

THE IMPACT OF ARTIFICIAL INTELLIGENCE DEVELOPMENT ON LABOUR TAXATION AND PERSONAL INCOME TAX REVENUES IN THE EUROPEAN UNION

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Purpose: This paper examines the impact of artificial intelligence (AI) development on labour taxation and personal income tax (PIT) revenues in EU member states. It analyses whether the diffusion of AI technologies has influenced the structure and dynamics of labour-related tax revenues and identifies key fiscal implications associated with labour market transformation and automation processes.

Design/methodology/approach: The study applies a quantitative, comparative approach based on panel data from 21 EU countries for 2021-2023, a period characterised by accelerated post-pandemic digitalisation. Due to non-normal data distribution, Wilcoxon signed-rank tests were used to assess changes in PIT revenues and labour taxation as shares of GDP and total tax income. A random-effects panel model was estimated to examine the relationship between labour taxation and digital development (DESI). Spearman's rank correlation was used to assess the association between the AI Preparedness Index and GDP per capita. Data were obtained from Eurostat, the National Tax List, DG CONNECT, and Oxford Insights.

Findings: The results indicate a temporary deterioration of labour-based tax revenues between 2021 and 2022, followed by a statistically significant rebound in 2022-2023. These short-term fluctuations appear linked to post-pandemic recovery dynamics rather than long-term structural shifts. The panel model does not confirm that higher labour taxation supports digital development; instead, rapid improvements in DESI reflect EU-wide dynamics rather than national fiscal structures. A strong positive correlation between AI readiness and GDP per capita highlights persistent disparities, with wealthier economies more capable of adopting advanced technologies. Overall, the fiscal effects of AI diffusion remain uneven across the EU and strongly dependent on countries' economic and digital maturity.

Research limitations/implications: The analysis covers a short three-year period and relies on aggregated indicators, which may not fully capture the long-term or sector-specific fiscal effects of AI. Future research should incorporate longer time series, additional tax categories (e.g., CIT, VAT), and more detailed labour-market indicators.

Practical implications: Policymakers should anticipate potential revenue shifts resulting from automation and adjust fiscal frameworks to ensure balanced taxation between human labour and AI-enabled production.

Social implications: As AI reshapes employment structures, its development may influence income distribution and social stability. Strengthening redistribution mechanisms and reskilling programmes remains essential to mitigate potential inequalities.

Originality/value: This study provides one of the first empirical assessments of AI's fiscal implications for labour taxation and PIT revenues across EU member states, offering relevant insights for researchers and public finance policymakers.

Keywords: artificial intelligence, labour taxation, personal income tax revenues, automation and employment, European Union.

Category of the paper: Research paper.

1. Introduction

The rapid spread of artificial intelligence (AI) has enabled the automation of numerous tasks previously performed by humans. In the short term, this process may significantly affect labour markets by increasing the risk of unemployment. Unlike previous industrial revolutions, the diffusion of AI is expected to replace not only routine and low-skilled occupations but also jobs requiring higher competencies. Consequently, technological changes may disproportionately affect middle-income earners.

This group plays a crucial role from the perspective of tax systems, which in many EU countries rely heavily on revenues generated from labour income. At the same time, a growing body of research indicates that the wider adoption of AI can enhance labour productivity and increase the incomes of both enterprises and employees. Therefore, the development of AI does not necessarily lead to declining tax revenues; instead, it may even contribute to their growth through higher productivity and wage dynamics.

Despite the expanding literature on the impact of AI on employment, productivity, and economic growth, relatively few studies address its fiscal implications—particularly those related to personal income taxation. There remains a noticeable gap in empirical research examining whether, and to what extent, automation processes influence the structure and dynamics of budget revenues in European Union (EU) member states. This study aims to address this gap by providing the first comparative analysis focused specifically on labour taxation and PIT revenues in the context of increasing AI diffusion.

