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An Intra-European Perspective

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Abstract

In this note, we study the relationship between the use of new technologies (e.g. robots and various ICT assets), labour demand and migration patterns. The adoption of new technologies might change the demand for labour in various ways, which in turn will have an impact on skill composition and wage levels of different types of workers. We report the main results from a study that first analyses the impact of robot adoption on wages by sector and skills. Second, we study the impact of robot adoption in manufacturing industries on the attraction of migrants while controlling for other factors in the labour demand function. This is followed by an analysis of push and pull factors of bilateral migration that focuses on the impact of relative automation gaps across countries. Finally, using the OeNB Euro Survey, we examine determinants of the intention to migrate and the role of income differentials between the countries of origin and destination.

Keywords: Migration, migrant jobs, wages, employment, novel technologies, adoption of robots, digitalisation, European labour markets, Central Eastern European countries

JEL classification: F22, F66, J61, J24, J20, O33

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New technologies, migration and labour market adjustment: an intra-European perspective

1. INTRODUCTION

The rise of cutting-edge technologies in the fields of artificial intelligence (AI), machine learning and robotics is exerting notable effects on employment and wages across various sectors. This shift has sparked widespread debates on the future of work driven by 'automation risks' (Arntz et al. 2016) and the concerns regarding the potential of a 'jobless future' (Aronowitz and DiFazio 2010). Public sentiment widely holds that the advent of Industry 4.0 will result in robots taking over human jobs, a fear substantiated by the Eurobarometer survey (2012). The onset of the coronavirus (COVID-19) pandemic and subsequent government mandates for remote work have underscored the need for increased digitalisation and automation in the workplace while offering the opportunities of telemigration in some occupations (Baldwin 2019). Empirical studies however, present diverse findings regarding the substitutability of labour through technological advancements, ranging from those indicating high levels of 'jobs at risk to automation' (Frey and Osborne 2017) to research suggesting considerably lower projections of occupational disruption (Arntz et al. 2016), with this difference being attributable to the focus on the automatability of individual tasks rather than entire occupations. Some studies highlight the adverse impact of industrial robots on employment (Acemoglu and Restrepo 2017, 2018; Graetz and Michaels 2018), while others even suggest that robotisation may have a beneficial effect on employment growth at both the industry and firm levels (Ghodsi et al. 2020; Koch et al. 2019). As Klenert et al. (2022) observe, the academic debate on this matter remains unresolved. More recent studies also find no or even slightly positive employment effects of technologies (Jestl 2024; Stehrer 2024).

Another factor amid the rapidly evolving economic landscape is that the European Union (EU) will likely face important demographic challenges given its ageing societies and shrinking working-age population. Grieveson et al. (2019) forecast that the EU will experience acute labour shortages across its member states by 2030, with Central, East and Southeast Europe (CESEE) also undergoing significant demographic and economic shifts. These developments are leading to increasingly noticeable labour market constraints, which might act as an impediment to economic growth. While Western Europe has historically managed labour supply challenges through the influx of Eastern European workers, the demographic shift reaching a 'tipping point' across Europe poses a new, formidable challenge for policy makers in Western Europe. There are already signs that outward mobility from the EU members states of Central and East Europe (EU-CEE) has slowed down. This is likely to continue, as these countries have themselves experienced negative demographic developments since the early 1990s, including low birthrates and outward migration. Owing to labour shortages and relatively favourable economic growth, a number of EU-CEE countries (e.g. Czechia, Hungary and Poland) have recently become net receivers of migrants. Return migration and migration from non-EU regions into EU-CEE countries might gain momentum. Push and pull factors of mobility within the EU (e.g. unemployment and better jobs and earnings prospects abroad, respectively) have recently become weaker, which has been accompanied by stricter immigration controls from outside the EU. The shrinking of the working-age population and the lower labour supply are raising the bargaining power of workers, which is forcing employers to adjust

and offer higher wages to avoid constraints on future investment growth. On the supply side, strong wage growth in the EU-CEE region might contribute to deterring outward migration because of improved earnings prospects at home. However, in specific sectors, wage gaps are still considerable and might still act as a strong pull factor for emigration. On the demand side, a number of companies are responding to labour shortages by employing automation/robots for certain tasks (Shotter 2019). Skill-biased technological change (SBTC) is widening the wage gap between low- and high-skilled workers (Lankisch et al. 2019). Automation is negatively/positively affecting demand for low-/high-skilled labour and consequently wage differentials, not only across skills but also across countries, depending on the speed of technological change. Migrants are more likely to be affected, especially those who are employed in labour-intensive sectors, while demand for high-skilled migrants is expanding (Basso et al. 2020; Biagi et al. 2018; Migali and Scipioni 2018). A number of EU countries are adjusting their migration policies, and there is a major push towards strong selectivity in attracting high-skilled migrants, as indicated, for example, by the Skilled Immigration Act in Germany, the Red-White-Red Card in Austria and, more generally, post-Brexit immigration policy in the EU that prioritise high-skilled migrants.

