Chapter 5

DETERMINANTS OF CARBON EMISSION AND THE POTENTIAL ECONOMIC IMPACT OF 'GREEN' ECONOMY STRATEGIES IN CENTRAL ASIA

Kazakhstan and Uzbekistan

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5.1 INTRODUCTION

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5.1.1 Definition, evolution, and theoretical background of the green economy concept

Global environmentalism and the 'green' movement related to protecting ecosystems dates back to the early nineteenth century. However, environmental activism of the 1970s was the most crucial stage in the history of the green movement and a period when humankind entered a new era of modern environmentalism. Earth science and activism of the 1970s and onwards brought more concepts connected to the effects of pollution on the earth and climate change. Since then, the green movement also spurred political interest and convinced multiple stakeholders to get involved in the green movement. The recognition that climate change happens faster than expected made research and academic topics in climate change adaptation and mitigation exciting and necessary (Pepper 1996, Doherty 2002). In recent years, the global green movement actively convinced governments to live in an eco-friendly way, use resources efficiently, and find methods to protect the earth.

The 'green economy' concept and its environmental objective lies in the 'sustainable development' discourse first popularized in the late 1980s. Since then, many concepts of what constitutes a green economy have been developed by various actors. Bina (2013) presents green economy as a response to both economies and environments in crisis. The United Nations Environment Programme (UNEP), which plays a leading role in promoting a green economy, defines the concept as improving social equity and human wellbeing while reducing environmental risks and ecological scarcities. A green economy is based on principles of sharing, circularity, collaboration, solidarity, resilience, opportunity, and interdependence.[1] Green economies are low in carbon emission, efficient and clean in production, and inclusive in consumption and product outcomes (UNEP 2010).

The Organization for Economic Cooperation and Development (OECD) uses the term 'green growth' in the same context as green economy. It emphasizes that the actual costing and proper pricing of resources are the keys to national green growth. Further, the OECD (2011) indicates that infrastructure investments in the energy, transport, and water management sectors; innovative promotion; and green jobs are vital for green growth. Lievens (2013) highlights that the green economy approach is based on four key strategies: the market as a central governance mechanism, technology, sustainable entrepreneurship, and sustainable consumption.

[1] See more on UNEP promotion of green economy at https://www.unep.org/explore-topics/green-economy/

The green economy concept is rooted in classical economic theories such as neoliberalism, free market environmentalism, and eco-modernization. The neoliberal and free market environmentalism paradigms emphasize private investment, free trade, and market-based solutions to protect the environment through market mechanisms (Dale et al. 2016). Free market environmentalism promotes the idea that free market principles should solve and prevent environmental problems. This calls for a system of environmental regulation based on private property rights, using positive incentives and market forces to encourage property owners to conserve resources (Hyder 2015).

Ecological modernization theory arose in the 1980s to advocate for technological involvement and continuous industrial development as the key to greening the economy (Glynn et al. 2017). The main aim of the eco-modernization theory is to analyze how modern society integrates and deals with environmental crises (Mol and Sannefeld 2000). Eco-modernization argues that manufacturing companies and industries become green by developing more efficient technologies, which supposedly reduce resource use (Hyder 2015). It emphasizes that industrial development is the best option for escaping ecological crises. According to Jänicke and Weidner (1997), ecological modernization theory assumes that modern human initiatives will match economic advancement with environmental improvement. Technological innovations and continuous industrial development are the keys to this theory. The theory argues that capitalists do not opt for an environmentally friendly process by their own choice; instead, they adopt the green manufacturing process forced by economic efficiency needs.

Regarding green investments, the United Nations emphasizes that public and private investments in the environment can reduce carbon emissions, enhance resource efficiency, and prevent the loss of biodiversity and ecosystems service while reducing unemployment (UN 2011). Similarly, UNEP (2011) argues that growth in income and employment in a green economy are driven by public and private investments that reduce carbon emissions and pollution. UNEP highlights that the causes of global crises affecting human wellbeing have resulted mainly from 'the gross misallocation of capital.' Therefore, it emphasizes that redirecting investments to greener renewable energy, energy efficiency, public transportation, sustainable agriculture, ecosystem, biodiversity protection, and land and water conservations will result in substantial growth and improved human living conditions.

In 2012 the United Nations General Assembly called for the green economy as an institutional framework for sustainable development and poverty eradication. Over recent years, the green economy concept has become a strategic priority for many government and intergovernmental organizations. There is also an emerging practice in designing and implementing national green economy strategies. By 2018, the Global Green Economy Index report recorded 130 countries that have embarked on a green economy and related strategies by transforming their economies into drivers of sustainability, compared to 61 in 2016.[2]

5.1.2 Green Economy in Central Asia: Kazakhstan and Uzbekistan

The CA region inherited an environmental crisis, including nuclear waste, destruction of water management, and the drying up of the Aral Sea from the Soviet Union's mode of production (Cohen 2021). The region contributes 1.44 percent of total global carbon (CO_2) emissions, with a total volume of over 500 million tonnes in 2020, as in Table 5.1. The region suffers from outstanding environmental issues like the lack of standards on pollution emissions, the increase of greenhouse gas (GHG) emissions, and the lack of development of green legislation (such as waste management and organic agriculture).

[2] The 2018 Global Green Economy Index (GGEI) measures the green economy performance of 130 countries and how experts assess that performance. Published by Dual Citizen LLC, a private US based consultancy. See the GGEI report https://dualcitizeninc.com/global-green-economy-index/index.php#interior_section_link

Kazakhstan and Uzbekistan are the main emitters of CO_2 in the region, while Kazakhstan has the highest per capita CO_2 emissions compared to the other countries in the region. A comparison in CO_2 emissions for Kazakhstan and Uzbekistan for the 30 year period 1990-2020 is provided in the Annex (Figure A1). Because of Kazakhstan's public health concerns, the country was ranked second in environmental pollution by organic substances in Central and Eastern Europe and CA (Kazbekova 2020).

Table 5.1. CO_2 emission by Central Asian countries, 2020

	CO_2 emission (million tonnes)	CO_2 per capita (tonnes)	Share in global CO_2 emission (percent)
Kazakhstan	291.34	15.52	0.84
Kyrgyzstan	11.51	1.76	0.03
Tajikistan	9.45	0.99	0.03
Turkmenistan	75.34	12.49	0.22
Uzbekistan	112.78	3.37	0.32
Total	500.41		1.44

Source: Calculated by authors using OWID data[3]

A green transition strategy that includes economic, social, and environmental dimensions is fundamental to the sustainable development of a nation. Over the past decade, CA countries adopted the green economy concept as a strategic priority to revert past environmental destructions and become greener. Renewable and efficient energy use has become a vital part of the region's transition towards a greener economy.

[3] Data is available at: https://github.com/owid/co$_2$-data

CA's economic leader, Kazakhstan, was the pioneer among the other five Central Asian countries in adopting a green economy concept in 2013 to 'green' its key economic sectors by 2050. The Kazakhstan green economy concept paper (assessed in this work) defines the green economy as an economy with high living standards and the rational use of natural resources in the present and future generations (Kazakhstan Green Economy Policy 2013). Likewise, in 2019, the most populous country in CA, Uzbekistan, adopted a strategy to transition into a green economy by 2030.

The governments of Kazakhstan and Uzbekistan adopted the green transition concept through their respective green economy and development strategies. Both countries aspire to resource-intensive, energy-efficient, and green development pathways. They also aim to diversify their energy sources with alternative, cleaner, and renewable energy sources. Kazakhstan and Uzbekistan are committed to embracing alternative energy sources, saving water, and greening their priority sectors, including agriculture, construction, and transport. Amid the global transition to renewables, the two nations strive to do away with over-reliance on fossil fuel extractive industries and hydrocarbon-dependent growth, attracting renewable energy investments. Kazakhstan and Uzbekistan are also restoring the Aral Sea (Cohen 2021).

