nedelkoska and Quintini (2018) that 14% of European workers between 24 and 65 years of age face a high risk of automation.

In contrast to many of the above-mentioned studies, Dengler and Matthes (2018) used their own expert estimates of the risk of automation faced by individual occupations in Germany. They noted that they did not try to predict the future but focused on the current technological possibilities. According to them, compared to the 47% in the case of using the occupation-based approach, the share using the task-based approach is significantly lower, namely 15% of German employment faces a high risk of automation. The results of their research also indicate that employment growth in individual occupations decreases with their automatability. A similar approach was chosen by Mihaylov and Tijdens (2019), who analysed the task content of the individual occupations in the International Standard Classification of Occupations (ISCO-08). They categorise these tasks into five groups – non-routine analytic, non-routine interactive, routine cognitive, routine manual and non-routine manual – and then estimate the share of employment at a high risk of automation in the Netherlands (11%). Furthermore, Haiss et al. (2020) using the data from micro-census labour force survey carried out by Statistics Austria for 2015, calculated that more than 40% of the Austrian employment is exposed to a high risk of computerisation. They found that 3 ISCO-08 major groups, namely "Clerical support workers", "Service and sales workers" as well as "Craft and related trade workers", include more than 72% of all people who work in high-risk occupations. However, they claim that only a small proportion of occupations falling into the high-risk category will be completely automated. Instead, the vast majority of these occupations will go through significant changes in the requirements for the competences, skills and education of workers and in the tasks performed as a part of these occupations. The authors also estimate that the implementation of new technologies will affect women more negatively than men.

Moreover, according to Acemoglu and Restrepo (2019), automation, has multiple effects. The first one lies in the destruction of jobs which he calls "the displacement effect" and it represents the cost of automation. The benefits of automation are characterised as "a productivity effect" that makes industry more capable of producing more and cheaper goods leading to companies to be more profitable and allowing them to hire more workers. On the other hand, humans can benefit from the new jobs like a robot technician or a software coder. The economists often call these job-creating benefits of new technology "the reinstatement effect." The question Acemoglu and Restrepo have sought to figure out is which of these effects tend to dominate. Between 1947 and 1987, the productivity and reinstatement effects of new technologies were large, so they were able to more than compensate for the displacement effects. The recent stagnation of labour demand can be explained by an acceleration of automation, particularly in manufacturing, and a deceleration in the creation of new tasks. In addition to this, the economy also experienced a slowdown in productivity growth, contributing to a slower demand.

As regards the impacts of automation specific for the pharmacy sector, automated dispensing systems have been implemented for over a decade. They have replaced a wide range of repetitive processes which are at a high risk of error such as record keeping, item selection, labelling and dose packing. Most of these applications have been installed in hospital pharmacies. Future technological disruptions related to centralised automated dispensing models are discussed in Spinks et al. (2017) since they have the potential to reshape the network of community pharmacies and the task performed by pharmacists. Spinks et al. (2017) present examples of centralised automated dispensing systems for the elderly population, people with chronic diseases, and a general application of the so-called "hub and spoke model". The literature on automation in the pharmacy sector is focused predominantly on the improvements in medication safety, savings, and increased productivity generated by inpatient pharmacy automation solutions. In community pharmacies, automation changes the pharmacy dispensing workflow, from receiving a prescription (transcribing), prescription filling, to dispensing and final patient contact. Tan et al. (2009) simulated different scenarios of the automated prescription-filling systems on patient waiting times. They showed that only high-speed systems could shorten patient waiting times and reduce the number of pharmacy technicians. Moreover, Sng et al. (2019) conducted a systematic review of the literature on pharmacy automation in community pharmacies. Their review confirms the reduction in medication errors, labour savings and to a lower extent overall cost savings. However, the evidence is inconclusive on the perceivable benefits for staff and patients. In James et al. (2013), pharmacists reported that automation has enabled the expansion of their roles, but pharmaceutical technicians felt like "production-line workers" and that automated dispensing systems devalued their skills. Piercy and Gist-Mackey (2021) studied the socioeconomic disparities in the perceptions of automation between pharmacists and pharmaceutical technicians who, despite working side-by-side, have different education, income, and skill requirements. Surprisingly, their results show that both high- and low-skilled pharmacy workers share automation anxieties. Finally, Angelo et al. (2005) compared non-automated pharmacies to a pharmacy with an automated dispensing system. They did not find any relationship between patient satisfaction and the presence of an automated dispensing system. It was associated with higher prescription productivity, but the counselling rates were no different from those observed in nonautomated pharmacies.

