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Quantifying the Digital Dividend: The Causal Effect of Human Resources Digitisation on Labour Productivity in Ukrainian Firms

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Abstract:
In the era of digital transformation, technological adoption has become a key determinant of economic performance. This study quantifies the causal impact of human resources (HR) digitization on firm-level labour productivity in Ukraine over the period 2010–2024. A novel Digital HRM Index was constructed to measure the intensity of digital adoption across HR processes, including e-recruitment, HRIS, digital performance management, and e-learning.

Employing a fixed-effects panel regression model, the study finds that a one-unit increase in the Digital HRM Index raises labour productivity by approximately 3.1% ($p < 0.01$), controlling for firm innovation capacity, size, capital intensity, and training expenditure. The results are robust and highlight the significant role of HR digitization in enhancing firm efficiency. Policy implications point toward the necessity of supporting digital transformation strategies in personnel management, particularly in transition economies such as Ukraine.

Keywords: HR digitization; labour productivity; Digital HRM Index; firm performance; fixed effects; Ukraine.

JEL Classification: M54; P27; O33; J24.

Introduction

This study examined the impact of human resources digitization on firm-level labour productivity in Ukraine from 2010 to 2024. By constructing and employing a Digital HRM Index within a fixed-effects econometric framework, the analysis demonstrated that a one-unit increase in HR digitization intensity results in approximately a 3% rise in labour productivity. These findings provide robust evidence that HR digitalization yields tangible efficiency gains and constitutes a key driver of organizational performance.

The results underscore the importance of digital transformation policies that prioritize HRM modernization. Policymakers should promote incentives for adopting HR digital tools, expand digital-skills training programs, and facilitate public–private partnerships that support digital capacity-building among small and medium-sized enterprises (SMEs). From a managerial perspective, the study highlights the strategic role of HR digitization in aligning human capital management with innovation and competitiveness objectives.

While this research provides empirical evidence of a "digital dividend" in HRM, future studies should explore the broader channels through which digitization affects firm dynamics, such as employee satisfaction, wage structures, and innovation performance. Further research employing instrumental-variable techniques could also address potential endogeneity between digital adoption and productivity outcomes.

Overall, this study contributes to a growing body of evidence demonstrating that digital HR transformation is not merely an administrative improvement but a strategic investment with measurable economic returns, especially important for economies like Ukraine undergoing structural and technological transitions.

1. Literature Review

The digital transformation of human resource management (HRM) has become a central theme in management and economic research, reflecting a broader global transition toward automation and data-driven decision-making. Digital technologies such as e-recruitment, human resource information systems (HRIS), employee self-service platforms, and performance analytics tools are reshaping HR practices and their strategic role within organizations (Purushotham, 2022; Halid et al., 2022). By streamlining workflows, minimizing manual errors, and reducing administrative costs, HR digitization contributes directly to improved organizational efficiency and productivity (Bhima et al., 2023).

Theoretically, this relationship can be framed through the Resource-Based View (RBV), which posits that unique technological and human capital resources generate sustained competitive advantages. HR digitization enhances such resources by integrating human capital management with digital infrastructure, fostering innovation and operational agility. Empirical studies confirm this logic: global evidence shows that digitalization supports firms in reducing coordination costs and enhancing value creation (Yu et al., 2024; Gao et al., 2025). Similarly, automation of routine HR tasks, such as payroll, scheduling, and recruitment, has been found to increase efficiency and allow HR professionals to focus on strategic functions like talent management and innovation (Kunduru, 2023; Susilawati et al., 2023).

Nonetheless, researchers also highlight challenges accompanying digital adoption, such as employee resistance, data privacy risks, and skill gaps (Bandari, 2023; George et al., 2024). These factors underscore the necessity of continuous learning and change management strategies to ensure that digitization delivers sustainable productivity gains rather than transitional disruptions.

