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Global labour markets and workplaces in the age of intelligent machines

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ABSTRACT

This paper examines how labour productivity will increase in future workplaces that employ human resources and machine technologies. This paper expands the concept of intelligent machines as systems of automating labour based on robots and artificial intelligence. Furthermore, it aims to develop recommendations for improving productivity by managing competition and marketing in current global labour markets. We model the dependence of output per worker on robots' international distribution, the ease of hiring foreign labour, and the dependence on pay and productivity. As a result of this research, labour productivity is defined by human resource availability and not through automation. The study develops comprehensive guidance for economic policy in the global labour market for the medium-term period. Management implications include representing a vision for the future of workplaces drawn on the productivity benefits of different workplace models that stimulate growth in labour efficiency. The recommended concept validates how innovation and digitalisation reshape the workplace.

Introduction

The labour market is a complex social and economic relations system constantly changing. It thus needs to be studied and managed to consider the specifics of the current context in which this system operates and determine the future of work (Moffett et al., 2021). Knowledge-intensive and high-tech manufacturing is a priority for forming global competitive advantages; therefore, it is a vector of labour market growth (Al-Omoush et al., 2020; Puranam, 2021). A transformation of global labour markets and workplaces takes place and reshapes workplaces since more functions previously performed by human resources are passed on to intelligent machines (Schäfer et al., 2023).

Intelligent machines are means of automatization that rely on the leading technologies of Industry 4.0 – robots and artificial intelligence. Unlike an established concept of digital technologies undoubtedly linked to Industry 4.0, intelligent machines are treated as disruptive technologies that systematically change the character of human labour and reshape workplaces. Digital technologies complement human labour, and intelligent machines replace and oust (even wholly) human resources from entrepreneurial processes and systems.

Second, globalisation has vastly increased the accessibility of national labour markets. Global labour markets are characterised by the flow of international labour migration and the parallel involvement of foreign labour (Corella, 2020; Hober et al., 2021). Third, human resources are represented in the labour market and machine technologies (Schumacher, 2021). In the pre-digital period, it was common to assess the labour market from the points of view of quantitative sufficiency (lack of deficit) and the quality (level of qualification) of human resources (Ballestar et al., 2021; Camargo et al., 2021). However, human resources formed a fundamentally new conceptual approach to assessing the labour market from the productivity perspective, provided through technological support and automation tools (Boza & Ilyés, 2020). In this context, labour efficiency is defined not so much by human resources as by automation tools.

Despite fragmented research and general theoretical assumptions about both sources of productivity growth – human resources and machine technologies –uncertainty remains about their contribution to productivity growth and the prospects to intensify and unlock their potential to increase productivity. Economic policies restricting the market mechanism regulate the global labour market. Labour productivity shows moderate growth – the opportunities of the age of intelligent machines are entirely unrealised. Therefore, the price of labour productivity was a constant amongst OECD countries in 2015.

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GDP per hour worked in 2001 was $84.0 but had increased in 2021 to $107.86 (OECD, 2022).

The literature gap consists of the uncertainty of the role and value of human resources in the growth of labour efficiency in the age of intelligent machines. Actual research proposes only general theoretical assumptions on the reduced contribution of human resources to labour efficiency. Due to insufficient empirical research, i.e., weak evidence base, uncertainty emerges regarding the contribution of human resources and machine technologies to productivity growth.

In this paper, the research focuses on the future of global labour markets and workplaces. This paper aims to determine how automatisation reshapes the workplace. The main theoretical implications of the research lie in the vital role and significant value of human resources in the growth of labour efficiency. Future labour markets and workplaces are linked to labour conditions by redistributing functions between intelligent machines for complex and routine activity and human resources for creative and knowledge-intensive labour in decent workplaces. The research implications are connected with the prospects of improving human resources management. Reducing human resources' participation is related to a flexible, functional load on human resources and comfortable conditions for unlocking human potential and labour efficiency growth.

The research question of this paper is as follows: How do innovation and digitalisation reshape the workplace? Moreover, what are the consequences of this for labour efficiency? The research hypothesises that the age of intelligent machines has just begun; therefore, machine technologies are characterised by moderate automation, maintaining their dependence on human resources. In the current age of intelligent machines, productivity growth is the attraction of foreign human resources (a key source) through the global labour market. The pressure of government regulation must be eased and give way to competition and marketing.

