“Employee autonomy as a global trend and resource in the Industry 5.0 paradigm”

AUTHORS	Leonid Melnyk Lyudmila Kalinichenko Oleksandr Kubatko Yuliia Rozghon Yuliia Zavdovieva

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Leonid Melnyk (Ukraine), **Lyudmila Kalinichenko** (Ukraine),
Oleksandr Kubatko (Ukraine), **Yuliia Rozghon** (Ukraine), **Yuliia Zavdovieva** (Ukraine)

EMPLOYEE AUTONOMY AS A GLOBAL TREND AND RESOURCE IN THE INDUSTRY 5.0 PARADIGM

Abstract

The relevance of the study stems from the transformation of modern work models from the technologically oriented Industry 4.0 paradigm to the human-centric Industry 5.0, where employee autonomy is emerging and becoming established as a global trend. The paper aims to conceptualize employee autonomy as an economic resource by optimizing work–life balance and assessing its impact on productivity and population well-being. For the analysis, panel data were collected for 123 countries over the period 2005–2023. The methodological basis of the study is the Levin–Lin–Chu unit root test, the Breusch–Pagan Lagrangian multiplier test, the Hausman specification test, and GLS regression estimation. The study found that, on average, in the group of accessible countries, each additional 100 hours worked per year reduces labor productivity by USD 2 per hour. An increase of one hour in the working year reduces GDP per capita by USD 28.48 per person.

Furthermore, a one percent increase in the length of the working year is associated with a 2.71 percent drop in GDP per capita per hour. Thus, productivity in the Industry 5.0 paradigm at the global level is predominantly qualitative and is shaped by focus, intrinsic motivation, and decentralized decision-making, rather than by increasing working hours. It is concluded that worker autonomy is an economically significant factor in enhancing productivity, innovation potential, and contributing to the geopolitical and geoeconomic sustainability of societies in the era of globalization.

Keywords productivity, work organization, human capital, motivation, innovation, flexible employment, economic sustainability, people-centered economy

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Leonid Melnyk, D.Sc. in Economics, Professor, Department of Economics, Entrepreneurship and Business Administration, Sumy State University, Ukraine.

Lyudmila Kalinichenko, D.Sc. in Economics, Professor, Department of Economics and Management, V. Karazin Kharkiv National University, Ukraine.

Oleksandr Kubatko, D.Sc. in Economics, Professor, Department of Economics, Entrepreneurship and Business Administration, Sumy State University, Ukraine. (Corresponding author)

Yuliia Rozghon, Researcher, Department of Economics, Entrepreneurship and Business Administration, Sumy State University, Ukraine.

Yuliia Zavdovieva, Researcher, Department of Economics, Entrepreneurship and Business Administration, Sumy State University, Ukraine.

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INTRODUCTION

Global economic shifts driven by digitalization, technological competition, and geopolitical instability require a re-examination of the human role in work systems. The move from Industry 4.0 to Industry 5.0 is not solely technological; it responds to globalization challenges, including fragmented markets, socio-economic inequality, and increased security risks. While Industry 4.0 prioritized automation and efficiency, Industry 5.0 places the worker at the center, emphasizing knowledge, creativity, and autonomy as keys to adapting economic systems.

In this scenario, worker autonomy stands out as an emerging global trend, driving changes in the division of labor, human capital mobility, and transnational employment. Industry 5.0, as defined by the European Commission, prioritizes human-centricity, sustainability, and technological partnership, recognizing workers' well-being and engagement as essential for competitiveness and stability (EC, 2021).

Global digitalization and the spread of the gig economy are shaping transnational labor markets, within which autonomy, freedom of choice, and self-regulation are becoming key conditions for effective employment and innovative activity (Sundararajan, 2016; Kalleberg & Dunn, 2016). Geopolitical conflicts, wars, and economic crises are disrupting traditional production chains and forcing states and companies to reorient themselves towards more flexible, decentralized, and sustainable models of labor organization. In such conditions, worker autonomy is not only an individual characteristic but also a resource for geoeconomic sustainability.

Despite the growing scholarly interest in autonomy within organizational and behavioral economics, its role as an economic resource in global and geopolitical dimensions remains under-conceptualized. This necessitates the integration of approaches from labor economics, globalization studies, and the concept of Industry 5.0.

The study aims to conceptualize employee autonomy as an economic resource by optimizing work–life balance and assessing its impact on productivity and population well-being in the context of Industry 5.0 and global structural shifts.

1. THEORETICAL BASIS

Employee autonomy has increasingly emerged as a defining characteristic of contemporary labor systems, reflecting profound transformations in work organization, digitalization, and human-centered production models. At its conceptual core, autonomy is grounded in self-determination theory, which identifies autonomy as a fundamental psychological need enabling intrinsic motivation, creativity, productivity, and well-being, thereby linking individual agency directly to organizational and economic performance (Deci & Ryan, 1985; Ryan & Deci, 2000; Ryan et al., 2022). This theoretical foundation has been widely applied to explain why autonomy functions not merely as a subjective preference but as a structural driver of sustainable work outcomes.