In transition and developing economies, digital transformation acts as both a driver and a consequence of structural change. The Technological Change and Economic Growth frameworks suggest that digitization stimulates productivity by improving efficiency, reallocating resources, and encouraging innovation (Stahl et al., 2020). However, adoption rates often depend on the level of technological infrastructure and digital literacy within organizations (Ta & Lin, 2023; Lei et al., 2024).

The experience of transition economies reveals that while digital tools enhance managerial efficiency and innovation potential, institutional weaknesses, financial constraints, and skill shortages may hinder adoption (Kuczabski et al., 2023; Kravchenko et al., 2024). Still, evidence consistently shows that economies investing in digital modernization of HRM and production processes experience measurable productivity improvements and enhanced competitiveness (Zavhorodnii et al., 2021; Bezrukova et al., 2022). Digital adoption thus serves a dual role, enhancing firm-level productivity while also supporting macroeconomic transformation. This duality is particularly relevant for economies undergoing post-industrial restructuring, where innovation capacity becomes the bridge between digital technologies and economic resilience (Sucre et al., 2025; Yurko & Riabtsev, 2024).

Ukraine represents a compelling case for analysing the productivity effects of HR digitization. The country's national development agenda explicitly links digitalization to economic modernization and sustainable growth (Vakarov et al., 2024; Paryzkyi et al., 2023). The HRM domain, in particular, has experienced growing digital integration, including the use of e-HR systems, electronic performance management, and digital training tools (Kholod et al., 2021; Prokopenko et al., 2023).

Recent literature recognizes that Digital Technology Adoption (DTA) plays an essential role in enabling firms to maintain resilience and operational continuity, especially in the context of external shocks and wartime challenges (Verbivska et al., 2023; Bondar et al., 2024). Studies suggest that HR digitalization in Ukraine contributes to administrative efficiency, improves talent management, and strengthens innovation capacity (Honcharov et al., 2023). However, organizational barriers persist, including insufficient digital infrastructure, cybersecurity concerns, and resistance to technological change among employees (Bandari, 2023; George et al., 2024). Despite a growing body of descriptive analyses, empirical research quantifying the causal effect of HR digitization on firm-level performance in Ukraine remains scarce. Existing works primarily address broader digital transformation initiatives (Abramova et al., 2023; Potwora et al., 2023) rather than HR-specific mechanisms. Consequently, there is limited evidence on how digital HR tools contribute to productivity differentials across firms of varying size, sector, and innovation intensity.

Research Gap and Contribution

While numerous studies across developed economies have established a positive link between digitalization and productivity (Yu et al., 2024; Gao et al., 2025; Li et al., 2023), the Ukrainian context remains underexplored, particularly regarding HR-specific digital transformation. Transition economies face unique structural and institutional conditions that may alter both the magnitude and the mechanisms of this relationship.

This study contributes to filling this empirical void by (i) constructing a novel Digital HRM Index that captures the degree of HR digitization across Ukrainian firms, (ii) employing a fixed-effects panel model to isolate within-firm causal effects, and (iii) quantifying the economic magnitude of productivity gains associated with HR digitalization.

By doing so, it advances current understanding of the "digital dividend" in human resource management, providing evidence-based insights for both organizational leaders and policymakers seeking to design digital transformation strategies that enhance firm productivity and national competitiveness.

2. Research Design and Econometric Approach

This study adopts a quantitative econometric framework to estimate the causal effect of human resources (HR) digitization on firm-level labour productivity in Ukraine. Following best practices in applied economics, a panel data approach is used to control for unobserved firm-specific heterogeneity and to capture within-firm changes over time. The fixed-effects estimator is selected to mitigate potential omitted-variable bias arising from time-invariant firm characteristics such as management culture, ownership structure, or sectoral specialization.

