Exploring the Potential of Artificial Intelligence in Transforming Tax Administration: Some Evidence from Central and Eastern Europe

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Abstract:

Abstract: The emergence of artificial intelligence within tax administrations is anticipated to be a catalyst for significant improvements in the efficiency and effectiveness of tax systems. Therefore, the paper aims to examine the transformational potential of artificial intelligence to enhance tax administration efficiency and quality, with a focus on its implications for Central and Eastern Europe. Based on data from 2022 for 27 countries from the European Union examined through analytical (compilation) and empirical (t-test) methods, the results show the following. Artificial intelligence has been widely integrated into tax administration processes across approximately 70% of EU countries, indicating its strategic importance in improving the efficiency and accuracy of tax systems. Primarily utilized in risk assessment processes, artificial intelligence assists in analyzing large datasets to detect irregularities and prioritize audits. While less prevalent, applications such as nudging, social network analysis, and taxpayer assistance are gradually gaining traction. However, there is a notable lag in artificial intelligence adoption in Central and Eastern European countries, highlighting regional disparities in technological uptake. Specific artificial intelligence applications vary widely, including risk management, nudging tools, social network analysis, and taxpayer assistance, each demonstrating unique impacts on tax administration effectiveness measured through tax revenue and the shadow economy. Notably, artificial intelligence-driven risk management and web scraping show significant improvements in tax compliance and revenue collection, while the effectiveness of other applications varies depending on their specific goals and contexts. Overall, the findings provide empirically supported evidence of the potential of artificial intelligence in transforming tax administration, potentially aiding Central and Eastern European countries in adopting best practices and anticipating future trends in tax administration in the digital age.

Keywords: Artificial intelligence, tax administration, tax revenue, shadow economy, Central and Eastern Europe

1 Introduction

The emergence of artificial intelligence, with its rapid advancements in recent years, has the potential to transform tax administration, particularly in terms of improving its operation (Saba & Monkam, 2024). Artificial intelligence comprises a spectrum of technologies and applications that simulate human intelligence and execute tasks autonomously. Accordingly, its potential benefits in areas such as automation, data analysis, and decision-making make it a powerful tool for enhancing effectiveness and efficiency for its users (Aristovnik et al., 2023; Makridakis, 2017; Murko et al., 2024). In the context of tax administration, artificial intelligence can speed up the processing of tax returns and error identification, as well as facilitate the handling of routine inquiries, consequently leading to increased compliance and reduced backlogs in tax offices. Moreover, artificial intelligence can facilitate the detection of patterns and anomalies that may suggest fraud or non-compliance by analyzing tax returns, financial statements, and other relevant data. Using artificial intelligence to automate routine tasks such as processing forms, answering basic taxpayer inquiries, and managing databases can also reduce administrative costs for tax authorities (Faúndez-Ugalde et al., 2020; Kuznetsova et al., 2023; Saragih et al., 2023). Also, taxpayers, including citizens and businesses, can benefit from artificial intelligence-driven tools, which provide personalized guidance to aid in their comprehension of complex tax laws and obligations, and consequently simplify tax planning, reduce errors, and automate reporting, ultimately saving time and resources for taxpayers, thereby enhancing taxpayer satisfaction and compliance (Kamil, 2022; Saba & Monkam, 2024; Serrano Antón, 2021).

Given the numerous benefits of artificial intelligence in tax administration, it has the potential to increase the effectiveness and efficiency of tax collection and create an environment conducive to economic growth by limiting the shadow economy. Namely, artificial intelligence-driven tax administration and insights into taxpayer behaviour may foster a stable and growth-oriented fiscal environment with the potential for high tax revenues and a limited shadow economy. These capabilities of artificial intelligence could effectively narrow the divide between tax revenue collection and the shadow economy, thus positioning artificial intelligence as a mediator in the relationship between tax revenue and the shadow economy (Gorshkova et al., 2022). The efficient and effective tax collection mechanisms are crucial for economies, as tax revenue plays a pivotal role in fiscal systems, constituting a substantial portion of government revenue (Cottarelli & Schaechter, 2010). Moreover, actions aimed at boosting tax revenues can also be helpful in reducing the shadow economy. However, several countries in the European Union (EU) often face challenges with low automation of processes, organizational structure, and operational performance (Kelmanson et al., 2019). Accordingly, greater digital adoption in tax administration may provide a solution to these challenges. This can be especially beneficial for Central and Eastern European (CEE) countries, which usually face lower tax revenues and higher rates of the shadow economy compared to other more developed EU countries (Navickas et al., 2019).

