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## ACCOUNTING, CORPORATE GOVERNANCE & BUSINESS ETHICS | RESEARCH ARTICLE

# Environmental tax, carbon emission and female economic inclusion

Michael Gift Soku<sup>1\*</sup>, Mohammed Amidu<sup>1</sup> and Coffie William<sup>1</sup>

**Abstract:** This research examines the nexus between environmental tax, carbon emission, and female economic inclusion. The study employs a quantitative research method, utilizing the Generalized method of moments (GMM) on a dataset of 65 countries from the period 1994 to 2020. The research finds that environmental tax has a significant negative effect on carbon emission, and that firms with a higher level of female economic inclusion tend to have lower carbon emission levels. Furthermore, the research shows that firms with a higher level of female economic inclusion are more likely to implement environmentally sustainable practices, which in turn reduces their carbon emission levels. These findings suggest that policies that promote environmental taxation and female economic inclusion can be effective in reducing carbon emissions and promoting sustainable business practices. The sampling technique used in this study is purposive sampling, where 64 countries were selected based on their availability of data on environmental tax, carbon emissions, and female economic inclusion. The population of the study comprises all countries that have data available on these variables between the period of 1994 to 2020. While there are limitations to this study, including the need for further research to fully understand the complex relationship between environmental taxation, carbon emissions, and female economic inclusion, this research represents an important contribution to the literature on these critical issues.

**Subjects:** Environmental Economics; Accounting; Corporate Governance

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**Keywords: Environmental tax; carbon emission; female inclusion; generalized method of moments; environmental pollution**

## 1. Introduction

The issue of environmental degradation and its impact on human welfare has become a critical global concern in recent years. Carbon emissions which is the release of greenhouse gases into the atmosphere as a result of human activities such as burning fossil fuels, deforestation, and industrial production is a significant contributor to climate change and have severe implications for ecological and economic sustainability (Bastida, García-Cartagena, et al., 2020; D. Debnath et al., 2021). Hence, the need for policies that promote environmental sustainability and economic development has become a priority for policymakers worldwide. One potential solution is the use of environmental taxation, which refers to the use of taxes and other market-based instruments to internalize the external costs associated with environmental degradation. Environmental taxation can help promote environmentally sustainable practices and encourage the adoption of cleaner technologies which can help reduce carbon emissions while promoting sustainable economic growth (Chen & Chen, 2020; Goulder, 2013). Additionally, promoting female economic inclusion which refers to the integration of women into the economy, where they have equal access to employment opportunities, resources, and decision-making has been identified as a key strategy for reducing poverty and promoting sustainable development (Kabeer, 2012; World Bank, 2019). In this research, we explore the nexus between environmental taxation, carbon emissions, and female economic inclusion.

The nexus between environmental taxation, carbon emissions, and female economic inclusion has received increasing attention in recent years. Researchers have explored various aspects of this topic, from the impact of environmental taxation policies on carbon emissions to the role of gender in shaping the distributional effects of these policies.

This paper provides an overview of several studies on this topic, summarizing their findings and highlighting their contributions to literature. For instance, Pless and Rogge (2016) examine the impact of environmental taxation policies on carbon emissions in OECD countries. They find that environmental taxes can be an effective tool for reducing carbon emissions, particularly in countries with high levels of carbon intensity. Despite its contributions, the study by Pless and Rogge (2016) also has some weaknesses. One potential weakness is that the study focuses only on OECD countries, which limits its generalizability to other regions of the world. Additionally, the study does not explore the potential distributional effects of environmental taxation policies on different segments of the population, including women. This is an important consideration, as previous research has shown that environmental policies can have differential impacts on different social groups, particularly those who are already disadvantaged. Another potential weakness is that the study does not examine the specific design features of environmental taxes that are most effective in reducing carbon emissions. However, our research seeks to consider countries within and outside the OECD and examine as well various environmental policies that can help ensure maximum female economic inclusion in countries. Also, Clancy and Ruz (2018) provide a comprehensive review of the literature on the intersection of gender, environmental taxation, and inequality. They find that environmental taxation policies have the potential to exacerbate gender inequalities, particularly in countries where women are already disadvantaged in the labor market. However, they also note that gender-sensitive environmental taxation policies can promote gender equality and reduce environmental harm. Despite its contributions, the study by Clancy and Ruz (2018) also has some weaknesses. One potential weakness is that the study relies heavily on secondary sources, such as academic articles and reports, which may limit its scope and depth. Additionally, the study does not provide a detailed analysis of the specific design features of environmental taxation policies that are most effective in promoting gender equality. This information would be useful to our research as it seeks to design effective environmental taxation policies that promote gender equality.

Another potential weakness is that the study does not explore the potential trade-offs between environmental objectives and gender equality objectives in the design of environmental taxation policies. However, our research seeks to close this gap by exploring potential trade-offs between environmental objectives and gender equality objectives in the design of environmental taxation policies. However, it is appalling to note that, all these are similar studies that are linked to our current study and will contribute massively to our literature.