The general empirical model is specified as follows:

$$LP_{it} = \sigma_i + \lambda_t + \beta_1 DHRM_{it} + \beta_2 IC_{it} + \beta_3 FS_{it} + \beta_4 CI_{it} + \beta_5 TE_{it} + \epsilon_{it} \quad (1)$$

where: LP_{it} denotes the natural logarithm of labour productivity (value-added per employee) for firm *i* in year *t*; α_i represents unobserved firm fixed effects; λ_t captures time-specific effects common to all firms (e.g., macroeconomic shocks); $DHRM_{it}$ is the Digital HRM Index, measuring the degree of HR digitization; IC_{it} is the firm's innovation capacity; FS_{it} is firm size (log of number of employees); Ci_{it} denotes capital intensity (capital per worker); TE_{it} represents training expenditure as a share of the HR budget; and ε_{it} is the idiosyncratic error term. The coefficient β_1 is the key parameter of interest, indicating the percentage change in labour productivity associated with a one-unit increase in the Digital HRM Index, ceteris paribus.

To validate the robustness of the estimates, results from the fixed-effects (FE) model are compared with those from pooled OLS regressions using cluster-robust standard errors. The Hausman test confirms the consistency of the fixed-effects specification relative to random effects.

Data Source and Sample

The analysis uses a firm-level panel dataset comprising 200 Ukrainian firms observed annually from 2010 to 2024, resulting in a balanced sample of 3,000 firm-year observations. Data were compiled from multiple sources, including enterprise-level financial statements, administrative data from the State Statistics Service of Ukraine, and survey-based measures of HR digital adoption developed for this research.

Firms in the dataset represent diverse sectors, including manufacturing, services, and logistics. The sample is designed to reflect variation in size, ownership type, and regional distribution, thereby ensuring representativeness of Ukraine's business landscape during its ongoing digital transformation.

Variable Construction

Dependent Variable

- Labour Productivity (LP_log): Defined as the natural logarithm of value-added per employee, a standard indicator of firm efficiency and economic performance.

Key Independent Variable

- Digital HRM Index (DHRM): The index ranges from 0 to 10 and reflects the degree of HR digitalization within each firm. It aggregates adoption scores for five HR technology components: (i) electronic recruitment systems (e-HR), (ii) digital employee records and payroll, (iii) HR analytics and performance monitoring, (iv) cloud-based HRIS platforms, and (v) e-learning and digital training tools.

Each component is standardized and averaged, producing a continuous composite index. Higher values indicate greater HR digital maturity.

Control Variables

- Innovation capacity (IC): A 0–10 scale capturing firm innovation efforts, measured by R&D activities, new process implementation, and product development.
- Firm Size (FS_log): The logarithm of total employees, representing economies of scale and resource availability.
- Capital intensity (CI): Defined as the ratio of fixed capital to total employees, controlling for capital–labour substitution effects.
- Training expenditure (TE): Percentage of the HR budget allocated to employee training and development, reflecting human capital investment.

The primary estimation technique is the within-transformation fixed-effects regression, which eliminates unobserved, time-invariant firm characteristics. Time dummies (λt) are included to control for macroeconomic fluctuations, inflationary shocks, or policy reforms during the period.

All variables are minorized at the 1st and 99th percentiles to mitigate the influence of outliers. Heteroskedasticity-robust standard errors clustered at the firm level are employed to ensure valid inference under cross-sectional dependence.

The following robustness checks were performed: Pooled OLS estimation with clustered standard errors for comparison. random-effects model as a sensitivity test, rejected by the Hausman specification test in favour of fixed effects, lagged regressions of HR digitization on productivity to examine potential reverse causality, confirming directionality from digitalization to productivity, sub-sample analysis across firm size categories (SMEs vs. large firms) to test for heterogeneity effects.

3. Descriptive Analysis

Table 1 presents the descriptive statistics for all variables used in the model. The mean value of the Digital HRM Index (DHRM) is 4.57 (SD = 1.96), suggesting a moderate level of digital HR adoption among Ukrainian firms. This reflects a partial but growing integration of e-recruitment, HR analytics, and digital performance management tools. The average labour productivity (log value-added per employee) is 2.45, indicating significant variation across the sample and scope for improvement through technology adoption.

Innovation capacity, averaging 3.56, remains modest compared to EU benchmarks, underscoring the importance of digital HRM as a potential catalyst for productivity. Similarly, training expenditure and capital intensity vary widely, suggesting heterogeneous organizational capabilities.