To answer these research questions and verify the hypothesis, we specify the causal connections of the development of the global labour market and model output per worker on global robot distribution and the ease of hiring foreign labour, as well as on active labour market policies, pay, and productivity. The article aims to model the regularity of labour productivity growth in future workplaces depending on human resources and machine technologies and develop recommendations on productivity increases by managing competition and marketing in the global labour market.

The article's uniqueness lies in modelling global labour markets and gauging human resources and machine technologies' contribution to labour productivity growth in future workplaces. We achieve this by quantifying their potential to promote productivity growth and set clear economic policy guidelines by prioritising human resources and machine technology. Labour productivity is determined by human resource availability, not through automation. The study's novelty lies in contrasting alternative approaches to managing the development of the global labour market: government regulation (the first approach) and competition and marketing (the second approach). This offers detailed applied recommendations for economic policy.

This paper provides a new vision of reshaping workplaces under automatization (innovation and digitalization). In this new vision, machine technologies do not replace but supplement human resources in the age of intelligent machines. This is an essential difference compared to the existing literature, which makes this paper helpful in improving the effectiveness of intelligent machines and the organization of workplaces. The following idea was offered: human resources management remains essential under the conditions of the Fourth Industrial Revolution and requires transformation: an addition of support for human resources adaptation to the expanding automatization.

The article includes the following: 1) Modelling the global labour market and future workplaces through the measurement of the contribution of human resources and machine technologies on labour productivity; 2) Factor analysis of state regulation and de-regulation based on competition and marketing; 3) Policy implications for the development of the global labour market and workplaces.

Literature review

Theory of the future of workplaces

The article draws on the theory of the future of workplaces, which consists of the alternative character of future conditions and content of labour and organisation of workspace dependence on the course of the Fourth Industrial Revolution. This theory also implies a close interconnection between labour efficiency and automatisation. According to this theory, international labour and the latest trends in the global labour market in current economic conditions are found in Diab (2020); Han (2020); McGann, Murphy and Whelan (2020); Yadav (2020) and Zhang et al., (2020).

Productivity is justified as an assessment criterion for the development of the global labour market, as per Agbahey et al. (2020), Grodzicki and Skrzypek (M.J. 2020), Haeussler and Sauermann (C. 2020), Matthess and Kunkel (M. 2020), Rikap and Flacher (2020); Robinson (2020); Shahen et al. (2020) and Vecchiato (2020). The specifics of the functioning of labour markets are studied by Al-Ubaydli and List (2019), Bolíbar (2020), Mair (2018), Moro, Frank, Pentland, Rutherford, Cebrian and Rahwan (2021), Ricciardi et al. (2021) and Zhang et al. (2019). Finally, the fundamental issues of human resources management are explored by Angrist et al. (2021), Levy et al. (2021) and Soreq et al. (2021).

The literature review showed that the literature indicates a severe effect of innovation and digitalisation on workplaces. The future of global labour markets and workplaces depends on the distribution of roles between human resources and intelligent machines.

The global labour market in the age of intelligent machines

A qualitative interpretation of the sources of development of the global labour market – human resources and machine technologies – as well as the aspects of the organisation and future workplaces, are given in the works of Bertello et al. (2021b), Bresciani et al. (2021a), Bresciani et al. (2021b), Coff et al. (2020), Haynes (2020), López-Cabarcos et al. (2020), Skare and Soriano (2021), Wan (2019), Yang and Gan (2020) and Zong et al. (2020). Selected competition and marketing issues in the global labour market are reflected in Felix (2020), Man (2020), and Shook et al. (2020).

The existing literature provides mixed evidence on the extant competition between human resources and machine technologies. Nevertheless, their contribution to productivity growth is not precisely determined (span 1). Moreover, the features of competition and marketing in the global labour market in intelligent machines have not yet been sufficiently studied. The importance of their relationship for labour productivity growth compared to government regulation has not been revealed (gap 2). The need to fill these gaps dictates a systematic modelling of future labour markets and workplaces, considering both sources of human resources and machine technologies in the context of government regulation and competition. Consequently, this research aims to fill these gaps.

The extant literature addresses the future of workplaces. Gianecchini et al. (2022) note that future labour is shaped by the pace of technological progress, accelerated by the impact of the Fourth Industrial Revolution. Similarly, Erickson and Norlander (2022) highlight that previous outsourcing and offshoring trends would be transformed into a future of remote work after the pandemic. Levasseur et al. (2022) also identified the strong influence of venture capital priorities on the future of labour.