In the literature, it is established that greater adoption of digital technologies in tax administration improves tax collection and consequently increases tax revenue in EU countries (Nose & Mengistu, 2023; Zídková et al., 2024). Moreover, it is also established that digitalization reduces tax evasion and leads to a reduction in the size of the shadow economy, particularly in the EU transition countries, where this problem is more pronounced (Remeikienė et al., 2022). Therefore, dynamic technological advancements, including artificial intelligence, can empower tax agency personnel and modernize tax services, serving as the primary catalyst for driving digital transformation in tax administration (Saba & Monkam, 2024). However, despite some general attempts to examine the potential of artificial intelligence in tax administration (Saba & Monkam, 2024; Saragih et al., 2023; Raikov, 2021; Serrano Antón, 2021; Shakil & Tasnia, 2022), there is a lack of empirical evidence on specific applications of artificial intelligence in tax administration. This is presumably attributed to the exponential development of artificial intelligence, coupled with the scarcity of reliable data on its utilization in tax administrations across EU countries, reflecting the fact that the adoption of artificial intelligence in tax administration is still in its experimental stages (OECD, 2023). Therefore, the paper aims to address the gap in the literature by understanding the situation through the perspective of early adopting EU countries and highlighting the important role of artificial intelligence in driving forward a tax administration that is more effective and efficient. Given that tax administrations across the EU are presently at various stages of artificial intelligence implementation, the paper aims to unveil the current state of artificial intelligence and assess its potential to enhance tax administration efficiency and effectiveness, with particular implications for CEE countries. More specifically, the paper aims to address the following research questions:

- RQ1: To what extent do tax administrations in EU countries employ artificial intelligence in specific applications?
- RQ2: What are examples of specific applications of artificial intelligence in tax administrations in EU countries?
- RQ3: Which specific applications of artificial intelligence affect tax administration effectiveness in EU countries?

By answering these questions, the paper provides some novel, evidence-based insights into the important role of artificial intelligence in transforming tax administration. The remainder of the paper is structured as follows. The next section outlines the materials and methods used in the study, detailing the data collection techniques and analytical procedures employed. The following section presents the main results, providing answers to the research questions. Finally, the last section offers a conclusion, summarizing the main findings and broader implications.

2 Materials and Methods

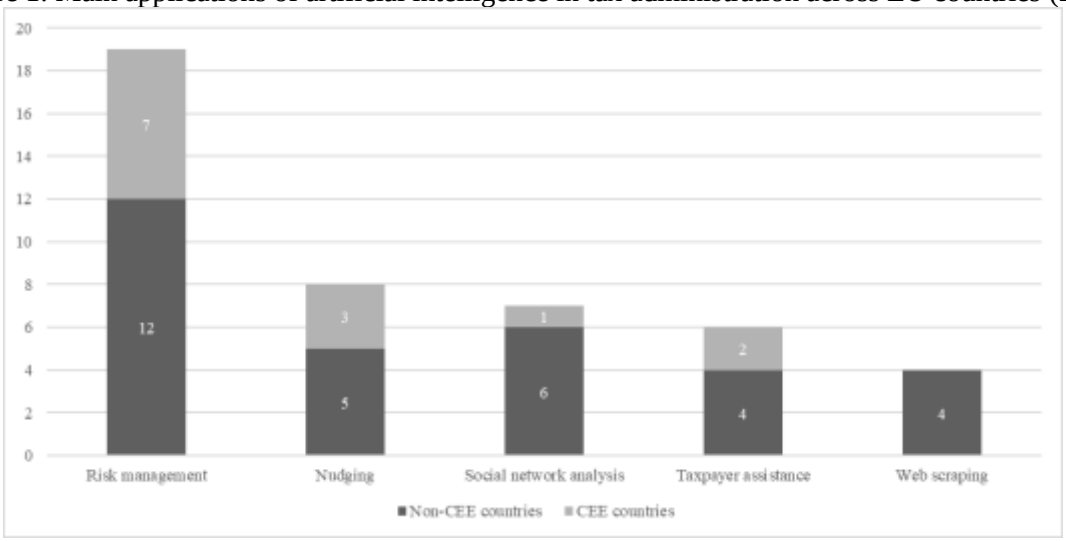
The data for this paper were obtained from several secondary sources. First, the data for artificial intelligence use cases in tax administration were obtained from AI TAXADMIN.EU, an open-access repository of the use cases of artificial intelligence by tax administrations in the EU (Hadwick, 2022). Since the data from this repository is only updated to February 2022, it was supplemented by regularly updated data from Public Sector Tech Watch, which includes a list of use cases for emerging technologies, including artificial intelligence, in public administration (European Commission, 2024). Moreover, additional macroeconomic indicators were obtained to explore the potential of artificial intelligence in transforming tax administration. First, the latest data on tax revenue, measured as the tax-to-GDP ratio for 2022, were obtained from Tax Revenue Statistics (Eurostat, 2024). Second, the estimated data on the shadow economy for 2022, measured as a percentage of GDP, were obtained from Schneider (2022).