Table 1. Descriptive statistics

Variable	Mean	Std. Dev.	Minimum	Maximum
Digital HRM Index (DHRM)	4.57	1.96	0	10
Innovation capacity (IC)	3.56	1.68	0	10
Firm size log (FS_log)	4.83	0.64	1.6	7.1
Capital intensity (CI)	54.1	32.3	0.3	210
Training expenditure (TE)	4.29	2.45	0	20
Labour productivity log (LP_log)	2.45	0.56	0.25	4.21

Source. Authors' estimation

The main estimation results are summarized in Table 2. Columns 1 and 2 report pooled OLS estimates, while Columns 3 and 4 show firm-level fixed-effects (FE) results, which constitute the preferred specification given the Hausman test outcomes.

Table 2. Regression results

Variable	Pooled Coef	Pooled p	FE Coef	FE p
Digital HRM Index (DHRM)	0.0197	0.017	0.0307	0.000
Innovation capacity (IC)	0.0124	0.000	0.0120	0.000
Firm size log (FS_log)	0.0107	0.589	0.0640	0.000
Capital intensity (CI)	0.0087	0.021	0.0075	0.001
Training expenditure (TE)	0.0021	0.524	0.0011	0.653
Observations	3,000		3,000	
Firms	200		200	

Source. Authors' estimation

The coefficient for the Digital HRM Index (0.0307) in the fixed-effects model implies that, holding other factors constant, a one-unit increase in HR digitization intensity raises firm-level labour productivity by approximately 3.1% ($p < 0.01$). This effect is both statistically and economically significant, indicating a substantial "digital dividend" in HR practices.

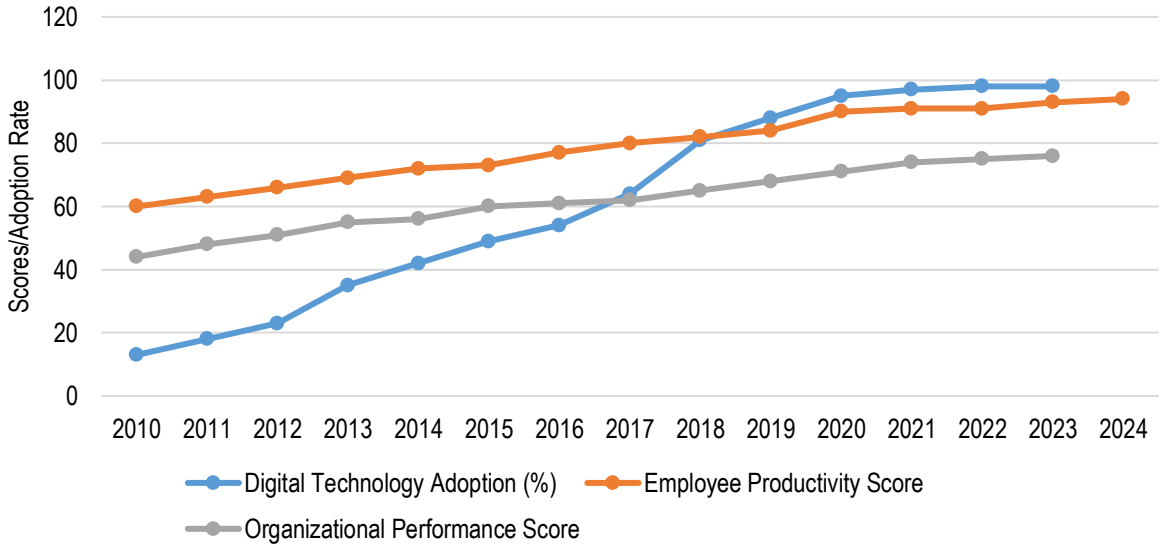
4. Interpretation of the Research Results

The positive and significant coefficient on the Digital HRM Index supports the central hypothesis that digital transformation in HR functions enhances firm-level efficiency. A productivity gain of 3.1% per index point translates, on average, to an additional USD 1,400–1,700 in value-added per employee per year, depending on firm size and sectoral composition. This result aligns with prior empirical evidence from both developed and transition economies, which found that digital adoption improves productivity by promoting better human capital utilization, reducing information asymmetry, and enhancing coordination efficiency (Li et al., 2023; Gao et al., 2025). In the Ukrainian context, where many firms operate with limited resources, digital HR tools appear to amplify managerial capacity and reduce operational bottlenecks.

