INTRODUCING ETS AND CARBON TAX IN UZBEKISTAN: OPPORTUNITIES AND COMPARATIVE ANALYSIS”

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Abstract. The article analyzes the prospects of introducing a carbon tax and an emissions trading system (ETS) in Uzbekistan and their comparative advantages. Based on World Bank data and the experience of advanced countries, the fiscal, economic, and environmental implications of carbon pricing mechanisms are examined. The results show that while a carbon tax ensures short-term stability, ETS encourages long-term industrial modernization. The analysis suggests that for Uzbekistan, a step-by-step hybrid approach to implementing carbon pricing mechanisms is the most appropriate solution.

Keywords: Carbon tax, ETS, carbon pricing, green budgeting, climate change

Аннотация. В статье анализируются перспективы внедрения углеродного налога и системы торговли выбросами (ETS) в Узбекистане, а также их сравнительные преимущества. На основе данных Всемирного банка и опыта передовых стран изучены фискальные, экономические и экологические последствия механизмов ценообразования на углерод. Результаты показывают, что углеродный налог обеспечивает краткосрочную стабильность, тогда как ETS стимулирует долгосрочную модернизацию промышленности. По итогам анализа для Узбекистана в качестве наилучшего решения предлагается поэтапное внедрение гибридного подхода к ценообразованию на углерод.

Ключевые слова: углеродный налог, ETS, механизм ценообразования на углерод, зеленое бюджетирование, изменение климата

I. Introduction

Climate change today stands as one of the most pressing global challenges, giving rise to economic, environmental, and social risks. The intensification of this problem has compelled many countries to strengthen their climate policies, particularly through the adoption of strict measures aimed at reducing greenhouse gas emissions. Among such measures, carbon pricing occupies a special place, as it represents an economic approach to addressing environmental challenges by imposing a financial burden on polluting activities.

The carbon tax is one of the most widely applied market-based instruments at the global level, designed to incentivize firms and consumers to reduce emissions of carbon dioxide (CO_2) and other greenhouse gases. Beyond its environmental objectives, the carbon tax also generates additional fiscal revenues, serving as an important tool in the transition to a green economy. At the same time, the implementation of this mechanism entails not only economic considerations but also complex political and social dimensions.

Between 1990 and 2004, carbon taxes covered only about 1% of global greenhouse gas emissions. During the period 2005–2011, the combined coverage of Emissions Trading Systems (ETS) and carbon taxes amounted to approximately 5%. The most significant increase in coverage occurred in 2021–2024, reaching 22–24%, largely due to the sharp expansion of ETS (World bank, 2024). A USD 10/tCO_2 increase in the carbon tax reduces per capita CO_2 emissions by 1.3% in the short term and by 4.6% in the long term (E.Kohlscheen, 2021).

Research gap

At the international level, there is a broad body of literature on carbon taxation and ETS, with a strong focus on developed economies such as the European Union, the United States, Canada, China, and South Korea. These studies provide in-depth analyses of the economic efficiency, environmental effectiveness, and social implications of such mechanisms. However, the context of developing countries—particularly Central Asian economies, including Uzbekistan—remains underexplored. Specifically, there is limited research on the opportunities, challenges, and policy design aspects of introducing carbon pricing instruments in these regions.

Existing domestic research has primarily focused on the broader concepts of the green economy, sustainable development strategies, or general environmental challenges. However, there is a notable absence of comparative analyses of carbon taxes and ETS, particularly in relation to their role in fiscal policy, state budget revenues, international integration processes, and climate finance.

Moreover, there is a lack of scholarly work examining the institutional, economic, and social implications of these mechanisms within Uzbekistan, as well as their potential phased implementation and associated constraints. Therefore, this study seeks to address these gaps in the literature by providing a comparative assessment of carbon pricing instruments, highlighting their relative advantages, and exploring the practical prospects for their application in Uzbekistan.

Research Question

To what extent would the implementation of a carbon tax and an ETS be effective in the context of Uzbekistan, and which mechanism offers greater institutional and economic advantages for the country?