Several analytical and empirical methods were applied using the merged dataset. First, based on the descriptions provided by the repositories (AI TAXADMIN.EM and Public Sector Tech Watch), it was possible to identify those EU countries that use artificial intelligence in tax administration, as well as the main specific applications. Based on the identified specific applications, use cases were coded in a manner where a '1' was assigned to countries having a specific application and '0' to those not having a specific application of artificial intelligence in tax administration. This coding facilitated further empirical considerations, such as descriptive statistics, which helped identify the extent to which tax administrations in EU countries employ artificial intelligence in specific applications. Second, based on the descriptions provided by the repositories, a compilation of main use cases was made to present examples of specific applications of artificial intelligence in tax administrations across EU countries. Finally, based on the coded data of artificial intelligence use cases, along with approximations of tax administration effectiveness (data on the tax-to-GDP ratio and estimations of the shadow economy), a comparison was made between countries using specific applications and those that do not. Accordingly, an independent samples t-test was performed to identify differences in mean values. This parametric statistical technique is considered very robust and is the most commonly used method for detecting differences in mean values between two unrelated groups (Rasch et al., 2007).

3 Results

Drawing on a sample of 27 EU countries, 70% use artificial intelligence in tax administration, suggesting a relatively widespread recognition of the benefits that artificial intelligence can offer in enhancing tax processes within the EU. This widespread adoption is presented in Figure 1, which identifies several different main use cases or specific applications of artificial intelligence within tax administration. Most EU countries use artificial intelligence in risk assessment (70%), which involves leveraging artificial intelligence to analyze large datasets to help identify discrepancies, potential fraud, and other irregularities, thereby aiding tax authorities in prioritizing and streamlining audits, which not only enhances the efficiency of the process but also potentially increases the accuracy of targeting tax evasion (Braun Binder, 2020). Moreover, artificial intelligence is less used in nudging (sending tailored messages and reminders to taxpayers) (30%), social network analysis (scrutinizing data patterns within the social and business networks of taxpayers) (26%), and taxpayer assistance (providing real-time help to taxpayers through chatbots and automated response systems) (22%). Finally, only 15% of EU countries use artificial intelligence in web scraping (extracting data from public and private websites to identify undeclared economic activities). However, due to the exponential development of artificial intelligence, particularly the recent emergence of generative artificial intelligence and large language models, these tools are expected to undergo significant acceleration, becoming increasingly important in the context of tax administration (Ugale & Hall, 2024). Notably, CEE countries lag behind in all these applications, especially in web scraping, with no tax administrations from CEE countries observed using artificial intelligence for this purpose. This suggests a regional disparity in the adoption of artificial intelligence in tax administration, with this lag potentially attributed to varying levels of technological advancement, budgetary constraints, or policy priorities within CEE countries (Aristovnik et al., 2024; OECD, 2023).

Figure 1: Main applications of artificial intelligence in tax administration across EU countries (2022)



Source: Authors' elaboration based on secondary data.