Geyman (2022) argues that the future of labour in America lies in the decline of employer-sponsored insurance and the need to find a replacement. In turn, Iwashita (2021) proves that the consequences of COVID-19 can be associated with a decrease in the effectiveness of international personnel management, which determined the future of remote work in Japan. Jeffrey (2021) argues that automation will define the future of labour. On the other hand, Makridis and Han (2021), in examining decades of technological change, conclude that the future of labour is about employee empowerment and job satisfaction requirements. Donley (2021) substantiates the strong impact of the work environment on job satisfaction in a pre-pandemic database.

The analysis of the existing literature showed that it acknowledges and emphasises changes in the global labour market. These changes are directly connected with the use and management of human resources and thus require a new organisation of workplaces.

Gap analysis

The content analysis of the available literature showed that it focuses on disclosing the potential of using advanced technologies. At the same time, it failed to comprehensively explore the social consequences, from slightly different from the modern workplace model with an inevitable increase in the share of automated labour processes to a model of total automation and autonomous "smart" industries. The uncertainty (blurring) of the outlines of the model for future workplaces is another gap in the literature (gap 3).

Drawing on organising future workplaces, there are market features (e.g., the impossibility of fully automating workplaces in those processions where communications with customers are supposed) and technology limits (different possibilities for automating various business processes). This article proposes a new basis for choosing a future model of workplace organisation and considers the interests of entrepreneurs and employees of Industry 4.0. The proposed new model for organising future workplaces allows for shifting the focus from technology to workers and ensures a balanced and efficient sharing of human and technological resources – technological and social systems working in harmony – in Industry 4.0.

As a result of this literature review, it is possible to conclude that the theory of the future of workplaces connects the prospect of improving labour organisation with the dissemination of intelligent machines. The contribution of intelligent machines to improving workplace organisation remains unclear, and the consequences of automatisation could be contradictory.

The works by Baird et al. (2022), Davenport and Euchner (T. 2023), Fossa (2023) and Peng et al. (2023) indicate that the age of intelligent machines just started. Therefore, machine technologies are characterised by moderate automatisation, retaining their dependence on human resources.

The following hypothesis H is proposed: Labour efficiency is determined by human resources.

With the reliance on the materials of the official statistics, the proposed hypothesis acquires the following form: output per worker (GDP constant 2011 international $ in PPP) in 2019 positively depends on the ease of hiring foreign labour in 2020. To test this hypothesis, we use the method of regression analysis and find the regression dependence of the output per worker (GDP constant 2011 international $ in PPP) in 2019 on the ease of hiring foreign labour in 2020.

Materials and methods

This article quantitatively measures and composes a competition model between human resources and intelligent machines with a systematic assessment of the factors they depend on and their influence on labour productivity. In the first stage, we employ a regression equation of the form:

$$y = a + b_1 * x_1 + b_2 * x_2$$

We regress the dependence of labour productivity in constant 2011 prices (y) according to the International Labour Organization (M. 2020) on the potential sources of its increase through the development of the global labour market, namely, the global distribution of robots (x_1) according to IMD (M. 2020) and the availability of foreign human resources as a manifestation of international labour migration (x_2) according to the World Economic Forum (M. 2020). We used 2011 as a baseline because, firstly, this is the form of the official statistics of the International Labour Organization (M. 2020). Secondly, 2011 belongs to the period of transition. Thus, the statistics on the digital competitiveness of IMD (M. 2020) have been collected since 2013. Therefore, 2011 is the beginning of the age of intelligent machines, the starting point at which the measuring of the change of labour efficiency in the current stage of intelligent machines should be applied. The second stage of the research is a regression equation of the form:

$$x_1 = c_1 + d_{11} * f_1 + d_{12} * f_2 \text{ and } x_2 = c_2 + d_{21} * f_1 + d_{22} * f_2.$$

This determines the regression dependence of the global distribution of robots (x_1) and the availability of foreign human resources (x_2) on active labour market policies (factor of state regulation of the labour market, f_1) and the connection of wages with productivity (factor of competition and marketing in the labour market, f_2). The values of both factors (f_1 and f_2) are taken from the World Economic Forum (M. 2020).

Since the global distribution of robots is measured by the IMD (M. 2020) in ranking positions (the higher the ranking, the better) and all other indicators in points (the larger, the better), the positive effect of the x_1 factor on y will be evidenced by a negative regression coefficient ($b_1<0$). In all other cases, the values of regression coefficients greater than 0 indicate a positive effect. It follows that H is true if all conditions are met:

$$\begin{cases} b_2 > b_1; \\ d_{11} > d_{12}; \end{cases}$$

Our representative selection includes three countries from each category according to the level of economic freedom per the rating and classification of The Heritage Foundation (2022), except for "Repressed" and "Non-Ranked", for which the values of the indicators are not available. We give the economic freedom index values in a selection of countries in 2022 in Fig. 1.