While immigration is viewed as a temporary fix for some sectors, automation represents a potential long-term solution for others and particularly for manufacturing. Regardless of the approach, the outcomes for wages and labour demand will vary, influenced by the degree of labour market tightness and the negotiating strength of workers, which depends on the specific skill sets and human capital required in each sector. Adoption of robots in skill-intensive sectors, such as automotive industries, seems to reduce the demand for low-skilled labour and, consequently, the wages paid for it in manufacturing sectors. According to the literature, the availability of affordable technology (e.g. robots) to produce goods in manufacturing is making it easier to replace workers. Lower wage offers for low-skilled labour induced by robot adoption in destination countries can then reduce incentives to migrate. Furthermore, migrants tend to be employed in jobs that have high automation potential (Biagi et al. 2018). The research covered in this policy note (and financed under a OeNB research project grant) comprehensively studies these shifts by taking a closer look at the intricate interplay of robotisation, digital technologies, wage dynamics and migration patterns.

Against this backdrop, several challenges seem to arise for the EU and CESEE countries. For instance, the main question is how to maintain economic growth and investment activity in the face of looming labour market shortages, the demographic ‘tipping point’, a slowdown in migration, and the fact that automation is contributing to rising demand for high-skilled workers. The primary goal of this research project is to analyse to what extent novel technologies could address the demographic challenges while serving as either a substitute for or complement to migration. This is achieved through a comprehensive analysis of the mechanisms through which adoption of novel technologies influences various economic indicators that serve as the drivers of migration, including those positively attracting migrants to certain destinations (pull factors) or the negative factors affecting their decision to leave their home country in the first place (push factors). These interactions constitute the main area that this research project studied, and the issues are elaborated in the four working papers briefly discussed below (Section 3).

2. AUTOMATION, MIGRATION AND LABOUR MARKET IMPLICATIONS – MOTIVATION FOR THE RESEARCH PROJECT

Before this research project was launched, the scholarly debate on automation's effects on employment and wages remained open and a wide range of potential impacts had already been highlighted. For example, automation and the introduction of new technologies could diminish the need for low-skilled labour (Arntz et al. 2016; Acemoglu and Restrepo 2017, 2018; Graetz and Michaels 2018). In certain sectors or industries, the automation of low-skilled tasks may enhance the roles of high-skilled workers and thereby increase demand for them. Additionally, automation's contribution to productivity could paradoxically boost demand for low-skilled labour. The wage implications might include an increase in earnings for high-skilled workers, while wages for low-skilled workers may decline or stagnate at minimum-wage levels. An increasing body of research focuses on the effects of automation and robot adoption on employment (e.g. Ghodsi et al. 2020), suggesting that while robot adoption may not impact overall employment significantly, it is likely to lead to the disappearance or replacement of low-skilled jobs (Graetz and Michaels 2018). Moreover, while a future devoid of jobs is a potential risk, such a scenario is not imminent (OECD 2019; Stehrer 2019; World Economic Forum 2018). These trends are already evident in the EU-CEE countries (EBRD 2019). It is also important to highlight that immigrants often fill low-skilled positions for which they are overqualified in addition to experiencing higher unemployment rates. Thus, as automation advances, migrants in low-skilled occupations may face an increased likelihood of unemployment.

2.1. New technologies and labour markets

The literature review shows that there are diverse findings concerning automation and its impacts on the labour market. The analysis of a potentially 'jobless future' in the coming decades shows diverse outcomes, ranging from a dystopian future of reduced labour demand (Frey and Osborne 2017) to more optimistic outlooks in which technology complements human labour (Autor 2015; Acemoglu and Restrepo 2017). Borjas and Freeman (2019) suggest that the locus of substitutes for workers has already shifted in favour of robots rather than immigrants in the US, particularly in its manufacturing sector. Their research also shows that robots have a negative impact on employment and wages as well as a much stronger one than the impact of immigration, estimating that the displacement effect of robots might be two to three times higher than the displacement effect of immigrants. However, Stehrer (2019) recommends caution rather than any panicked adjustments to the labour market in response to disruptive technologies, noting that revolutions in industry and technology are not a new phenomenon.[1] Nevertheless, a study by Ghodsi et al. (2019) shows that robot adoption has an overall positive impact on employment growth at the sector level globally. Moreover, it seems that robots do not increase the number of unemployed because people adjust and find new jobs (Klenert et al. 2022). While many recent studies in the literature mentioned earlier mostly analyse the impact of robot adoption on employment, we will contribute to the literature by supplying major findings on the impact of robotisation on wages.