The relatively lower usage rates of artificial intelligence in nudging, social network analysis, taxpayer assistance, and especially web scraping, compared to applications like risk assessment, may be due to several factors. The first is the complexity and specific requirements; these applications often require sophisticated algorithms capable of interpreting complex human behaviours, and the challenges of designing, implementing, and maintaining such systems can deter their widespread adoption (Korteling et al., 2021). The second factor involves privacy and ethical concerns; the processing of potentially sensitive personal and business data in social network analysis and web scraping can raise significant issues, leading to stricter regulations and hesitancy among tax authorities (Munoko et al., 2020). The third factor is public acceptance and trust; applications that directly interact with the public, such as nudging and taxpayer assistance, depend on a high level of public trust, and concerns over automated systems handling sensitive tax matters could dampen enthusiasm for these technologies (Kaur et al., 2022).

Moreover, a detailed compilation of the main use cases of artificial intelligence in tax administrations across EU countries is presented in Table 1. More specifically, it highlights the adoption of artificial intelligence across CEE and non-CEE countries, with references to each EU country that uses artificial intelligence in tax administration. Notably, both regions utilize artificial intelligence for risk management, nudging, social network analysis, and taxpayer assistance for similar purposes. However, a stark contrast is observed in the use of web scraping: it is prevalent in non-CEE countries for gathering taxpayer data from various online sources, while CEE countries do not report any use of this technology. The results also reveal that there are some CEE countries (Bulgaria, Croatia, Czechia, Romania) and non-CEE countries, particularly Mediterranean countries (Cyprus, Greece, Malta, Portugal), that do not use artificial intelligence in tax administration.

Table 1: Compilation of the main use cases of artificial intelligence in tax administrations across EU countries (2022)

Use cases	Non-CEE countries	CEE countries
Risk management	Risk management utilizes artificial intelligence for various tasks. It is primarily used for predictive modeling, anomaly detection, risk scoring, and case prioritization. Artificial intelligence analyzes tax data to identify high-risk cases, detect anomalies, and prioritize investigations based on non-compliance likelihood. This comprehensive approach enhances non-compliance detection and supports targeted audits, optimizing resource allocation to high-risk cases **(Austria, Belgium, France, Germany, Finland, Sweden, Denmark, Netherlands)**. Additionally, artificial intelligence is employed for innovative analysis and pattern detection using algorithms to analyze complex relationships and predict evasion activities **(Spain, Italy)**. It is also used to identify unusual transactions indicating potential fraud, enabling tax authorities to respond swiftly and effectively to signs of tax fraud **(Luxembourg, Ireland)**.	Risk management utilizes artificial intelligence for various tasks. It is primarily used for detecting non-compliance and fraud, helping to uncover and mitigate tax evasion. This involves comprehensive audits and analyzing tax return data to identify anomalies and suspicious activities, thereby supporting targeted audits and optimizing resource allocation to high-risk cases **(Estonia, Lithuania, Poland)**. Additionally, artificial intelligence is employed for risk analysis and prioritization, focusing on high-risk cases to enhance the effectiveness of tax compliance efforts **(Latvia, Slovakia)**. It is also used for compliance monitoring and efficiency, improving the accuracy of tax assessments and streamlining compliance checks to ensure a thorough examination of tax submissions. This use of artificial intelligence helps prevent tax evasion and ensures a higher degree of compliance through meticulous data analysis **(Hungary, Slovenia)**.
Nudging	Nudging tools adapt the language based on predicted risk factors and historical taxpayer data **(Austria, Belgium)**. In some cases, they target specific demographics, such as recently divorced individuals who have been identified as particularly prone to tax non-compliance **(Netherlands)**. In some countries, nudging tools are in the experimental phase **(Denmark, Germany)**.	Nudging tools adapt the language of standard communications to taxpayers by profiling historical data, subtly encouraging compliance without resorting to coercive enforcement methods. They aim to gently influence taxpayer behaviour towards timely and accurate compliance, which is mostly in the experimental phase **(Hungary, Poland, Slovenia)**.
Social network analysis	Social network analysis uses graph theory to visually represent a network of individual taxpayers, depicting them as nodes for individuals or points of interest. These nodes are connected by lines that measure the quantitative and qualitative relationships between them **(Belgium, France, Ireland, Netherlands, Sweden)**. In some cases, it can identify and represent relationships between individual taxpayers in near real-time **(Spain)**.	Social network analysis uses graph theory to visually represent a network of individual taxpayers, depicting them as nodes for individuals or points of interest. These nodes are connected by lines that measure the quantitative and qualitative relationships between them **(Poland)**.
Taxpayer assistance	Taxpayer assistance is facilitated by chatbots, which provide automated guidance to natural persons **(Finland)** and answer questions related to personal taxation and population registration, offering efficient service to individual taxpayers **(Sweden)**. In some cases, chatbots assist legal entities with inquiries about the immediate supply of information, corporate income tax, value-added tax, and e-invoicing **(Spain)**, while in others, they assist both legal and natural persons **(Germany)**.	Taxpayer assistance is facilitated by chatbots, which answer queries on tax-relevant domains such as business registration, e-filing, annual tax return submission, and eligible expenses **(Latvia)**. In some cases, similar support extends to broader areas, including tax returns, tax documentation, corporate, labour, and personal tax burdens, as well as value-added tax **(Slovakia)**.
Web scraping	Web scraping automatically collects taxpayer data from e-commerce platforms (eBay, Amazon) and e-sharing platforms (AirBnB, LeBonCoin, 2emeMain, Uber) and matches it with the data provided by taxpayers **(Belgium, Netherlands)**. In some cases, social media platforms (Facebook, Instagram, LinkedIn) are also included, with the data required to be openly accessible and not necessitating the creation of an account, a password, or registration on the platform from which the data is collected **(France)**. There are also cases where web scraping extends to gambling websites, the deep web, and specific websites at the request of the authorities **(Sweden)**.	No cases.

