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INDUSTRIAL GREEN TRANSFORMATION AND LABOR PRODUCTIVITY: EVIDENCE FROM UZBEKISTAN

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Abstract

This paper analyzes how the implementation of green transition initiatives influences labor productivity within the context of Uzbekistan's ongoing environmental and economic reform agenda. Drawing on firm-level data from the 2024 World Bank Enterprise Survey, this study evaluates the influence of energy efficiency measures, CO2 emissions monitoring, and compliance with international environmental standards on productivity outcomes. Anchored in the theoretical framework of the Porter Hypothesis and supported by a robust body of empirical literature, this study applies an Ordinary Least Squares (OLS) regression method to examine the relationship between green management practices and labor productivity at the firm level. Labor productivity - defined as output per employee - serves as the dependent variable, while independent variables include key green transition indicators such as energy management, CO2 emissions monitoring, and adherence to international environmental standards, alongside a range of firm specific control variables. The empirical findings reveal a statistically significant and positive relationship between labor productivity and the implementation of both energy management practices and CO2 monitoring systems. Conversely, the effect of international environmental certifications appears more limited in the Uzbek context. By offering firm-level evidence from a transitional economy, this research contributes to the expanding literature on sustainable economic transformation. It underscores the importance of designing cohesive policy frameworks that align environmental goals with productivity enhancement and labor market efficiency.

Keywords: Green economy; Labor productivity; Energy management; CO2 monitoring; Environmental certifications; Uzbekistan; Green transition; Firm performance; Sustainability; WBES dataset.

1. Introduction

In recent years, Uzbekistan has taken meaningful steps toward building a greener and more sustainable economy. This ongoing transformation commonly referred to as the green transition involves a wide range of reforms designed to reduce environmental damage, improve energy efficiency, support the use of renewable energy, and embed sustainability across key sectors of the economy. The urgency behind these efforts reflects a growing international understanding that long-term development must go hand in hand with environmental responsibility and climate resilience. For Uzbekistan, a country traditionally dependent on natural resources and currently facing serious environmental issues such as water shortages, land degradation, and air pollution, adopting a green growth path is not only a strategic policy choice but also a vital opportunity for sustainable progress. The government of Uzbekistan has introduced several bold policy initiatives to drive this green transition forward. One of the most significant steps was the adoption of the "Green Economy Transition Strategy for 2019–2030",

which established a clear framework for embedding environmental goals into national development plans. Building on this, the Presidential Decree set out a roadmap to expand the use of renewable energy, targeting 25% of electricity generation from renewables by 2030. In 2024, Uzbekistan added 2,787.9 MW of new energy capacity, including major contributions from solar (1,000 MW), wind (800 MW), and thermal (965.2 MW) sources, along with a smaller addition from hydropower (22.7 MW). This highlights the country's continued shift toward a diversified and renewable energy mix. Additionally, green public procurement policies are being implemented to encourage environmentally responsible spending. These reforms have been further supported through strategic partnerships with international organizations like the World Bank and the Asian Development Bank, reinforcing Uzbekistan's commitment to low-carbon and sustainable growth.

Despite these important policy advances, there is still a notable gap in understanding how green reforms translate into firm-level economic performance. In particular, the relationship between green management practices and labor productivity in emerging economies like Uzbekistan remains underexplored. Addressing this gap is crucial for ensuring that sustainability policies are not only environmentally effective but also economically beneficial. By focusing on how initiatives such as energy management, CO2 monitoring, and international environmental certifications relate to productivity, this study offers timely insights into the dual promise of environmental responsibility and economic efficiency. A central debate within the discourse on sustainable development concerns whether firms adopting environmentally responsible practices face competitive disadvantages relative to those that do not, and whether such practices impede their growth prospects. Porter and van der Linde (1995) contend that well-structured environmental regulations can serve as a catalyst for innovation, enabling firms to reduce overall production costs or enhance product value. According to their view, such innovations improve the efficiency with which firms utilize key inputs - including raw materials, energy, and labor thereby enhancing productivity. Expanding on this perspective, Lannelongue and Gonzalez-Benito (2017) highlight the increasing academic focus on the nexus between firm performance and environmental management, suggesting that this relationship has emerged as a prominent theme in contemporary research agendas.