Tight labour markets and demographic decline in EU-CEE countries are putting upward pressure on wages and signal more labour supply shortages in the future. Firms may respond to these challenges

[1] Leitner and Stehrer (2019) point out that the working-age population is even expected to become negative for most EU countries, depending on the direction that migration will take in the coming years. The EU-CEE countries risk reaching the 'tipping point' – at which labour demand exceeds labour supply and labour shortage might negatively affect production and investment growth – by the first half of the next decade.

with further catching up in automation (wiiw 2019a; Stehrer 2019). Other relevant studies, such as Basso et al. (2020), argue that technological progress without migration might generate polarisation across natives in employment as well as wages. They show that adoption of new technology combined with low-skilled migration contributed to a lower polarisation in employment and wages among natives in the US by shifting the latter group to more skill-intensive/high-skilled jobs and higher-paid production occupations.

2.2. Intra-European migration

Over the past three decades, migration from East to West within Europe has significantly increased. This trend accelerated notably following the EU enlargement beginning in 2004 and was further propelled by the international financial crisis in 2007. For several EU-CEE countries that had already been grappling with high unemployment rates for years, this high level of emigration has been a boon. From 2004 to 2018, annual net outward migration from these countries ranged between 150,000 and 200,000, with the total for this period exceeding 2.2 million citizens.

The liberalisation of CESEE economies and their integration into those of Western Europe have facilitated the fragmentation of production activities from the European manufacturing core to the periphery as well as the expansion of manufacturing networks across the global value chain (GVC), as discussed by Stehrer and Stöllinger (2015) and Hagemejer and Ghodsi (2017). This was achieved through large investment by multinational enterprises (MNEs) in CESEE factories to enable them to become specialised in producing part of the GVC with low value added owing to an abundance of less expensive high-skilled labour (e.g. technicians) for these tasks. This has led to a middle-income trap (Stöllinger 2019), which has exerted persistent pressure on wages in CESEE countries.

EU enlargement led to a large net outward flow of migration – some 4.2 million people between 2004 and 2017 – from the CESEE to Western European countries, where immigrants were attracted by higher wages and a better quality of life. While their wages have remained relatively low given their position at the low end of the value-added segment of the GVCs, they were seeking higher relative wages in sectors facing labour shortages in Western Europe. In migration studies, the former motivating factor is categorised as a push factor and the latter a pull factor.

However, recent trends indicate a shift, with several EU-CEE countries now becoming net recipients of migrants as mobility patterns evolve. Countries such as Czechia, Estonia, Hungary and Slovakia have experienced positive net migration rates (Mara 2019a, 2019b; wiiw 2019b). Immigration predominantly from non-EU countries – mainly Ukraine and several Asian countries – has become the norm for EU-CEE nations. In Poland, for instance, the influx of Ukrainian immigrants has significantly offset the outflow of Polish nationals. Although outward migration remains a characteristic of EU-CEE countries, some have seen their net migration rates turn positive.

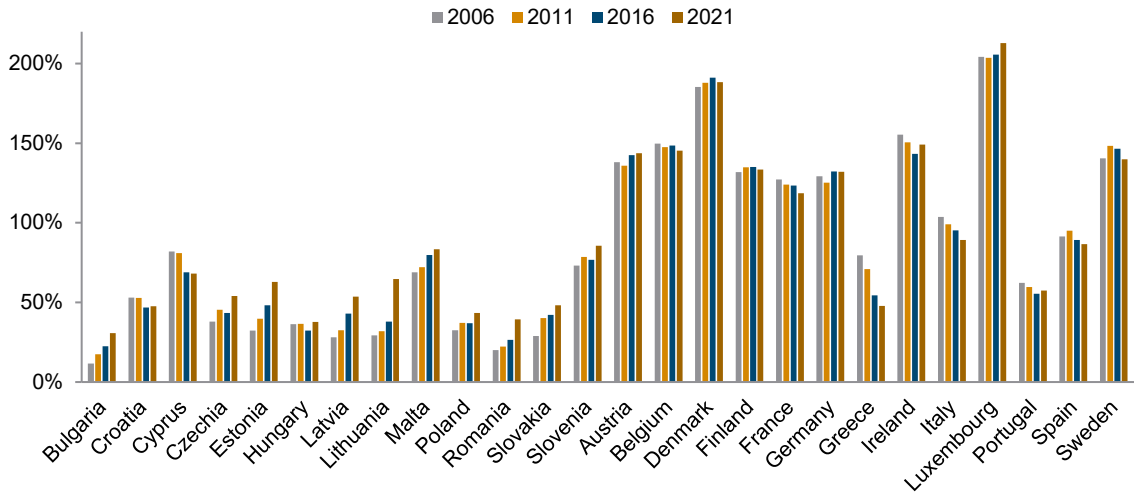
These migratory trends carry various implications, particularly for the labour market. While they have helped to bridge labour gaps in the West, they could potentially lead to long-term challenges in the East. Nonetheless, the trend of East-to-West migration is expected to diminish due to influences such as demographic factors and tightening labour markets.