The theoretical motivation for this research is grounded in the literature on environmental taxation, carbon emissions, and sustainable development. Our literature suggests that environmental taxation policies can be an effective tool for reducing carbon emissions and promoting sustainable development. However, policymakers must ensure that these policies are equitable and progressive and do not place an undue burden on vulnerable groups. The empirical motivation for this research is based on the growing interest in environmental taxation policies and gender equality policies at the global level. Many countries are implementing environmental taxation policies to reduce carbon emissions, promote sustainable development and ensure gender equality across various industries. For instance, Klasen and Lamanna (2009) found that gender inequality can be a significant barrier to economic growth and development. Moreover, policies that promote gender equality can help reduce poverty and inequality and promote economic growth (United Nations Development Programme UNDP, 2015). These studies highlight the importance of considering gender-sensitive policy design in the context of environmental taxation and sustainable development. However, there is a need for further research to explore the implications of these policies for vulnerable groups, particularly women, and to identify ways to ensure that these policies are equitable and progressive which makes our current study very important.

Furthermore, this current paper on the nexus between environmental taxation, carbon emissions, and female economic inclusion makes several important contributions to the literature. Firstly, this paper contributes to the literature on environmental taxation by examining the potential for environmental taxation policies to reduce carbon emissions. It provides a comprehensive review of the existing literature on environmental taxation policies and their impact on carbon emissions in both developed and developing countries. This review highlights the potential of environmental taxation policies to reduce carbon emissions and identifies key design features that are likely to be most effective in achieving this goal. Secondly, this paper contributes to the literature on gender and the environment by exploring the gendered impacts of environmental taxation policies. It highlights the potential for environmental taxation policies to disproportionately affect women, particularly those who are already disadvantaged, and emphasizes the need for policymakers to consider gender in the design and implementation of environmental taxation policies. This is an important contribution, as previous research has shown that gender is an important factor in shaping the distributional effects of environmental policies. Also, this paper contributes to the literature on economic inclusion by exploring the potential for environmental taxation policies to promote female economic inclusion. It identifies potential policy solutions that can simultaneously promote environmental sustainability and gender equality and highlights the importance of considering gender in the design and implementation of environmental taxation policies. Lastly, this research identifies avenues for further research to deepen our understanding of the nexus between environmental taxation, carbon emissions, and female economic inclusion.

In conclusion, this study highlights the complex and multifaceted nature of the nexus between environmental taxation, carbon emissions, and female economic inclusion. While environmental taxation policies have the potential to promote sustainable development and reduce carbon emissions, policymakers must be mindful of the potential distributional effects of these policies, particularly on vulnerable groups such as women. The rest of the study is organized as follows; section two reviews pertinent literature surrounding environmental tax, carbon emission and female economic inclusion, Section three describes the methodological approach. Section four present the results while section five concludes the entire study.

According to Eastin (2018), environmental pollution adversely affects girls' school attendance, impairs women's capacity to earn independent income, and ultimately has an impact on gender equality. Raworth (2012) opines that, given the recent rise in unsustainable development strategies that prioritise economic expansion above and beyond what the world can tolerate, it is thought that women and children will be the most negatively impacted by the negative effects of climate change. The underlying idea that gender equality and climate justice must be connected derives from this. An association between employed women and environmental changes, such as CO<sub>2</sub> emissions in the atmosphere, was found in earlier studies (Kronsell et al., 2016; Lv & Deng, 2019; Waygood & Avineri, 2016; Winslott Hiselius et al., 2019). Women are more concerned about the environment and perceive the risk as a threat to the environment because they are more sensitive to it (Buckingham, 2016; Eisler et al., 2003).

According to a study, women have a distinct perspective on environmental issues, are more concerned about them, and have suggested a potential solution to the problem of environmental pollution in the United States of America (McCright, 2010). In another study, women's employment might increase organisational profits and increase the global gross domestic product by up to 28 trillion dollars annually by 2025 (Trivedi et al., 2019). Higher returns will result from more women working in the energy sector, and this labour force may contribute to development with low carbon emissions. There is evidence that having more women in senior positions will increase energy efficiency and investment in renewable energy, which will ultimately lead to a decrease in CO<sub>2</sub> emissions. The majority of the time, women control energy at the household level in low-income nations. Because of this, women working in sales and marketing jobs can persuade and inspire other women to utilise sustainable energy sources and give them the space and conveniences they need to learn about cutting-edge technologies that increase the system's energy efficiency (Gill et al., 2012). Additionally, a study revealed that educated women in positions of power plan better for the society and adopt and promote a green economy and products which are beneficial for the environment (Kwauk & Braga, 2017).

There are three ways in which environmental pollution affects women's levels of economic activity, either directly or indirectly. First, research indicates that environmental pollution directly affects workers' health, which in turn affects the number of hours they are productive (ILO, 2018). Workers may therefore become ill and report to work sick in situations where environmental degradation reaches severe levels (Montt et al., 2018). As a result, Kim et al. (2017) notes that over time, the declining labour supply often has an impact on workers' personal health. According to Aragon et al. (2017), the second way that environmental pollution affects the labour supply is through the care of their dependents' illnesses. Evidence suggests that children are especially susceptible to the negative effects of air pollution on their health. Last but not least, environmental degradation frequently causes the ecology and other facilities that support jobs to suffer (Montt et al., 2018). The majority of women work in climate-sensitive industries including agriculture, forestry, and fisheries in most developing nations (Terry, 2009). The destruction of the environment and the loss of natural resources, however, may have a disproportionately negative impact on female labour participation because the effects of climate change and global warming are brought on by the production of greenhouse gases. According to studies, women make up the majority of smallholder farmers who work on marginal areas, which are prone to floods, landslides, droughts, and other climate hazards (Koehler, 2016).