Nevertheless, the green transition is accompanied by various challenges and barriers to pursuing the main goals. There are risks of slowing down the implementation of the green strategy owing to exogenous factors such as government measures directed towards the social protection of the population. Uzbekistan's fast-moving economic reforms consider social protection programs to be one of the priority areas.

A critical dimension of social protection is the practice of subsidized electricity and gas pricing. On the one hand, social programs that support people, especially vulnerable groups, perfectly align with national priorities. On the other hand, these policies may slow down reforms in the energy sector and the whole green transition. The government is, therefore, in a trade-off about whether to cut social programs and speed up the reforms or to keep strong social policies by subsidizing energy prices. There are some concerns such as, how businesses whose production relies heavily on cheap fossil fuel and how different income level households — again, especially vulnerable groups — will be affected.

Long-term good development interventions of the government may slow down the transition toward the green economy. For instance, it is clear that both Kazakhstan and Uzbekistan need reforms in the energy market to improve energy efficiency, but the actual speed of the reforms is not apparent yet; transitioning to a green economy is a long-term process. Lazzet et al. (2014) indicate that ensuring economic growth and food security under the transition to a green economy in Kazakhstan requires the formation of systems and regulations oriented toward the context of the transition; such institutional reforms need a longer period of time. The current green transition strategies of Kazakhstan and Uzbekistan envisage a relatively short time window — namely, 2030 for Uzbekistan and 2050 for Kazakhstan. However, the transition may take place more than 50 years into the future. Despite the approval of the transition to a green economy, both countries still have a limited long-term vision for environmental protection and climate change.

Another challenge is the cost of a green transition. To achieve green growth, countries should have sustainable technological changes. Thus, moving away from fossil fuels towards clean energy sources will require significant investments by governments, businesses, and households. The shift might be quite expensive. Another concern is that the transition will lead to a significant rise in energy bills; households and businesses are unprepared for this kind of challenge. The transition may raise overall price levels in the economy, thereby harming it owing to higher input costs and labor market because of an increased unemployment rate.

A review of existing secondary reports on the challenges in the transition towards a green economy in Uzbekistan shows an insufficient capacity for sector transformation. While Uzbekistan's green economy transition strategy for 2019-2030 identifies the role of priority sectors and mechanisms for transition, there are areas for improvement. Gaps persist in the availability of qualified human labor, legal base, and coordination among sector institutions (UNECE 2020, World Bank 2022, UNDP 2021). Most of the capacity transfer from international/donor organizations — including human and technological skills — is at an early stage. Awareness of green transition among local communities is also limited (UNECE 2020). The engagement of the private sector in the country's green economy transition is defined in the strategy; however, most of the private sector efforts are at an infant stage, including legal, technological, information, coordination, and human capacities. Likewise, the role of civil society in building a green economy requires institutional mechanisms. Currently, there are gaps in coordination, information exchange, and sufficient human and training needs of non-government organizations (NGOs). Financial capacity for green economy transition is developing in Uzbekistan, as the country made substantial progress in attracting donor funds to support the transition (UNDP, 2021). On the other hand, the long-term financial burden associated with the repayment of donor funds and its implications for the future is not clear.

Similarly, Kazakhstan exhibits a gap concerning environmental policy transparency and collaborative nature between government and NGOs. Kazbekova (2020) explains that it is hard to implement the green economy concept in Kazakhstan because the economy does not allow the establishment of a unified set of measures to implement green technologies. There is also a limited technological capacity for energy efficiency and emission reduction.

Intensive agriculture techniques, and the production of fossil fuels and mineral resources are additional examples of the many barriers to realizing the transition to a green economy in both Kazakhstan and Uzbekistan.

5.1.3 Study rationale

The paper aims to assess the determinants of a green economy in Kazakhstan and Uzbekistan through an empirical assessment of a 30 year (1990-2020) dataset. The study results indicate where to focus for a greener economy in the two countries. Such a study provides valuable insight for decision-making in green economy strategies. Analyzing the emerging green policies in Kazakhstan and Uzbekistan will serve as a lesson to the other countries in the region.

Kazakhstan and Uzbekistan are major CO_2 emitters in CA. However, both countries indicated that a transition to a green economy is vital both from an ecological perspective and for the economic growth of the nation. These national development strategy documents of these countries echo that their economic system cannot continue to treat nature as an endless resource. Instead, the countries propose to invest in green policies to boost national economic growth, innovation, and green employment in the future.
The green economy concept is optimistic about the possibility of moving toward high income and industrialized society by incorporating natural environment protection and

the efficient use of resources into the redesign of modern institutions and sectors. Thus, the green economy approach assumes no trade-off between environmental protection and economic costs; nevertheless, the argument on the economic impact of green transitions is inconclusive. Jacob et al. (2015) argue that, on the one hand, environmental focus and economic development can go together because they avoid the costs related to environmental degradation, and environmentally friendly business and technology open up economic opportunity. However, they indicate that policy interventions that bring transformation towards a green economy may threaten businesses and sectors that rely on cheap energy resources, thus developing resistance. Lievens (2013) highlights that the green economy idea is worrisome in that it will not tackle the root causes of climate change; instead, he argues that the concept may create new markets and industries, and some interventions proposed by governments could be just a form of 'green washing.' The green economy approach emphasizes substantial private investment and technological development. At the same time, countries in CA are still mostly centralized with massive state intervention, and the green economy transition is not market led. Also, the dominating economic model with fast reforms in the region may not allow for an equally green future for all. In this regard, it is difficult to claim that a green economy could achieve sustainable development in all three economic, social, and environmental pillars.

The World Bank (2012), OECD (2012), and UNEP (2011) assert that innovations and technological change form the basis for future economic growth and employment in a green economy. Green technologies are associated with higher work intensity and increased employment compared to conventional technologies. Jacob et al. (2015) highlight that, in assessing the economic impact of green economies, it is important to focus on the number of jobs created compared to an alternative allocation of funding. They also emphasize that in the longer term, economic gains are expected to come from the use of renewable energies. Similarly, Strand and Tomon (2010) and Kammen et al.

(2004) indicate that energy efficiency measures and technologies in renewable energy have higher job intensity than traditional energy economies, particularly in the areas of production and installation. Thus, the development of renewable energy has a positive economic impact. Besides being labor-intensive, renewable energies are also human capital intensive, thereby improving labor productivity. New green jobs that will be created in green economies are among the economic promises and hope for Kazakistan and Uzbekistan while these countries undergo green economy transitions. Nevertheless, it is not apparent whether the economic promise applies to the Central Asian countries or if the costs of transitioning to a green economy outweigh and compromise opportunities for the fast development of the nations.

Institutions and human capacity are limited in Kazakhstan and Uzbekistan. Jacob et al. (2015) argue that the innovation effects of green economies depend on the form of policy instruments and other contextual factors such as sector capacity to develop and use technological solutions. In addition to the policy instruments, the impact of policies depends on the configuration of actors and the sector capacities (Janicke and Lindermann 2010). Similarly, Bowem (2012) points out that labor market rigidities can hinder or delay the transition to a green economy.