The relevance of this topic is confirmed by previous research, which has revealed a range of both positive and negative views expressed by scholars; these perspectives are presented in the following literature review section of our study. Understanding the relationship between green transition initiatives and labor productivity is therefore of critical importance. On one hand, green investments such as energy-efficient technologies and cleaner production methods may foster innovation, reduce operational inefficiencies, and improve workplace safety, all of which can enhance worker productivity. On the other hand, compliance with new environmental regulations may impose adjustment costs on firms, potentially hindering performance in the short term. This duality raises an essential policy question: Does the shift towards a green economy stimulate or constrain labor productivity in the context of a transitioning economy like Uzbekistan?

The primary aim of this study is to empirically investigate the impact of green transition measures on labor productivity in Uzbekistan, with a particular focus on firm-level dynamics. To achieve this objective, the methodology employs a robust Ordinary Least Squares (OLS) regression model based on micro-level data from the 2024 World Bank Enterprise Survey (WBES). This analytical approach enables the assessment of how specific green practices—such as energy management, CO_2 emissions

monitoring, and the adoption of environmental certifications—affect labor productivity, measured in terms of output per employee. The results section of the study presents compelling empirical evidence on the effectiveness of environmental reforms in enhancing firm-level productivity within the context of Uzbekistan's green transition. To test the robustness and generalizability of the findings, the analysis is also extended to a broader Central Asian sample, incorporating data from four countries: Uzbekistan, Kazakhstan, Kyrgyzstan, and Tajikistan. Drawing on these findings, the conclusion and policy recommendations aim to enrich the academic literature on green growth in Uzbekistan and to provide policymakers with actionable insights into the economic implications of sustainability reforms. The study offers practical guidance on how green strategies can be effectively leveraged to foster inclusive, innovation driven, and sustainable economic development.

2. Literature Review

The transition to a green economy has become an integral part of modern economic policy in the 21st century, fundamentally reshaping how countries approach growth, innovation, and competitiveness. This transformation has significant implications for labor productivity, employment structures, and the overall efficiency of firms. Global research increasingly highlights the economic benefits of green reforms; however, there remains a lack of empirical evidence on how these reforms specifically affect labor productivity particularly in developing and transitioning economies such as Uzbekistan.

This literature review brings together key theoretical approaches and empirical findings to explore how environmental policies and green investments may influence labor productivity. By examining these insights in the context of Uzbekistan's ongoing green transformation, the review aims to identify critical factors that policymakers and business leaders should consider when designing strategies for sustainable economic development.

Environmental policies and green investments are commonly assessed through two contrasting perspectives. According to the traditional view, environmental regulations raise production costs and limit technological flexibility, which can negatively impact productivity, especially in the short term. In contrast, the Porter Hypothesis (1995) argues that well-designed environmental standards can stimulate innovation, leading to more efficient resource use and long term productivity improvements.

In recent years, there has been a growing number of empirical studies attempting to evaluate these competing views, although results vary depending on methodology and regional context. Nevertheless, a consistent trend has emerged showing that labour productivity typically measured as output per worker or per hour worked is sensitive to a range of environmental factors. These include improvements in energy efficiency, the adoption of renewable energy sources, the implementation of environmental management systems, and firms' level of exposure to environmental regulations.

Moreover, a number of scholars emphasize the important role of firm-specific characteristics in determining the impact of green practices. In particular, Lannelongue et al. (2017) and Russo and Fouts (1997) highlight that the benefits of adopting green management practices are closely tied to the quality of human capital within firms. They argue that elements such as workforce capacity and labour productivity are essential in determining how environmental initiatives influence a firm's competitive position. In particular, Russo and Fouts (1997) make a compelling case that well-designed environmental regulations can enhance economic performance by promoting efficiency and driving innovation. Lannelongue et al. (2017) further emphasize that in today's era of globalization and

intensifying industrial competition, labour productivity has emerged as a vital determinant of firm competitiveness and a key indicator of long-term business success.

When it comes to the concepts of environmental performance and workplace culture, they have been interpreted differently by various scholars. For instance, Ma et al. (2020) view environmental management as a set of actions undertaken by companies to enhance their environmental outcomes. In contrast, Sambasivan et al. (2013) define it as the degree to which a firm optimizes its use of resources, minimizes waste, and mitigates environmental risks thus serving as an indicator of how effectively a company lessens its environmental harm. Delmas and Petkovic (2012) highlight that corporate engagement in social and environmental causes tends to boost a company's reputation, which in turn can positively influence employee morale and motivation, ultimately improving productivity. Additionally, employees tend to show greater loyalty and engagement in organizations with strong environmental values, which may foster higher organizational quality through enhanced training and interpersonal collaboration contributing further to labour productivity.