2.3. Push and pull factors of migration and a role for automation

In migration studies (Lee 1966), push factors are conditions in a migrant's home country that prompt them to leave. These can include challenging labour conditions (e.g. high unemployment) or dangers (e.g. war and civil unrest). Conversely, pull factors are attributes of the destination country that attract migrants, such as a high quality of life and positive labour market conditions.

The dynamics of and motivations behind migration from CESEE countries are diminishing. In contrast to other regions, EU-CEE countries are experiencing negative population growth accompanied by a significant decline in the working-age population. This trend is driven not only by high levels of emigration but also by a decrease in the natural population growth rate. As a result, emigration from EU-CEE countries is likely to decrease. Additionally, due to economic improvements over the past few decades, unemployment rates in EU-CEE countries have significantly fallen and are now below the EU15 average. Furthermore, a growing number of workers in EU-CEE countries are finding employment in sectors with high labour productivity, where the introduction and expansion of new technologies are driving up demand for highly skilled labour.

Figure 1 / Average full-time adjusted salary per employee relative to the EU27



Source: Eurostat.

Meanwhile, wages in EU-CEE countries have been increasing, and the disparity in average full-time adjusted salary per employee between EU15 and EU-CEE countries is narrowing (as shown in Figure 1). In fact, while the average full-time adjusted salary per employee relative to the EU27 has been stagnating in most Western members of the EU, the increasing average salary in EU-CEE has narrowed the gap. Although workers in EU-CEE countries are increasingly employed in industries with high labour productivity, their wages remain lower than those for similar roles in EU15 countries in terms of purchasing power parity. Thus, while the overall wage gap has narrowed, the disparity remains substantial in specific sectors characterised by higher labour productivity. Considering the favourable economic growth and tight labour markets in the region, workers may demand higher wages. However, the prospect of relatively higher earnings abroad might still encourage emigration (wiiw 2019a). In such circumstances, further wage increases through significant investments in assembly lines requiring

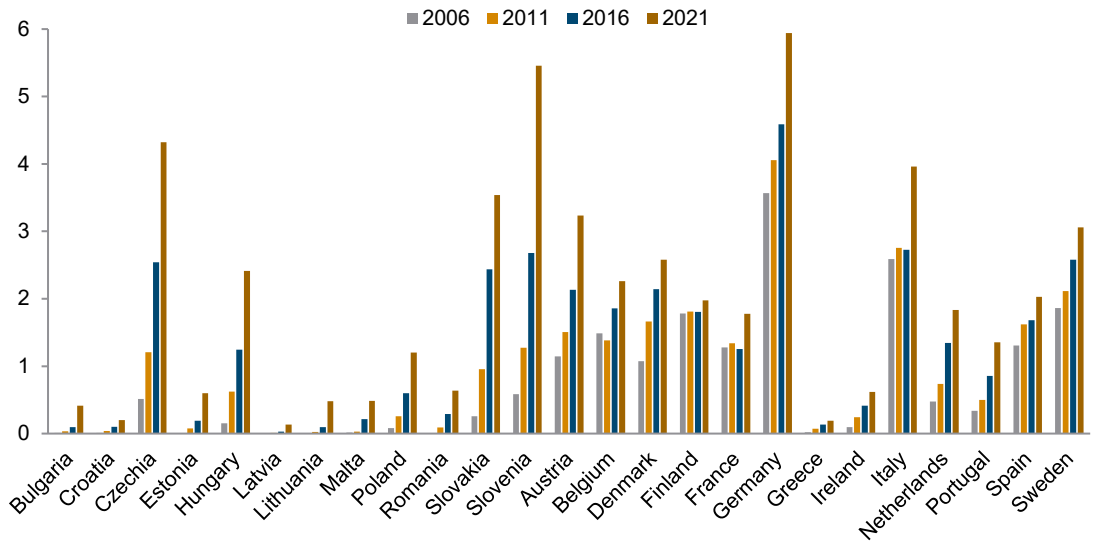
technical or low-skilled workers might help retain and/or attract workers in specific sectors. At the same time, this could also simultaneously cause certain industries in Eu-CEE countries (e.g. manufacturing) to lose their competitive edge, which has traditionally been based on lower wages.