The representative selection of countries is as follows: 1) Different levels of economic freedom, from high, e.g., in Ireland (82.0 points) – to moderate, e.g., in China (48.0 points); 2) Different levels of income according to the classification by the World Bank (T. 2023) for 2022 –2023 (e.g., high income – Australia, upper middle – Russia, lower middle - India); 3) Different levels of socio-economic development (the sample contains developed countries of the OECD – Australia, Ireland, and developing countries, in particular, BRICS countries.

The prospects of global labour markets amidst intelligent machines are determined by optimising factors (contrasting human resources and machine technologies) and the sources of their initiation (government regulation, competition, and marketing). Statistics for 2020 are illustrated in Table 1.

The multicollinearity test is provided in Table 2.

As shown in Table 2, neither of the coefficients of cross-correlation of the considered variables exceeded the value of 0.90.

Results

Modelling the global labour market and workplaces of the future in the age of intelligent machines by measuring the contribution of human resources and machine technologies to labour productivity

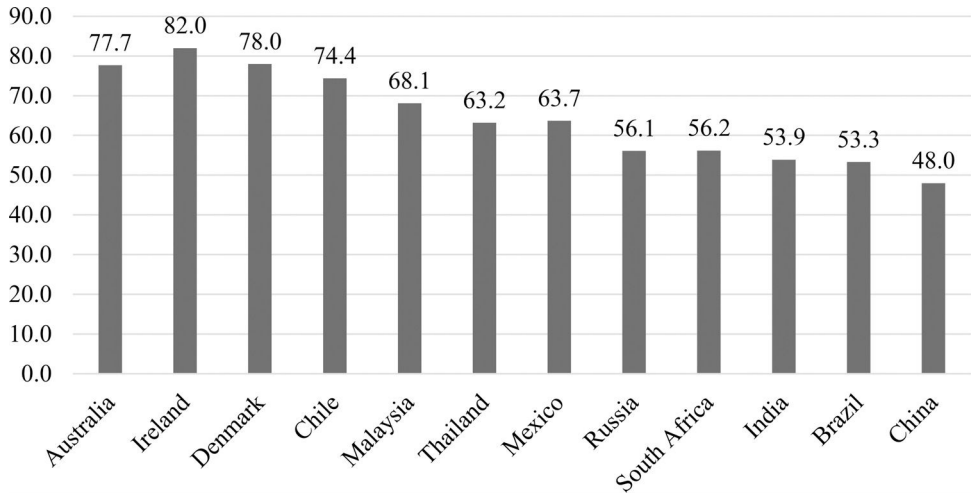


Fig. 1. Index of economic freedom in the selected countries in 2022, points 1–100. Source: Authors' elaboration based on The Heritage Foundation (2022)

The statistical approach relies on statistics from The Heritage Foundation, the IMD, and the World Economic Forum, amongst others. We cover a representative sample in which countries with varying levels of economic freedom are included. We modelled the global labour market by measuring human resources and machine technologies to labour productivity, as shown in Fig. 2.

Productivity increases along with the expanded availability of human resources but decreases as the use of robots spreads across the globe ($b_2>b_1$) (see Fig. 2). The global spread of robots does not contribute to developing the worldwide labour market and will not be further considered in this article. The regression model refines the global labour market by measuring human resources' contribution (see Fig. 3).

According to Fig. 3, a 1-point increase in human resources availability will result in a $1024.60 increase in labour productivity (at constant prices in 2011). Organizing future workplaces implies limited automatisation to effectively preserve the key role of human resources.

Factor analysis of state regulation and de-regulation on competition and marketing in the development of the global labour market in the age of intelligent machines

A factor analysis of state regulation and de-regulation in the era of smart machines is displayed in Fig. 4.

According to Fig. 4, the availability of human resources decreases as government regulation increases and competition and marketing-based de-regulation increase ($d_{21}>d_{22}$). We thus present a refined regression model of the global labour market through the dependence of the availability of human resources on competition and marketing in Fig. 5.

According to Fig. 5, a 1-point increase in competition and marketing will result in a 0.3765-point increase in the availability of human resources.

Policy implications for developing the worldwide labour market and future workplaces in the age of intelligent machines based on competition and marketing

We turn to solve the optimisation problem ($y\rightarrow max$). There are, however, limitations in such optimisation. Specifically, the availability of foreign human resources should not exceed 100 points ($x_2\leq100$), and the association of remuneration with productivity should not exceed 100 points ($f_2\leq100$). The simple substitution method yields the following result (Fig. 6).