In contrast to the perspectives outlined above, some earlier studies have presented opposing conclusions, suggesting that the implementation of green practices may negatively affect firm performance. For instance, McGuire et al. (1982) observed that environmental regulations might reduce productivity if they adversely impact labour. Similar conflicting views have also been observed in several recent studies. In particular, studies conducted in 2017, 2018, and 2020 reported a negative correlation between firm performance and environmental management practices. Specifically, Lannelongue et al. (2017) found that in capital-intensive firms, environmental management was associated with lower labour productivity. Likewise, Ma et al. (2020), focusing on Chinese listed companies, also identified a negative link between environmental management and labour productivity. However, both studies emphasized that this relationship is not uniform. Lannelongue et al. (2017) noted that firms with lower capital intensity actually experienced a positive effect on productivity from environmental management. Similarly, Ma et al. (2020) showed that strong quality management practices could mitigate the negative impacts of environmental efforts on productivity, highlighting the importance of contextual and organizational factors in shaping these outcomes.

Integrating environmentally sustainable practices has become a crucial priority for modern businesses. Many organizations, especially those facing societal expectations and competitive market pressures, are increasingly compelled to improve their environmental performance. Key drivers such as limited natural resources, evolving consumer demands, societal concerns, and environmental regulations are encouraging companies to adopt a more balanced approach between economic development and ecological responsibility. Research suggests that embedding environmental management into corporate strategies can yield tangible benefits like higher returns on investment and increased sales. However, the literature still lacks clarity on which specific environmental actions such as emission reduction, energy efficiency, or sustainable material usage most effectively enhance firm performance.

Lun (2011) contends that the primary factor behind improved corporate performance lies in the competitive edge offered by green management practices (GMP). These practices push firms toward more advanced environmental strategies, which in turn promote the inclusion of external stakeholders in their operations. Revising operational systems to minimize environmental harm not only prevents unintended consequences within subsystems but also boosts overall organizational efficiency. Through

ongoing environmental and structural upgrades, firms are likely to experience gains in labour productivity and can further capitalize on their competitive strengths.

Furthermore, Delmas and Pekovic (2012) highlight that adopting green policies can positively shape a firm's public image and potentially improve employee morale and engagement. Similarly, Lannelongue et al. (2017) argue that effective human resource management, when aligned with cost-saving strategies, may foster better workforce productivity. This implies that in certain contexts, implementing environmentally friendly practices can directly enhance employee performance.

Although the financial burden of environmental protection has grown significantly since the 1970s and is expected to rise further, cost-effective green management remains vital for maintaining a firm's competitive advantage. The broader body of environmental management literature supports the view that strategically adopting GMP can not only mitigate ecological harm but also strengthen a company's market position.

One of the most insightful and up-to-date studies in this field is by Nugent and Radicic (2023), who examined how environmental management practices influence firm productivity across 10 European Union countries, using BEEPS VI data from 2018 to 2020. Their findings reveal that companies with a dedicated environmental manager tend to have, on average, 11.9% higher labour productivity. This improvement is largely credited to more efficient operations, better employee training, and innovations in work processes.

Moreover, firms that use renewable energy sources see a 9.3% boost in productivity, lending support to the idea that cleaner energy inputs lead to more efficient production. Interestingly, companies that are subject to energy taxes or environmental levies show 13% higher productivity, possibly a result of internal improvements driven by the need to cut costs. Their empirical model also takes into account firm-level characteristics such as size, labour costs, age, and export activity. Even after adjusting for these factors, environmental variables still show a strong, independent impact on productivity performance.

Rutskiy and Osipenko (2020) explore the impact of investments in pollution control equipment on labour productivity within the manufacturing sectors of seven EU countries. Their study finds a clear and statistically significant positive link between green investments and productivity at the sectoral level. However, the effects of green policies differ across countries and industries, highlighting the importance of institutional readiness and technological capability in shaping outcomes. These insights are especially relevant for Uzbekistan's industrial landscape, where outdated technologies and environmental challenges pose both obstacles and opportunities. With the right reforms, green investments could become a powerful driver of productivity and sustainable growth in the country's manufacturing sector.