The extent of automation varies considerably across different countries and sectors within the EU15 and EU-CEE regions. Bykova (2019) notes that in certain industries, such as 'food and textiles, chemicals, and metals production', the disparity in robot adoption rates surpasses 20%. As Figure 2 illustrates, the intensity of installed robots per 1,000 employees has increased substantially in many EU-CEE countries. However, the gap between the adoption of robots in Western EU members and Eastern EU members is still wide. While the automation gap in other manufacturing sectors is less pronounced, the wage disparity remains significant, indicating that the push and pull factors influencing worker migration could continue to be influential.

In specific sectors, automation may not readily substitute human labour. For instance, in fields such as health care (Mara 2019), where the scope for automation is limited, migration is more likely to remain a crucial mechanism for meeting the demand for labour. This also holds true for low-skilled manual jobs in the services sector that are performed on-site and in-person, such as cleaners and hairdressers. Due to relatively high-income elasticity of demand for these services, rising demand for this low-technology sector can occur even if it is not directly affected by technological change (Autor and Salomons 2018). Such jobs in advanced economies are predominantly filled by immigrants, which reveals that routine-biased technological change (RBTC) (Autor et al. 2003) is evident in the migrant population, while the employment patterns of natives tend to reflect SBTC (Mandelman and Zlate 2022; Basso et al. 2020), as noted earlier.

Conversely, in sectors like manufacturing, tasks are increasingly susceptible to automation. This suggests a hypothesis that while migration may still be necessary to meet labour needs in certain occupational groups or sectors, automation could serve to balance labour demands in others.

Figure 2 / Intensity of stocks of installed robots per 1,000 employees across the EU27



Sources: Eurostat, International Federation of Robotics (IFR); authors' elaboration.

Over the past decade, there has been a notable divergence in wage trends across industries of varying technological levels. In low- and medium-tech industries, wages have seen a decline, whereas wages in high-tech industries have experienced significant growth, particularly in the EU-CEE countries (Lankisch et al. 2019; Reiter 2019). This trend indicates that high-tech sectors, especially within the manufacturing industry, have undergone more robust expansion in EU-CEE countries compared to the EU15. This growth in the high-tech sector has been accompanied by increases not only in automation but also in workforce numbers. Despite the rise in wages, the wage disparity in this sector remains substantial, as highlighted by Bykova (2019).

In the next section, we provide brief descriptions of the four working papers in this project's series.

3. EUROPEAN LABOUR MARKETS, NEW TECHNOLOGIES AND MIGRATION

3.1. The impact of new technologies on wages and labour income shares

Currently ongoing significant transformations in the labour markets are being driven by the Fourth Industrial Revolution and having implications for wages and labour income shares. In this paper, we investigate how new technologies – proxied by patents, information and communication technology (ICT) capital usage and robot intensity – are having impacts on wage levels and labour income shares across various countries and industries.

The analysis is based on a comprehensive dataset compiled from multiple sources – namely, the OECD's Structural Analysis Database (STAN), the OECD's Trade in Value Added (TiVA) database, the International Federation of Robotics (IFR) and the Amadeus database for patents – and encompassing 32 countries and 38 industries over the 1996-2017 period. The analysis incorporates sector-specific technological advancements and their domestic and international spill-overs within global value chains (GVCs) utilising the TiVA database. Key variables include the intensity of stock of robots, the share of ICT investment in gross fixed capital formation (GFCF), and the number of granted patents owned by firms active in sectors of countries, all while controlling for total factor productivity (TFP) and capital stock.

Employing an econometric approach, this paper examines the effects of new technologies on average wages and labour income shares of sectors across countries. Our findings reveal a positive correlation between patents and wage levels, suggesting that innovation leads to economic rewards for workers, albeit with a minor negative impact on labour income shares. The safeguarding of intellectual property through patents by business owners not only enhances the innovation and availability of novel products but also leads to increased sales, market dominance and, ultimately, higher profits and returns from innovation in that sector. This dynamic has the potential to elevate the proportion of capital's contribution to added value over that of labour. However, this potential imbalance in the distribution of added value between capital and labour can be mitigated by the innovative contributions from international partners within the same industry.