From a work-design perspective, autonomy constitutes a central dimension of high-quality jobs and innovative work environments. Control over tasks, decision-making authority, and flexibility in work execution have been shown to enhance engagement, job satisfaction, innovative behavior, and performance, particularly in knowledge-intensive and digitally mediated settings (Humphrey et al., 2007; Christian et al., 2011; Ariani, 2025). These effects are further reinforced when autonomy is complemented by job crafting, creative self-efficacy, and supportive leadership practices, indicating that autonomy operates most effectively as part of a broader empowerment ecosystem (Mamdouh et al., 2025).

At the same time, the literature cautions against viewing autonomy as an unconditionally positive factor. Excessive discretion without adequate institutional, social, or technological support may generate uncertainty, stress, and declining performance, illustrating the "too-much-of-a-good-thing" effect in work design (Pierce & Aguinis, 2013; Zhang & Bartol, 2017). This risk is particularly salient in flexible and non-standard employment forms, where autonomy is often accompanied by job insecurity, limited social protection, and blurred work–life boundaries (Jamunarani & Syed, 2025; Sarwar et al., 2026). Consequently, autonomy must be embedded within governance structures that ensure psychological safety, work-life balance, and health protection (Mujtaba, 2025; Eke, 2026).

The expansion of the gig economy and platform-mediated work has further elevated autonomy as a global labor trend. Flexible scheduling, project choice, and self-management represent core features of gig work, yet their productive and innovative potential depends critically on institutional safeguards, lifelong learning opportunities, and skills development systems (Kalleberg & Dunn, 2016; Onopriienko et al., 2023; Kytsak & Ovsiannykov, 2025). Empirical evidence indicates that autonomy yields positive outcomes when supported by organizational culture, communication quality, and leadership practices that foster trust and shared responsibility (Evans & Kasztelnik, 2025; George & Mattathil, 2025).

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Within the Industry 5.0 paradigm, autonomy acquires a distinctly strategic meaning. Industry 5.0 explicitly re-centers production systems around human creativity, resilience, and self-fulfillment, positioning autonomy as a key lever for aligning technological advancement with social sustainability (EC, 2021). Recent empirical studies demonstrate that daily autonomy enhances productivity, psychological energy, and creativity, while long-term autonomy contributes to sustainable career trajectories and adaptive labor markets (Zolg & Herbig, 2023; Rigó et al., 2025). These dynamics are particularly visible in innovation-driven sectors, renewable energy industries, and university–industry collaboration ecosystems, where autonomous knowledge workers act as catalysts of technological diffusion and start-up performance (Dobrovolska et al., 2024; Kuzior et al., 2024). Also within Industry 5.0, the physiological needs of humans are expected to be outrun in terms of time and effort by the personality needs, such as intellectual, creative abilities development, etc. (Melnyk et al., 2025). Beyond the organizational level, growing evidence suggests that autonomy functions as an economic resource with macro-level implications. Labor productivity, national competitiveness, and resilience to socio-economic shocks are increasingly shaped by employment structures that allow individual agency, flexible work arrangements, and inclusive participation (Kuzior et al., 2023; Grytten, 2025). Autonomy-enhancing institutions interact with broader societal factors such as welfare systems, human rights frameworks, demographic change, and social inclusion, reinforcing the role of autonomy in sustaining economic and social stability (Zahorodnia et al., 2026; Reissová et al., 2024; Vasylieva et al., 2023).

Digital transformation further amplifies the economic relevance of autonomy. Remote work, virtual teamwork, AI-supported decision-making, and intelligent industry models reshape temporal, spatial, and relational dimensions of work, increasing both autonomy and interdependence (Quisenberry & Burrell, 2026; Yarovenko et al., 2024). These transformations underline that autonomy must be understood as a relational and institutional construct rather than isolated individual freedom, embedded in governance, technological design, and collective norms (Shin & Park, 2024; Saha & Mitra, 2025).

Unlike approaches that interpret employee autonomy solely as a psychological or organizational variable, the present study conceptualizes autonomy as an economic resource rooted in the exercise of individual free will and capable of generating productivity gains, innovation spillovers, and broader geopolitical and developmental effects under Industry 5.0 conditions (Deci et al., 2017; Nie et al., 2023; McAnally & Hagger, 2024).

The reviewed literature demonstrates that employee autonomy has evolved into a global structural trend shaping labor markets, innovation systems, and economic resilience. Autonomy emerges not only as a basic human need but as a strategic resource whose effectiveness depends on supportive institutions, inclusive governance, and human-centered technological design. Within the Industry 5.0 paradigm, autonomy constitutes a cornerstone for aligning productivity, innovation, and social sustainability in a rapidly transforming global economy.

2. RESULTS AND DISCUSSION

In modern conditions, employee autonomy appears not only as an organizational characteristic of the labor process but also as a manifestation of the individual's free will, enabling them to consciously choose actions, make decisions, and take responsibility for their consequences. Free will, in this context, is one of the basic conditions for the realization of the employee's labor potential, since it ensures the transition from externally determined behavior to conscious, self-regulated economic activity.

In the context of digital transformation and the spread of autonomous employment formats, free will cannot be considered an isolated psychological attribute; rather, it becomes a multidimensional economic resource that directly affects the productivity, innovation, and sustainability of labor systems within the Industry 5.0 paradigm.