Recent data from industrial sectors across the EU reinforces the idea that green industries often outperform their non-green counterparts in employment, value-added, and overall productivity. A 2024 working paper on green industrial transformation reveals that sectors with a higher intensity of green production tend to experience stronger growth in both employment and value-added output.

However, the gap between green and non-green firms within the same sector narrows significantly when differences in workforce skills are taken into account. This suggests that human capital and innovation play a crucial role in realizing the benefits of green transformation. These findings underline the need to pair green policies with active labour market measures such as upskilling and retraining

programs to fully unlock their potential. For a country like Uzbekistan, which is currently undergoing significant reforms, this approach is especially relevant and timely.

While the reviewed studies are focused primarily on European contexts, their insights offer valuable implications for Uzbekistan, which is currently pursuing green transition reforms under the "Green Economy Strategy for 2019–2030" and the Presidential Decree No. UP-6024 (2020). Specific Uzbek policies such as the expansion of renewable energy sources, introduction of green bonds, and promotion of energy-efficient construction standards mirror the variables studied in EU settings. However, Uzbekistan's distinct economic structure, labour market composition, and regulatory environment necessitate context-specific research. Current evidence supports the hypothesis that green transition initiatives if strategically implemented can enhance productivity outcomes, especially in energy-intensive and environmentally sensitive industries. The lack of firm-level empirical studies in the Uzbek context remains a notable research gap that this study aims to address.

The literature affirms that green transition policies, especially those promoting energy efficiency, environmental management, and renewable energy can yield positive productivity effects. These benefits, however, are conditional on regulatory quality, managerial capacity, and technological adoption. This review sets the stage for an empirical analysis of Uzbekistan's green reforms, highlighting the need to investigate firm-level behavioural responses to environmental policy. Based on the above academic sources, the following three hypotheses were formulated for this study:

2.1 Energy Management Has a Positive Effect on Firm's Productivity.

Energy management helps reduce energy consumption without sacrificing output, leading to cost savings. According to Cagno et al. (2013), energy management systems identify inefficiencies and lower operational costs, enabling reinvestment in production and boosting productivity. Fujii et al. (2016) also found that energy-efficient practices lead to significant cost savings and improved performance. Moreover, energy management improves overall operational efficiency. Optimizing energy use boosts productivity by reducing costs and improving resource efficiency, particularly in energy intensive sectors. Steinbrunner (2022) highlights that in such industries, energy management systems increase output per energy unit consumed, contributing directly to higher productivity. Energy management is a strategic tool that enhances productivity through cost savings, innovation, and operational efficiency. Therefore, the current study tries to answer whether implementing effective energy management practices positively impacts a firm's productivity.

2.2 CO2 Monitoring Positively Affects Labour Productivity

CO2 monitoring can enhance environmental awareness within firms, motivating employees to contribute to sustainability efforts. Delmas and Pekovic (2012) found that firms with strong environmental practices, such as CO2 reduction efforts, tend to experience higher employee morale and engagement, which in turn boosts productivity. When employees are aware of their company's environmental impact, they often become more committed to organizational goals, leading to improved performance. CO2 monitoring systems help firms identify inefficiencies in energy consumption and emissions. By addressing these inefficiencies, companies can lower their operational costs, freeing up resources that can be reinvested into improving labour productivity. Fujii et al. (2016) found that firms adhering to environmental regulations, including CO2 monitoring, are more likely to achieve higher productivity due to reduced regulatory risks and enhanced market reputation. CO2 monitoring not only

helps companies reduce their environmental footprint but also creates an environment that encourages innovation, cost efficiency, and employee engagement. Based on the above we claim that implementing CO2 monitoring practices leads to improved labour productivity in firms.

2.3 Environmental International Certifications Positively Impact Firm's Productivity

Environmental international certifications, such as ISO 14001 or EMAS, signal a company's commitment to sustainability and environmental management. This not only improves the company's public image but also provides access to new markets that prioritize eco-friendly practices. Delmas and Pekovic (2012) found that companies with recognized environmental certifications tend to have better reputations, which can increase consumer demand and lead to higher sales, contributing to improved productivity. Environmental certifications help firms comply with national and international environmental regulations, reducing the risk of legal penalties. Fujii et al. (2015) argue that companies adhering to these standards are less likely to face regulatory disruptions or fines, which improves operational stability and allows for more consistent production. By reducing risks and compliance costs, these certifications can lead to higher productivity. Following the discussion above, we evaluate whether obtaining environmental international certifications leads to improved firm productivity.