Research Objective

The primary objective of this study is to analyze the prospects for introducing carbon tax and ETS mechanisms in Uzbekistan, to comparatively assess their fiscal, economic, and social implications, and to develop evidence-based conclusions and recommendations on the mechanism most suitable for the country's specific conditions.

Research Hypotheses

H1. The introduction of a carbon tax in Uzbekistan will lead to a short-term reduction in CO_2 emissions.

H2. The implementation of an ETS will, in the long run, incentivize high-emission industrial sectors to adopt low-carbon technologies, thereby significantly broadening the scope of emission reductions.

H3. A hybrid approach—starting with a carbon tax and gradually transitioning to an ETS—will represent the most feasible and effective carbon pricing mechanism for Uzbekistan.

II. Methodology

This article is based on an in-depth review of the academic literature and a systematic analysis of advanced international practices. It provides a comprehensive examination of existing theoretical approaches, the practical

mechanisms applied in various countries, and their outcomes, which serve as the foundation for policy recommendations tailored to Uzbekistan. The theoretical framework relies on both market-based and non-market regulatory approaches, particularly the concept of A Pigouvian tax and related theories.

Empirical evidence draws upon the dynamic panel regression analysis (E.Kohlscheen, 2021), covering 121 countries over 1971–2016, as well as the meta-analysis based on 81 studies from 2011–2022 (Ahmad et al., 2024). Furthermore, the article incorporates coverage indicators from the World Bank's *State and Trends of Carbon Pricing 2024* report, experiences from the Asia-Pacific region (including China's ETS, Singapore's carbon tax, and Indonesia's hybrid system), and ex-post analyses of macroeconomic impacts (Gilber et al., 2019), (Gilbert et al., 2020).

Furthermore, the study undertakes a comparative analysis of the experiences of countries that have implemented carbon taxation and green budgeting practices, including France, Sweden, Ireland, Singapore, and Japan. For this purpose, a descriptive analytical method was applied, examining the dynamics of GHG emissions, per capita emission indicators, and changes in the energy mix over the past decade from a statistical perspective. All data and analyses in this section is based on official World Bank statistics, as reprocessed by the authors.

The methodological approach of this article encompasses the following steps: (i) identifying the definitions and functions of economic policy instruments (carbon tax and ETS); (ii) comparing each instrument in terms of price/emission certainty and flexibility; (iii) consolidating the findings of ex-post studies; (iv) developing a phased roadmap for Uzbekistan to implement carbon pricing mechanisms (ETS and carbon tax).

III. Results

According to economic theory, the reduction of GHG emissions can be achieved through two main types of solutions: market-based and non-market-based instruments. Non-market approaches impose various standards and regulations on economic agents (for instance, technology or efficiency standards). In contrast, market-based approaches regulate GHG emissions through the price-signaling mechanism, with carbon taxes and Emissions Trading Systems (ETS) being the two most prominent examples.

A carbon tax is a fiscal instrument designed to reduce pollution by assigning a price to carbon dioxide (CO_2) or other GHG emissions released into the

atmosphere. Based on the Pigouvian tax principle, this mechanism treats pollution as a negative externality and integrates its costs into the economy through government intervention. Numerous studies have shown that carbon taxes are effective in reducing emissions without significantly hampering economic growth. For example, Sweden, which introduced a carbon tax in 1991, has experienced a notable decline in carbon intensity following its implementation.

The Emissions Trading System (ETS) is a market-based mechanism that allows the trading of permits to emit a specified amount of greenhouse gases. Under this system, the total volume of emissions is capped, and market participants are incentivized to adapt using the most cost-effective methods. The European Union's ETS is among the most prominent and comprehensive schemes, effectively encouraging industrial enterprises to reduce their emissions.

Alongside the carbon tax, the ETS occupies a central place among the key economic instruments adopted by governments in the fight against global climate change. Like the carbon tax, the ETS is specifically designed to reduce greenhouse gas emissions, though its implementation varies across countries in terms of scale and design.