This empirical research enables Kazhakistan and Uzbekistan to examine the validity of some of the several assumptions expressed as hypotheses before moving to any conclusions. This paper assesses the potential economic promise of adopted green economy interventions in the study countries through a method of descriptive analysis. The analysis provides quantifiable information on the likely speed and the long-run multiplier effect of announced green interventions. The paper questions whether green interventions announced by the governments of Kazakhstan and Uzbekistan will achieve economic sustainability. It investigates the potential economic impacts of the proposed interventions in the study countries. The assessment of strategies establishes the potential impacts of state led and financed green interventions versus a scenario in which the countries make no policy intervention. An a priori assessment of the impact of the announced interventions in the green economy strategies would increase their credibility, transparency, and usefulness.

The paper is organized into five sections. Section two describes the study methodology for both the empirical regression model and descriptive analysis of the economic impact of green strategies. Section three then presents the regression analysis findings of the determinants of CO_2 emissions in the study countries and descriptive analyses of the potential economic impact of announced green strategies. Section four presents the conclusions from the study and their implications. Finally, section five provides some policy options based on the study findings and conclusions.

5.2 RESEARCH METHODOLOGY, APPROACHES, AND DATA

The study empirically studies the relationship between CO_2 emissions (as a proxy for green economy) and GDP, international trade, energy use, population, urbanization, and forest cover. The paper then assesses the likely economic impact of the green economy strategies adopted by Kazakhstan and Uzbekistan.

5.2.1 The econometric model, variable specification, and data

The paper examines a 30 year panel of data spanning from 1990 to 2020 for Kazakhstan, Uzbekistan, and Denmark. Denmark is included in the research as a benchmark for its substantial restrictions on GHG emissions and its efforts to mitigate climate change.

The fixed effect (FE) regression model analysis includes only Kazakhstan and Uzbekistan, with data limitations on some variables. While the ordinary least squares (OLS) model can efficiently discover associations between explanatory factors and CO_2 emissions, the FE model exploits within group variations over time with a powerful ability to remove the potential omitted variable bias. The study also uses the random effects model, which allows the inclusion of time-invariant variables. The Hausman test was used to determine whether fixed or random effect models were suitable. The test reports in favor of the FE model.

In this context, CO_2 emissions depend on GDP and the square of GDP; therefore, the model specification is as follows:

$$CO^{2it} = \beta_0 + \beta_1 Yit + \beta_2 Yit^2 + \beta_3 Eit + \beta_4 X^{it} + \varepsilon^{it}$$

Where CO_2 is carbon dioxide emission; Y is GDP, E is energy use, and X is a vector of other determinants in country i at time t. The unit of measurement for some variables was in monetary terms and numbers, and the normality test of the data suggested using the logarithmic form of GDP, GDP squared, export, import, and population variables. Carbon dioxide emission is utilized as the dependent variable. The annual time series data for the model variables was obtained from the World Development Indicators (WDI) and OECD database. Table 5.2 reports descriptions of the variables and sources of the data.

Table 5.2. Empirical model: variable descriptions and data sources

Variable name	Description	Source
CO_2	CO_2 emissions (kt). Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during the consumption of solid, liquid, and gas fuels and gas flaring.	World Bank (WDI)
GDP	GDP (constant at 2015 USD rate).	World Bank (WDI)
Export	Exports of goods and services (constant 2015 USD).	World Bank (WDI)
Import	Imports of goods and services (constant 2015 USD).	World Bank (WDI)
Energy use	Use of primary energy before transformation to other end-use fuels (such as electricity and refined petroleum products). Combustible renewables and waste — solid biomass and animal products; biogas and liquids; industrial and municipal waste. Biomass is any plant matter used for fuel, heat, or electricity. (Measured in kilograms.)	OECD.org
Renewable energy	Renewable energy consumption (percentage of total final energy consumption).	World Bank (WDI)
Population	Population, total.	World Bank (WDI)
Forest	Forest area (percentage of total land area).	Food and Agriculture Organization (fao.org)
Urbanization	Urban population (percentage of total population).	World bank (WDI)

Table 5.3 lists the summary statistics of variables used for Kazakhstan and Uzbekistan. The sample shows that the average GDP over the 30 years for the two countries is USD86,868, and the mean CO_2 emission is 152 million tonnes annually. The mean share of the urban population and forest land area is 52.09 percent and 4.3 percent, respectively. The mean energy use per capita is 2,804.31 kg of oil, whereas renewable energy consumption share

varies from 0.71 percent to 2.77 percent of total energy consumption. Country-specific statistics are provided in Tables A4 and A5 in the Annex.

Table 5.3. Summary statistics, Kazakhstan and Uzbekistan, 1990-2020

VARIABLES	Number of observations	Mean	Standard deviation	Minimum	Maximum
CO_2	58	0.152	0.051	0.096	0.256
GDP	62	86,868.01	53,855.33	26,042.60	211,107
Export	57	28,084.86	20,368.16	2,490.49	60,627.67
Import	57	25,094.12	16,999.02	3,135.35	78,239.09
Energy use	49	2,804.31	1,080.32	1,419.48	4,796.14
Renewable energy	58	1.496	0.43	0.71	2.773
Population	62	21.531	6.067	14.858	34.232
Forest	62	4.302	3.175	1.142	8.375
Urbanization	62	52.097	5.078	41.365	57.671

5.2.2 Descriptive analysis of green economy strategies, method, and data

The descriptive analysis of the potential economic impact of green interventions employs a policy evaluation framework called the Global Recovery Observatory Methodology. The methodology (hereafter referred to as the Observatory methodology) is developed by the Oxford University Economic Recovery Project in partnership with the IMF, UNEP, and GIZ, as described in O'Callaghan et al. 2021. The Observatory methodology aligns with the objectives and scope of the a priori assessment of the announced green economy strategies in the current study. Though the Observatory methodology was designed to evaluate COVID-19 interventions, the method has broad applicability (O'Callaghan et al. 2021). The methodology uses a taxonomy and coding of archetypes (interventions) that are then preassigned a Likert scale value. The Observatory methodology identifies mutually exclusive archetypes and subarchetypes that have a social, environmental, and economic impact. [4] In this paper, we use the term intervention interchangeably with archetypes.

In the Observatory methodology, the potential impact of announced interventions is evaluated across three pillars: (i) environmental, (ii) social, and (iii) economic. In this study, we dwell only on the potential economic impact of the announced green strategic interventions. The potential economic impact of an intervention, following the Observatory methodology, has two metrics: (i) speed of policy implementation (SPI) and (ii) long-run economic multiplier (LEM) effect. The Observatory methodology defines the SPI as the pace at which a policy archetype can be deployed and exert its economic effect. The same methodology defines an LEM effect as the change in national income that results from a financial injection/intervention (O'Callaghan et al. 2021).

Some scholars also employed O'Callaghan methodology in their research (O'Callaghan and Murdock 2021, Hans et al. 2021, Johnstone 2022, Funke et al. 2021, Köppl and Schratzenstaller 2022). Hans et al. (2021) investigated that economic stimulus investment to combat the COVID-19 epidemic promotes low-carbon transition. In May 2021, 26 emitters announced approximately 2,500 actions, representing around 65 percent of world GHG emissions in 2018. Their results indicate that the majority (35 percent) of expenditure with potential GHG emission consequences was spent on initiatives that maintained the status quo in different nations when low carbon options existed. Their evaluation demonstrates the various degrees to which emitters have wasted the chance for a green recovery. Besides, O'Callaghan and Murdock (2021) mentioned that a green

[4] See more on UNEP promotion of green economy at https://www.unep.org/explore-topics/green-economy/

recovery accounted for less than a fifth of total fiscal expenditure in 2020, despite evidence that ecologically restorative fiscal policies are among the most effective instruments for economic recovery. Funke et al. (2021) monitored the climate impact of fiscal policy lessons from tracking COVID-19 responses. The report assesses the different contributions of trackers along with their strengths and flaws, and draws lessons for future climate policy assessments. The report concludes that, although trackers produced meaningful ratings of (usually low) greenness and boosted awareness, their techniques varied widely, with some fundamental and inevitable shortcomings. The Global Recovery Observatory's open-source stimulus expenditure data is used to investigate green recovery practices (Johnston 2022). It shows that the world developed nations (G7, G20, and BRICS) all invest more cleanly in response to COVID-19. Nevertheless, compared to the G7's potential norm entrepreneurial role, both individually and collectively the study provides vital insights into the paths and challenges to the Global Green New Deal norm dissemination throughout plurilateral summit institutions.