The discourse on female inclusion and carbon emission has been mostly centered on the inputs that females can make towards reducing pollution and maintain climate balance (Konadu, Ahinful, Boakye & Kwauk & Braga, 2017; McKinney & Fulkerson, 2015). Unfortunately, there is little data on how environmental challenges affect gender norms (Denton et al., 2002), and there is even less information on how it affects women's participation in the labour force (Montt et al., 2018). The literature reveals that already marginalised and vulnerable parts of the population experience the most brunt of the effects of climate change, despite the tendency to believe that women and men are equally affected by it because the effects are most obvious on social scales. Eastin (2018). This

study therefore seeks to first identify the effect of carbon emission on the level of female employment in an economy. More so, given the varied pros and cons of the imposition of environmental tax in an economy. This study seeks to identify whether the imposition of environmental tax increases or decreases the level of female employment in an economy. Finally, the study examines the joint impact of carbon emission and environmental tax on female inclusion. The interaction between environmental tax and carbon emission on the level of female economic participation is examined in order to ascertain whether the imposition of environmental tax in an economy will reduce the level of carbon emission and thus increase the demand for female labour in these economies. The female labour force participation rate (FLFPR) can boost a nation's potential output and economic development as it increases labour supply and, consequently, the country's production capability (Cooray et al., 2017). As a result, a study on how environmental taxes and carbon emissions affect female inclusion is important.

The study makes the following contribution to literature. First, an assessment of the impact of carbon emission on the level of female employment/participation is new. Additionally, an examination of the joint impact of carbon emission and environmental tax also adds new knowledge to the literature. The outcome from this study informs policy on the management of environmental tax to reduce carbon emission as well as increase the level of female employment in an economy.

## 2. Background

Environmental taxation has gained significant attention in recent years, especially concerning its potential to reduce carbon emissions and promote sustainable development. The primary objective of environmental taxation is to reduce the negative impacts of human activities on the environment by internalizing environmental externalities, such as greenhouse gas emissions. This paper aims to examine the nexus between environmental taxation, carbon emissions, and female economic inclusion. The paper provides an overview of regulatory, reform, and policy issues and developments within the context. Environmental taxation refers to the use of taxes, fees, and charges to internalize the environmental costs of human activities. Environmental taxes are levied on activities that generate environmental externalities, such as pollution, and the revenue generated is used to promote sustainable development. Environmental taxation can take various forms, such as carbon taxes, congestion charges, and waste disposal taxes. Carbon emissions refer to the release of carbon dioxide and other greenhouse gases into the atmosphere, which contribute to global warming and climate change. The transportation and energy sectors are the largest emitters of greenhouse gases. The reduction of carbon emissions is crucial for mitigating the adverse effects of climate change. Female economic inclusion refers to the participation of women in the labor market and their access to economic resources, such as education, training, and finance. Gender inequality is a pervasive issue globally, and women are disproportionately affected by poverty, discrimination, and marginalization. Female economic inclusion is essential for promoting economic growth and sustainable development.

Environmental taxation has been widely debated by policymakers, industry stakeholders, and civil society organizations. One of the significant challenges of environmental taxation is ensuring that it does not place an undue burden on vulnerable groups, such as low-income households and small businesses. To address this concern, policymakers must design environmental tax policies that are equitable and progressive.

Another regulatory issue is the potential for environmental tax policies to lead to carbon leakage, whereby carbon-intensive activities relocate to countries with less stringent environmental regulations. To mitigate this risk, policymakers need to adopt a coordinated approach to environmental taxation at the global level.

Many countries have implemented various forms of environmental taxation in recent years. For instance, Sweden has introduced a carbon tax that is applied to fossil fuels, and the revenue

generated is used to fund climate change mitigation and adaptation projects. The United Kingdom has also introduced a carbon price floor that provides a minimum price for carbon emissions.

In terms of female economic inclusion, many countries have introduced policies and programs to promote gender equality in the labor market. For instance, Rwanda has introduced a gender quota system that requires political parties to ensure that at least 30% of their candidates are women. In India, the government has launched the Beti Bachao Beti Padhao (Save the daughter, Educate the daughter) program, which aims to improve access to education and employment opportunities for girls and women.

In conclusion, environmental taxation has the potential to reduce carbon emissions and promote sustainable development. However, policymakers must ensure that environmental tax policies are equitable and progressive and do not place an undue burden on vulnerable groups. Furthermore, promoting female economic inclusion is crucial for achieving sustainable development and reducing poverty and inequality. To achieve this, policymakers must adopt policies and programs that promote gender equality in the labor market and ensure that women have access to economic resources.

### 3. Theory and empirical literature

#### 3.1. Theoretical overview

The theory motivating the nexus among environmental tax, carbon emission, and female economic inclusion are the double dividend hypothesis and Corrective Taxation.

##### 3.1.1. Double dividend hypothesis

According to the double dividend hypothesis, taxes on consumption, labour, and capital are reduced while a tax on the environment is imposed. This way, overall government revenues are unaffected, or revenue neutrality is maintained.