When it comes to integrating technology into production, the adoption of industrial robots has been found to enhance the proportion of labour income within the total income of an industry, exemplifying the 'productivity bandwagon' theory. Furthermore, the deployment of robots by international suppliers to an

industry can similarly boost the labour income share of the industry's total revenue. In contrast, the introduction of robots by supplying industries, as well as by domestic and international purchasers, tends to negatively affect the labour income share within an industry. Despite these conflicting dynamics, the overall impact of deploying industrial robots across various sectors through global networks tends to affirm the 'so-so automation' theory, which suggests a notable decline in the labour income share across these industries. This highlights a complex interplay between technological advancements and economic distribution.

Our investigation also indicates that investments in ICT assets, such as computers and digital infrastructure, do not significantly influence wages. Nevertheless, the digitalisation of capital, which increases the share of digital capital in total capital, has stimulated overall demand. In 2021, employment in the ICT sector was equivalent to 3.7% of total employment in OECD countries (OECD 2017). This increase in demand has led to a higher need for labour, ultimately enhancing workers' aggregate income and welfare in these nations, which is in line with the 'productivity bandwagon' theory.

These results therefore suggest that technological advancements only have a limited impact on wages and labour income shares. However, the distribution of technological benefits requires deliberate policy choices to ensure equitable growth, which underscores the importance of considering sectoral and GVC linkages in efforts to understand the full and global impact of technological advancements on the labour market.

3.2. Adoption of new technologies and attraction of migrant workers

In a second exercise, we explore the complex interplay of migration, technology adoption and the labour market within the EU. This study delves into the evolving landscape of novel technologies, including robotisation and digitalisation, against the backdrop of globalisation in an effort to understand how recent technological advancements impacted migrant employment across 18 EU member states between 2005 and 2019. The motivation stems from the need to assess the differential effects of technology on native versus migrant workers given the sparse literature on the subject.

The analysis leverages a rich dataset of the number of employees across several sectors, which encompasses the years 2005 to 2019 for 18 EU member states. Utilising multiple data sources – including the OECD's STAN, the IFR and the Amadeus database for patents – this paper examines the impact of technological innovations (patents), robot adoption, three types of digital assets (i.e. computing equipment capital, communications equipment capital, and computer software and database capital), and TFP on the number of employees in each sector, migrant employment and the share of migrant workers in total labour. Furthermore, empirical results on employment are also provided according to the occupation of workers in the one-digit International Standard Classification of Occupations (ISCO) classes and according to the International Standard Classification of Education (ISCED) levels of education.

Empirical results reveal a complex picture. The number of patents granted is negatively correlated with the total employment but positively correlated with the share of migrant workers, indicating that innovation may benefit migrant labour. While robots are replacing jobs, their impact is less pronounced on migrant workers, suggesting a potential complementarity between migrant labour and robotisation in

certain sectors. The effects of digital assets on migrant employment are heterogeneous, with some types of digital capital being positively associated with migrant employment, while others have no significant impact. Furthermore, higher productivity positively influences migrant employment, underscoring the nuanced relationship between technological progress and the labour market.

The paper concludes that technological advancements, while reshaping the labour market, have a differentiated impact on migrant workers. The relationship between technology adoption and migrant employment is complex and varies across sectors, occupations and educational levels.

3.3. Technological push and pull factors of bilateral migration

Related to the previous section, we then study the intricate relationship between technological adoption, including robotisation and digitalisation, and bilateral international migration within the EU and other advanced economies. Specifically, motivated by significant technological transformations and their influence on labour market dynamics, we focus on the impact of technological advancements on bilateral migration patterns in an effort to understand how technology serves as both a push and pull factor in migration.

This paper utilises bilateral migration flows data from 2001 to 2019 across 26 EU member states (all except Romania) and other advanced economies, including Australia, Japan, Norway, the UK and the US. The analysis focuses on the role of two technological variables – namely, ICT capital per person employed and the stock of robots per 1,000 workers – in influencing migration flows. Adopting a gravity model approach grounded in neoclassical migration theory, the study analyses the bilateral flows of migration in relation to technological advancements. The methodology allows for a comprehensive analysis of push and pull effects, integrating technological factors into the migration analysis while controlling for macroeconomic, demographic and policy variables.