According to Fig. 6, the prospects for optimising the global labour market suggest a necessary increase in labour productivity (in constant prices in 2011) by 24.78% (from 66.04 in 2020 to 82.40). The following policy implications apply:

Table 1
Statistics of the global labour market in the age of intelligent machines in 2020.

–	–	State labour market regulation factor	Competition and marketing factors	Provisional results		Result
Economic freedom	Country	Active labour market policies, points 1–100	Pay and productivity, points 1–100	World robot distribution, position 1–63	Ease of hiring foreign labour, points 1–100	Output per worker (GDP constant 2011 international $ in PPP), 2019
		f_1	f_2	x_1	x_2	y
Free	Australia	64.5	58.1	29	32.8	94,644
	Ireland	61.4	62.4	43	62.8	155,654
Mostly free	Denmark	70.6	65.1	30	45.0	97,696
	Chile	34.4	56.0	48	58.9	49,464
	Malaysia	64.7	70.3	22	63.0	61,291
Moderately free	Mexico	29.3	46.4	10	56.7	41,554
	Russia	44.0	58.9	32	48.1	52,971
	Thailand	46.3	60.1	11	52.5	31,204
	China*	58.2	60.5	1	58.0	13,800
Mostly unfree	South Africa	24.9	46.0	34	40.6	42,210
	India	41.8	51.3	12	44.4	21,181
	Brazil	27.4	40.4	17	43.9	32,232

*As classified by the authors of this paper, China is assigned to the "moderately free" category.
Source: Authors' elaboration.

Table 2
Multicollinearity test.

	f1	f2	x1	x2	y
f1	1	0.8729	0.0464	0.1248	0.5618
f2	–	1	0.1635	0.4107	0.4357
x1	–	–	1	0.0031	0.6455
x2	–	–	–	1	0.0899
y	–	–	–	–	1

Source: Authors' elaboration.

- Increase the availability of foreign human resources by 31.72% (from 50.35 points in 2020 to 66.32 points).
- This increases wages with productivity by 73.69% (from 57.58 points in 2020 to 100 points).

Since we researched a representative selection of countries, our policy implications might be universal for countries with any level of economic freedom. Thus, the organisation of workplaces of the future, which stimulates the growth of labour efficiency, can be outlined as follows:

- Use of human resources as the subject of labour during the creation of international workgroups and the use of international project teams.
- Active use of intelligent machines as a tool of labour.
- Use of intelligent machines (i.e., machine vision) to assess the individual results of each employee's labour for stimulation of "healthy" competition of human resources.
- Intensive use of the mechanisms of material stimulation of employees' labour (within marketing human resources) to support competition of human resources.

Discussion

The article contributes to developing the theory of the future of workplaces, specifying the character of the influence of machine technology on labour efficiency in labour markets and workplaces. In

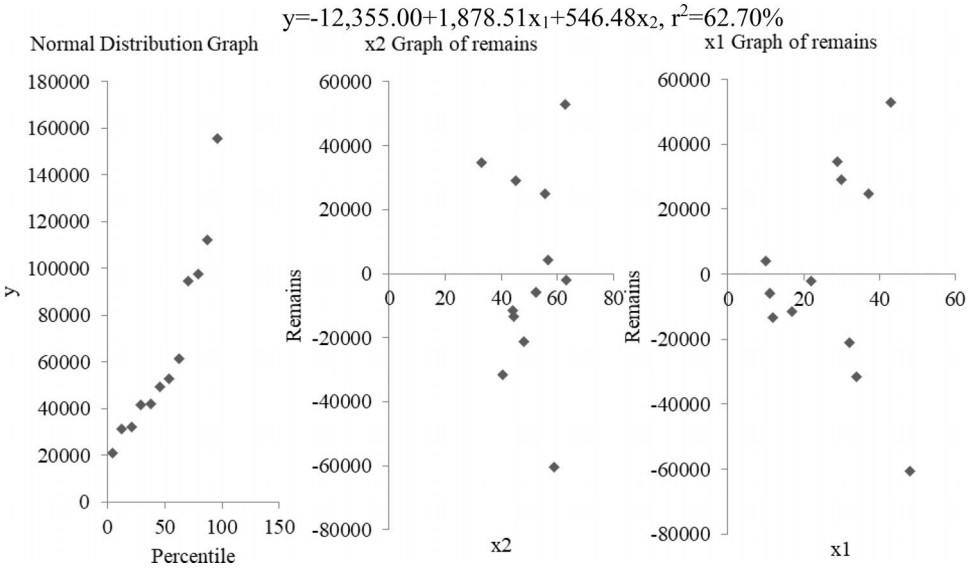


Fig. 2. Regression statistics of the dependence of labour productivity on human resources and machine technologies. Source: Authors' elaboration