Source: Authors' elaboration based on secondary data.

Finally, the specific applications of artificial intelligence in tax administration that have been identified are further used as grouping variables in independent samples t-test to determine their potential effect on the effectiveness of tax administration in EU countries by considering tax revenue and the shadow economy. Both indicators are useful for assessing aspects of tax administration effectiveness, but in different ways. Namely, tax revenue directly quantifies the success of the administration in fulfilling its primary function, i.e., collecting taxes, while the shadow economy provides a broader, more circumstantial view of how well the tax system is managed. The sample of 27 EU countries covers 11 CEE countries and 16 non-CEE countries. In 2022, CEE countries had an average tax-to-GDP ratio of 33.67%, ranging from the lowest in Romania at 27.48% to the highest in Slovenia at 37.83%. Additionally, the average shadow economy as a percentage of GDP was 22.98%, which varied from the lowest in Slovakia at 13.06% to the highest in Bulgaria at 33.05%. Meanwhile, non-CEE countries had an average tax-to-GDP ratio of 39.77%, ranging from the lowest in Ireland at 21.72% to the highest in France at 47.95%. Additionally, the average shadow economy as a percentage of GDP is 14.01%, which varied from the lowest in Austria at 7.05% to the highest in Cyprus at 23.90%.

The differences in tax revenue and shadow economy between EU countries using artificial intelligence in specific applications and those that do not are revealed in Table 2 and graphically presented in Figures 2 and 3. In general, the descriptive overview reveals that EU countries employing artificial intelligence in tax administration achieve higher tax revenue and lower shadow economy compared to those that do not use it. In order to empirically verify whether these differences are statistically significant, an independent samples t-test was performed, preceded by Levene's test to check whether the assumption of equal variances applies (Zimmerman, 2004). Based on the p-value of Levene's test, it may be concluded that the variance in most cases (except for the cases of shadow economy in social network analysis, taxpayer assistance, and web scraping) is not significantly different between EU countries using artificial intelligence in specific applications and those that do not. Therefore, the corresponding version of the t-test was used. Since it is anticipated that the use of artificial intelligence will improve tax administration effectiveness in terms of higher tax revenue and a smaller shadow economy, a one-sided p-value is considered when making judgments about the significance of differences in the t-test for equality of means (Ludbrook, 2013). Although conclusions about causality cannot be made due to the existence of potential confounders (Wright, 2006), the results may highlight which specific applications of artificial intelligence affect the effectiveness of tax administration in EU countries from the perspectives of tax revenue and the shadow economy.