In the literature, the differences between carbon taxes and Emissions Trading Systems (ETS) have been widely discussed. A carbon tax provides certainty with regard to the price of emissions but does not directly control the overall volume of emissions. In contrast, the ETS caps the total level of emissions but leaves the price subject to market fluctuations. Both instruments have their respective advantages and disadvantages: while a carbon tax generates additional revenue for the state budget, the ETS ensures greater market flexibility. Several studies suggest that the combined use of these instruments may represent the most effective solution.

According to experts of *The Economist* (Economist, 2021) , the ETS—particularly the "cap-and-trade" model—is theoretically ideal, as it provides a pathway to successfully decarbonize the economy. However, the experts emphasize that in practice achieving these goals is far more challenging than it appears, noting that current carbon prices remain considerably low. They further highlight several issues associated with the real-world implementation of the system. These include the concealment of accurate data on carbon emissions, circumvention of

rules within the carbon market (cheating), and the relocation of economic activities to regions or countries with less stringent environmental requirements (carbon leakage). These challenges constitute some of the major limitations of applying the cap-and-trade system in practice.

Ex-post empirical analysis of the impact of climate policies on national-level carbon dioxide emissions, using a comprehensive dataset covering 121 countries over the period 1971–2016 (E.Kohlscheen, 2021). The study primarily examined two policy instruments: the carbon tax and the Emissions ETS. To control for macroeconomic factors such as economic development, GDP growth, urbanization, and energy efficiency, the authors employed dynamic panel regressions.

The findings indicate that an increase of USD 10 per ton of CO_2 under a carbon tax reduces per capita CO_2 emissions by 1.3 percent in the short run and by 4.6 percent in the long run. Similarly, under an ETS, a USD 10 per ton increase in the carbon price decreases per capita CO_2 emissions by 1.4 percent in the short term and by 5.0 percent in the long term. The study concludes that, in terms of reducing per capita carbon emissions, the use of either a carbon tax or an ETS—or their combination—represents an effective policy solution (E.Kohlscheen, 2021).

Based on the reviewed studies, a comparative table of the carbon tax and the Emissions Trading System (ETS) can be constructed (Table 1).

Table 1. Comparative Analysis of Carbon Tax and Emissions Trading System (ETS) Based on the Reviewed Studies

Criteria	Carbon Tax	Emissions Trading System (ETS)
Definition	A fixed tax rate per ton of CO_2 emitted	A total emission cap is set, and emission permits are traded in the market
Price Certainty	Certain: set by the government	Uncertain: determined by market supply and demand
Emission Quantity Certainty	Uncertain: price is fixed, but total emissions are unknown in advance	Certain: the government sets the overall emission cap
Short-Term	A \$10/tCO_2 increase reduces CO_2	A \$10/tCO_2 increase reduces CO_2

Effectiveness	emissions by 1.3%	emissions by 1.4%
Long-Term Effectiveness	A \$10/tCO_2 increase reduces CO_2 emissions by 4.6%	A \$10/tCO_2 increase reduces CO_2 emissions by 5.0%
Economic Stability	Tax revenues are stable and predictable	Price volatility complicates budget planning
Political Acceptability	Politically more challenging: viewed as a direct tax	Politically easier: considered a "market mechanism"
Administrative Complexity	Simple: managed through tax authorities	Complex: requires setting and monitoring emission quotas
Reliability (Statistical Significance)	Strong statistical effect across all models	Significant results in some models (5 out of 9)
Flexibility	Less flexible: changing the price is politically difficult	More flexible: responds quickly to market changes
Signal to Investors	Strong and stable signal	Signal may be weaker due to market uncertainties

In conclusion, both instruments are effective in reducing CO_2 emissions. The carbon tax has an advantage in terms of price certainty and revenue stability, whereas the ETS performs better in ensuring strict emission control and flexibility. According to the analysis, the effectiveness of the carbon tax is statistically more robust and stable compared to that of the ETS.