According to this hypothesis, imposing higher taxes on activities that causes pollution may have two different positive effects.

The first is an improvement in the environment, and the second is an improvement in economic efficiency due to the reduction of other taxes, such income taxes that affect labour supply and saving decisions, due to the use of environmental tax revenues (Fullerton & Metcalf, 2007). If there are economic and environmental benefits, the DD hypothesis is supported (Grubb et al., 1993; Nordhaus, 1993; Pearce, 1991; Repetto, 1992).

The consequences of environmental taxes on economies, as well as how their conception and use may influence both economic output and the environment, are still being debated (Babiker et al., 2003; Carbone et al., 2013; Devarajan et al., 2011). The double dividend (DD) hypothesis emerges as an intriguing concept in this setting for accomplishing environmental goals since the policy may result in efficiency improvements that might be used to make up for losers. It entails enacting an environmental tax or a series of levies while lowering other existing taxes such as those on labour, capital, or consumption so that overall tax receipts for the government are unaffected, or, to put it another way, revenues stay neutral. According to Goulder's concept, environmental taxes may result in a double dividend by both enhancing environmental quality and establishing a less distortionary tax structure as governments use the proceeds from pollution taxes to reduce other distortionary taxes (Chiroleu-Assouline & Fodha, 2006; Goulder, 1995).

Older studies, such as Klasen and Lamanna (2009), have highlighted the potential for gender inequality to limit economic development in developing countries. These studies suggest that environmental taxation policies that can simultaneously promote environmental sustainability and gender equality may be particularly effective at promoting economic development. The double

dividend hypothesis suggests that such policies may be possible, as the revenue generated by environmental taxes can be used to support policies that promote gender equality, such as investments in education or healthcare.

More recent studies, such as Pless and Rogge (2016), have examined the impact of environmental taxation policies on carbon emissions in OECD countries. These studies suggest that environmental taxation policies can be effective at reducing carbon emissions, particularly when they are designed to provide a regulatory fit with taxpayers' political values. The double dividend hypothesis suggests that the revenue generated by environmental taxes can be used to support policies that promote female economic inclusion, such as investments in childcare or parental leave.

Clancy and Ruz (2018) provide a comprehensive review of the literature on the intersection of gender, environmental taxation, and inequality. They highlight the potential for environmental taxation policies to disproportionately affect women, particularly those who are already disadvantaged. They also emphasize the need for policymakers to consider gender in the design and implementation of environmental taxation policies. The double dividend hypothesis suggests that policies that are designed to promote both environmental sustainability and gender equality may be particularly effective at reducing the negative impact of environmental taxes on women

This theory is relevant to the study since it aims to determine how environmental taxes over the long term affects carbon emissions and female inclusion. According to this theory, "a cleaner environment is the first dividend while an increase in female employment or GDP is the second dividend" (Clinch et al., 2006).

### 3.1.2. Corrective taxation

The concept of using taxes to address harmful externalities like pollution is traced to Pigou (1920), and these corrective taxes are sometimes referred to as Pigouvian taxes. Simple logic underpins the fundamental idea. When a good is produced or consumed and causes harm to a party other than the buyer or seller, that party is said to have a negative externality. Due to the failure of the buyer and seller to take the external cost into account, this is a market failure. As a result, any good with a negative externality will nearly always have an inefficiently huge supply produced by an unrestrained free market. By levying a tax on the good that causes the externality, the problem can be fixed. The external cost is included in the transaction, ensuring that the buyer pays the full marginal social cost of the good, if the tax rate is equal to marginal external damage (the total harm produced by one additional unit of the good to persons other than the buyer and seller). The tax incentive guarantees that the market offers the good at the efficient level in the absence of any other unaddressed market imperfections. If a product's minor external damage varies depending on who creates it or how it is created, that could be an issue. For instance, the carbon dioxide (CO<sub>2</sub>) emissions from a megawatt-hour of electricity produced by a natural gas-fired power station are far lower than those from a same amount of electricity produced by a coal-fired power plant (and even lower if generated by a wind turbine). However, that apparent complexity can be readily incorporated into this straightforward theory by either categorising those as separate goods (and consequently levying various tax rates on electricity generated from various sources) or, more simply, by categorising CO<sub>2</sub> emissions as the good with the negative externality and levying a tax per tonne of CO<sub>2</sub> emissions.

Older studies, such as Klasen and Lamanna (2009), have highlighted the potential for gender inequality to limit economic development in developing countries. These studies suggest that corrective taxation policies that can simultaneously promote environmental sustainability and gender equality may be particularly effective at promoting economic development. By internalizing the negative externalities associated with carbon emissions through taxes, environmental taxation policies can encourage polluters to reduce their emissions, which in turn can benefit the

environment and public health. The revenue generated by these taxes can then be used to support policies that promote female economic inclusion, such as investments in education or healthcare.

More recent studies, such as Pless and Rogge (2016), have examined the impact of environmental taxation policies on carbon emissions in OECD countries. These studies suggest that corrective taxation policies can be effective at reducing carbon emissions, particularly when they are designed to provide a regulatory fit with taxpayers' political values. By making polluters pay for the negative externalities associated with their emissions, these policies can encourage innovation and efficiency in pollution abatement, while also generating revenue that can be used to support policies that promote female economic inclusion.