III. Methodology

In this paper, the estimates of Frey and Osborne (2017), Dengler and Matthes (2018) and Mihaylov and Tijdens (2019) are applied to detailed Slovak employment data provided by TREXIMA Bratislava. At the country level, data on employment and for 401 4-digit SK ISCO-08 occupations for 2014 and 2019 are available. In addition to country-level data, TREXIMA Bratislava provided the corresponding data at the regional (SK-NUTS 4) and industry (2-digit SK NACE Rev. 2 codes) level. At the regional level, 8 regions can be distinguished. The estimates of Dengler and Matthes (2018) and Mihaylov and Tijdens (2019) are easily applicable to the data used in this paper, as they use the same classification of occupations. In the case of Frey and Osborne (2017), a crosswalk between ISCO-08 and the 2010 SOC had to be used. This crosswalk is provided by the Bureau of Labour Statistics[1]. Frey and Osborne (2017) distinguish between high-, medium- and low-risk occupations, depending on their probability of automation (thresholding at the probabilities of 0.7 and 0.3). The same categorisation is used by Dengler and Matthes (2018) and Mihaylov and Tijdens (2019). Therefore, this categorisation is used in this paper, too.

In particular, using these estimates, we explore the changing role of pharmacists and related occupations (pharmaceutical technicians and assistants) driven by automation technologies. We list the tasks performed by pharmacists as they are defined in the ISCO-08 codes to see the various aspects of the profession in the following paragraphs:

Definition of the ISCO 08 Code 2262: Pharmacists: Pharmacists usually compound and dispense medications following prescriptions issued by physicians, dentists, or other authorised health practitioners. Also, they ensure safe and quality use of medicines, and optimise health outcomes by contributing to selecting, prescribing, monitoring, and evaluating medicine therapy, and researching, testing, and developing pharmaceuticals and medical products. Other tasks include preparing or supervising the preparation and labelling of liquid medicines, ointments, powders, tablets and other medications; providing information and advice to prescribers and clients regarding drug interactions, contra-indications, side effects or dosage; collaborating with other healthcare professionals to plan, monitor, review, and evaluate the quality and effectiveness of the medicine therapy of individual patients; storing and preserving vaccines, serums and other drugs subject to deterioration; supplying non-prescription medicines, and diagnostic and therapeutic aids; supervising and coordinating the work of pharmacy technicians, pharmacy interns and pharmacy Sales Assistants; conducting research to develop and improve pharmaceuticals, cosmetics and related chemical products; conferring with

[1] Available for download at: https://www.bls.gov/soc/isco_soc_crosswalk.xls

Chemists, Engineering Professionals and other professionals about manufacturing techniques and ingredients; testing and analysing drugs to determine their identity, purity and strength in relation to specified standards and other activities.

Definition of the ISCO 08 Code 3213: Pharmaceutical technicians and assistants
Pharmaceutical technicians and assistants dispense and prepare medications, lotions and mixtures under the guidance of pharmacists, in pharmacies, hospitals and dispensaries. Some other tasks include: preparing medications and other pharmaceutical compounds under the guidance of pharmacists; dispensing medicines and drugs and giving written and oral instructions on their use receiving written prescription or refill requests; maintaining proper storage and security conditions for drugs; filling and labelling containers with prescribed medications; assisting customers by answering questions, locating items or referring them to a pharmacist for medication information; pricing and filing prescriptions; ordering, labelling, and counting stock of medications and entering inventory data into a computer; cleaning and preparing equipment and other.