A meta-analysis of 81 studies carried out between 2011 and 2022 to evaluate the effectiveness of carbon taxes and ETS (Ahmad et al., 2024). The results indicate that both instruments contribute to the reduction of carbon emissions; however, carbon taxes were found to be more effective in lowering greenhouse gas emissions than ETS. The analysis also revealed that the impact of these policies is not uniform and depends on country-specific characteristics, such as the level of financial system development and the rate of economic growth, which influence the effectiveness of both carbon taxes and ETS. According to the study, the carbon tax was most effective in Asia (excluding Japan), whereas ETS demonstrated the strongest results in the United States.

The currently implemented carbon pricing mechanisms are not sufficiently effective to bring about a true paradigm shift (Isabelle et al., 2024). Although countries applying carbon pricing policies at the national or regional level account for over 70% of global GDP and 60% of greenhouse gas emissions, only 23% of global emissions are effectively regulated (World Bank, 2023).

The study indicates that differences in carbon tax structures can lead to variations in emissions coverage across countries and regions. In most cases, carbon taxes are primarily applied to emissions from fossil fuels, such as gasoline, diesel, kerosene, fuel oil, liquefied petroleum gas, natural gas, and coal, including peat. Although some carbon tax systems are designed to cover all greenhouse gases (GHGs), certain countries' policies focus solely on carbon dioxide (CO_2). For example, the European Union's Emissions Trading System (ETS) covers only CO_2, nitrous oxide (N_2O), and perfluorocarbons (PFCs). Typically, the tax obligation is imposed at the top of the supply chain, i.e., on fuel sellers or importers. However, in some cases, this obligation may be passed directly to the end users who emit the pollutants into the atmosphere.

IV. Discussion

Macroeconomic Impacts of Carbon Taxation

Concerns that environmental taxes—particularly the introduction of a carbon tax—may exert negative effects on key macroeconomic indicators such as GDP or employment have been raised from the very outset in both theoretical and policy debates. This, in turn, has led governments to adopt a cautious approach toward implementing such taxes. In response to these concerns, the so-called "double dividend" hypothesis has been put forward in the literature. According to this hypothesis, reallocating the revenues from environmental taxes to reduce other taxes (for example, income taxes) can generate not only environmental benefits but also economic gains.

According to this hypothesis, revenues collected through environmental taxes can generate benefits for the economy in two distinct ways. First, such taxes help achieve environmental objectives (for example, reducing pollution). Second, allocating these revenues to reduce labor taxes or other types of taxation may stimulate economic growth or increase employment. For this reason, the approach is referred to as the "double dividend."

Theoretical research findings indicate that this hypothesis does not always yield clear positive outcomes. Empirical studies—i.e., analyses that test the hypothesis in real-world settings—remain relatively scarce. This is largely because most countries have not introduced environmental taxes within the framework of broader tax system reforms aimed at maintaining revenue neutrality.

First, let us review the existing assessments and recent studies on the economic impacts of carbon taxation (see Table 2).

Table 2. Ex-post Studies on the Macroeconomic Impacts of Carbon Taxes

Authors	Country (Group)	Period	Methodological Approach	Findings
Withana et al. (2013)	Denmark	1990–1995	Not specified	Achieved GDP growth of 0.3%
Murray & Rivers (2015)	British Columbia (Canada)	N/A	Review of multiple ex-post evaluations	No significant impact on economic growth
Bernard et al. (2018)	France	2008–2016	VAR specification methodology	Achieved a 4.5% increase in total employment
Elgie & McClay (2013)	British Columbia (Canada)	2008–2012	Difference-in-differences approach	No significant impact on per capita GDP
Azevedo et al. (2018)	Portugal	2001–2013	Synthetic control method	No impact on total employment
Metcalf (2019)	Various (OECD countries)	1990–2016	Difference-in-differences approach	No negative or significant positive impact on GDP
Andersen et al. (2007)	Denmark, Finland, Sweden, Slovenia, United Kingdom	1994–2012	E3ME macroeconomic model	Long-term annual GDP growth increased by 0.4%–0.5% (DK, FI, SE)
Metcalf & Stock (2020a)	EU-28, Iceland, Norway, Switzerland	N/A	Regression analysis	No negative effects on GDP growth and employment
Metcalf & Stock (2020b)	EU-15	N/A	Regression analysis	No negative effects on GDP growth and employment

Source: Developed by the authors based on *"Carbon Taxation: A Review of the Empirical Literature*

The Experience of Selected Countries in Implementing a Carbon Tax

The Asia-Pacific region, home to some of the world's most populous countries and fastest-growing economies, accounts for more than 50 percent of global greenhouse gas emissions, with China alone responsible for over 30 percent. As of April 2023, several countries in the region have adopted carbon pricing mechanisms: Japan, China, and Singapore have introduced carbon taxes, while Kazakhstan, New Zealand, Korea, and Thailand have implemented emissions trading systems (ETS).