3. Methodology

3.1 Sample and Data

The data utilized in this model was sourced from the 2024 World Bank Enterprise Survey (2024 WBES). The survey covers over 2705 enterprises across 4 countries in Central Asia to robusting testing with the results of Uzbekistan. The survey used stratified random sampling, grouping population units into homogeneous categories and then selecting random samples from these groups. It includes firms of varying sizes, categorized by employee count: small (5–19 employees), medium (20–99 employees), and large (100+ employees). The survey covers both the manufacturing (excluding extraction industries) and service sectors. Notably, the latest survey introduces a green transition module, focusing on green management practices and investments, which allows for the assessment of their impact on firm performance.

3.2 Model Specification

In this study, the dependent variable is labour productivity (LP), which is measured as the logarithm of total annual sales divided by the number of full-time employees. Labour productivity is considered a crucial indicator of firm performance, reflecting how efficiently the workforce contributes to production.

To assess the impact of green transition on labour productivity, we specify the following model:

$$_{it} = \beta_0 + \beta_1 \; _{it} + \beta_2 \; _{it} + \beta_3 \; _{it} + \beta_4 \; _{it} + \beta_5 \; _{it} + \beta_6 \; _{it} + \beta_7 \; _{it} + \; _{it}$$

Regarding variables of interest, we include the following. First, the variable EM (Energy Management) is a dummy variable that takes the value of 1 if the firm has implemented energy management practices, such as energy-efficient processes or renewable energy usage, and 0 otherwise. These variable tests the hypothesis that energy management positively affects labour productivity. Second, the variable CM (CO2 Monitoring) is a dummy variable that takes the value of 1 if the firm monitors CO2 emissions or implements carbon emission reduction strategies, and 0 otherwise. This variable assesses whether CO2 monitoring positively impacts labour productivity. The third variable of IC (International Certifications) is a dummy variable that takes the value of 1 if the firm holds

international environmental certifications (e.g., ISO 14001) and 0 otherwise. This variable evaluates whether international certifications positively influence labour productivity.

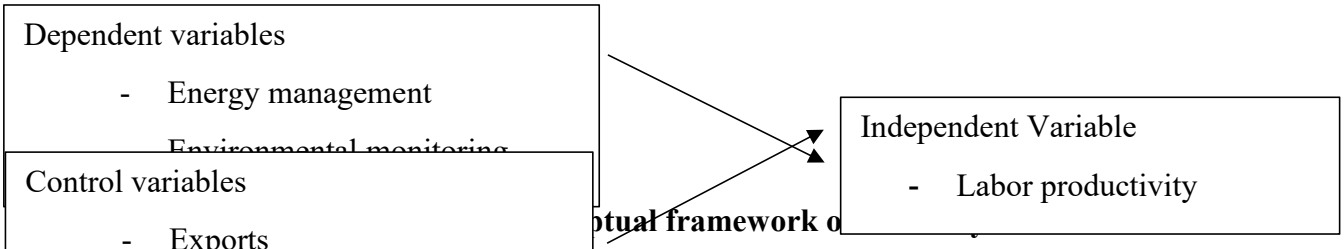
In terms of control variables, the empirical model includes the following factors:

Labour costs are represented as the logarithm of total annual wage expenses. This variable is crucial as it is typically considered part of a firm's capital, which directly impacts productivity. It is also valuable to examine whether firms that allocate more resources to wages experience higher labour productivity. Nishitani et al. (2014) also incorporated wage expenses in their model when exploring the effects of greenhouse gas management on firm performance.

The age variable is calculated as the natural logarithm of the firm's age in years. Research suggests that the age of a firm plays a significant role in influencing productivity. Thus, this model includes the age of the firm as a variable, measured as the natural logarithm of its years of operation.

Firm size is measured using the natural logarithm of the firm's number of employees. This control is important because, as Singh et al. (2015) note, larger firms tend to have more advanced environmental management practices, and the larger the firm, the greater its scale, which can positively affect productivity. Moreover, Dangelico et al. (2015) argue that firm size may also influence the environmental behavior of employees.