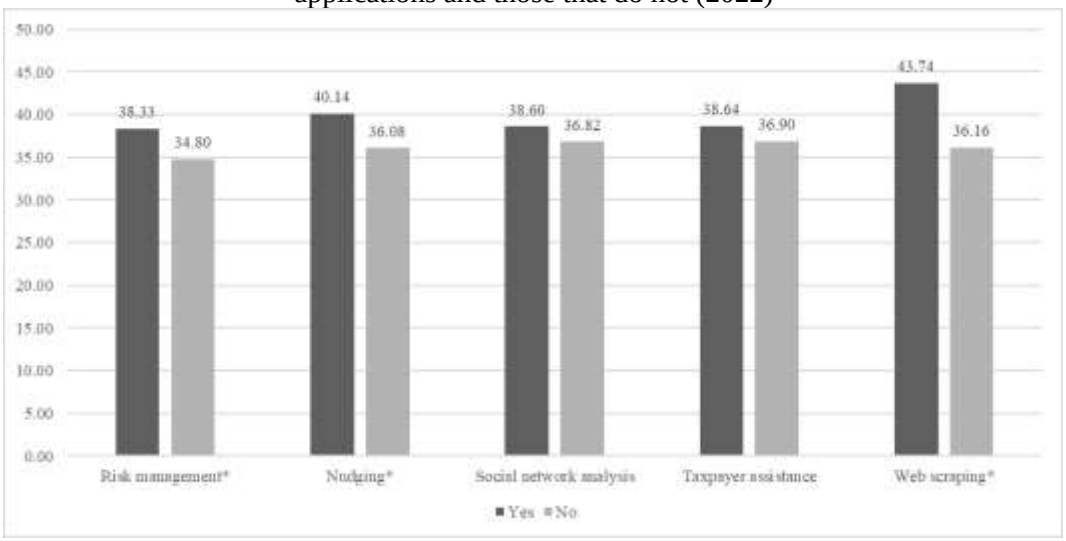
Table 2: The results of Levene's test for equality of variances and t-test for equality of means (2022)

Application	F	p	Mean Diff.	t	One-sided p
Risk-management					
Tax revenue	0.270	0.608	3.525	1.409	0.086*
Shadow economy	0.000	0.982	-8.501	-3.211	0.002*
Nudging					
Tax revenue	1.595	0.218	4.052	1.641	0.057*
Shadow economy	0.097	0.758	-3.915	-1.285	0.105
Social network analysis					
Tax revenue	1.063	0.312	1.779	0.663	0.257
Shadow economy	3.449	0.075*	-5.119	-2.085	0.026*
Taxpayer assistance					
Tax revenue	0.336	0.567	1.737	0.613	0.273
Shadow economy	4.136	0.053*	-5.724	-2.437	0.013*
Web-scraping					
Tax revenue	0.636	0.433	7.574	2.544	0.009*
Shadow economy	3.572	0.070*	-6.277	-2.686	0.013*

Note: An asterisk (*) indicates statistical significance at $p < 0.1$.
Source: Authors' elaboration based on secondary data.

The comparison of means of tax revenue between EU countries using artificial intelligence in specific applications and those that do not (Figure 2) reveals significant differences for the case of web scraping (diff = 7.754 p.p.), nudging (diff = 4.052 p.p.), and risk management (diff = 3.525 p.p.). This implies that EU countries that use artificial intelligence in these applications, on average, achieve a higher tax-to-GDP ratio compared to those countries that do not use artificial intelligence for these purposes. However, the differences in the remaining specific applications, such as social network analysis and taxpayer assistance, are not significant. These results highlight that the effectiveness of tax administration in achieving higher tax revenue can plausibly vary depending on the specific application of artificial intelligence employed. While artificial intelligence tools designed for web scraping, nudging, and risk management have demonstrated clear benefits in enhancing tax revenues, applications such as social network analysis and taxpayer assistance have yet to show a measurable impact on tax revenue outcomes.