The results show that employee autonomy affects productivity through three main channels:

1) reducing coordination losses;
2) increasing intrinsic motivation;
3) decentralization of decision-making, with the second channel playing a dominant role in industries requiring a high level of knowledge.

Table 1. Dimensions of autonomy as an economic resource in Industry 5.0

Dimension	Conceptual definition	Economic function
Awareness	Reflective understanding of goals, constraints, and consequences	Strategic allocation of efforts
Rationality	Ability to evaluate alternatives and trade-offs	Decision-making efficiency
Choice	Freedom to choose tasks, schedules, and collaboration formats	Labor flexibility
Motivation	Intrinsic motivation to perform and develop skills	Stable performance
Responsibility	Accepting results and risks	Reducing monitoring costs
Self-regulation	Ability to maintain performance without external control	Stability in autonomy

Table 1 summarizes the conceptual framework of autonomy and shows how its dimensions are translated into specific economic functions critical to human-centered production systems in Industry 5.0.

An analysis of current research (Troisi et al., 2024; Gamberini & Pluchino, 2024) allows us to identify three key mechanisms through which employee autonomy affects productivity and innovation in modern work systems.

First, autonomy increases cognitive focus and prioritization, allowing employees to direct their time and attention to the activities with the greatest added value. Reducing dependence on external control reduces coordination losses and administrative costs, which has a direct economic effect.

Second, autonomy enhances intrinsic motivation, which promotes creativity, persistence, and adaptive problem-solving. In this context, productivity gains result from qualitative improvements in effort driven by the worker's conscious choice and responsibility, rather than quantitative increases in working hours.

Third, autonomy supports distributed decision-making by bringing authority closer to the point of action. This approach speeds up organizations' response to environmental changes and reduces the transaction costs associated with hierarchical control, which is especially important in times of global instability.

The analysis establishes a causal relationship in which employee autonomy, grounded in free will and responsibility, promotes self-regulation and intrinsic motivation, which, in turn, improve quality performance and strengthen organizational and macroeconomic resilience in the face of global uncertainty.

These mechanisms and their impact at the individual and organizational levels are systematized in Table 2.

Taken together, the results presented support the interpretation of autonomy as a productivity multiplier, especially in knowledge-intensive and creative sectors characteristic of Industry 5.0.

The results show that worker autonomy serves as a stabilizing mechanism for labor markets during periods of geopolitical instability, enhancing individual adaptability, reducing reliance on centralized control, and supporting decentralized economic activity.

Within the Industry 5.0 framework, employee autonomy is a systemic factor in the transition from technologically oriented models of work organization to human-centric ones, in which human judgment and freedom of choice complement digital and algorithmic tools (Figure 1).

The study results provide an analytical framework for developing labor market policies that prioritize autonomy-based employment models

Table 2. Mechanisms through which autonomy affects productivity and innovation

Mechanism	Micro-level effect	Organizational result
Cognitive focus	Improving task prioritization	Higher quality results
Intrinsic motivation	Increasing engagement and creativity	Innovation intensity
Distributed decision-making	Faster response	Organizational flexibility
Self-regulation	Reducing dependence on supervision	Reducing transaction costs

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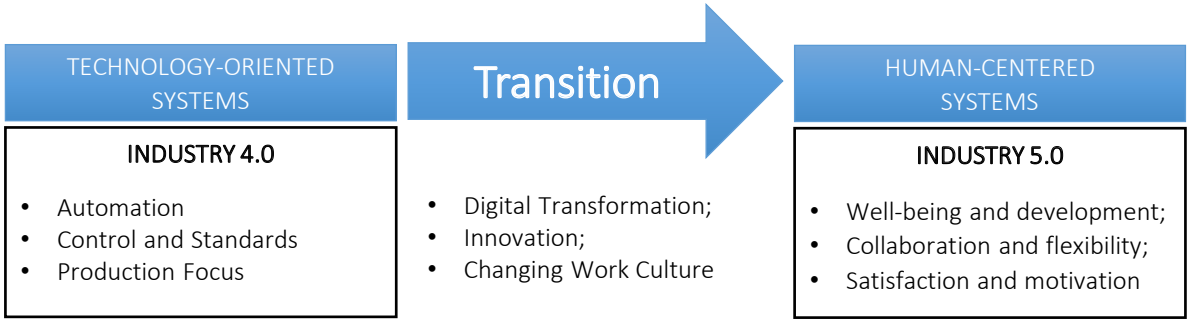

Figure 1. Conceptual transition from technology-centric to human-centric work systems

as tools for economic sustainability and geopolitical stability.

Autonomy allows workers to compensate for reduced time through improved concentration, self-regulation, and strategic allocation of effort. Productivity arises not from extended working hours, but from coordination based on trust and intrinsic motivation.

The relationship between autonomy, reduced working hours, and productivity outcomes is systematized in Table 3, which compares autonomy-based work models in the context of Industry 5.0.

The conceptual structure of the 100-80-100 model is further illustrated in Figure 2, where autonomy is emphasized as a compensatory mechanism that compensates for reduced working hours.