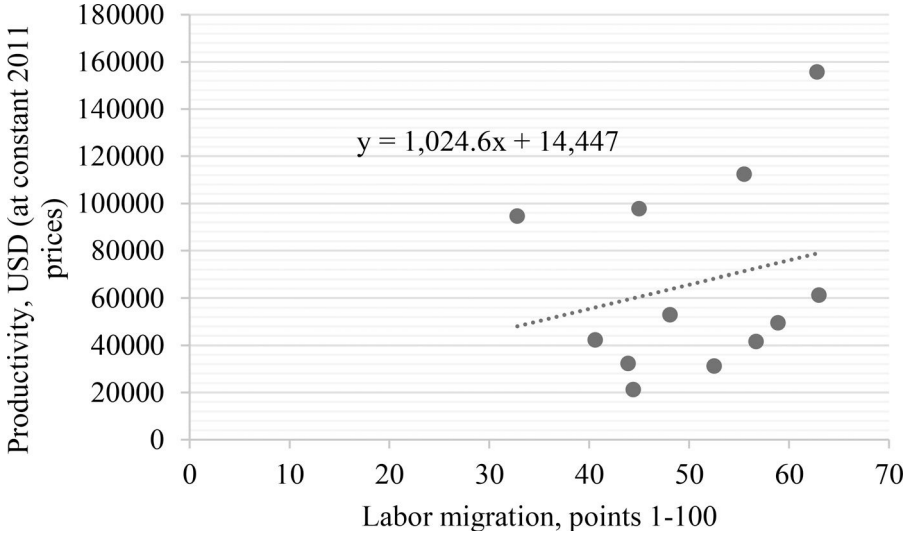


Fig. 3. Regression curve of labour productivity versus human resources in 2020. Source: Authors' elaboration

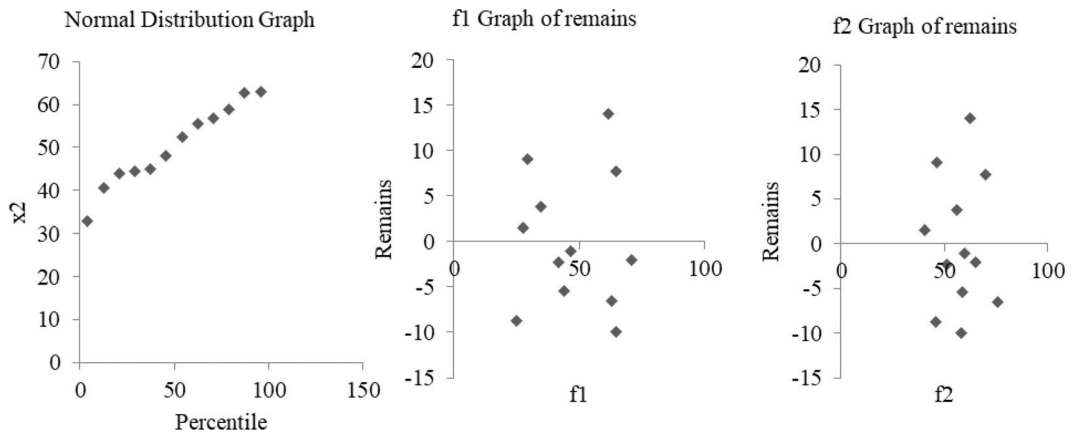


Fig. 4. Regression statistics of the dependence of human resources availability on government regulation and deregulation based on competition and marketing. Source: Authors' elaboration