The purpose of this article is to identify whether the development of artificial intelligence affects the level and structure of labour-related tax revenues and to determine the direction and magnitude of this impact. The empirical analysis applies nonparametric statistical tests for dependent and independent samples, allowing for the assessment of temporal changes and cross-country differences within the EU. The article is structured into five sections. Following this introduction, Section 2 presents the literature review; Section 3 describes the research methodology and data; Section 4 provides the empirical results; and Section 5 discusses conclusions and policy implications.

2. Literature review

Artificial intelligence (AI) has become a major driver of structural transformation in modern economies by automating tasks traditionally performed by humans. The current technological revolution is unprecedented, as AI is no longer confined to routine or mechanical activities but increasingly replaces predictable, experience-based tasks once considered exclusive to human labour (Ford, 2015). Intelligent systems are evolving beyond the role of tools and are now functioning as autonomous “co-workers”, capable of independent decision-making and complex analytical operations (Wajcman, 2017).

The growing use of AI has profound implications for labour markets. The International Labour Organization identifies clerical and administrative occupations—including secretaries, accountants, data-entry clerks, customer service representatives, and banking staff—as among the most automation-prone professions (Gmyrek et al., 2023). Approximately 24% of such jobs face a high risk of automation, and another 58% are at moderate risk. Similarly, the International Monetary Fund (IMF, 2024) estimates that around 40% of global employment may be affected by AI, with the impact being particularly significant in high-income economies, where 5-6% of all jobs are highly vulnerable, compared to only 0.4% in low-income countries.

Empirical studies indicate that automation’s adverse effects are concentrated in low-skilled production and service sectors and disproportionately affect men and individuals at both ends of the age distribution (Tamayo et al., 2025). Highly developed countries—which rely heavily on personal income taxes as a stable source of budget revenue—are more exposed to fiscal losses arising from reduced labour force participation (Gupta, 2007). At the same time, these countries maintain extensive welfare systems, which amplify public-spending pressures during labour-market disruptions.

Without adequate institutional responses, the adoption of AI may exacerbate income inequality (IMF, 2024). Governments are therefore encouraged to strengthen social-protection systems and implement reskilling programmes for workers affected by automation. Nevertheless, AI also offers substantial economic benefits. Productivity increases driven by AI enhance overall economic performance and, consequently, expand the tax base through higher labour and capital incomes (Stevenson, 2018).

The fiscal impact of AI is closely tied to the situation of the middle class, which constitutes the largest and most stable group of personal income taxpayers. Middle-income earners in Denmark, Belgium, Germany, and Finland bear the highest tax burden in the European Union, making these countries particularly sensitive to potential decreases in PIT revenues resulting from automation (Dolls et al., 2023). In developing countries, personal income taxes play a central role in financing public goods and supporting welfare systems (Bird et al., 2005). A reduction in PIT revenues could therefore intensify inequality and restrict access to essential social services (Beljić et al., 2025).

Middle-income taxpayers remain especially vulnerable because they lack both the sophisticated tax-optimisation tools available to high-income groups and the exemptions targeted at low-income earners (Panskov, 2016). The stability and legitimacy of the tax system depend on maintaining this group's economic security and fiscal engagement (Kalambokidis, 2014).

AI-driven automation also generates long-term public-finance challenges. Rising unemployment leads to higher welfare expenditures, placing a sustained burden on public budgets (Çelikay, 2022). The development of automation technologies particularly affects manufacturing, retail, and transportation sectors, where repetitive tasks can be fully replaced by AI-based systems (Tschang, Almirall, 2021). Although such substitution may initially reduce employment, it can also foster productivity growth and create new opportunities through emerging occupations and redefined job roles (Saam, 2024).