The main data for the assessment of the green economy strategy part of the study is the list of green interventions announced by the governments of Kazakhstan and Uzbekistan in the last decade. The study inspected, classified, and assessed the multiple interventions in each country's respective green economy strategy document (available from the website). [5] The strategic document content is multifold, with each policy document having several measures. Summaries of the policy documents are presented in Table A1 in the Annex.

To assess the potential economic impact of the interventions, we first taxonomized the green economy interventions of Kazakhstan and Uzbekistan individually. The announced interventions include a large number of incentive and investment measures.

[5] The concept for transition of the Republic of Kazakhstan to Green Economy by 2050 is available at: https://www.oneplanetnetwork.org/sites/default/files/kazakhstan_concept_for_transition_of_the_republic_of_kazakhstan_to_green_economy.pdf

The strategy for the transition of the Republic of Uzbekistan to a green economy in the period of 2019-2030 is available at https://lex.uz/ru/docs/4539506

We classified and coded the respective country's green economy interventions following the Observatory methodology relevant architype codes (based on O'Callaghan et al. 2021). The Annex lists archetype codes and descriptions for each country's intervention in Tables A2 and A3.

Next, we assigned a Likert scale value for each country's coded intervention across the economic impact metrics (LEM and SPI mentioned earlier). The current paper uses the Likert values from the Observatory methodology (as in O'Callaghan et al. 2021). The values are preassigned based on empirical evidence, extensive literature review, and consultations with leading experts. The Observatory methodology assesses the potential economic impact of interventions on a three-point Likert scale (ranging from -1 [regress in economy]; 0 [little net change], and +1 [improvement in economy]). The Likert assessment for the identified interventions is provided in Tables A2 and A3 in the Annex.

Finally, we descriptively analyze the mean potential economic impact of the identified mix of green interventions and present the finding using charts and narratives. The analysis of the current paper of the potential economic impact of green interventions is descriptive and provides a general but valuable picture. The economic impact study is not a substitute for detailed ex-post policy analysis or impact assessment.

5.3 RESULTS

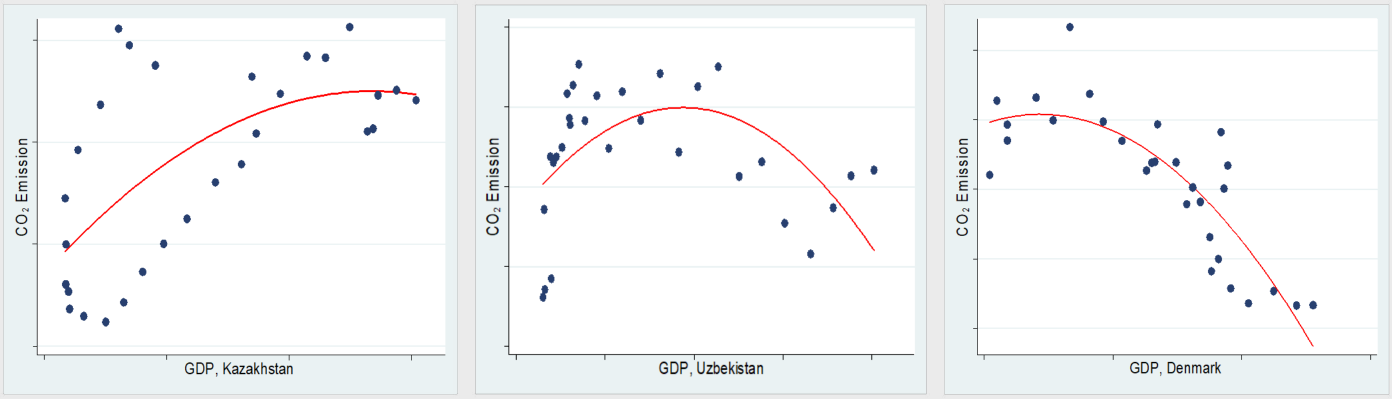
5.3.1 Correlation between CO_2 emissions and GDP values

Annual CO_2 emissions by country over the 30 years (Figure A1 in the Annex) demonstrate that the least CO_2 emission rate was observed in Denmark for almost three decades (1990-2018), despite GDP growth. In Kazakhstan, emissions had a decreasing pattern until 2000, and then significantly changed in the opposite direction. This pattern is similar to the changes in GDP levels of the country over time. Uzbekistan has a relatively stable level of emissions with slight variations. The CO_2 emissions per capita among the study nations for the 30 years are provided in Figure A2 (in the Annex). In Uzbekistan, it is around 0.005 units with a slightly decreasing pattern. Uzbekistan's low per capita emission is owing to the higher population growth rate in Uzbekistan relative to Kazakhstan and Denmark. [6] In Kazakhstan, per capita CO_2 emissions decreased until 2000, followed by a sharp increase. In Denmark, CO_2 emissions per capita have a decreasing pattern in the long term. The variability in CO_2 emissions by country is depicted in Figure A3 (in the Annex). Over time, the variations of CO_2 emissions are higher in Kazakhstan and Denmark relative to Uzbekistan.

Using the 30 year panel data, Figure 5.1 illustrates the correlation between CO_2 and GDP in the selected CA countries compared to Denmark. The linear term of GDP is positive and the nonlinear term is negative, which proves the presence of the inverted U-shaped association between economic growth and CO_2 emissions.

[6] The average population growth rate during 1990 to 2018 in Uzbekistan was 1.74 percent, Kazakhstan 0.46 percent, and Denmark 0.41 percent.

Figure 5.1. Correlation between CO_2 and GDP



Source: Authors using the dataset

The correlation figure suggests that the sign of GDP is expected to be positive, and the square of GDP is negative in the regression analysis. The positive sign for GDP indicates that the higher the economic growth, the higher the CO_2 emissions. On the other hand, a negative sign in the square of GDP indicates a turning point where the relationship is inverted, and further higher economic growth leads to a reduction in CO_2 emissions. The correlation between CO_2 and GDP for all three countries confirms this statement.

5.3.2 Determinants of CO_2 emissions

Table 5.4 compares the effect of determinants of CO_2 emissions employing the fixed effects (FE), random effects (RE), and ordinary least squares (OLS) models for Kazakhstan and Uzbekistan, based on our preferred base model that uses FE techniques. [7] The estimates show that GDP positively affects CO_2 emissions, suggesting that GDP growth generally increases emissions, which is significant with a 45.32 t value (column 1). However, the square term of GDP is negative and statistically highly significant at a level of 95. It confirms that countries with increased income invest more in sustainable environmental projects. A study by Grossman and Kruger (1995) notes that if the square of GDP is statistically insignificant, then a rise in GDP will lead to an increase in pollution-related emissions. If statistically significant, however, it shows that countries with increasing incomes invest more in green energy, thereby contributing to reductions in CO_2 emission in the long run.

The FE model also shows that a 1 percent increase in population growth, energy use, and urbanization in Kazakhstan and Uzbekistan increases CO_2 emissions by 1.146 units, 0.0003 units, and 0.071 units, respectively. In contrast, the use of green energy has a negative association with CO_2 emissions. If renewable energy consumption expands by 1 percent, it will reduce CO_2 emissions by -0.063. An increase in forest cover also reduces CO_2 emission by -0.516 units.