From an economic perspective, autonomy increases the liquidity of human capital, reducing adaptation costs and facilitating continuous skill development. This transformation transforms labor from a fixed resource into a dynamic, adaptive resource capable of responding to technological and institutional shifts. The experience of freelancing and the results of international experiments confirm the potential of autonomy as an economic resource for the formation of flexible and sustainable market systems.

For the analysis, panel data for 123 countries were collected for the period 2005–2023, which gives a database of 2,337 point observations on the working indicators, hours per worker (annual measurement, hours), GDP per capita (PPP, current international USD), population, GDP per capita per hour, and world region according to OWID.

Before conducting the modelling and constructing the regressions, Levin–Lin–Chu unit-root tests and GDP per capita per hour were found to be non-stationary (Appendix A). To obtain a stationary variable, the data were logarithmized, and the Levin–Lin–Chu unit-root transformation was repeated.

The next step was to conduct the Breusch and Pagan Lagrangian multiplier test for random effects, the Hausman specification test, and the Random-effects GLS regression. The results favored random effects (Appendix B).

The study found that, on average, in the group of accessible countries, every additional 100 hours worked per year reduces labor productivity by USD 2.1 per hour. An increase of 1 hour in the working year reduces GDP per capita by USD 28.48 per person. With a 1 percent increase in the

Table 3. Autonomy-based work models in the transition to Industry 5.0

Work model	Level of autonomy	Coordination logic	Impact on performance
Employment in Industry 4.0	Low-moderate	Hierarchical control	Efficiency through standardization
Freelance	High	Market coordination	Flexible productivity
Model 100-80-100	High	Coordination based on trust	Focus-based productivity
Industry 5.0 work systems	High	Partnership between man and technology	Creating sustainable value

Source: Our elaborations based on Abrams (2025), Baskin (2023).

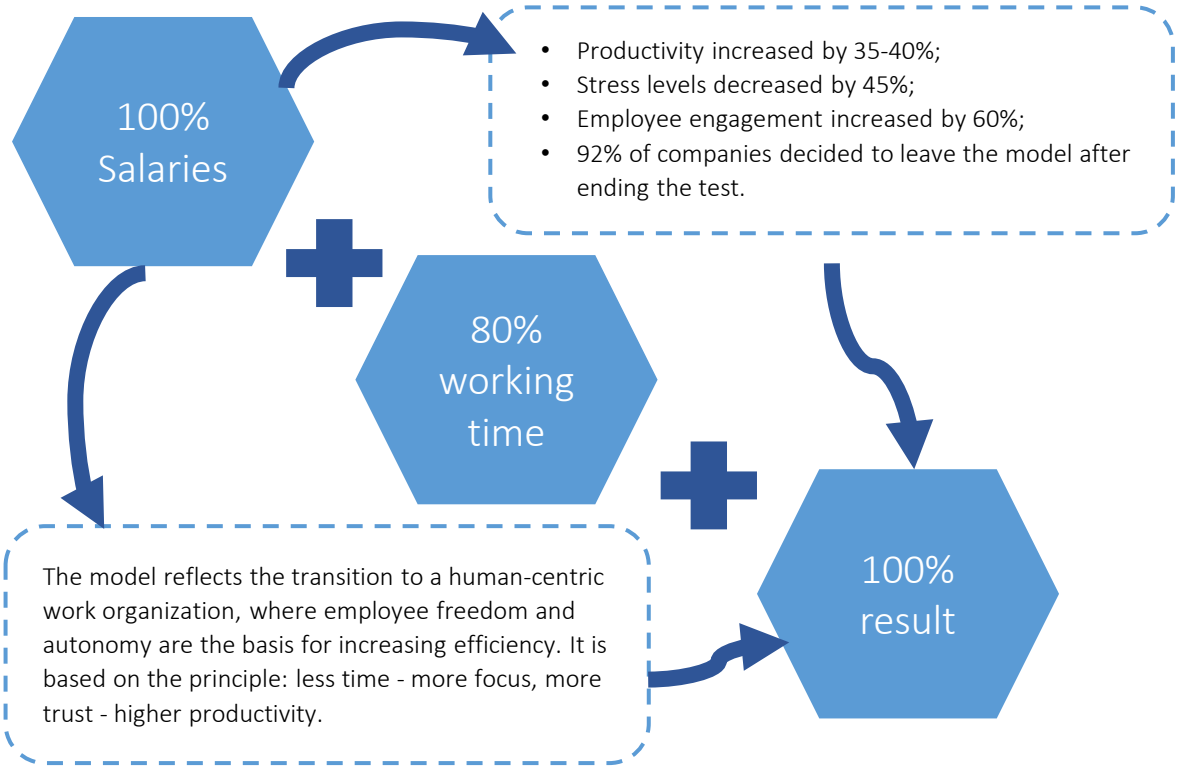

Figure 2. Conceptual logic of the 100-80-100 model: Autonomy as a compensatory mechanism for reduced working hours

working year duration, GDP per capita per hour falls by 2.71 percent.

From an economic perspective, autonomy increases the liquidity of human capital, reducing adaptation costs and facilitating continuous skill development. This transformation transforms labor from a fixed resource to a dynamic, adaptive resource capable of responding to technological, institutional, and geopolitical shifts.