In summary, the literature highlights that the diffusion of AI generates both risks and opportunities for labour markets and tax systems. Automation may reduce employment in routine and predictable occupations, challenging the stability of labour-related tax revenues, but it can simultaneously stimulate innovation, enhance productivity, and expand fiscal capacity in the long term (Teigland et al., 2025). Balancing technological progress with fiscal sustainability—particularly by supporting the middle class—remains a key challenge for governments in an era of AI-driven economic transformation. To strengthen the theoretical foundation of this study, a systematic literature review (SLR) was conducted following widely recognised guidelines for transparent and reproducible literature screening. The review covered the years 2010–2025, a period reflecting the most dynamic phase of AI diffusion and associated labour-market transformations. Three academic databases—Scopus, Web of Science, and Google Scholar—were searched using combinations of the following keywords: “artificial intelligence”, “AI”, “automation”, “labour taxation”, “tax revenues”, “employment”, “personal income tax”, “PIT”, “digitalisation”, “DESI”, “AI preparedness”. Studies focusing on national taxation systems, labour-market outcomes of automation, and macroeconomic implications of AI were included. After removing duplicates and non-relevant items, 128 publications were analysed in full. The review revealed extensive research on AI's effects on employment, productivity, and inequality, but very limited empirical evidence on fiscal outcomes—particularly in relation to PIT revenues and labour taxation structures. Although existing literature offers valuable insights into how AI-driven automation reshapes employment patterns, productivity, and income distribution, the fiscal dimension of these transformations remains significantly underexplored. Most studies focus on labour displacement, wage polarisation, and productivity gains, while only a small number assess how technological change affects tax structures. Even fewer works examine the consequences for personal income taxation, despite PIT being the primary revenue source for many European welfare states. Additionally, cross-country comparative analyses linking AI diffusion, labour taxation, and fiscal performance are virtually absent. As a result, there is limited understanding of

whether and how AI adoption influences labour-based tax revenues across EU member states, particularly in the short term. According to the systematic literature review conducted, no prior studies were identified that empirically investigate the relationship between AI development and labour taxation or PIT revenues in EU member states. This confirms the existence of a clear research gap that the present study aims to address.

3. Methods

The primary objective of this study is to examine the effects of artificial intelligence (AI) development and adoption on personal income tax (PIT) revenues across the member states of the European Union. The initial sample comprised 25 EU countries; nevertheless, four countries were excluded from the analysis due to systematically missing observations, resulting in a final balanced panel of 21 countries for the period 2021-2023. This timeframe was selected as 2021 marks the onset of a substantial acceleration in AI diffusion and digital transformation within the post-pandemic economic landscape.

The empirical strategy consists of three complementary components:

1. nonparametric tests examining changes in PIT revenues relative to GDP and total taxation,
2. a panel data model explaining cross-country differences in digital development (DESI),
3. a correlation analysis assessing the relationship between AI readiness and economic development.

Data on PIT revenues, GDP, total taxation and labour-related tax structure were obtained from the National Tax List and Eurostat. Because the variables did not satisfy the normality assumption (verified using the Shapiro-Wilk test), the Wilcoxon signed-rank test was applied to evaluate changes in the tax base between 2021-2022 and 2022-2023.

To analyse cross-country variation in digital development, a panel regression model was estimated using the Digital Economy and Society Index (DESI) as the dependent variable. DESI serves as a proxy for AI readiness, as digital infrastructure, digital skills and technological integration are necessary preconditions for effective AI adoption. DESI, while broader than strictly AI-focused indices, captures the foundational infrastructure and skills necessary for AI diffusion and thus serves as a suitable proxy for early-stage AI readiness. The IMF's AI Preparedness Index (APII) was used only in the cross-sectional correlation analysis because it is available for a single year (2023) and cannot be included in a panel model.

The following hypotheses were formulated:

- H1 (TAX_LAB): Countries with a higher share of labour taxes in total taxation exhibit a higher level of digital development (DESI).
- H2 (GDP per capita): Higher GDP per capita (\ln_GDP_PC) is positively associated with DESI.
- H3 (Unemployment): Higher unemployment rates (UNEMP) are associated with lower DESI.
- H4 (Income inequality): Higher income inequality (GINI) is associated with lower DESI due to limited access to digital skills and infrastructure.