All in all, there are three main occupations for pharmacists. Most of them are employed as retail pharmacists, and others work as industrial pharmacists and hospital pharmacists. Pharmaceutical technicians and assistants mostly compound and dispense medications in pharmacies, hospitals or provide assistance to industrial pharmacists.

III. Empirical results

First, we compare the probabilities of automation across professions that perform tasks similar to pharmacists, pharmaceutical technicians and assistants. Then, we analyse the employment of pharmacists in Slovakia by industries and regions. Finally, the shifts in the relative employment of pharmacists and pharmaceutical technicians and assistants in the periods 2014 and 2019 are examined.

Most of the pharmacists are employed in community pharmacies. They store, compound and dispense medication to patients with or without a prescription issued by medical doctors and other healthcare professionals. In this way, they perform many tasks similar to retailers. They determine customer requirements, provide advice on products, price, and product use. They sell goods (drugs), accept payments, prepare sales invoices, record sales using cash registers, dispense medication. These are the tasks similar to shop sales assistants, cashiers and shop keepers. On the other hand, pharmacists are healthcare professionals that counsel on the proper use of drugs and medicines. They contribute to preparing, prescribing and monitoring medical therapies to optimise the health of the patients and to counsel on the adverse effects of medication. They evaluate the quality and effectiveness of the medicine therapy of individual patients and the effectiveness of particular therapies.

The probability of automation of pharmacists and pharmaceutical technicians and assistants reflects this mixture of the tasks. To explore the future role of pharmacists and their tasks at a high risk of automation, we compare pharmacists with selected healthcare professionals on the one hand, and certain retail, dispensing and recording occupations on the other.

In general, healthcare professions do not fall within the group of occupations with a high risk of automation (over 70 %). On the contrary, tasks performed by retailers related to dispensing and recording are usually associated with the highest risk of automation. Pharmacists and pharmaceutical technicians perform tasks related to both occupations. They are well-educated healthcare specialists also responsible for storing and dispensing medication (see a detailed description of their tasks in ISCO Codes definitions). However, there are higher demands placed on pharmacists than on pharmaceutical technicians. This is reflected in automation probabilities, too. While Frey and Osborne (2017) predict a very low automation probability for pharmacists (0.01), pharmaceutical technicians and assistants are at a high risk of automation (0.92). On the other hand, Dengler and Matthes (2018) and Mihaylov and Tijdens (2019) also studied the task content of the occupations. The differences in automation probabilities between pharmacists and pharmaceutical technicians and assistants are present in their estimates too but they are not so significant – around one third for pharmacists and two thirds for pharmaceutical technicians. The task content of pharmaceutical technicians and assistants is predicted to change more in the future compared to the task content of the work performed by pharmacists. There is a higher proportion of tasks performed by pharmacists that are related to healthcare specialists such as general practitioners, ambulance workers or specialist medical practitioners. For these occupations, all methodologies predict very low rates of automation probabilities (see Table 1).

Table 1 Comparison of probabilities of automation across professions and methodologies

ISCO-08	Probability			Job title
	Frey and Osborne	Dengler and Matthes	Mihaylov and Tijdens	
Healthcare professionals				
2211	-	0.00	0.13	Generalist medical practitioners
3258	0.05	0.00	0.17	Ambulance workers
2212	-	0.03	0.13	Specialist medical practitioners
2261	0.02	0.04	0.00	Dentists
Pharmacists, pharmaceutical technicians, and assistants				
2622	0.01	0.37	0.29	Pharmacists
3213	0.92	0.65	0.67	Pharmaceutical technicians and assistants
Retailers, dispensing and recording professions				
3252	0.91	0.72	0.71	Medical records and health information technicians
3254	0.71	0.44	0.40	Dispensing opticians
3256	0.30	0.55	0.30	Medical assistants
5223	0.95	0.38	0.33	Shop sales assistants
5230	0.90	0.92	0.88	Cashiers and ticket clerks
5221	0.16	0.22	0.44	Shop keepers