Overall, the integrated results confirm that worker autonomy within Industry 5.0 is not just an organizational characteristic but a strategic economic resource grounded in the realization of individual free will. It activates intrinsic motivation and cre-

Table 4. Assessment of the impact of working hours on labor productivity (GDP per capita per hour worked) in a group of 123 countries for 2005–2023

Random-effects GLS regression	Number of obs = 2.337
Group variable: id	Number of groups = 123
R-squared:	Obs per group:
Within = 0.0950	min = 19
Between = 0.1591	average = 19.0
Overall = 0.1511	max = 19
corr (u_i, X) = 0 (assumed)	Wald chi2(1) = 253.87
	Prob > chi2 = 0.0000

gdppercapit~r	Coefficient	Std. err.	z	P > |z|	[95% conf.	interval]
workinghour~r	–.0209652	.0013158	–15.93	0.000	–.0235442	–.0183863
_con ns	54.27081	2.789186	19.46	0.000	48.8041	59.73751
sigma_u	11.943877					
sigma_e	4.6307399					
rho	86932506 (fraction of variance due to u_i)					

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Table 5. Assessment of the impact of working hours on labor productivity (GDP per capita per hour worked) in a group of 123 countries for 2005–2023

Random-effects GLS regression	Number of obs = 2.337
Group variable: id	Number of groups = 123
R-squared:	Obs per group:
Within = 0.1221	min = 19
Between = 0.1072	average = 19.0
Overall = 0.1079	max = 19
corr (u_i, X) = 0 (assumed)	Wald chi2(1) = 322.19
	Prob > chi2 = 0.0000

lnGDPperH	Coefficient	Std. err.	z-	P > |z|	[95% conf. interval]	
lnHOURS	–2.71051	.1510066	17.95	0.000	–3.006478	–2.414543
_con ns	22.50561	1.146636	19.63	0.000	20.25824	24.75297
sigma_u	1.099427					
sigma_e	.26305494					
rho	.94585189 (fraction of variance due to u_i)					

ativity, supports distributed decision-making, ensures the effectiveness of short-term work models, and increases the adaptability and resilience of the labor market in the face of globalization and geopolitical challenges. This creates a conceptual framework for rethinking productivity, labor organization, and the creation of human-centered economic value in modern economic systems.

The results of the study are consistent with existing evidence that autonomy increases adaptability to the labor market in conditions of structural change and uncertainty. In particular, autonomous forms of labor organization enable faster reorientation of professional activities, redistributing skills and competencies across projects, organizations, and sectors (Purnomo et al., 2025; Ahart & Nature Magazine, 2025).

Further analysis of empirical data on the implementation of reduced working hours (Lewis et al., 2023) demonstrates that the economic efficiency of such models is possible only under the condition of a high level of employee autonomy, which ensures self-regulation, responsibility, and strategic distribution of efforts. Generalized data on the implementation of such approaches in different countries are systematized and presented in Table 6.

The conceptual logic of the 100-80-100 model illustrates how productivity can be maintained or increased despite reduced official working hours. The introduction of the "100-80-100" model and the shortened work week is a subject of active discussion among academics and management practitioners. Empirical evidence suggests that such approaches have a positive impact on employee well-being, reducing stress, increasing motivation, and creativity (Lewis et al., 2023; Beard, 2024). At the same time, the questions of universality and scalability of this model remain under discussion.

Table 6. Countries' experience in implementing a 4-day workweek

Source: Compiled by Beard (2024), Nocchi (2025), Putri (2025).

Country	Implementation period/stage	Key results/features
Iceland	2015–2019 – large-scale state experiment; implemented in most sectors by 2022	Over 51% of workers switched to reduced hours without loss of pay; productivity increased, and the economy remained stable
Belgium	From 2022, it is legally allowed to choose a 4-day work week while maintaining 40 hours in total	Flexibility for employees without loss of income; aimed at improving work-life balance
Germany	2023–2024 – pilot project in 41 companies	73% of companies decided to keep the shortened week after the test; increased satisfaction and productivity were noted
Japan	From April 2025, Tokyo civil servants work 4 days a week	Government initiative to reduce stress and stimulate innovation; plans to expand to other regions
Spain, Portugal, the United Kingdom	2022–2024 – State and corporate experiments conducted	According to the test results, there is an increase in employee productivity and satisfaction, and a reduction in stress
The Netherlands, Denmark	Long-term experience of short- time work	One of the shortest average working weeks in Europe: 29 hours (the Netherlands) and 37 hours (Denmark)

Source: Compiled by 4 Day Week Global (2025).