Also, there are several research in the Ghanaian perspective that sampled the use of corrective taxation as a theoretical literature in their research. Corrective taxes for environmental protection in Ghana: An evaluation of the plastic waste levy (Adam & Buabeng, 2017) is an example of a research that made use of corrective taxation. Again, Examining the impact of corrective taxes on air pollution in Ghana (Amponsah & Kpienbaareh, 2019) is also another instance. Also, The impact of corrective taxes on firms' environmental performance in Ghana (Apau et al., 2019) is also another example of Ghanaian studies that have sampled corrective taxation as a theory in their research.

This theory is absolutely applicable to our research since it looks at how environmental taxes can be implemented to reduce carbon emissions in the global economy, which will eventually encourage the inclusion of women.

### **3.2. Empirical review**

The review of literature on impact of tax policy on environmental pollution point to a scenario that several researchers assessed this impact by using different models.

#### **3.2.1. The relevance of environmental tax**

Environmental taxes have the effect of promoting research into clean energy sources to meet the population's growing needs or to lead to the introduction of new technologies, production cycles, and products, thereby reducing the consumption of polluting raw materials and production of waste and generating revenue. Despite the literature's emphasis on the benefits of environmental taxes, several studies point out their drawbacks. Environmental regulations frequently result in a decline in manufacturing jobs (Curtis, 2014; Kahn & Mansur, 2013), which is met with vehement opposition from decision-makers. These regulations may cause manufacturing employment to move to other industries. However, nothing is known about how these measures would affect the labour market overall or in terms of distribution. Environmental levies reduce business earnings, which in turn reduces labour demand (Yip, 2018).

The European Union (EU) implemented Environmental Tax Reform (ETR) in the 1990s to assist in transferring the tax burden from producers to consumers of natural resources and polluters (Ekins & Speck, 2011). Environmental tax reform and increased environmental taxes, according to studies by Brännlund et al. (2007) and Bosquet (2000), can benefit the environment and lower carbon emissions. Yip (2018) calculates the effects of environmental policies on the labour market and finds that, in the first place, the policy increases the unemployment rate as a whole by 1.3 percentage points. Second, consequences of unemployment vary greatly across demographic groups and are present regardless of gender or educational level. Males with less education bear the brunt of the repercussions of unemployment. Third, the percentage of job losses rises independent of gender or educational level, indicating that the policy's involuntary unemployment is substantially to blame. Fourth, after the policy, layoffs for unemployed men with a medium level of education are more likely to be transitory. Fifth, even while the policy does not favour layoffs of temporary or part-time employees, it results in an increase in the number of males with medium or low

education who are hired on a temporary or part-time basis. Sixth, the strategy eventually lowers the low-educated group's labour force participation (LFP) rate.

According to Miller and Vela (2013), nations that collect more environmental taxes also have superior reductions in CO<sub>2</sub> emissions per person, energy use, the use of fossil fuels, and water pollution. By examining the effect of environmental taxes on the levels of air pollution and energy consumption, Morley (2012) evaluated the influence of environmental taxes on environmental protection actions. They discovered that the EU's implementation of environmental fees has a significant impact on reducing pollution, but has little bearing on the usage of natural resources. According to the study, the effectiveness of environmental taxes is strongly influenced by how much of other taxes and overall tax revenue is collected in relation to environmental taxes. B. Wang et al. (2018) 's research demonstrates how environmental taxes can both improve pollution management outcomes and mitigate ecological environment losses. Piciu and Tric (2012) demonstrate that environmental taxes can be paid back to polluters, demonstrating that under some circumstances, environmental taxes can reduce pollution and safeguard the environment. Only after high-tech, reasonably priced solutions have been found are environmental taxes useful for completely reducing carbon dioxide emissions. According to G. Niu et al. (2014), environmental tax shocks can lead to a decrease in carbon emissions. According to B. Wang et al. (2018), China might reduce CO<sub>2</sub> and air pollution emissions more effectively by enacting higher environmental and carbon tax levels.

### 3.2.2. *Environment, carbon emissions and labour participation*

The nexus between carbon emission and labour have been given attention in the literature. A detailed analysis of China's embodied carbon emission and labour income share by Y. Wang and Song (2014) revealed that the labour income share would decrease significantly if the embodied carbon emission was reduced. The relationship between Chinese education spending, female employment, use of renewable energy, and CO<sub>2</sub> emissions is empirically investigated by Zaman et al. (2021). The study's conclusions suggest that raising education spending, expanding the number of female employers, and boosting the use of renewable energy as a share of total energy use will all contribute to lowering CO<sub>2</sub> emissions in China over the long and short terms. On the other hand, S. H. Wang et al. (2019) analyse the global value chain to evaluate the relationship between carbon emissions and labour income share in the imports and exports of intermediate items. According to empirical findings, worker income shares in developing nations has a negative association with trade and a positive link with embodied carbon emission. Zhang et al. (2018) looked into how environmental pollution affected China's labour supply. Their findings revealed that the impact of pollution on labour supply is negatively and nonlinearly correlated with economic development levels.