Our results indicate that both ICT capital and robot adoption are significant determinants of migration and have nuanced effects on migrant flows. The adoption of industrial robots in destination countries tends to increase demand for migrant labour, acting as a pull factor and indicating a complementary relationship between technological change and migrant labour. In the origin countries, higher robot adoption may reduce emigration, suggesting that technological advancement can retain labour and therefore also indicating a complementary relationship between robots and labour. The extent of digitalisation, measured by ICT capital per person employed, shows varied effects. In some contexts, digitalisation in destination countries pulls migrant workers, which can especially be attributed to those sectors requiring specific digital skills. However, the impact is more mixed in origin countries, where high levels of digitalisation may either push or pull migrants, depending on the relative technological gap and labour market conditions.

The study concludes that technology adoption plays a significant role in shaping migration patterns, with robotisation and digitalisation acting as pull factors, although digitalisation also acts as a push factor in some cases. The findings underscore once again the complexity of the relationship between technological advancements and migration.

3.4. The factors driving migration intentions and destination preferences in CESEE countries

A large part of EU migrants are originally from CESEE countries. Given this fact, in the final paper of this series, we analyse the determinants of migration aspirations and aspired destination choices in CESEE. This allows us to provide deeper insights into what migrants want, so to speak, which is an essential aspect for understanding the push and pull factors of actual migration and for facilitating informed policy making. Utilising a two-stage Heckman model, this comprehensive study aims to elucidate the complex interplay of various factors influencing migration aspirations and the subsequent choice of destination countries. The paper is motivated by the increasing global migrant population and the rising number of individuals aspiring to migrate. With a focus on Europe, the study explores the factors behind migration aspirations (including the macroeconomic conditions) and individual migrant characteristics in the context of CESEE countries (including various demographic and household characteristics, financial situation, past experiences, and the expectations behind these aspirations).

The analysis is based on data from the OeNB Euro Survey of 2019, which surveyed approximately 10,000 individuals across 10 CESEE countries. This dataset provides a rich source of information on individual- and country-level characteristics, which are pivotal for understanding migration aspirations and decisions to migrate. Employing a two-stage Heckman model, the paper first identifies the determinants of migration aspirations using a probit model. The second stage then examines the choice of destination among those who expressed a desire to migrate, applying a conditional logit model (McFadden's choice model) to address sample selection bias and analyse destination choices. This methodological approach allows for a nuanced analysis of migration intentions and destination preferences while correcting for potential biases. As the data on technological variables are not available for some of the home countries of the individuals surveyed, we proxy technologies using GDP per capita.

The analysis reveals that younger individuals, males, those with higher education levels, unemployed persons and those with relatives abroad are more inclined to aspire to migrate. Factors such as being married, being the head of household, and having financial ties (i.e. owning both a car and a house) reduce the likelihood of migration aspirations. Moreover, economic conditions in the home country, including GDP per capita and personal income, exhibit a non-linear relationship with migration intentions, indicating a complex interplay between economic incentives and the desire to migrate.

Among individuals expressing a desire to migrate, preferences for destination countries vary, with a significant majority indicating a preference for EU15 countries, followed by a group of 20 non-EU countries making up so-called 'EU-Extra' destinations. The choice of destination is influenced by both individual characteristics and macroeconomic factors of potential host countries, reflecting the importance of economic opportunities, labour market conditions and quality of life in the process of making a decision regarding destination.

4. POLICY RELEVANCE

The series of four working papers presented in the research project offers a comprehensive analysis of migration dynamics, technological advancements and their intersection with the labour market while drawing upon rich datasets and applying robust econometric methodologies across different contexts within the EU and other advanced economies.

Collectively, these papers contribute to fostering a deeper understanding of the dynamic interplay of technology, labour markets and migration. While technological advancements are making certain occupations obsolete, they are simultaneously creating new jobs that complement them. This shift induces changes in labour demand and distributional outcomes across occupations and sectors. The evidence suggests that these technological advancements can have both positive and negative effects on employment, wages, labour income shares and migration patterns, which underscores the need for nuanced policy responses. Given the economic implications for both countries of emigration and immigration, crafting effective policies that foster inclusive pathways as well as leveraging technological advancements for economic growth will be crucial. To harness the benefits of technological progress and manage migration effectively, policies should aim to:

› Promote inclusive growth by implementing educational/training policies and supporting skills development to equip the workforce for the evolving labour demand given technological trajectories. This should prepare individuals for future job markets and reduce the risk of 'technological unemployment'. Such education/training should address the entire spectrum of the skills, gender and age distribution of the actual and potential labour forces. Setting up vocational training facilities should be of particular importance.

› Counteract the potential adverse effects on labour markets of adopting novel technologies (e.g. job displacement and income inequality) through social protection measures and, in particular, active labour market policies. These measures should facilitate the transition of workers displaced by automation to jobs and tasks that are less substitutable by automation, particularly in occupations facing labour shortages.