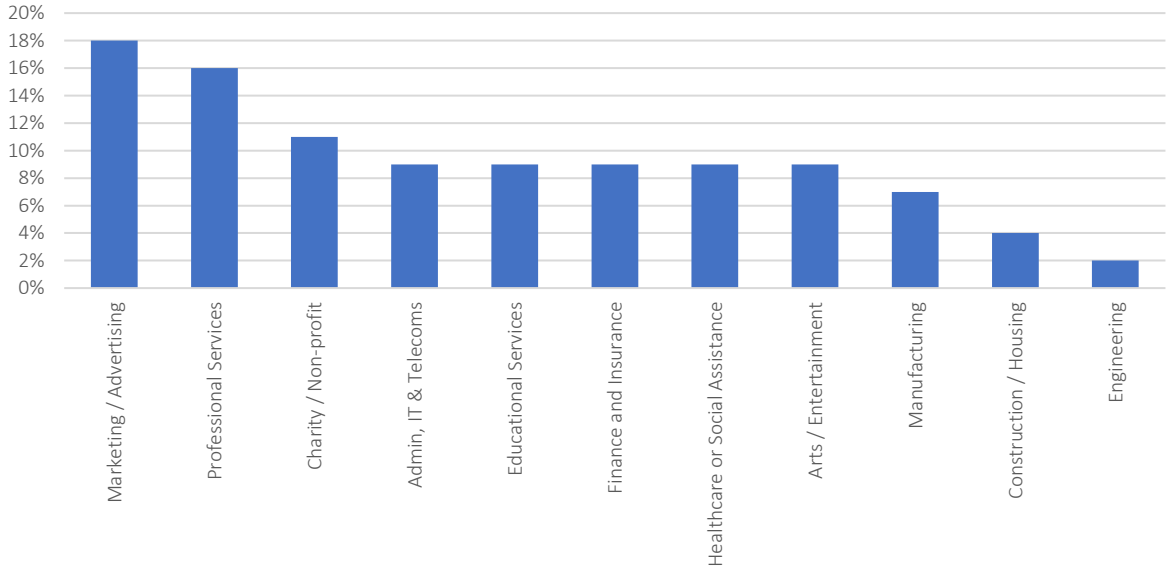

Figure 3. Distribution of companies by industry that have implemented a 4-day work week

Analytical reviews and interdisciplinary studies demonstrate the positive impact of a four-day workweek on employee well-being and organizational performance, especially in sectors with high levels of autonomy and creativity (Purnomo et al., 2025; Ahart & Nature Magazine, 2025).

Figure 3 shows the share of companies across sectors that are experimenting with or already implementing flexible working arrangements, allowing us to assess in which industries initiatives such as the 4-day work week or the "100-80-100" model have the greatest economic and organizational impact.

The sectoral breakdown shows that short-time work initiatives are most effective in the creative and service sectors, while they are gradually being adapted in traditional industries.

The analysis also shows that autonomy increases adaptability to the labor market in conditions of structural change and uncertainty. Autonomous forms of labor organization enable faster reorientation of professional activities, redistributing skills and competencies across projects, organizations, and sectors (Purnomo et al., 2025; Ahart & Nature Magazine, 2025).

Purnomo et al. (2025) show that reducing working time is effective in sectors with high levels of autonomy and creativity, but in traditional manufacturing or regulated sectors, its implementation may be limited by technological and organizational requirements. Similar findings are supported by studies of Japanese companies, where the implementation of a four-day work week requires process adaptation and changes in corporate culture (World Economic Forum, 2025).

A key discussion point is employee motivation in the context of Industry 5.0. The main task of this concept is to form a personality capable of realizing the socio-economic goals of the new stage, including supporting sustainable development and integrating people and technologies into a single anti-entropic potential of the planet. Previous experiments with unconditional basic income (UBI) in Switzerland, Finland, the Netherlands and other countries demonstrate that even guaranteed financial payments do not always stimulate social activity and personal development of citizens (Samuel, 2020; Rahimi, 2025; Allas et al., 2020). The results of the 2015 Swiss referendum, in which 77% of participants voted against the introduction of the BOD, raise concerns that the lack of need to work could lead to reduced motivation and social participation.

In this context, the "100-80-100" model acquires strategic importance. It demonstrates that produc-

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tivity and social activity can be maintained even with reduced formal working hours, provided employees are given autonomy and independence in planning their activities. Autonomy here acts not only as a factor in increasing efficiency but also as a potential mechanism for shaping the motivational structure necessary for implementing the goals of Industry 5.0 (Abrams, 2025; Baskin, 2023).

The debate also covers the economic efficiency of a shortened workweek. While the "100-80-100" model has been shown to maintain or increase productivity, critics point to potential additional costs of organizing processes and the risk of overloading workers on short working days (Griep et al., 2025). At the same time, at the macro level, a shortened week and worker autonomy can stimulate the development of human capital, learning, and innovation, which aligns with the principles of the people-centered economy of Industry 5.0 (Adel, 2022).

Thus, the discussion demonstrates that the "100-80-100" model has the potential to increase productivity, social sustainability, and human capital development, while highlighting the complexity of achieving the global sustainable development goals. Its effectiveness depends on organizational culture, technological infrastructure, and motivational mechanisms that ensure a balance between autonomy, personal development, and economic activity. Further research could focus on scaling the model across sectors, assessing long-term economic and social effects, and integrating with cyber-manufacturing systems and Industry 5.0 technologies.

CONCLUSION

The study aims to investigate the autonomy of the global worker as an economic resource by optimizing work–life balance and assessing the corresponding impact on the population's productivity and well-being in the context of Industry 5.0 and global structural shifts.

Employee autonomy is considered not only a psychological or organizational characteristic but also a strategic economic resource, gaining particular importance in the context of globalization and growing geopolitical instability.