According to Almunem et al. (2018), a variety of economic, structural, social, and demographic characteristics have an impact on women's economic involvement. Economic factors were the best at explaining 51% of the phenomenon of female labour market involvement; GDP per capita was the biggest explanatory factor favouring female labour market participation. 28% of the entire occurrence was interpreted in light of demographic factors. Tertiary education was the strongest explanatory factor within this set of determinants as it positively affects females' participation in the labour market. Social determinants also play a significant role in the interpretation of females' participation in the labour market, which is estimated to be of relative importance at 21%. Weak evidence of the U-shaped association between the log of per capita Gross Domestic Product and FLFP rate was found in a different study by Verick (2018) utilising cross-section data on 172 developing nations. And he concluded that a variety of socioeconomic factors, such as education, societal standards, and the type and potential for job development, are what drive FLFP. Only empirical review on FLFP was used to analyse Reena Kumari (2018). She discussed the beneficial link between FLFP, economic growth, and female education. The report also reveals a sizable gender pay disparity that disadvantages women. She also mentioned that a variety of variables, including demographic ones (such as fertility, migration, marriages, and child care), economic ones

(such as unemployment, per capita income, non-farm jobs, and infrastructure), and other explanatory ones (such as the regulatory context encompassing family and childcare policies, tax regimes, and the presence of subsidised health- and care for workers) influence FLFP. According to Langnel et al. (2021), environmental pollution has an impact on women's economic inclusion. They note that CO<sub>2</sub> intensity (emission from solid fuels like wood, charcoal, and coal) and CO<sub>2</sub> emission (metric per capita) appear to have a negative impact on female economic inclusion, as do CO<sub>2</sub> emissions from electricity and heat, liquid and fuel consumption, and CO<sub>2</sub> emissions. This suggests that the participation of women in the labour force is disproportionately impacted by environmental degradation. A fresh perspective on the connection between female labour force participation and economic growth in 162 world countries from 1990 to 2012 was offered by Lechman and Kaur (2015). The U-shaped association between female labour force participation and economic growth was substantiated by their findings. In 29 OECD nations, Tatli and BARAK's (2019) study looked at the connections between energy use and female unemployment. The results show that energy use has a strong and negative relationship with female unemployment. Elhaj and Pawar (2019) investigate the socioeconomic and environmental factors that have an impact on women's labour force participation in Saudi Arabia between 1990 and 2018. They discovered that education had little effect on female labour force participation in the short run. evaluating the claim made by ecofeminists that women are more inclined than males to embrace environmental protection legislation. According to Ergas and York (2012), countries with higher political status for women have lower carbon dioxide emissions per capita than nations with fewer political rights for women. Similar to this, McKinney and Fulkerson (2015) observed that countries with more women in governing bodies are less likely to have large climate footprints.

At the end of the day, it can be said that labour force participation is crucial in this context because it is associated with female empowerment in the household and in larger society. Women who actively participate in the workforce have more control over the economic decisions that affect their lives and social priorities. This study's major question is: To what extent does environmental taxes and carbon emissions influence the economic inclusion of women in high- and middle-income countries?

#### **4. Methods**

##### **4.1. Data sources**

This study employs macro country-level data. The data contains information on environmental pollution, taxes and other economic information on the countries under study. The sources of these data are World Development indicator database (World bank) and the Organization of economic and cooperative development (OECD). The data covers a sample of 65 countries over the period of 1994 to 2020.

##### **4.2. Research design and approach**

The research makes use of a quantitative approach as its research design. A quantitative research design is a research approach that involves the collection and analysis of numerical data to test research hypotheses and answer research questions. This approach was chosen because we believed it will serve as the best measure of the relationship between environmental taxation, carbon emission and female economic inclusion since it will easily determine the strength and direction of the relationship between the variables and provide insights into how environmental taxation policies can impact female economic inclusion.

##### **4.3. Population and sampling technique**

The population of the study comprises all countries that have data available on these variables between the period of 1994 to 2020. The sampling technique used in this study is purposive sampling, where 64 countries were selected based on their availability of data on environmental tax, carbon emissions, and female economic inclusion.

#### **4.4. Variables and measurements**

The main variables for the study are female economic inclusion, environmental tax and carbon emission.

Previous authors have made use of the variables; environmental taxation, carbon emissions and female economic inclusion in the studies. For instance, Bastida, García-Cartagena, et al. (2020) examined the relationship between environmental taxation and carbon emissions in a sample of 28 European Union countries. Although the study did not focus explicitly on female economic inclusion, it provides insights into the potential impact of environmental taxation on carbon emissions, which could have spillover effects on economic activity and employment, including for women. Similarly, D. Debnath et al. (2021) explored the relationship between carbon emissions and economic growth in South Asia. The study did not explicitly examine environmental taxation or female economic inclusion. However, it highlights the importance of balancing economic growth and environmental sustainability and suggests that policy interventions, such as environmental taxation, may be necessary to achieve this balance. Another relevant study by Raza et al. (2019) examined the relationship between carbon emissions and economic growth in a sample of 57 developing countries, with a focus on the role of environmental taxation. The study found that environmental taxation was negatively associated with carbon emissions and suggested that such policies could be effective in reducing emissions while also promoting economic growth. Generally, while there is limited research that has examined the relationship between environmental taxation, carbon emissions, and female economic inclusion together, these studies highlight the importance of considering the interplay between economic, environmental, and social factors in policy design and analysis.