The exports variable is a dummy variable, taking the value of 1 if the firm is involved in exports and 0 otherwise. Studies indicate that export activities can boost firm productivity due to the international exposure to competition and knowledge transfer. Additionally, export-oriented firms generally exhibit higher labour productivity to remain competitive on the global stage. Empirical studies also suggest that exports play a significant role in motivating firms to adopt environmental standards. Gogokhia and Berulava (2021) similarly identified direct exportation as a key factor influencing labour productivity. Figure 1 illustrates the conceptual framework, which is based on the proposed hypothesis and the control variables included in the model.



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e relationship between green management practices and labour productivity using Ordinary Least Squares (OLS) estimation. Two separate models are estimated: the first includes data from firms across four Central Asian countries, while the second focuses specifically on firms operating in Uzbekistan, in order to test the robustness of the results across regions. Labour productivity measured as the natural logarithm of total sales per full-time employee is regressed on green variables, including energy management (EM), CO2 monitoring (CM), and international environmental certifications (IC), alongside control variables such as firm size, labour costs, firm age, export status, and sector dummies.

In the broader Central Asian sample, which comprises 2,353 observations, the regression model performed exceptionally well. The model explains nearly 70% of the variation in labour productivity (R-

squared = 0.696), indicating a strong fit. The high F-statistic confirms that the independent variables jointly provide significant explanatory power. For the Uzbekistan-specific model, which includes 778 firms, the model still demonstrates statistical significance, though the explanatory power is more modest, accounting for about 15% of the variation in productivity. This suggests that while green practices matter in Uzbekistan, other unobserved country-specific factors may also play a role in determining productivity outcomes.

Across both models, energy management emerged as the most consistently influential factor. Firms that adopted energy-saving technologies or implemented structured energy management practices showed significantly higher productivity levels. In the Central Asian model, these firms were found to be approximately 64% more productive than their counterparts, while in Uzbekistan, the productivity premium stood at around 59%. These findings are statistically significant at the 1% level and indicate that energy efficiency measures not only reduce operational costs but also enhance output per worker affirming the core principles of the Porter Hypothesis.

The role of CO2 monitoring was more nuanced. While it did not reach conventional levels of statistical significance in the broader Central Asian sample, it displayed a moderately positive and marginally significant effect in the Uzbekistan model. Firms that tracked their carbon emissions or employed emission-reduction strategies were roughly 35% more productive, suggesting that environmental awareness and monitoring may be contributing to operational improvements, particularly in countries where environmental policy is gaining traction. Although the relationship is less robust than that of energy management, it still points to a potential link between sustainability practices and firm performance.

In contrast, the effect of holding international environmental certifications such as ISO 14001 - was more ambiguous. In the Central Asian model, firms with such certifications actually demonstrated significantly lower productivity levels. This counterintuitive finding may reflect the costs associated with compliance or the fact that some firms pursue certifications more for reputational purposes than for operational improvement. In Uzbekistan, however, the relationship between certification and productivity was weak and statistically insignificant. This suggests that certifications alone, especially in early-stage green transitions, may not be sufficient to drive productivity gains unless accompanied by deeper organizational changes or innovation.

Among the control variables, labour costs were positively and significantly associated with productivity in both models (CA: 0.433, $p < 0.001$; Uzbekistan: 0.190, $p < 0.001$). This aligns with expectations, as firms that pay higher wages may attract more skilled workers or maintain more efficient teams. In Uzbekistan, for example, higher wage expenditures were linked to improved productivity, reinforcing the importance of investing in human capital alongside green measures.

Table 1. Regression Analysis.

	(1) lprod	(2) lprod
energy_management	.644***	.593***
	(.108)	(.205)
co2_monitoring	.177	.352*
	(.112)	(.212)

	(1)	(2)
cert_international	.763***	.155
	(.11)	(.356)
Labourcost	.433***	.19***
	(.015)	(.023)
firm size	-28.942***	-27.88*
	(8.001)	(16.895)
firm age	-52.608	-178.717*
	(44.306)	(103.866)
exporter	.886***	.87***
	(.118)	(.325)
1bn.sector		
textiles	.191	.737**
	(.133)	(.333)
garments	.278**	.149
	(.121)	(.329)
other manufac…	.187	.048
	(.147)	(.313)
retail	.238	-.157
	(.159)	(.324)
construction	.382**	.529
	(.156)	(.324)
other serv…	.251*	-.008
	(.142)	(.303)
1bn.countrycat		
Kyrgyz Rep…	-1.593***	
	(.161)	
Tajikistan	-2.792***	
	(.164)	
Kazakhstan	.473***	
	(.1)	
_cons	624.438*	1581.655**
	(334.221)	(773.909)
Observations	2353	778
R-squared	.696	.151