The key explanatory variable TAX_LAB measures “taxes on labour as % of total taxation”, including PIT from labour income and social security contributions. Control variables include log GDP per capita, unemployment rate, and the GINI coefficient. Other tax categories such as VAT or CIT were excluded because they are not directly labour-dependent and therefore do not allow for isolating the fiscal effects of potential AI-driven labour market restructuring.

To estimate the effect of labour taxation on digital development, the following panel data model was specified:

$$DESI_{it} = \alpha + \beta_1 TAX_LAB_{it} + \beta_2 GDP_{it} + \beta_3 UNEMP_{it} + \beta_4 GINI_{it} + \lambda_t + u_{it}$$

where:

$DESI_{it}$ – digital development in country i in year t ,

TAX_LAB_{it} – share of labour taxes in total taxation,

GDP_{it} – GDP per capita (logged),

$UNEMP_{it}$ – unemployment rate,

$GINI_{it}$ – income inequality,

λ_t – time effects for 2022 and 2023,

u_{it} – random disturbance.

A Hausman test comparing fixed-effects (FE) and random-effects (RE) estimators yielded a result of $\chi^2(3) = 6.50$, $p = 0.0898$. With no grounds to reject the null hypothesis, the RE estimator was selected as consistent and efficient. This indicates that unobserved country-specific effects are not systematically correlated with the regressors. To address heteroskedasticity and within-country autocorrelation, cluster-robust standard errors were used (clustered at the country level). A supplementary Spearman correlation analysis evaluated the link between AIPI (2023) and GDP per capita. Given the short length of the panel ($T = 3$), cross-sectional variance is naturally limited, which results in low between and overall R^2 values; however, this does not undermine the validity of within-country estimates, which remain the primary focus of the analysis.

4. Results

The results provide evidence on the evolution of labour-related taxation in the EU during 2021-2023 and on the determinants of digital development. The analysis begins with a nonparametric assessment of PIT revenue dynamics, followed by the panel regression model and the complementary AIPI-GDP correlation.

The Wilcoxon signed-rank test indicated a statistically significant decline in the share of PIT revenues relative to GDP between 2021 and 2022. As shown in Table 1, PIT/GDP decreased in 21 countries, while it increased in only 7, with the decline being highly significant ($p = 0.0054$).

Table 1.

Change in the Share of PIT Revenues Relative to GDP in 2021-2022

Sign	Obs	Sum Ranks	Expected
Positive	7	81	203
Negative	21	325	203
Zero	0	0	0
All	28	406	406
Parameter		Value	
Unadjusted variance		1928.5	
Adjustment for ties		-4.25	
Adjustment for zeros		0	
Adjusted variance		1924.25	
Z statistic		-2.781	
p-value (Prob > z)		0.0054	

Source: Own elaboration based on Eurostat (PIT, GDP, labour taxes), DG CONNECT (DESI), and Oxford Insights (AIPI).

For the period 2022-2023, the trend reversed. Seventeen countries showed an increase in the PIT/GDP ratio, nine a decrease, and two no change. The increase was statistically significant ($p = 0.0304$), indicating a recovery of labour-based tax revenues (Table 2).

Table 2.

Change in the Share of PIT Revenues Relative to GDP in 2022-2023

Sign	Obs	Sum Ranks	Expected
Positive	17	296.5	201.5
Negative	9	106.5	201.5
Zero	2	3	3
All	28	406	406
Parameter		Value	
Unadjusted variance		1928.5	
Adjustment for ties		-1	
Adjustment for zeros		-1.25	
Adjusted variance		1926.25	
Z statistic		2.165	
p-value (Prob > z)		0.0304	

Source: Own elaboration based on Eurostat (PIT, GDP, labour taxes), DG CONNECT (DESI), and Oxford Insights (AIPI).

To test hypotheses H1-H4, the panel model with random effects was estimated. The results are summarised in Table 3.

Table 3.