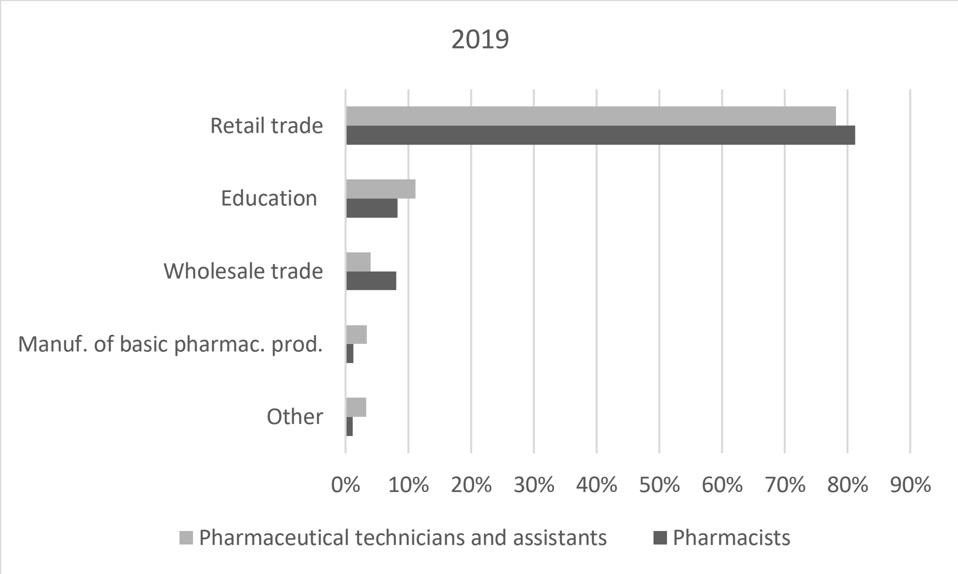
Source: Authors based on Frey and Osborne (2017), Dengler and Matthes (2018), and Mihaylov and Tijdens (2019).

Most of pharmacists work in community pharmacies, where they dispense and sell medication. They perform tasks such as orders of goods and medicines, inventory controls, labelling, recording and other activities that are close to retail sales. Also, these tasks are at high risk of automation. Frey and Osborne (2017), Dengler and Matthes (2018) and Mihaylov and Tijdens (2019) predict high probabilities of automation for occupations such as shop sales assistants, cashiers, or dispensing opticians. Similarly, tasks related to medical recording or other activities usually performed by health information technicians are at a high risk of computerisation. Therefore, in the future, we should expect a relative increase in the role of pharmacists compared to pharmaceutical technicians and assistants, and an increase of tasks performed by pharmacists that are linked to counselling and other highly specialised healthcare activities.

The relative distribution of pharmacists and pharmaceutical technicians and assistants by industry and region changed slightly between 2014 and 2019. Both occupations are mostly represented in retail trade, where the task content consists of storing, compounding, and dispensing medication to patients with or without a prescription issued by healthcare professionals. However, in a five-year period, we observe a relative shift of employment from pharmaceutical technicians to pharmacists (Figure 1 and

Figure 2). Based on this finding, we assume that retail trade services may have increased in quality, because of a greater representation of more qualified workers, abstracting from other factors.