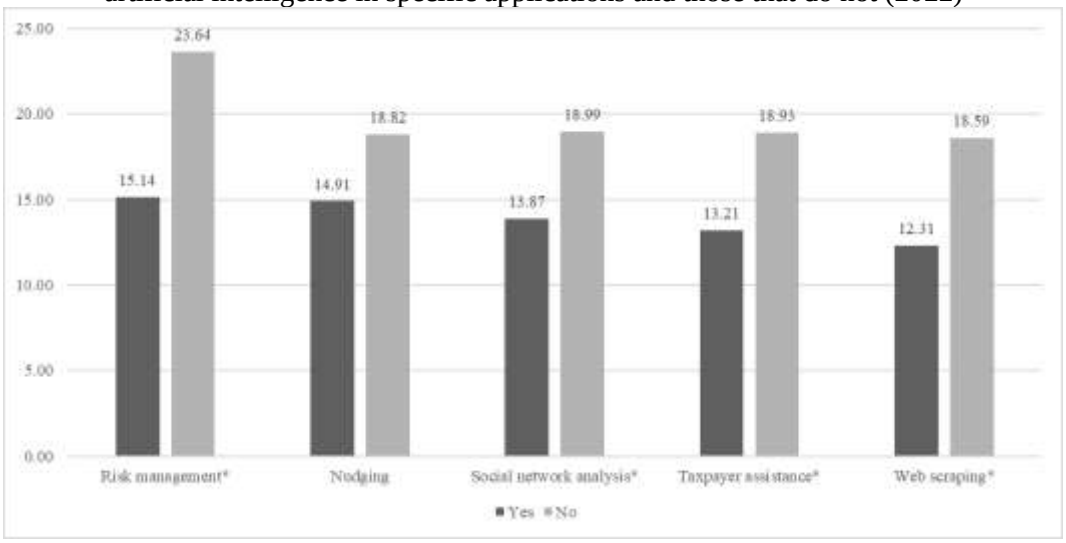
Figure 2: Differences in tax revenue between EU countries using artificial intelligence in specific applications and those that do not (2022)



Note: An asterisk (*) indicates statistical significance at $p < 0.1$.
Source: Authors' elaboration based on secondary data.

Moreover, the comparison of means of shadow economy sizes between EU countries using artificial intelligence in specific applications and those that do not (Figure 3) reveals significant differences for risk management (diff = -8.501 p.p.), web scraping (diff = -6.277 p.p.), taxpayer assistance (diff = -5.724 p.p.), and social network analysis (diff = -5.119 p.p.). This implies that EU countries using artificial intelligence in these applications, on average, achieve a lower share of the shadow economy as a percentage of GDP compared to those that do not use artificial intelligence for these purposes. However, the difference in the application of nudging is not significant. These results highlight that the effectiveness of tax administration in achieving a lower shadow economy can plausibly vary depending on the specific application of artificial intelligence employed. While artificial intelligence tools in most specific applications have demonstrated clear benefits in reducing the shadow economy, applications such as social network analysis have yet to show a measurable impact on shadow economy outcomes.

Figure 2: Differences in shadow economy as a percentage of GDP between EU countries using artificial intelligence in specific applications and those that do not (2022)



Note: An asterisk (*) indicates statistical significance at $p < 0.1$.
Source: Authors' elaboration based on secondary data.

To summarize, a comprehensive comparison of the effectiveness of specific artificial intelligence applications in tax administration across EU countries reveals that both risk management and web scraping have plausibly proven effective in enhancing tax revenue and reducing the shadow economy, whereas nudging has shown plausible effectiveness solely in improving tax revenue, and applications such as social network analysis and taxpayer assistance have demonstrated plausible impacts exclusively on reducing the shadow economy. In examining the effectiveness of specific artificial intelligence applications in tax administration across EU countries, it becomes evident that each application serves distinct aspects of tax administration. Risk management and web scraping have been notably effective in both enhancing tax revenue and curtailing the shadow economy by using artificial intelligence to identify patterns indicative of fraud and gathering data on undeclared activities. In contrast, nudging has predominantly improved tax revenue through behavioural techniques that encourage compliance without directly impacting the shadow economy. Meanwhile, applications like social network analysis and taxpayer assistance are particularly adept at addressing the shadow economy by uncovering covert networks and facilitating compliance through educational resources, respectively. This differentiation in effectiveness highlights the tailored utility of artificial intelligence applications in addressing specific challenges within tax administration. These findings build on previous research demonstrating that the integration of digital technologies in tax administration not only improves tax collection and increases tax revenue (Nose & Mengistu, 2023; Zídková et al., 2024) but also plays a crucial role in curbing tax evasion and reducing the extent of the shadow economy (Remeikienė et al., 2022). Consequently, ongoing technological advancements, including the use of artificial intelligence, enhance the capabilities of tax agency personnel and modernize tax services, thereby acting as key drivers in the digital transformation of tax administration (Saba & Monkam, 2024).