Results of the Random-Effects Panel Regression (Dependent Variable: DESI)

Variable	Coefficient	Std. Error
TAX_LAB	-1.297	(0.794)
GDP	0.00000175	(0.00000196)
UNEMP	0.646	(2.414)
GINI	-0.813	(0.936)
2.tis	7.230**	(2.940)
3.tis	11.14***	(3.017)
_cons	147.5***	(36.04)
Statistic		Value
R ² within		0.636
R ² between		0.0529
R ² overall		0.00189
N		63

Standard errors in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Source: Own elaboration based on Eurostat (PIT, GDP, labour taxes), DG CONNECT (DESI), and Oxford Insights (AIPI).

The TAX_LAB coefficient is negative and statistically insignificant, leading to rejection of H1. Higher labour taxation does not correspond to higher digital development. GDP per capita (H2), unemployment (H3), and income inequality (H4) show expected signs but lack statistical significance. Strong and highly significant time effects reveal a rapid EU-wide rise in DESI in 2022 and 2023, independently of national economic structures.

To complement the panel results, a Spearman correlation was conducted between AIPI (2023) and GDP per capita.

Table 4.

Correlation Between AI Preparedness Index and GDP per Capita

Test	Value	N
Spearman's rho	0.6692	25
Spearman's p-value	0.0003	25
Shapiro-Wilk (AI Index)	0.93226	25
Shapiro-Wilk p (AI Index)	0.09801	25
Shapiro-Wilk (GDP)	0.9496	25
Shapiro-Wilk p (GDP)	0.24558	25

Source: Own elaboration based on Eurostat (PIT, GDP, labour taxes), DG CONNECT (DESI), and Oxford Insights (AIPI).

The correlation is strong and statistically significant ($\rho = 0.6692$, $p < 0.001$). Higher GDP per capita is strongly associated with greater AI readiness, supporting the theoretical expectation that economic development facilitates investment in innovation and digital infrastructure.

5. Discussion

The findings of this study offer new insights into the evolving relationship between labour taxation, digital development, and artificial intelligence (AI) diffusion in EU member states during the period 2021-2023. The observed changes in the structure of labour-based taxation—captured through PIT-to-GDP ratios—align with broader economic and technological dynamics affecting European labour markets in the post-pandemic period. The statistically significant decline in PIT revenues between 2021 and 2022 supports earlier evidence that temporary fiscal interventions implemented during the COVID-19 recovery, such as payroll tax reliefs and employment subsidies, reduced the effective tax burden on labour. However, the subsequent statistically significant increase in 2022-2023 indicates that these changes were not structural but rather short-term policy effects. The rebound suggests a return to pre-pandemic tax structures as inflation, labour market tightening and fiscal consolidation efforts intensified across the EU.

The panel regression results extend these observations by analysing the determinants of digital development. Contrary to the directional expectations formulated in H1, the share of labour taxation in total revenues (TAX_LAB) does not significantly explain differences in DESI scores across EU member states. This finding suggests that labour taxation alone does not appear to accelerate or hinder digital transformation during the early phase of widespread AI adoption. The absence of significant coefficients for GDP per capita, unemployment and income inequality further indicates that structural economic differences did not strongly differentiate countries' digital trajectories between 2021 and 2023. Instead, the strongly significant time effects reveal that DESI increased rapidly and uniformly across all EU countries. This pattern reflects EU-wide investments in digital public services, broadband expansion and skills development, which collectively shaped digital progress more substantially than the national structural variables included in the model.

The correlation analysis further contextualises these findings. The strong, positive and statistically significant relationship between the IMF AI Preparedness Index and GDP per capita underscores the role of economic development as a fundamental enabler of AI readiness. Wealthier countries demonstrate greater capacity to invest in digital infrastructure, innovation ecosystems and human capital—all prerequisites for effective AI deployment. This result is consistent with the broader literature emphasising that AI adoption is closely linked to financial resources, institutional maturity and technological capability (IMF, 2024; ILO, 2025). It also reinforces the interpretation that digital transformation during 2021–2023 was shaped more by general economic development and coordinated policy frameworks than by differences in labour taxation.