Table 5.4. Determinants of CO_2 emissions: FE, RE, and OLS models [8]

VARIABLES	(1) FE Kazakhstan, Uzbekistan	(2) RE Kazakhstan, Uzbekistan	(3) OLS Kazakhstan, Uzbekistan
GDP	4.120**	1.064	1.064
	(45.32)	(0.58)	(0.65)

[7] Hausman test reports that the FE model is preferred.

[8] The Hausman test reports that the FE model is preferred.

GDP2	-0.245**	-0.069	-0.069
	(-50.58)	(-0.68)	(-0.74)
Export	-0.054	0.040	0.040
	(-4.93)	(0.96)	(0.70)
Import	-0.045	-0.074***	-0.074
	(-2.10)	(-12.11)	(-1.59)
Population	1.146**	0.768***	0.768*
	(35.47)	(2.78)	(1.78)
Energy use	0.0003***	0.0003***	0.0003***
	(699.67)	(70.25)	(10.54)
Renewable energy	-0.063*	-0.061***	-0.061***
	(-8.14)	(-6.07)	(-2.79)
Forest	-0.516***	-0.034	-0.034
	(-98.53)	(-1.10)	(-0.76)
Urbanization	0.071**	0.021	0.021
	(18.14)	(0.77)	(1.05)
Constant	-24.748***	-6.033	-6.033
	(-396.00)	(-0.60)	(-0.81)
Observations	44	44	44
R squared	0.932	0.932	0.989

Notes: The dependent variable is $LnCO_2$. GDP, GDP2, export, import, and population are in the natural log form. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

The RE (column 2) and OLS (column 3) regression model estimates in Table 5.4 show that, generally, renewable energy has a negative effect on CO_2 emissions, and population and energy use have a positive effect. The RE model also suggests that exports of goods increase CO_2 emissions, while import has a negative association.

Table 5.5 below demonstrates the OLS model results for each country. The table reports statistically significant variables only. The results show that high total energy use has an environmentally detrimental effect in Kazakhstan and Denmark (0.0003), compared to Uzbekistan. In contrast, renewable energy contributes to emission reduction in all three countries: Kazakhstan, Uzbekistan, and Denmark (-0.085, -0.117, and -0.014, respectively).

Urbanization shows a negative impact on the environment in Uzbekistan. A 1 percent increase in urbanization in Uzbekistan increases CO_2 emissions by 0.169 unit.

Table 5.5. Determinants of CO2 emissions: OLS models

VARIABLES	(1) OLS Kazakhstan	(2) OLS Uzbekistan	(3) OLS Denmark
Energy use	0.0003***	0.0003	0.0003***
	(3.37)	(1.65)	(12.90)
Renewable energy	-0.085**	-0.117***	-0.014*
	(-2.34)	(-3.88)	(-2.04)
Urbanization	0.188	-0.169**	0.019
	(0.38)	(2.97)	(0.39)

Notes: Regressions include all variables from Table 5.3. Only statistically significant observations are reported. Robust t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

5.3.3 Assessment of announced green interventions

Kazakhstan's green economy strategy as of 2013 focuses on seven intervention sectors. These are (i) water management, (ii) green agriculture, (iii) energy-efficient buildings, (iv) renewable sources of energy, (v) green transport, (vi) waste management, and (vii) building human capacity and regulations for GE transition. We identified a total of 61 interventions across the seven pillars in Kazakhstan's green economy strategy document that are matched and mapped to 21 subarchetype codes provided by the Observatory methodology. The 21 standardized interventions are then assigned Likert scale values (-1, 0, 1) based on preassigned values in the Observatory methodology, as in Table A2 in the Annex.

Uzbekistan's strategy for green economy transition as of 2019 focuses on eight sectors: (i) energy efficiency and diversification into renewable sources, (ii) green construction, (iii) green transportation, (iv) smart irrigation in the agriculture sector, (v) solid waste management, (vi) Aral Sea restoration and green spaces, (vii) green research and development, and (viii) human capacity and regulation. We identified 114 announced interventions that are matched to 28 subarchetypes provided in the Observatory methodology. Each of the 28 subarchetypes is assigned a Likert scale value (-1,0,1) as in Table A3 in the Annex.

5.3.3.1 Speed of policy implementation(SPI)

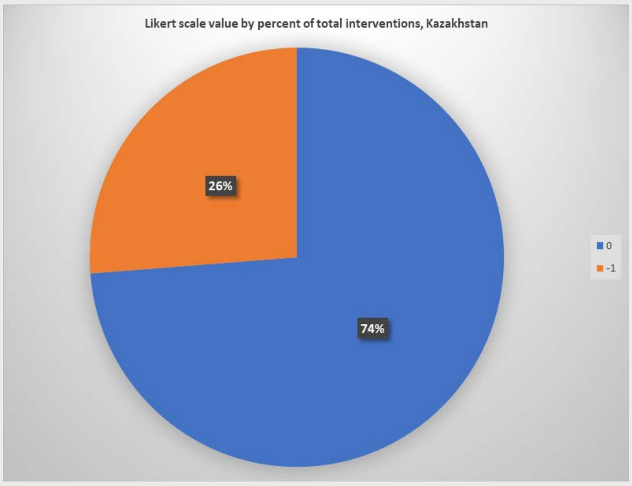
The SPI for Kazakhstan announced green interventions are evaluated to likely have a negative Likert scale assessment in 26 percent of cases (Figure 5.2a). This shows an expected delay in the implantation of a quarter of the announced interventions, having a regressive effect on the economy. At the same time, above 70 percent of the interventions have zero Likert scale values and thus a likely implementation speed that has a neutral impact on the economy.

For Uzbekistan, the speed of implementation of the announced green interventions is evaluated to have a negative Likert scale value in 39 percent of cases (Figure 5.2b). This shows an expected implementation lag in implementing over one third of the total announced interventions. In contrast, more than half of the interventions (61 percent of cases) have zero Likert scale values and thus implementation speed with a neutral impact on the economy.

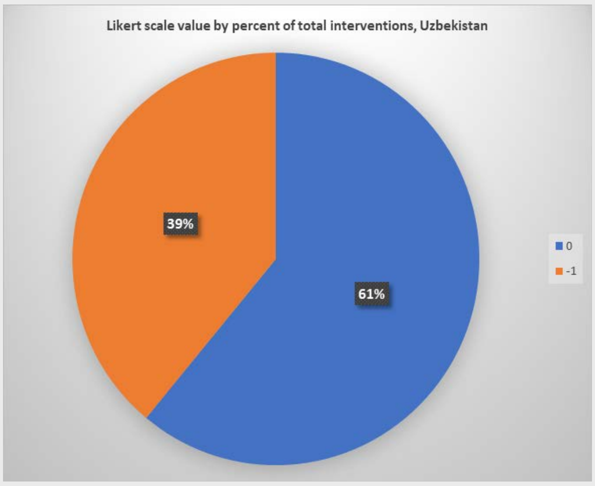
Both Kazakhstan and Uzbekistan economies are unlikely to benefit from a fast (positive Likert scale value) SPI of green interventions. Instead, in both countries, economic loss is expected owing to a likely delay in the implementation of announced interventions. The speed of implementation of announced interventions is likely to be better in Kazakhstan compared to Uzbekistan.

Figure 5.2. The potential impact of speed of policy implementation, by country

5.2a. SPI in Kazakhstan (N = 61)



5.2b. SPI in Uzbekistan (N = 114)



Source: Authors' calculation

Note: A Likert scale of -1 is expected delay in implementation and 0 is neutral speed of implementation.