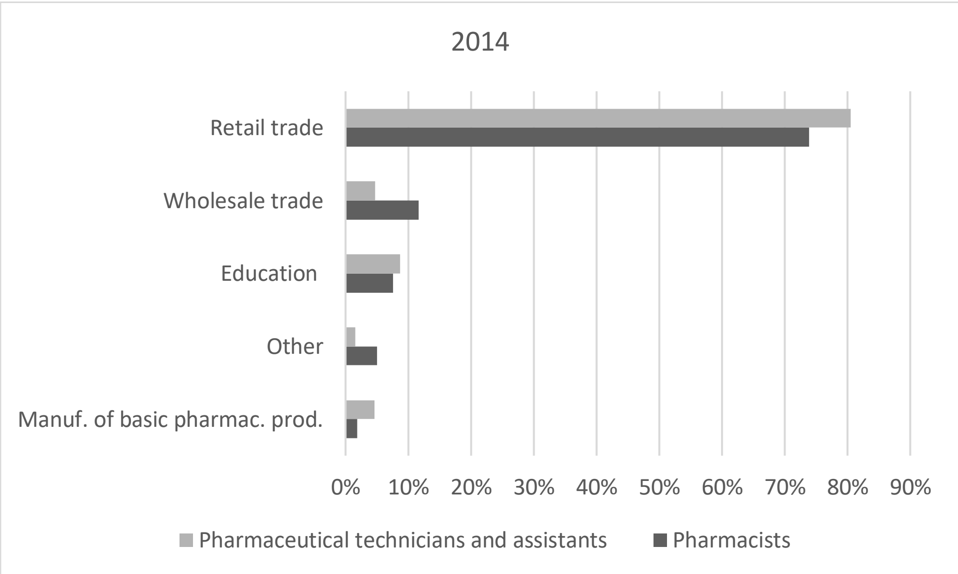
Figure 1 Distribution of pharmacists and pharmaceutical technicians and assistants by industry, in %, 2019



Source: Authors based on data from TREXIMA Bratislava (2019).

On the other hand, the share of pharmacists in wholesale trade has become lower with a less significant change in the case of pharmaceutical technicians. Furthermore, besides education and the manufacture of basic pharmaceutical products and chemical products, other industries include other manufacturing, advertising and market research, public administration and defence, and human health activities. However, these account only for up to 1% in most industries.

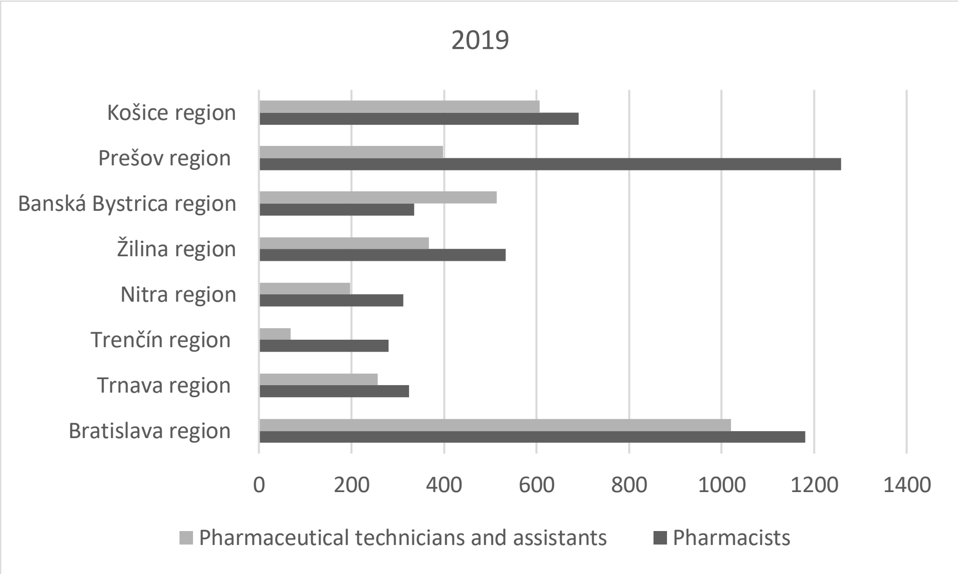
Figure 2 Distribution of pharmacists and pharmaceutical technicians and assistants by industry, in %, 2014



Source: Authors based on data from TREXIMA Bratislava (2014).