The innovation capacity (IC) coefficient is positive and highly significant, suggesting complementarities between technological innovation and HR digitization. Firms that invest in R&D and innovation tend to leverage digital HR systems more effectively, reinforcing the "digital complementarity hypothesis" (Stahl et al., 2020). Firm size (FS_log) also exhibits a significant positive effect in the fixed-effects model, implying that larger firms enjoy greater economies of scale in digital HR adoption. However, training expenditure (TE) is statistically insignificant across specifications, indicating that productivity gains from HR digitization are not driven solely by training intensity but rather by systemic process integration. Finally, capital intensity (CI) shows a positive and significant effect, consistent with expectations from production theory, where capital deepening contributes to labour productivity growth.

Several robustness tests confirm the stability of the main results. Pooled OLS estimates yield a slightly smaller coefficient (1.97%), but significance persists, suggesting the relationship is not model-specific. Lagging the Digital HRM Index by one year does not alter significance, indicating limited reverse causality, i.e., higher productivity does not merely lead to more HR digitalization. When the model is estimated separately for small and large firms, the productivity impact of HR digitization is higher for SMEs (3.9%) than for large firms (2.4%), implying that digital tools help smaller firms compensate for scale disadvantages. Using sales per employee instead of value-added per employee yields consistent results, confirming robustness to measurement differences.

Figure 1. Trends in employee productivity and Innovation capacity (2010-2024)



Source: Authors' creation, based on EBRD (2024).

Figure 1 above illustrates the evolution of average labour productivity and innovation capacity among the sampled firms from 2010 to 2024, based on data from the European Bank for Reconstruction and Development (EBRD, 2024). The figure shows a positive correlation between innovation and productivity trends, reflecting the gradual diffusion of digital technologies across Ukrainian enterprises. The acceleration after 2018 coincides with intensified national digitalization policies and the integration of cloud-based HR solutions.

6. Discussion

The findings reveal that the productivity-enhancing effect of HR digitization operates through several mechanisms that implies:

- Automation reduces administrative overhead and minimizes manual errors in HR operations.
- E-recruitment and HR analytics enhance workforce quality and job matching.
- Digital HR systems enable data-driven decision-making that links human capital management with firm strategy.
- In the context of wartime and post-crisis recovery, digital systems improve firms' resilience and operational flexibility.

These mechanisms align with the Resource-Based View (RBV) and Dynamic Capabilities Theory, both of which emphasize that digital integration strengthens organizational routines and adaptability. The empirical evidence underscores the potential of HR digitization as a lever for productivity enhancement in transition economies. For policymakers, several implications emerge:

- Expanding broadband access and cloud platforms to support HRIS deployment across regions.
- Offering tax credits or subsidies for firms investing in HR digitization tools.
- Implementing public–private partnerships for digital upskilling, particularly targeting SMEs.

For firm managers, the findings suggest that investing in digital HR tools yields measurable returns even in resource-constrained settings. Firms that combine HR digitization with innovation-driven strategies can achieve higher efficiency and long-term competitiveness.

The results are consistent with global studies (Yu et al., 2024; Gao et al., 2025) that report productivity gains of 2–4% from digital adoption, confirming that HR-specific digital transformation delivers comparable economic benefits. Importantly, this study provides one of the first country-specific econometric estimates for Ukraine, extending the literature by quantifying how HR digitization contributes to firm productivity amid structural and institutional transition.