5.3.4 Long-run multiplier effect

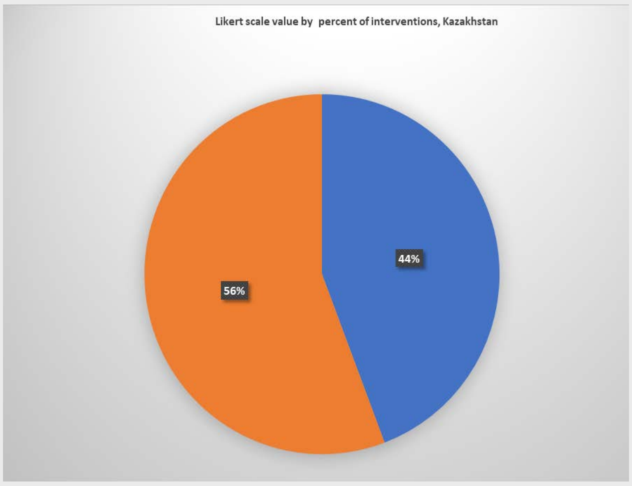
Kazakhstan's 56 percent of the 61 announced green interventions have a positive long-run multiplier effect in the economy, while 44 percent of the interventions have an overall negligible long-run multiplier effect on the country's economy (Figure 5.3a).

On the other hand, Uzbekistan's 71 percent of the total 114 announced green economy interventions have a likely positive and increased multiplier effect, while 33 interventions (29 percent) may likely have only a little impact on the long-run economy.

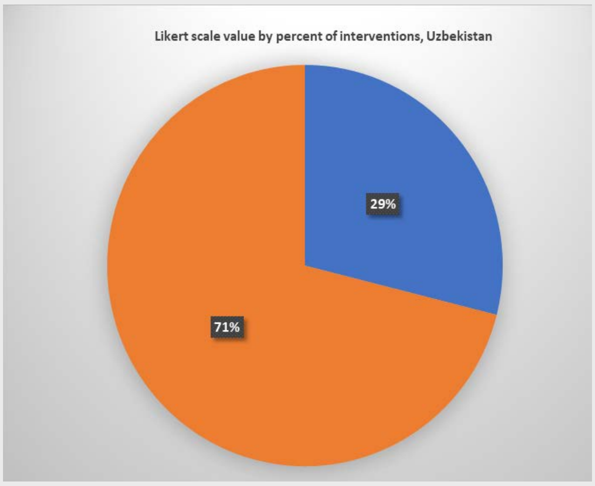
Interventions in both countries either have expected positive long-run multiplier effect in their economy or little net change in the long run [Likert scale value 0, 1] (Figure 5.3). This means that the interventions announced by both countries are expected to contribute to an increase in the long-run economy of the countries. Uzbekistan's interventions are expected to have a more long-run multiplier effect than Kazakhstan's. This means Uzbekistan will create more green jobs and income by implementing the green interventions in the country's green economy strategy.

Figure 5.3. Potential long-run multiplier impact of announced green interventions, by country

5.3a. Kazakhstan (N = 61)



5.3b. Uzbekistan (N = 114)



Source: Authors' calculation

Note: A Likert scale of 0 is a negligible long-run multiplier effect and 1 is a positive long-run multiplier effect in the economy.

5.4 DISCUSSION AND CONCLUSION

The current work used mixed quantitative and qualitative research methods to analyze the correlation between GDP and CO_2, the effect of determinants of CO_2 emissions, and to assess the potential economic impact of announced green economy strategies for Kazakhstan and Uzbekistan.

Our econometric analysis findings confirm that CO_2 emissions rise as the economy in both Kazakhstan and Uzbekistan grows. However, CO_2 starts declining after GDP reaches a certain threshold. These results are consistent with the findings of Zambrano-Monserrate et al. (2016) and Pao and Tsai (2011). The results suggest that nations with high GDP per capita are more likely to encourage sustainable development and economic growth. Tawiah et al. (2021) show that countries with high income can fund green initiatives. The results also suggest that both Kazakhstan and Uzbekistan should direct investments in mainly green energy production in pursuing green growth policies. The RE model suggests that Uzbekistan's exports of goods increase CO_2 emissions, while imports have a negative association. The result implies that, while increased trade openness is vital for any nation's economic wellbeing, internationalization may also hinder a country's efforts to achieve its environmental objectives. The pollution haven theory (Walter and Ugelow 1979) claims that foreign investment and commerce facilitate the transfer of pollution-intensive enterprises from one country to another. As a result, foreign investment and trade relate to poor environmental quality in the host nation (Beradovic, 2009). Some studies state that trade is asymmetrically related with carbon emissions. Increasing exports produces an increase in carbon emission while increasing imports causes a decrease in carbon emission (Tawiah et al. 2021). This was also the case in our study.

Urbanization contributes to increased carbon emissions in Uzbekistan, possibly owing to the high level of unplanned urbanization (ADB 2021). The poor city planning in Tashkent and other cities in Uzbekistan is also consistent with the World Bank (2022) paper, also highlighted in section 1.2. As the rural population moves to the cities, energy consumption increases. Also, growing cities require excessive land use for urbanization, which results in forest losses. However, planned urbanization structure correlates with lower urban CO_2 emissions (Li et al. 2021). With adequate planning and laws in place for carbon emission and city development, the economic advantages of urbanization may be reached without harming the environment. Also, land use planning helps minimize carbon emissions and hence the effect of urbanization on climate (Li et al. 2021).

The analysis of green transition strategies for both Kazakhstan and Uzbekistan show that the interventions are relevant and address the empirical challenges. The analysis of the potential economic impacts of announced green interventions shows that, despite promising interventions, the economic gain from the speedy implementation of announced interventions in both Kazakhstan and Uzbekistan is likely to be negligible. On the other hand, Kazakhstan is likely to lose less than Uzbekistan from an expected regressive speed of policy implementation.

The assessment revealed that the announced green interventions by both countries are expected to bring more economic benefits in the long term. However, Uzbekistan is likely to gain more from the long-run multiplier effect of the interventions than Kazakhstan, possibly owing to the nature of the announced interventions (in the Annex).

In summary, the green economy policies in both countries have an economic impact in the long run, which can therefore be an incentive for investing in the transition now.

This means that the green strategies are likely to have an impact on economic growth and employment generation, while addressing resource efficiency and environmental protection in the long run. In other words, green policies will boost growth, innovation, and green employment as investments in the renewable energy sector rise and priority sectors are decarbonized.

5.5 POLICY OPTIONS

This section provides policy options and recommendations to tackle the challenges facing the green economy transition (identified in sections 1.2 and 4).

- Both Kazakhstan and Uzbekistan need to implement development strategies that result in greater GDP and have the resources to provide green growth incentives as high economic growth encourages green transition. The adopted green economy strategies of both countries will improve economic wellbeing while reducing environmental risks. The introduction and expansion of modern, energy-saving technology and green innovation will upgrade existing high-emission sectors. Consequently, carbon emissions will be lowered while the economy continues to thrive.

- In the long term, the green economy goals of Uzbekistan should include population and urbanization projection. Population and urbanization can increase owing to high fertility rates or migration. Increased population growth results in higher consumption, including consumption of energy, which means CO_2 emissions will increase. Also, rapid population growth makes it more difficult for Uzbekistan to afford the increase in public expenditure per capita, making it challenging for the government to invest in green interventions.

- Uzbekistan needs a strategy for sustainable and green cities. Such an urbanization strategy and capacity building will pave the way for green governance and the planning of large and medium-size cities in Uzbekistan.