China's emissions trading system (ETS) is the largest in the world in terms of coverage and has been providing a price signal to the market since its launch in July 2021. Although carbon prices were initially set at relatively low levels, they have shown a steady upward trend. In 2024, the price of one ton of CO_2-equivalent emissions on the open market exceeded 100 yuan (approximately USD 13).

Singapore's carbon tax applies to all industrial facilities with annual direct greenhouse gas emissions of at least 25,000 tons of carbon dioxide equivalent (tCO_2e). For the period from 2019 to 2023, the initial tax rate was set at USD 5 per ton in order to provide companies with a transitional period to adapt (National Environment Agency, 2025).

Indonesia's "Carbon Economic Value" initiative was introduced in early 2023 as a mandatory, intensity-based ETS for the energy sector. The ETS in Indonesia operates in parallel with a carbon tax as part of a hybrid "cap-tax-and-trade" system. Under this hybrid mechanism, entities that fail to meet their ETS obligations are subject to a carbon tax, with the tax rate adjusted in line with the domestic carbon market price (International Carbon Actin Partnership, 2025).

Carbon tax and green butgeting

Developed countries that have implemented green budgeting practices and adopted carbon taxation as a tool for carbon pricing—such as France, Sweden, Ireland, Singapore, and Japan—are analyzed, along with the outcomes they have achieved, using statistical methods. All of the analyses presented herein are based on official World Bank data, as processed by the authors (World Bank, 2025).

The case of France clearly illustrates the impact of green budgeting. Following the introduction of green budgeting in 2020, a significant reduction in greenhouse gas

(GHG) emissions has been observed. In 2013, per capita GHG emissions amounted to 7.4 tons of CO_2 equivalent, whereas by 2023 this figure had declined to 5.6 tons. Over the same period, GHG emissions fell by 27.7 percent compared to 1990 levels. This outcome was largely driven by fiscal measures implemented alongside the carbon tax and by increased green investments. Moreover, the share of fossil fuels in the energy mix continued to decline, indicating a growing resilience of the energy system.

Sweden is among the countries that have achieved positive outcomes through the implementation of long-term green fiscal policies. Although a carbon tax was introduced as early as the 1990s, the practice of green budgeting was only adopted starting in 2020. As a result, by 2023 greenhouse gas (GHG) emissions had declined by 34.6 percent compared to 1990 levels, while per capita GHG emissions fell from 8.5 tons CO_2e to 4.7 tons CO_2e. Furthermore, the share of fossil fuels in total energy consumption decreased from around 35 percent to approximately 25 percent. This demonstrates the effectiveness of combining political commitment, fiscal instruments, and infrastructure transformation.

In Ireland, green budgeting has been implemented since 2019, contributing to a gradual decline in greenhouse gas (GHG) emissions. Although a carbon tax had already been introduced in 2010, the adoption of green budgeting reinforced the trend of a steady reduction in emissions. In 2010, per capita emissions stood at 14.6 tons of CO_2e, whereas by 2023 this figure had decreased to 10.9 tons. The share of fossil fuels in total energy consumption also fell, from 95 percent to 82 percent. However, the pace of reduction has been slower compared to other countries, suggesting that fiscal reforms require sufficient time to deliver their full effect.