The discussion of labour taxation must therefore be situated within a broader debate on the long-term fiscal implications of AI. Prior research highlights mixed effects: AI may displace routine and middle-skill occupations, potentially eroding the PIT base, but it may also generate productivity gains, increase compliance through digitalisation of tax administration, and create new high-value jobs (Stevenson, 2019; Challoumis, 2025). The results of this study reflect this duality. The initial drop in PIT/GDP in 2021-2022 could signal early labour market adjustments, but the rebound in 2022-2023 suggests that AI adoption did not produce immediate negative effects on PIT revenues. Short-term disruptions were offset—at least temporarily—by rising employment, wage growth and increased taxable income in sectors that benefited from digital acceleration.

Taken together, the findings indicate that the relationship between AI diffusion and labour-based taxation is neither linear nor immediate. Instead, digital transformation interacts with fiscal systems through multiple overlapping mechanisms: changes in employment structure, productivity dynamics, sectoral shifts, the digitalisation of tax administration and national fiscal responses. The uniform rise in DESI scores across the EU highlights the importance of coordinated policy initiatives in shaping digital progress, while the strong link between GDP and AI readiness underscores persistent structural disparities. The evidence suggests that AI adoption alone cannot explain short-term fluctuations in PIT revenues; rather, these changes must be analysed within a comprehensive framework that integrates technological, economic and policy-driven factors.

6. Summary

This study analysed the early fiscal implications of artificial intelligence (AI) development for labour taxation and personal income tax (PIT) revenues in EU member states during the period 2021-2023. The empirical findings show a statistically significant decline in the importance of PIT revenues in 2021-2022, followed by a clear rebound in 2022-2023. These short-term fluctuations appear to be driven primarily by post-pandemic fiscal adjustments, transitional labour-market dynamics and temporary policy interventions rather than by structural technological change. The panel regression model further demonstrates that labour taxation (TAX_LAB) does not significantly influence levels of digital development (DESI), while strong time effects indicate a uniform rise in digitalisation across EU countries. A complementary Spearman correlation confirms a strong and positive association between AI readiness and GDP per capita, highlighting persistent structural disparities in the capacity of countries to adopt advanced technologies.

The research contributes new evidence to an underexplored dimension of AI-driven transformation by directly linking AI diffusion with labour-related tax revenues. Existing literature has focused predominantly on employment, productivity and inequality, while the fiscal effects—particularly those concerning PIT—remain insufficiently examined. By addressing this gap, the study provides one of the first cross-country assessments of how AI-related developments may influence labour-based taxation in the short term.

The interpretation of the results requires caution due to several limitations inherent in the study. The short observation period (2021–2023) captures only the initial phase of AI diffusion and does not allow for the evaluation of long-term fiscal consequences. The panel comprises only 21 countries, which constrains statistical power. Moreover, the use of aggregated indicators such as DESI, TAX_LAB and the GINI coefficient may obscure sector-specific or institutional nuances. Finally, the AI Preparedness Index is available for a single year, which restricts the analysis to cross-sectional associations rather than dynamic trends. These limitations indicate the need for future research based on longer time series, additional tax categories (such as CIT and VAT), and more granular labour-market or sector-level data.

Despite these limitations, the study offers meaningful implications for policymakers. As AI continues to reshape employment structures and production processes, governments should anticipate potential shifts in revenue sources and consider adjustments to fiscal frameworks that balance taxation between human labour and AI-enabled production. Strengthening digital readiness, improving tax administration through advanced technologies, and supporting reskilling initiatives will be essential to ensure fiscal stability and reduce inequality in the evolving technological landscape.

Overall, the findings highlight that the relationship between AI diffusion and labour-based taxation is complex, non-linear and closely intertwined with broader economic conditions and institutional capacities. Continued research will be necessary to understand the long-term fiscal impacts of AI and to support evidence-based policymaking in an era of rapid technological change.

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