Female inclusion is the dependent variable. The suitable definition of female economic inclusion used in this paper is taken from the Organization for Economic Cooperation and Development (OECD), which defines it as “the capacity of women (ages 15 and over) to participate in, contribute to, and benefit from growth processes in ways that recognise the value of their contributions, respect their dignity, and make it possible for them to negotiate for fairer distribution of the benefits of economic development”. Environmental tax is defined as the environmental tax revenue as a percentage of GDP. Data on environmental tax is sourced from OECD. Carbon emission is measured as the rate of carbon emission per kilo ton as defined by the world bank.

Other variables are employed to control the errors and variations in the estimations. In order to stabilize the economic and environmental variations in our study, Population growth, trade, life expectancy, energy consumption and GDP per capita are included as control variables. These variables are sourced from the World bank. Population growth is defined as the percentage growth in population of a country from previous year. Trade is measured as the sum of exports and imports as a ratio of GDP. Life expectancy is the proxy for general health of a country it is measured as the expected number of years a newborn is expected to leave if conditions underlying birth remains unchanged. Energy Consumption is measured as the debased GDP with oil equivalent of energy use. GDP per capita, the proxy for economic growth, is the GDP as a percentage of population. A country's growth and development as well as general economic health are both indicated by its GDP per capita (I. B. Gaddis & Klasen, 2012).

#### **4.5. Empirical estimation**

A dynamic panel model is adopted to analyse the results, more specifically a twostep Generalized Methods of Moments (System GMM) Approach is used. The GMM method selects the parameter vector that minimises the discrepancy (or difference) between the population moment values and the sample moment values (where the orthogonality conditions are set to zero).

In essence, GMM is a two-step process. As it provides results that are resilient to outliers and resolves endogeneity issues in the model, this is favoured to the ordinary least square (OLS).

A significant econometric issue is created by the fixed effects model's usage of a lagged dependent variable. Lagged values of the dependent variable are included as a regressor in the Generalized Method of Moments (GMM).

To address the potential endogeneity problem that could damage the model, the study makes use of the benefits of the systems GMM. According to Roodman (2009), the lag dependent variable may correlate with the independent variables or the error term, and similarly, the dependent variable may affect some of the explanatory variables. For instance, the government may be required to improve population health (life expectancy) if the supply of female labour continues to decline, which is evidence of endogeneity. Again, using Hansen over-identification and second-order serial correlation tests that are captured in the estimator's power, the GMM estimator aids in the validation of the instruments employed in the model. The issue of omitted variable bias, which can invalidate the outcomes, can also be resolved via GMM. According to the panel dataset, the nations or cross sections are larger than the time dimension, which is the primary argument for the use of this estimator (Daumal & Ozyurt, 2010).

To examine the impact of environmental tax on female inclusion, the following model is estimated;

$$FI_{it} = \alpha_1 FI_{it-1} + \alpha_2 ET_{it} + \sum_{j=n}^k \alpha_j X_{ij} + \varepsilon_i \quad (2.1)$$

Next, the impact of carbon emission on female inclusion is examined with the model below;

$$FI_{it} = \alpha_1 FI_{it-1} + \alpha_2 CE_{it} + \sum_{j=n}^k \alpha_j X_{ij} + \varepsilon_i \quad (2.2)$$

Finally, the joint impact for carbon emission and environmental tax on female inclusion is examined as follows;

$$FI_{it} = \alpha_1 FI_{it-1} + \alpha_2 ET_{it} + \alpha_3 CE_{it} + \alpha_4 (ET_i * CE_{it}) + \sum_{j=n}^k \alpha_j X_{ij} + \varepsilon_i \quad (2.3)$$

Where  $FS_{it}$  is the measure for female inclusion in country  $i$ , over time  $t$   $ET_{it}$  is the measure for environmental tax in country  $i$ , over time  $t$ .  $CE_{it}$  is the measure of carbon emission for country  $i$  at time  $t$   $ET_i * CE_{it}$  is the interaction between environmental tax and carbon emission and  $\sum_{j=n}^k \alpha_j X_{ij}$  is the sum of  $k$  control variables employed in the model. These variables have been defined in section 3.2.

## 5. Analysis and presentation of results

### 5.1. Descriptive statistics

Table 1 present the descriptive statistics for the individual variables involved in the study. From the table, female employment participation rate has a mean of 60.86% a minimum value of 25% and a maximum value of 86%. On average, the level of female labour representation among the economies studied is relatively moderate. Environmental tax has a mean of 1.96, with minimum vale of  $-1.53$  and a maximum value of 5.36. The average contribution of environmental tax to a dollar of GDP is 1.96. The average emission per kilo ton of carbon into the atmosphere is 10.83. The overall average population growth among the 64 countries is 0.79%. Thus, these economies experienced a 0.79% growth in their population over the period. The average contribution of trade to economic growth is 92.29. Thus, there is a rapidly high level of trade amongst the economies. Life expectancy, the proxy for population health has a mean of 75.25, a standard deviation of 6.29, a minimum value of 50.23 and a maximum value of 84.62. The average life expectancy of 75.25 shows a relatively high level of health among the economies. The average level of Energy consumption on the other hand is 8.16.per kilogram. The average level of economic growth per population is 9.42%.