Standard errors are in parentheses
*** p<.01, ** p<.05, * p<.1

Export-oriented firms also stood out. In both samples, exporters consistently outperformed non-exporters in terms of labour productivity. The productivity advantage for exporting firms was around 87-89%, highlighting the competitive pressure and efficiency gains associated with participating in global markets. These results underline how exposure to international standards and practices can complement the adoption of green strategies.

Firm size and age, on the other hand, yielded more mixed results. Larger firms tended to show slightly lower productivity levels, in particular in the CA model (0.254, $p < 0.001$) which might be

attributed to coordination inefficiencies or legacy systems that slow down the adoption of green innovations. Similarly, older firms showed some indication of lower productivity, particularly in the Uzbekistan model, possibly reflecting resistance to change or outdated technologies that hinder performance improvements.

Finally, when controlling for industry and country-specific differences, the model found significant productivity disparities across countries. Firms in Kazakhstan (0.473, $p < 0.001$), for instance, showed higher productivity levels relative to the reference country, while firms in Kyrgyzstan (-1.593, $p < 0.001$) and Tajikistan (-2.792, $p < 0.001$) exhibited notably lower performance. These country effects highlight the importance of national policy environments, infrastructure, and institutional readiness in shaping the outcomes of green transition efforts.

In sum, the analysis provides compelling evidence that energy management practices have a strong and consistent positive impact on labour productivity. While the influence of CO2 monitoring is less definitive, it still shows promise especially in the context of Uzbekistan. International certifications, however, appear to yield limited performance benefits, underscoring the need for deeper integration of environmental goals into firm strategy rather than relying solely on formal compliance.These findings not only support the notion that sustainability and competitiveness can go hand in hand but also point to the importance of tailoring green policies to local contexts to maximize their effectiveness.

5. Conclusion

This study offers important empirical insights into how green transition efforts influence labour productivity in Uzbekistan - a country undergoing rapid environmental and economic transformation. Using firm-level data from the 2024 World Bank Enterprise Survey and applying an Ordinary Least Squares (OLS) estimation method, the research focused on three core green management practices: energy management, CO2 monitoring, and international environmental certifications.

The findings reveal that energy management practices are strongly and consistently associated with higher labour productivity. Firms that implemented structured energy-saving measures not only reduced operational inefficiencies but also saw substantial gains in output per employee. These results provide strong support for the Porter Hypothesis, affirming that well designed environmental practices can foster innovation and economic performance simultaneously.

CO2 monitoring also exhibited a positive association with productivity, particularly in the Uzbek context. Although its effect was less pronounced than that of energy management, it still suggests that environmental awareness and emissions tracking can contribute to improved firm efficiency especially in economies where environmental policy is gaining momentum.

In contrast, the role of international environmental certifications proved more ambiguous. The lack of significant productivity gains in firms holding such certifications especially in Uzbekistan indicates that certification alone may not lead to tangible operational improvements unless it is embedded within broader organizational change and innovation processes.

Control variables further reinforce the importance of firm characteristics in shaping productivity outcomes. Higher labour costs often linked to more skilled or better-compensated workers were positively associated with productivity, as was export orientation. This highlights the importance of investing in human capital and engaging with international markets. On the other hand, larger and older

firms tended to show lower productivity levels, possibly reflecting structural rigidities or slower adaptation to new green practices.

In sum, this research highlights that the green transition and productivity enhancement are not mutually exclusive. Instead, when supported by targeted policy interventions and a strong institutional framework, they can be mutually reinforcing. For Uzbekistan, the results underscore the importance of going beyond symbolic environmental commitments and promoting a deeper integration of sustainability into core business operations. Future research should explore sector-specific dynamics, longitudinal effects, and the role of digital innovation in shaping the green-productivity nexus. Nonetheless, this study makes a timely contribution to the literature by presenting robust micro-level evidence from a transitioning economy and by informing more effective and inclusive green policy design.

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