In Singapore, green budgeting has not been introduced; however, a carbon tax has been in place since 2019. Despite this measure, GHG emissions have increased rather than declined during this period. While GHG emissions were at 106.1 percent in 2019, by 2023 the figure had risen to 120.1 percent. Per capita emissions also increased, from 11.4 tons of CO_2e in 2010 to 12.6 tons of CO_2e in 2023. Although the share of fossil fuels in total energy consumption decreased from 35 percent to 24.9 percent, overall GHG emissions did not decline. This suggests that, in the absence of green budgeting, the carbon tax alone may not be sufficient to achieve meaningful emission reductions.

In Japan, green budgeting has not been adopted; however, a carbon tax has been in effect since 2012. Since then, a consistent decline in GHG emissions has been observed. For instance, while GHG emissions stood at +7.1 percent in 2012, by 2023 they had fallen to –21.0 percent. Per capita emissions also decreased, from 11.1 tons of CO_2e to 8.4 tons of CO_2e. The share of fossil fuels in total energy consumption declined as well, from 94 percent to 84 percent. These trends reflect the positive impact of Japan's technological advancement, energy efficiency improvements, and tax policy. Nevertheless, the findings suggest that the outcomes could be further strengthened through the introduction of green budgeting.

Conclusion

In summary, the evidence shows that countries which have introduced green budgeting demonstrate a clear decline in GHG emissions. The effectiveness of this policy is particularly evident when combined with carbon taxation and other fiscal instruments. Green budgeting practices have proven to positively influence not only environmental indicators but also the structure of the energy mix. Conversely, the experience of Singapore illustrates that relying on a single measure—such as the carbon tax alone—is insufficient to achieve substantial reductions in GHG emissions.

The analyses indicate that both the carbon tax and the ETS could play a crucial role for Uzbekistan not only in achieving environmental objectives but also in strengthening fiscal and economic stability. However, their effectiveness is directly contingent upon the country's institutional capacity, level of economic development, characteristics of the energy market, and the degree of political commitment.

In the short term, the carbon tax can serve as an effective instrument for ensuring fiscal stability and increasing budget revenues. International experience shows that in countries such as Sweden, Denmark, and Ireland, this tax has contributed to a significant reduction in emissions without exerting a serious negative impact on economic growth. In the context of Uzbekistan, the introduction of such a mechanism could also generate a "double dividend," meaning that environmental benefits could be achieved alongside greater economic efficiency. At the same time, it will be crucial to design targeted social protection measures to mitigate the regressive effects of the tax.

In the long term, the ETS offers advantages in ensuring strict control over emissions, incentivizing industrial enterprises to adopt innovative technologies, and increasing low-carbon investments. However, for the system to operate effectively in Uzbekistan, reliable monitoring mechanisms, well-developed financial markets, and a clear legal framework are required. Therefore, the implementation of ETS in Uzbekistan should be carried out gradually, in a phased manner.

The results of the study indicate that while the carbon tax is distinguished by its ability to provide a clear and stable price signal, the ETS offers the advantage of strict control over emission volumes. Therefore, as demonstrated by Indonesia's experience, a hybrid model—introducing a carbon tax first and subsequently moving step by step toward an ETS—appears to be the most appropriate approach for Uzbekistan.

International experience demonstrates that the combined application of the carbon tax and the ETS yields the most effective results. The carbon tax contributes to fiscal stability and provides a clear price signal, while the ETS guarantees environmental outcomes by imposing quantitative limits on emissions. Therefore, in Uzbekistan, these instruments should be considered as complementary measures.

The recommended **strategy for Uzbekistan** can be outlined as follows:

- short term (2026–2028): introduce a low-rate carbon tax applied to large industrial emitters;
- medium term (2028–2030): expand the coverage to include the transport and energy sectors while gradually increasing tax rates;
- long term (beyond 2030): establish an integrated system and incorporate elements of the Emissions Trading System (ETS);
- revenue use: allocate revenues from the carbon tax in a targeted manner to social protection measures, the development of green technologies, and tax redistribution.

Overall, the most appropriate approach for Uzbekistan is a phased hybrid model, which would ensure fiscal stability in the short term, extend coverage to high-emission sectors of the economy in the medium term, and, in the long term, accelerate technological modernization and the transition to a low-carbon economy through the introduction of an Emissions Trading System.

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