- Both Kazakhstan and Uzbekistan need to continue paying attention to energy use (mainly for electricity generation and heating). Energy use has a more detrimental effect in Kazakhstan because per capita energy use is two times more than in Uzbekistan.

- Increased forest cover decreases CO_2 emissions. Therefore, both countries should invest in afforestation programs as part of a long-term green solution. The programs need to increase their forest area with trees that are compatible with the local environment and are the most carbon-absorbing species.

Transition to a green economy is vital for the sustainable development of both countries. For transition to happen, the following criteria need to be met:

- Kazakhstan and Uzbekistan should gradually transition to competitive energy markets by shifting to clean energy sources. Expansion to renewable energy is the best alternative to the dominant economic model that uses primarily fossil fuel energy. Renewable energy will reduce environmental risks and economic loss in the future. Governments can support renewable energy by providing grants and loans to investors in that sector.

• To achieve the anticipated green growth, Kazakhstan and Uzbekistan must continue to encourage contextual legislative structure, enabling regulation and green technical standards to speed up the implementation of announced interventions. The governments should actively encourage private investors to enter the carbon-neutral economy. Another critical approach to minimizing carbon emissions is to continue raising public awareness and providing access to energy-efficient technology.

• To hasten the transition in Uzbekistan, approaches that include active engagement and investment of the civil society, private sector and green specialized NGOs, and the local communities are equally as important as state engagement. Fostering public–private partnership and supportive policies for green investment attracts finances for green initiatives.

• Public awareness using mass media is vital in Uzbekistan to mobilize and engage different layers of the population. Such green awareness campaigns are a long-term green investment in human capital.

• Green transition is a long-term evolution and vision; accordingly, the study recommends that planning and mapping of resources, stakeholders, and capacity building should be made for much longer horizons in both Kazakhstan and Uzbekistan.

• To meet the desired outcomes of the green economy transition in Uzbekistan, specific support is needed for reskilling and training the responsible government agencies for longer-term decarbonization. Capacity building is also needed for the key private sector personnel in the green transition process.

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ANNEX

Table A1. Summary of the green economy strategies for Kazakhstan and Uzbekistan studied in this paper

COUNTRY	Kazakhstan	Uzbekistan
Year the strategy was adopted	2013 (1st in CA)	2019
Strategy period	2013-2050 (37 years)	2019-2030 (11 years)
Policy title	CONCEPT for the transition of the Republic of Kazakhstan to a green economy	Presidential resolution # 4477 on the strategy for the transition of the Republic of Uzbekistan to a green economy for the period to 2030.
Objectives Of the strategy	To enable Kazakhstan to enter the top 30 developed countries of the world by 2050. Recover its water and land resources by 2030.	To increase the energy efficiency of the economy; diversify to renewable energy; introduce green criteria for public investment; Pilot green economy projects; training and retrain personnel on green economy.
Expected economic growth	3 percent increase in GDP per annum from 2013	Higher middle-income country by 2030.
Situation at the time of strategy adoption	Inefficient use of resources. Forecast to run short of water resources. One third of the agricultural lands are degraded. More than 10 million ha of potentially arable land abandoned or lower land productivity. Toxic and radioactive industrial waste a serious problem. Inadequate system of tariffs and pricing for energy.	zbek strategy does not provide a situation analysis of baseline.
Loss in the economy owing to inefficiency	USD7 billion per annum by 2030.	
Intent	Solid political momentum for change. Cost competitiveness of green technologies is improving very rapidly. The global promises of a green economy to stimulate development, social stability, and the creation of jobs.	The obligations of the Paris Agreement (ratified in 2015). Fast reform momentum.
Investments required for the transition to a green economy	1 percent of GDP per annum (equivalent to USD3 billion to USD4 billion).	

Targets	GDP energy intensity will decrease by around 25 percent by 2030 and around 40 percent by 2050 versus the 2013 level.	A decrease in GHG per unit of GDP (by 10 percent from the 2010 level (revised to 35 percent at the COP 26); Increase in energy efficiency/decrease in the carbon intensity of the GDP (twofold by 2030; Development of renewable energy sources (more than 25 percent of the total electricity generation by 2030); Access to modern, inexpensive, and reliable energy supply (100 percent of the population and sectors of the economy); Modernization of the infrastructure of industrial enterprises (increasing energy efficiency by 20 percent); Introduction of drip irrigation technologies (1 million ha); An increase in the yield of irrigated crops (20 percent to 40 percent); Achieving land degradation neutrality (LDN) and land use plan; Increase the average productivity of agricultural food products (20 percent to 25 percent)
Approaches for transition to a GE	Sustainable water use to completely close the water gap by 2050. Sustainable and high-productivity agriculture. Energy saving and energy efficiency in priority industries. Renewable energy/power source. Waste management.	Saving water in agriculture. Alternative and renewable energy source. Green transport. Green building. Technical capacity building.
Institutions to oversee the implement of the strategy	Council	Interdepartmental (interagency) council led by the MoEPR.

Table A2. Taxonomy and Likert value of announced interventions in the green economy strategies, Kazakhstan

SUBARCHETYPE CODEA[a]	Description of archetype	Frequency of announced interventions	Potential economic impact measured using Likert scale[b] (-1 = regress), (0 = little net change), and (+1 = improve)	
			Speed of implementation	Long-run multiplier effect
μ**4**	Water way protection and enhancement	6	0	0
λ**1**	Green retrofitting programs	6	0	1
θ**5**	Local utility investment	6	0	1
ψ**4**	Other sectoral R&D programs	6	-1	1
μ**5**	Agricultural uplift	5	0	0

X1	Green worker retraining	5	0	0
V2	Modernization and transition investments	4	0	1
λ3	Other building upgrade support	4	0	1
π2	Large scale infrastructure	3	-1	1
μ2	Tree planting and biodiversity protection	3	0	0
δ1	Public transport expansion	2	-1	1
η2	Nuclear energy generation	2	-1	0
μ1	Green space investment	1	0	0
η1	Renewable energy generation	1	-1	1
θ3	Clean housing investment	1	0	1
θ1	Urban development program	1	0	0
ε3	Refurbish coal mines and gas fields	1	-1	0
ε4	Refurbish transmission of fossil energy	1	-1	0
T1	Electric vehicle (fleet) exchange program	1	0	0
T2	Electric vehicle subsidies	1	0	0
δ5	Cycle and walking infrastructure	1	0	1
Total = 21		61	0 = 45 -1 = 16	0 = 27 1 = 34
Average			-0.26	0.56

Note: a are codes adopted from O'Callaghan et al. (2021); b are Likert scale values based on O'Callaghan et al. (2021)

Table A3. Taxonomy of archetypes/interventions and Likert value for economic impact variables according to Observatory methodology, Uzbekistan

SUBARCHETYPE CODE[a]	Description	Frequency of announced interventions	Potential economic impact measured using Likert scale[b] (-1 = regress), (0 = little net change), and (+1 = improve)	
			Speed of implementation	Long-run multiplier effect
V2	Modernization and transition investments	15	0	1
η**1**	Renewable energy generation	11	-1	1
V3	Support to innovative industries for green technology	9	0	1
λ**1**	Green retrofitting	9	0	1
ψ**1**	Energy sector R&D	8	-1	1
X1	Green worker retraining	6	0	0
μ**2**	Tree planting	6	0	0
V1	Clean energy market participation	4	0	1
ψ**2**	Agriculture R&D	5	-1	1
ψ**3**	Industrial R&D	5	-1	1
μ**5**	Agricultural uplift	4	0	0
μ**3**	Ecological conservation initiatives	3	0	0
μ**4**	Waterway protection	3	0	0
ψ**4**	Other sectoral R&D programs	3	-1	1
λ**3**	Building upgrade support	3	0	1
η**4**	Upgrade electric grid	3	-1	1
η**8**	Carbon capture and storage	2	-1	