Using the panel data for 123 countries for the period 2005–2023, the study found that, on average, in the group of accessible countries, every additional 100 hours worked per year reduces labor productivity by USD 2.1 per hour. Within the human-centric paradigm of Industry 5.0, employee autonomy is a key factor in the geoeconomic competitiveness and sustainability of national economies, as it directly affects labor systems' ability to adapt to structural shifts, technological transformations, and global risks.

An increase of one hour in the working year reduces GDP per capita by USD 28.48 per person. Employee autonomy is a manifestation of the individual's free will, which determines their ability to consciously choose labor actions, make decisions, and be responsible for their consequences. It is this property that ensures the transformation of the employee into an independent economic agent capable of functioning effectively in conditions of global uncertainty, market fragmentation, and increased competition for human capital.

With a 1 percent increase in the working year, GDP per capita per hour falls by 2.71 percent. Therefore, the effectiveness of short-time work models, in particular the "100-80-100" concept, stems from the levels of autonomy and trust in labor relations. In the context of globalization, such models can serve as tools to increase socio-economic sustainability only if employee autonomy is institutionalized as the basis for responsible, self-regulated labor behavior.

At the macroeconomic and geopolitical levels, autonomy facilitates the transformation of labor markets from hierarchical and tightly regulated models to decentralized, networked, and project-oriented forms

of labor organization. Therefore, worker autonomy is an economically significant factor in enhancing productivity, innovation potential, and contributing to the geopolitical and geoeconomic sustainability of societies in the era of globalization.

AUTHOR CONTRIBUTIONS

Conceptualization: Leonid Melnyk, Lyudmila Kalinichenko, Oleksandr Kubatko, Yuliia Zavdovieva.
Data curation: Leonid Melnyk, Yuliia Rozghon, Yuliia Zavdovieva.
Formal analysis: Leonid Melnyk, Lyudmila Kalinichenko, Oleksandr Kubatko, Yuliia Rozghon.
Funding acquisition: Lyudmila Kalinichenko.
Investigation: Yuliia Rozghon, Yuliia Zavdovieva.
Methodology: Leonid Melnyk, Oleksandr Kubatko, Yuliia Rozghon.
Project administration: Oleksandr Kubatko.
Resources: Lyudmila Kalinichenko, Yuliia Zavdovieva.
Software: Lyudmila Kalinichenko, Yuliia Rozghon.
Supervision: Leonid Melnyk.
Validation: Lyudmila Kalinichenko, Yuliia Rozghon.
Writing – original draft: Leonid Melnyk, Lyudmila Kalinichenko, Oleksandr Kubatko, Yuliia Rozghon, Yuliia Zavdovieva.
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APPENDIX A. Levin–Lin–Chu unit-root test for panel data variables

```
Levin -Lin-Chu unit- root test for workinghoursperworker
---------------------------------------------------
H0: Panels contain unit roots               Number of panels = 123
Ha: Panels are stationary                   Number of periods = 19

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means: Included
Time trend: Included

ADF regressions: 1 lag
LR variance: Bartlett kernel, 8.00 lags average (chosen) by LLC)
------------------------------------------------------------------------
                     Statistical p- value
Unadjusted t -28.2972
 Adjusted t* -9.8452 0.0000

Levin-Lin-Chu unit- root test for gdppercapitappcurrentinternatio
-----------------------------------------------------------------
H0: Panels contain unit roots               Number of panels = 123
Ha: Panels are stationary                   Number of periods = 19
AR parameter: Common                        Asymptotics: N/T -> 0
Panel means: Included
Time trend: Included
ADF regressions: 1 lag
LR variance: Bartlett kernel, 8.00 lags average (chosen) by LLC)
                     Statistical p- value
Unadjusted t -10.3730
Adjusted t* 10.4064 1.0000


Levin-Lin-Chu unit- root test for population
----------------------------------------
H0: Panels contain unit roots               Number of panels = 123
Ha: Panels are stationary                   Number of periods = 19

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means: Included
Time trend: Included

ADF regressions: 1 lag
LR variance: Bartlett kernel, 8.00 lags average (chosen) by LLC)
                     Statistical p- value
Unadjusted t -23.3679
 Adjusted t* -15.5182 0.0000


Levin-Lin-Chu unit- root test for gdppercapitaperhour
-----------------------------------------------
H0: Panels contain unit roots               Number of panels = 123
Ha: Panels are stationary                   Number of periods = 19

AR parameter: Common                        Asymptotics: N/T -> 0
Panel means: Included
Time trend: Included
```

```
ADF regressions: 1 lag
LR variance: Bartlett kernel, 8.00 lags average (chosen) by LLC)
                    Statistical p- value
Unadjusted t -8.7659
 Adjusted t* 9.8411 1.0000


Levin-Lin-Chu unit-root test for lnGDPperH
----------------------------------------
H0: Panels contain unit roots Number of panels = 123
Ha: Panels are stationary Number of periods = 19

AR parameter: Common Asymptotics: N/T -> 0
Panel means: Included
Time trend: Included

ADF regressions: 1 lag
LR variance: Bartlett kernel, 8.00 lags average (chosen by LLC)
Statistical p-value
Unadjusted t -22.4085
Adjusted t* -1.2060 0.1139
```