4 Conclusion

The integration of artificial intelligence into tax administration is heralded as a transformative advancement with significant implications for efficiency and compliance, and consequently, better tax revenue collection and reduction of the shadow economy across EU countries. Accordingly, this paper explores the extent to which artificial intelligence technologies are being adopted within EU tax systems, the specific applications being implemented, and their impact on the efficiency and effectiveness of tax administration. As technological adoption varies across regions, especially between CEE countries and their more developed and mostly Western (non-CEE) counterparts, this analysis

provides crucial insights into the implications of deploying artificial intelligence in tax administration through the perspective of early adopting EU countries.

The results reveal that approximately 70% of EU countries have integrated artificial intelligence into their tax administration processes. This widespread adoption underlines the strategic role artificial intelligence plays in enhancing the efficiency and accuracy of tax systems. Predominantly, artificial intelligence is applied in risk assessment processes where it assists in analyzing large datasets to identify discrepancies, fraud, and other irregularities, thereby aiding tax authorities in prioritizing and streamlining audits (Braun Binder, 2020). While applications such as nudging, social network analysis, and taxpayer assistance are less prevalent, they still represent critical areas where artificial intelligence is gradually making an impact (Korteling et al., 2021). Particularly in CEE countries, however, there is a noticeable lag in the adoption of these technologies, pointing towards regional disparities in technological uptake and application within tax administrations (OECD, 2023).

Moreover, the results show that artificial intelligence has been employed in a variety of specific applications across EU tax administrations, demonstrating its versatility and broad applicability. For example, risk management initiatives leverage artificial intelligence for predictive modeling, anomaly detection, and case prioritization, significantly enhancing the ability of tax authorities to target and mitigate non-compliance risks (Serrano Antón, 2021). Nudging tools utilize artificial intelligence to tailor communications based on behavioural insights, thereby improving taxpayer compliance through subtle behavioural prompts (Kamil, 2022). Social network analysis, implemented in a few countries, uses artificial intelligence to map relationships and interactions among taxpayers, which can be critical in identifying fraud networks (Munoko et al., 2020). Additionally, taxpayer assistance is facilitated via artificial intelligence-driven chatbots that provide real-time, accurate information to taxpayers, thereby improving service delivery and taxpayer satisfaction (Faúndez-Ugalde et al., 2020). Despite their potential, the uneven deployment of these tools, especially in less technologically advanced regions, underscores the need for a strategic focus on capacity building and infrastructure development in adopting artificial intelligence in tax administration.

Finally, the results reveal that specific applications of artificial intelligence have a significant impact on the effectiveness of tax administrations in the EU, notably in terms of enhancing tax revenue and reducing the shadow economy (Saba & Monkam, 2024). Artificial intelligence-driven risk management and web scraping are particularly effective, demonstrating substantial improvements in tax compliance and revenue collection (Zídková et al., 2024). These applications help detect and mitigate tax evasion by analyzing complex data patterns and scraping relevant taxpayer information from various online sources (Shakil & Tasnia, 2022). On the other hand, applications like nudging have been shown to positively influence tax revenue, though their impact on the shadow economy is less pronounced (Nose & Mengistu, 2023). Similarly, while social network analysis and taxpayer assistance are effective in reducing the shadow economy, their influence on tax revenue is not significant (Remeikienė et al., 2022). These findings suggest that while artificial intelligence can dramatically enhance certain aspects of tax administration, its effectiveness varies significantly depending on the application, necessitating a tailored approach to technology deployment based on specific administrative goals and contexts.

At the very least, the limitations of the paper should be noted. Notably, the scarcity of reliable data on the use of artificial intelligence in tax administrations across EU countries and the fact that the adoption of artificial intelligence in this sector is still in its experimental stages significantly constrain the depth and reliability of the findings. The available data may not fully capture the long-term potential or challenges associated with artificial intelligence applications in tax administration. Consequently, the results presented can be seen as preliminary, emphasizing the need for future research to access more robust datasets and examine the evolution of artificial intelligence applications as they mature and become more integrated into tax administration practices. Nevertheless, the findings contribute to existing scientific knowledge by offering empirical evidence of how tax administrations are leveraging the transformative potential of artificial intelligence to enhance efficiency and effectiveness. They also enable tax administrations from CEE countries to learn from identified best practices and to gain a deeper understanding of the future direction of tax administration in the digital age.

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