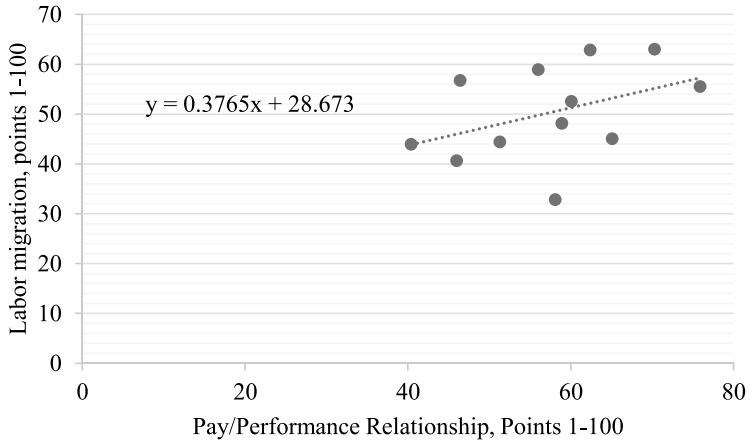
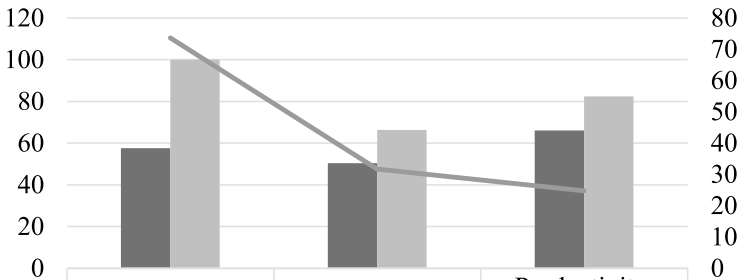


Fig. 5. Regression curve of human resource availability versus competition and marketing. Source: Authors' elaboration

contrast to the existing literature, e.g., Donley (2021), Erickson and Norlander (2022), Geyman (2022), Gianecchini et al. (2022), Iwashita (2021), Jeffrey (2021), Levasseur et al. (2022), and Makridis and Han (2021), this article's findings revealed that the future of workplaces is determined not by market features and technology limits but by the benefits of different workplace models. The article's new basis for choosing various models for organising future workplaces has subsequent implications for productivity. The advantages of the new base compared to the old base are illustrated in Table 3.



	Pay and Productivity, points 1-100	Ease of hiring foreign labour, points 1-100	Productivity, USD thousand (at constant 2011 prices)
Baseline values (2020)	57.58	50.35	66.04
Prospects for the progress of values	100	66.32	82.4
Recommended progress, %	73.69	31.72	24.78

Fig. 6. Prospects for optimising the development of the global labour market in the age of intelligent machines based on competition and marketing. Source: Authors' elaboration

Table 3
Advantages of the new basis for choosing a model for organising future workplaces.

Comparison criterion	Existing literature	New results obtained from the article	Benefits of new results
The basis for choosing a model for organising future workplaces	Market specifics and technology limits	Productivity implications	Focus not on inputs (causes, opportunities) but on outputs (consequences)
Interests are considered when choosing a model for organising future workplaces.	Business interests only	Both the interests of business and the interests of employees	Benefits for all stakeholders, as well as systemic social, economic, and technological crisis management in the organisation of future workplaces
Social implications of the workplace of the future	Technophobes, who fear or dislike technological development	Technophiles, who stand in defence of new technologies	Technological and social systems work in harmony and will support future technological progress
Consequences of the transition to new models of organisation of workplaces of the future for human potential	Limitation of opportunities for the development and realisation of human potential	Expanding opportunities for the development and realisation of human potential	Achieving a synergistic effect in the form of the complete realisation of human potential with systemic social and technological progress

Source: Authors' elaboration.

This paper clarified the causal relationships behind increases in labour productivity by exploring the consequence of workplace optimisation. Thus, the results of this research can contribute to ongoing discussions within the studied topics of the organisation of workplaces of the future in Agbahey et al. (2020), Grodzicki and Skrzypek (M. J. 2020), Haeussler and Sauermann (C. 2020), Matthess and Kunkel (M. 2020), Rikap and Flacher (2020); Robinson (2020); Shahen et al. (2020) and Vecchiato (2020).

As demonstrated in Table 3, one of the advantages of choosing the proposed basis is the focus not on inputs (causes, opportunities) but on outputs (consequences). This results in a transition from "technology for technology's sake" to seeking to benefit from new technologies and considering that future workplaces are not impersonal business process models but future working conditions for each individual. In this regard, the theory of the future of workplaces becomes multidisciplinary and covers both management science and social sciences. This opens up a wide field for further research and facilitates a deeper analysis of the theories of the future of workplaces.

Another advantage of the new basis for making managerial decisions on reshaping the workplace under innovation and digitalisation is that it systematically considers the consequences for both businesses and employees. The new foundation stimulates the desire to benefit all stakeholders. It provides systemic social, economic, and technological crisis management in future jobs.