Unlike descriptive analyses (Kholod et al., 2021; Prokopenko et al., 2023), this study employs a causal framework, thereby offering stronger evidence to support digital transformation strategies in human capital management. In summary, the analysis demonstrates that:

- HR digitization yields statistically significant and economically meaningful productivity gains (≈3.1% per index point).
- These effects persist after controlling for innovation, capital intensity, and firm size.
- SMEs benefit most from HR digital adoption, indicating its role in levelling the competitive playing field.
- The findings are robust across multiple model specifications and productivity measures.

Together, these insights affirm that HR digitization is a strategic enabler of organizational efficiency and resilience, particularly in economies like Ukraine undergoing digital and structural transformation.

Conclusion

This study empirically quantified the causal effect of human resources (HR) digitization on firm-level labour productivity in Ukraine between 2010 and 2024. By developing a novel Digital HRM Index and applying a fixed-effects panel regression, the analysis revealed that a one-unit increase in HR digitization intensity raises labour productivity by approximately 3.1% ($p < 0.01$), holding constant innovation capacity, firm size, capital intensity, and training expenditure. These findings confirm that HR digital transformation yields measurable and economically

meaningful productivity gains, reinforcing the argument that digitization represents not merely a technological upgrade but a strategic organizational asset. The results also highlight that firms with higher innovation capacity and capital intensity tend to leverage HR technologies more effectively, suggesting strong complementarities between technological modernization, innovation, and human capital management.

This paper contributes to both theoretical discourse and empirical evidence in the economics of digital transformation and human resource management:

- Theoretical integration: By linking the Resource-Based View (RBV) and Dynamic Capabilities Theory, the study demonstrates that HR digitization enhances firms' internal resource coordination and adaptability, thereby improving productivity.
- Methodological advancement: The construction of a Digital HRM Index provides a replicable framework for measuring HR digital maturity, applicable to other transition economies.
- Empirical originality: The findings offer one of the first causal estimates of HR digitization's impact on productivity in Ukraine, bridging a significant empirical gap in the literature on digital transformation in post-transition contexts.

While the study provides robust causal evidence, several limitations warrant consideration. First, the analysis focuses primarily on productivity outcomes, leaving other dimensions of organizational performance, such as employee well-being, turnover, and wage dynamics, unexplored. Second, potential measurement errors in the Digital HRM Index may exist due to self-reported adoption data. Third, although fixed effects and lagged models mitigate endogeneity, future research could employ instrumental-variable or difference-in-differences techniques for stronger causal inference. Future studies could also:

- Explore sectoral heterogeneity in digital adoption patterns across manufacturing, services, and technology industries;
- Examine the long-term effects of HR digitalization on innovation, job satisfaction, and employee retention;
- Conduct cross-country comparative analyses to identify contextual factors influencing digital transformation outcomes in other transition economies.

Overall, this research demonstrates that HR digitization generates a significant digital dividend for Ukrainian firms by improving operational efficiency and strengthening innovation-driven growth. The 3.1% productivity gain per unit of HR digital adoption underscores the economic relevance of digital transformation policies focused on human capital management. As Ukraine continues its path toward digital modernization and integration into the global digital economy, HR digitization should be viewed not merely as a management reform but as a strategic engine for national productivity and competitiveness. The findings thus offer both empirical validation and practical guidance for advancing digital resilience, inclusive growth, and sustainable economic development.

Credit Authorship Contribution Statement

The authors contributed to this work in various capacities. Vader, T. was responsible for conceptualization, methodology, and writing the original draft. Maidanovych, V. contributed through formal analysis and writing the original draft. Chyzh, L. participated in conceptualization, writing the original draft, data curation, and validation. Khoteyeva, N. contributed to conceptualization, data curation, validation, and writing through review and editing. Kravtsov, O. was involved in conceptualization, methodology, validation, and writing through review and editing.

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Conflict of Interest Statement

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability Statement

All firm-level data used in this study were anonymized to protect confidentiality. The dataset is available from the corresponding author upon reasonable request. No conflicts of interest or external funding influenced data collection or analysis.

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