When looking at the region distribution (Figure 3 and Figure 4), the majority of pharmacists work in the Prešov region. Compared to 2014, the number of these jobs has risen visibly, while the number of pharmaceutical technicians and assistants has been constantly falling. A similar pattern can be observed in the Košice, Žilina and Trenčín regions. The only region where pharmaceutical technicians and assistants keep outnumbering pharmacists is Banská Bystrica. Moreover, the number of people working as pharmacists has hardly changed in a five-year period. This development could indicate that the quality of retail trade services in this region has not changed much, and it is lower compared to other Slovak regions. Other findings suggest that many pharmacists work in the Bratislava and Košice regions and the highest disproportion between these two types of occupations is in the Trenčín region with the predominance of pharmacists (Figure 3).

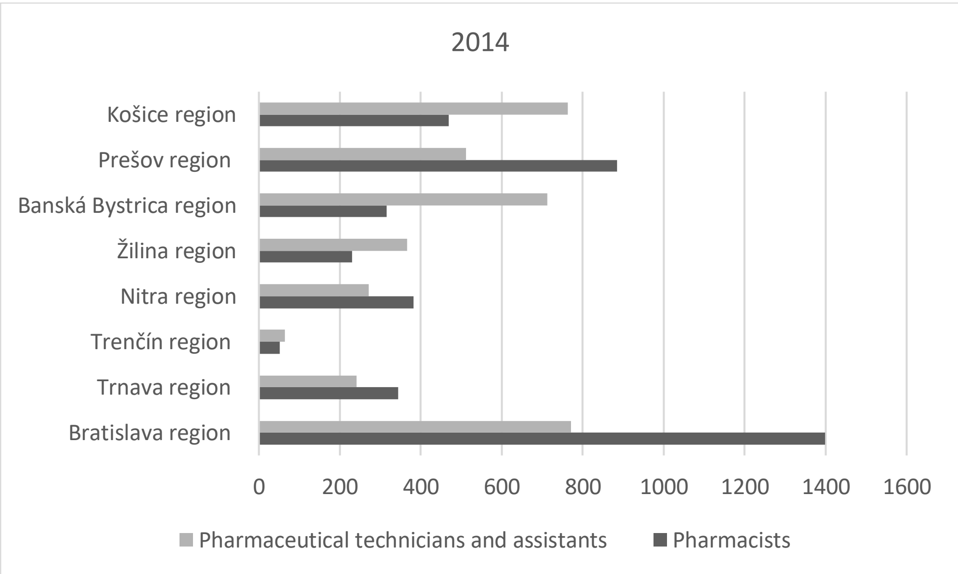
Figure 3 Distribution of pharmacists and pharmaceutical technicians and assistants by region, in number of workers, 2019



Source: Authors based on data from TREXIMA Bratislava (2019).

In the observed period, an improvement in favour of pharmacists can be observed at the regional level with an exception of the Banská Bystrica region. Another interesting fact is that the number of pharmacists in the Bratislava region slightly decreased, while at the same time, the number of pharmaceutical technicians and assistants increased.

Figure 4 Distribution of pharmacists and pharmaceutical technicians and assistants by region, in number of workers, 2014



Source: Authors based on data from TREXIMA Bratislava (2014).

The predictions on automation probabilities for pharmacies and pharmaceutical technicians and assistants suggest that the relative importance of pharmacists should increase over time. But there are many other factors other than automation, which could be responsible for the observed development in Slovakia in this specific period.

IV. Conclusion

Work automatability estimates for Slovakia differ depending on the methods used by individual authors. In general, the share of employment facing a high risk of automation is estimated in the range of 11% to 55%. What these studies have in common is that they categorise Slovakia among labour markets at the highest risk of automation.

In this paper, we focused on the implications of automation for the pharmacy sector. We explored the differences in the estimates of automation probabilities for pharmacists and pharmaceutical technicians and assistants. The empirical evidence on the impact of the Slovak labour market and pharmacists was presented. We found that between 2014 and 2019, there was a relative shift of employment from pharmaceutical technicians to pharmacists in the Slovak labour market, which is in line with the predictions on automation probabilities in the pharmacy sector. As there are many different factors other than automation, which could be responsible for the observed development in Slovakia in this specific period, more research has to be performed to better understand the role of automation in this development.

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