› Develop targeted migration policies to address labour and skill shortages. These policies should serve to close labour and skill gaps, and they should be aligned with dynamic changes in labour demand. This is especially crucial in the case of high-skilled migrants, who are particularly important for fostering economic growth. However, such policies should preferably be designed in consultation with potential countries of origin while also keeping their needs for a qualified labour force in mind. Ideally, joint efforts in training support (in both countries of origin and destination) as well as schemes for circular migration (i.e. returning home after training and employment periods abroad), often combined with cross-border business development programs, would be of importance to avoid a zero-sum competitive relationship across economies.

› Explore telemigration options to alleviate certain skill shortages without a permanent withdrawal of important local segments of the labour force. In addition to being of interest to businesses, this could also reduce the pressure on migration policy and would be of benefit to development processes in countries of (potential) emigration.

› Consider special tax and training policies to attract and retain workers in certain crucial occupations and to fill skill gaps. Such policies could extend to a wide range of benefits, such as support housing for returnees and financial incentives for business development.

- Improve the quality of governance and provision of public goods, acknowledging their influence on aspirations and intentions to migrate. Furthermore, governments should actively explore factors shaping the migration aspirations and actively engage to address them.
- Foster international cooperation to ensure that migration policies are aligned with labour market needs as they adapt to technological changes, thereby facilitating the integration of migrants into host societies and leveraging their contributions to economic development. In this context, it is important to acknowledge the role of migrants in high-skilled jobs while also keeping in mind the lower end of the income distribution (i.e. low-skilled manual jobs that are usually filled by migrants because natives are not willing to perform them).
- Utilise the increased data availability, especially enabled by the technological advancements, for implementing timely policies. In this regard, policy makers should make use of micro-level survey data on migration aspirations, which can guide efforts to prioritise both migration and public policy agendas (Carling and Mjelva 2021) as well as facilitate cooperation between source and destination countries regarding their respective labour market needs.
- Support research and innovation to create new employment opportunities with higher wages for both native and migrant workers in the face of technological transformation. For (potential) countries of origin, this would also reduce the technological gaps that are an important push factor for important highly qualified segments of the labour force.
- Ensure the diffusion of the benefits of technological advancements across the distribution of businesses and design competition policies appropriate for the digital era to enable novel technologies to fully deliver their growth promises across a wide radius of the economy (Aghion et al. 2019). It is also important to adjust regulatory frameworks to the challenges of the digital economy and to target undue market concentration (Ernst et al. 2019).
- Ensure that technological change and the resulting growth in productivity benefit society as a whole and do not erode the labour income share. This has implications for wage policy, and it is especially important to intervene in the regulation of specific forms of employment – in particular, gig work – to safeguard minimum standards (Stewart and Stanford 2017). In this context, various additional schemes should be considered, such as sharing profits, imposing taxes on digital capital, and exploring the option of reducing working hours in order to adapt them to the specific conditions in different businesses and sectors of the economy (Ernst et al. 2019).

This project's findings emphasise the importance of migration policies in shaping migration trends while also aligning other important state policies (e.g. labour market, education, taxation and competition policies) in the context of disruptive technological change so as to provide sustainable outcomes for natives, immigrants, and countries of origin and destination. By adopting a holistic approach that considers the multifaceted impacts of technology on labour markets and migration, policy makers can navigate the challenges and opportunities presented by the Fourth Industrial Revolution while ensuring that technological progress translates into broad-based benefits for all segments of society.

One important aspect of migration is its significant role in enhancing global productive capacities. For example, many developing and least developed economies suffer from high unemployment and low participation rates. Consequently, there are numerous instances in these countries in which talented, innovative and productive labour remains unemployed or is employed in occupations that do not match their skills. Migration policies designed to attract such talent can not only boost productivity in the

destination economy, where a suitable occupation matches the skills of the migrant, but also reduce labour market mismatches in the country of destination.

From a global perspective, the movement of labour to more productive employment opportunities in principle improves the allocation of labour. However, migration policy should be coordinated among governments to facilitate a welfare-improving movement of labour across economies. Without such an optimal allocation of labour, shortages in certain occupations may lead to the swift development and introduction of new technologies that produce outputs which are not necessarily of better quality and which could actually be provided more easily by skilled labour. An undue radical replacement of jobs by robots could also lead to mismatches and inefficiencies in the global economy, where some potentially innovative and productive labour remains unemployed and the introduction of technology might reduce product quality. The speed and scope of introduction as well as the expansion of genetically modified agricultural products is just one example of a low-quality solution devised to address productivity challenges in the face of labour shortages.

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