The social consequences of the organisation of future workplaces under the old basis are associated with transforming modern workers into technophobes who fear or dislike technological development. The new basis facilitates the creation of a society of technophiles who defend new technologies. This new basis will result in technological and social systems that work in harmony. Furthermore, social support will be provided for future technological progress and avoid massive resistance to change and undermining of technological innovations on the part of workers.

The consequences of the transition to new models of organising workplaces of the future for human potential under the old basis are associated with limited opportunities for developing and realizing human potential. Under the new ground, these consequences will be increased opportunities for growth and human potential. A synergistic effect will be achieved in realising human potential with systemic social and technological progress. The focus will be shifted from technology to workers to ensure the balanced and efficient sharing of human and technical resources.

The COVID-19 outbreak further amplifies the complexity of transitioning to future workplace models (Bertello et al., 2021a; Kraus et al., 2020). Indeed, social tensions seem to have reached their limit. Many workers have lost their jobs or learned new skills and filled digital competency gaps when moving to remote work (Wendt et al., 2021). Consequently, it is imperative to mitigate the social consequences of reshaping workplaces under the influence of innovation and digitalisation. Moreover, the new basis for decision-making will make it possible to use disruptive technological advancements to relieve social tension in the post-pandemic period.

The new basis will also support HR-related practices to select, motivate, develop, and retain employees. Firms' efforts to align strategies with their current employees' skills will provide them with reskilling and upskilling programmes and support their ability to manage people. The future of the workplace depends on the (re)actions of individuals and firms, as well as their adaptability to new technological scenarios; the new basis will thus make this possible. The policy implications of organisational behaviour and human resource management research in response to disruptive technological development are related to stimulating Industry 4.0 enterprises to increase labour productivity.

Conclusions

Labour productivity remains on human resource availability (not through automation). The global spread of machine technologies does not contribute to productivity growth, presumably under the long-term influence of the third law of philosophy. While there will be a transition from quantitative to qualitative, this has not yet happened, and tactical performance management. The lack of digital competencies by robot automation personnel can explain this; robots can be misused, slowing production. In the medium term, we associate this result with the prospects for developing the global labour market with increased human resource availability, as determined by de-regulation. The mass training of digital personnel will overcome this problem in the long term, at least with a shortage of digital personnel, increasing the efficiency of managing the global labour market. Reliance on competition and marketing will also maximise labour productivity in the medium term (until 2023).

The current results and conclusions of the article include the rationale that human resources make a significant and invaluable contribution to the increase in labour productivity. Despite the ongoing Fourth Industrial Revolution, the impact of robots' expansion on productivity in the modern age of intelligent machines is small and controversial. Therefore, it is advisable to focus on human resources development at the current stage of the Fourth Industrial Revolution. Second, contrary to the prevailing idea of state regulation of labour markets, the effective management of human resources in private entrepreneurship more extensively promotes the development of human resources.

Applied recommendations and benchmarks explain the importance of the results for policymaking, particularly for crucial

statistical indicators that improve labour productivity management. The guidance can apply in diverse contexts. Standards for key statistical indicators that enhance labour productivity management explain the importance of the results for policymaking. The proposed concept effectively demonstrates that innovation and digitalisation reshape the workplace. Although developing machine technologies stretched beyond the focus of this research, they could likely become the future growth vector of global labour markets, providing mass availability and high-quality digital personnel.

This paper's implications include clarifying the essence of reshaping workplaces through innovation and digitalisation. The main theoretical conclusion from the research is that machine technologies do not replace to complement human resources. Due to this, the paper contributes to and supports the ongoing productive discussions – in particular, in the works of Baird et al. (2022), Davenport and Euchner (T. 2023), Fossa (2023) and Peng et al. (2023) – with new evidence on the issues of the future organisation of workplaces, strengthening of the evidence base of human resources remaining and preserving its role in entrepreneurial processes. Therefore, the management of human resources is still topical. However, it undergoes profound changes supplemented by adapting human resources to the expanding automatisation.

The article's implications include the prospects for labour division between human resources and machine technologies in future workplaces. Human resource management implications of this research are creating equally favourable conditions for further automatisation and unlocking human potential. The appearance of a new phenomenon of intelligent machines and hybrid workplaces shows adaptability to comfortable human labour and the use of the leading automation tools – intelligent machines.

A limitation of the findings is the study's focus on the organisation of workplaces and results for productivity, while the psychology of labour requires further in-depth research. The phenomenon of hybrid workplaces requires further elaboration. Future studies should dwell on the experience of workplaces and a high level of automatisation. Identifying alternative forms of hybrid workplaces in various labour conditions would be expedient.

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