η**9**	Initiatives to clean dirty energy	2	-1	0
θ**1**	Urban development programs	2	0	0
δ**6**	Initiative to improve dirty transport	2	-1	0
θ**5**	Local utility investment	2	0	1
T2	Electric vehicle subsidy	1	0	0
T1	Electric vehicle transfer (fleet) program	1	0	0
δ**1**	Public transport expansion	1	-1	1
λ**2**	Solar support	1	0	1
γ**1**	Road construction	1	-1	1
γ**2**	Automobile support	1	-1	0
θ**3**	Clean housing investment	1	0	1
Total = 28		114	0 = 70 (61 percent) -1 = 44 (39 percent)	Zero = 33 (29 percent) One = 81 (71 percent)
Average			-0.39	0.71

Note: a = are codes adopted from O'Callaghan et al. (2021)
b = source of Likert scale value is O'Callaghan et al. (2021)

Table A4. Summary statistics, Kazakhstan (1990-2020)

VARIABLES	Number of observations	Mean	Standard deviation	Minimum	Maximum
CO_2	29	189,654.14	47,731.895	111,870	256,340
GDP	31	120,853.39	52,626.995	58,532.031	211,107
Export	31	44,785.881	11,022.67	26.918.938	60,627.672
Import	31	37,097.626	13,039.213	20,103.949	78,239.094
Energy use	25	3,658.637	853.639	2,324.548	4,796.144
Renewable energy	29	1.718	0.431	1.154	2.773
Population	31	16.25	1.177	14.858	18.754
Forest	31	1.189	0.043	1.142	1.28
Urbanization	31	56.575	0.546	55.9	57.671

Table A5. Summary statistics, Uzbekistan (1990-2020)

VARIABLES	Number of observations	Mean	Standard deviation	Minimum	Maximum
CO_2	29	113,920	8,330.951	96,130	125,390
GDP	31	52,882.635	27,218.752	26,042.596	107,981.99
Export	26	8,172.098	5,024.655	2,490.489	18,454.111
Import	26	10782.219	7181.359	3135.352	26494.666
Energy use	24	1914.38	235.622	1419.478	2294.824
Renewable energy	29	1.275	0.3	0.71	1.771
Population	31	26.812	3.977	20.51	34.232
Forest	31	7.416	0.677	6.187	8.375
Urbanization	31	47.619	3.27	41.365	51.15

Figure A1. Annual CO_2 emissions, by country

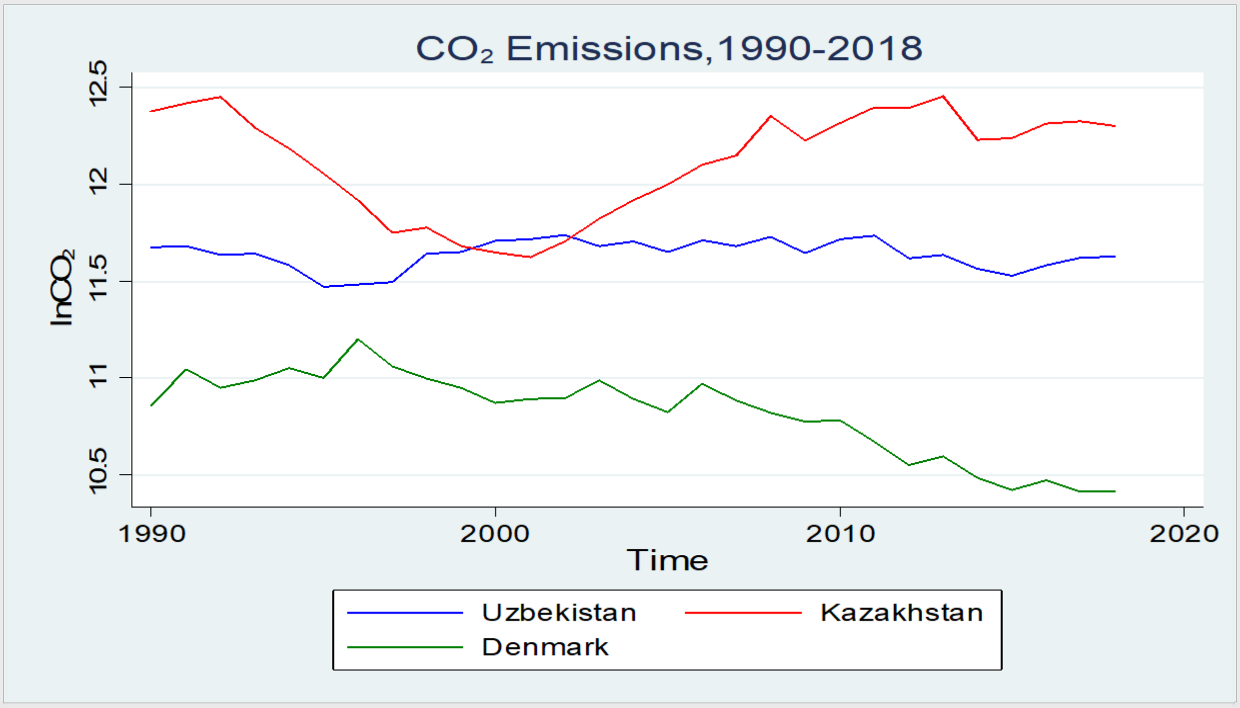

Figure A2. CO_2 per capita emissions, by country

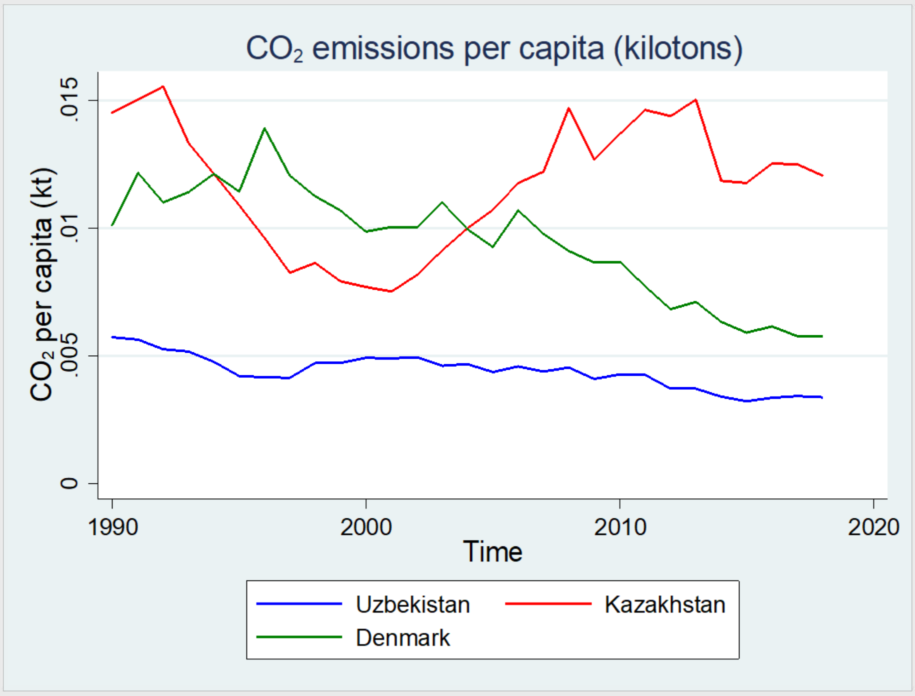

Figure A3. CO_2 emissions and variability