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APPENDIX B. Breusch and Pagan Lagrangian multiplier test for random effects reg lnGDPperH lnHOURS

```
reg lnGDPperH lnHOURS

Source | SS df MS Number of obs = 2.337
-------------+------------------------------ F(1, 2335) = 282.50
Model | 355.780537 1 355.780537 Prob > F = 0.0000
Residual | 2940.68443 2.335 1.25939376 R-squared = 0.1079
-------------+------------------------------ Adj R-squared = 0.1075
Total | 3296.46496 2.336 1.41115795 Root MSE = 1.1222

------------------------------------------------------------------------------
   lnGDPperH | Coefficient Std. err. t P>|t| [95% conf. interval]
-------------+----------------------------------------------------------------
     lnHOURS | -2.421344.1440609 -16.81 0.000 -2.703844 -2.138843
_cons | 20.31813 1.090035 18.64 0.000 18.18059 22.45567
------------------------------------------------------------------------------

.xtreg lnGDPperH lnHOURS, re

Random-effects GLS regression Number of obs = 2,337
Group variable: id Number of groups = 123

R-squared: Obs per group:
     Within = 0.1221 min = 19
Between = 0.1072 avg = 19.0
Overall = 0.1079 max = 19

Wald chi2(1) = 322.19
corr (u_i, X) = 0 (assumed) Prob > chi2 = 0.0000

------------------------------------------------------------------------------
   lnGDPperH | Coefficient Std. err. z P>|z| [95% conf. interval]
-------------+----------------------------------------------------------------
     lnHOURS | -2.71051.1510066 -17.95 0.000 -3.006478 -2.414543
_cons | 22.50561 1.146636 19.63 0.000 20.25824 24.75297
-------------+----------------------------------------------------------------
     sigma_u | 1.099427
     sigma_e |. 26305494
         rho |.94585189 (fraction of variance due to u_i)
------------------------------------------------------------------------------

xttest0

Breusch and Pagan Lagrangian multiplier test for random effects

        lnGDPperH [ id,t ] = Xb + u[id] + e[ id,t ]

Estimated results:
| Var SD = sqrt (Var)
---------+-------------------------
               lnGDPperH | 1.411158 1.187922
                       e |.0691979.2630549
                       u | 1.20874 1.099427

Test: Var (u) = 0
                                chibar2(01) = 18780.42
                           Prob > chibar2 = 0.0000

* the probability is less than 0.05 so it is safe to use random effects
```

```
treg lnGDPperH lnHOURS, fe

Fixed- effects (within) regression               Number of obs = 2.337
Group variable: id                              Number of groups = 123

R- squared: Obs per group:
     Within = 0.1221 min = 19
     Between = 0.1072 avg = 19.0
     Overall = 0.1079 max = 19

F(1, 2213) = 307.80
corr (u_i, Xb) = -0.0453 Prob > F = 0.0000

------------------------------------------------------------------------------
   lnGDPperH | Coefficient  Std. err. t P>|t| [95% conf. interval ]
-------------+----------------------------------------------------------------
     lnHOURS | -2.728998.1555499 -17.54 0.000 -3.034037 -2.423959
       _co ns | 22.64546 1.176712 19.24 0.000 20.33788 24.95304
-------------+----------------------------------------------------------------
sigma_u | 1.0977452
sigma_e |.26305494
         rho |.94569487 (fraction of variance due to u_i)
------------------------------------------------------------------------------
F -test that all u_i =0: F(122, 2213) = 330.19 Prob > F = 0.0000

estimates store fixed

xtreg lnGDPperH lnHOURS, re

Random-effects GLS regression                    Number of obs = 2.337
Group variable: id                               Number of groups = 123

R- squared: Obs per group:
     Within = 0.1221 min = 19
     Between = 0.1072 avg = 19.0
     Overall = 0.1079 max = 19

                                                 Wald chi2(1) = 322.19
corr (u_i, X) = 0 (assumed) Prob > chi2 = 0.0000

------------------------------------------------------------------------------
   lnGDPperH | Coefficient  Std. err. z P>|z| [95% conf. interval ]
-------------+----------------------------------------------------------------
     lnHOURS | -2.71051.1510066 -17.95 0.000 -3.006478 -2.414543
       _co ns | 22.50561 1.146636 19.63 0.000 20.25824 24.75297
-------------+----------------------------------------------------------------
sigma_u | 1.099427
sigma_e |.26305494
         rho |.94585189 (fraction of variance due to u_i)
------------------------------------------------------------------------------

estimates store random

hausman fixed random

---- Coefficients ----
| (b) (B) (bB) sqrt (diag (V_b-V_B))
```


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```
| fixed        random       Difference       Std. err.
-------------+----------------------------------------------------------------
     lnHOURS | -2.728998 -2.71051 -.0184872.03732
------------------------------------------------------------------------------
b = Consistent under H0 and Ha ; obtained from xtreg.
B = Inconsistent under Ha, efficient under H0; obtained from xtreg.

Test of H0: Difference in coefficients not systematic

chi2(1) = (bB)'[(V_b-V_B)^(-1)](bB)
= 0.25
Prob > chi2 = 0.6203

. probability is more than 0.05, it is safe to use the Random effects
```