**Table 1. Descriptive statistics**

**Table 1 presents the descriptive statistics of the variables used in this study. The sample consists of 65 countries during the period 1994–2020. Female inclusion is female labour participation rate. Environmental tax is environmental tax revenue as a percentage of GDP. Carbon emission is carbon emission per capita(kt) Population Growth is the exponential percentage growth in total population. Trade is Trade as a percentage of GDP. Life expectancy is the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. Energy Consumption is the GDP per kilogram of oil equivalent of energy use. GDP per Capita is gdp as a percentage of total population.**

Variable	Obs	Mean	Std. Dev.	Min	Max
Female Inclusion	1690	60.864	10.582	25.02	86.17
Environmental Tax	1602	1.966	1.071	-1.53	5.36
Carbon Emission	1690	10.836	1.821	6.937	16.186
Population growth	1755	.786	.993	-3.848	5.322
Trade	1709	92.288	61.745	13.388	437.327
Life expectancy	1725	75.25	6.285	50.232	84.616
Energy Consumption	1335	8.164	3.603	1.704	24.479
GDP per Capita	1748	9.421	1.106	5.349	11.725

The pairwise correlation matrix is presented in Table 2. The pairwise correlation matrix gives a firsthand information on the perceived relationship among the variables of interest. From the table, both environmental tax and carbon emission have a strong positive correlation with female inclusion. Population health and GDP per capita also have a strong positive correlation with female inclusion. This is practical, as Countries with higher GDP per capita tend to have more developed economies, which often means more opportunities for women to participate in the workforce and other aspects of society. As women become more financially independent, they may also have more say in decisions that affect their lives and greater access to education and healthcare, which can improve their overall health outcomes. Also, population growth and GDP per capita have a strong negative correlation with female inclusion. Over all, the matrix shows the absence of multicollinearity as the correlation coefficients are below 0.7.

The two step GMM results are presented in Table 3. The F test of overall joint significance has a p value below 0.01, implying that the model is fit. Diagnostic test for instrument count and endogeneity is insignificant across all three models, thus showing that the instruments are well specified, and issues of endogeneity have been sufficiently dealt with. Additionally, the number of groups for each model is greater than the number of instruments.

The first column present results on the first research objective which is to examine the impact of carbon emission on female inclusion. The second column presents results on the second objective which is to examine the impact of environmental tax on female inclusion. The third column present the result on the joint impact of environmental tax and carbon emission on female inclusion.

From the results, the lag of female inclusion is positive and significant. The positive significant lag implies that previous female labour participation rate affects the present rate. No significant relationship exists between carbon emission and female inclusion. However, Langnel et al. (2021) find that the participation of women in the labour market is adversely affected by environmental contamination. On the relationship between environmental tax and female inclusion, a positive significant impact is observed.

**Table 2. Pairwise correlation**

**Table 2 presents inferential statistics between some selected variable. Female inclusion is female labour participation rate. Environmental tax is environmental tax revenue as a percentage of GDP. Carbon emission is carbon emission per capita(kt) Population Growth is the exponential percentage growth in total population. Trade is Trade as a percentage of GDP. Life expectancy is the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. Energy Consumption is the GDP per kilogram of oil equivalent of energy use. GDP per Capita is gdp as a percentage of total population \* indicates a significance level of 5% or more.**

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Female Inclusion	1.000							
(2) Environmental Tax	0.140*	1.000						
(3) Carbon Emission	0.153*	-0.041	1.000					
(4) Population growth	-0.264*	-0.418*	-0.138*	1.000				
(5) Trade	-0.027	0.065	-0.353*	0.125*	1.000			
(6) Life expectancy	0.338*	0.321*	0.239*	-0.218*	0.112*	1.000		
(7) Energy Consumption	-0.128*	-0.098*	-0.220*	0.269*	0.187*	0.204*	1.000	
(8) GDP per Capita	0.461*	0.386*	0.235*	-0.042	0.248*	0.666*	0.185*	1.000

The positive relation implies the imposition of environmental tax increases the level of female employment in an economy. Other studies however identify different outcome. According to Curtis (2014) and Kahn and Mansur (2013) environmental regulations typically result in a decline in manufacturing jobs, which is met with strong opposition from legislators, additionally, Yip (2018) opines that environmental taxes reduce businesses' revenues, which in turn reduces labour demands. Walker (2013) breaks down the mechanism of environmental regulation resulting in unemployment. According to him, high productivity costs are also a result of strict environmental regulations. Enterprises reduced worker pay in order to reduce compliance expenses which resulted in widespread unemployment and changed labor-intensive industries.

The joint impact of environmental tax and carbon emission on female inclusion is negative. A negative relation between the variables of interest reveals that as the level of carbon emission rises, the positive impact of environmental tax on female inclusion reduces. Thus, environmental tax is able to some extent increase the level of female employment when there is low level of carbon emissions. Hence if governmental policies are directed towards increasing environmental tax with the quest of reducing carbon emission in the atmosphere, this will affect the rate of female employment in the economy.

Some positive significant relationships are observed among the control variables. Population growth, trade, life expectancy and energy consumption increase as female employment increases. A growth in the population increases the female employment rate at it make the supply of female labour available in the economy. According to literature, Trade on the other hand increases female inclusion because trading in all its forms builds capacity for females to participate in economic activities thus creating employment avenues as well as contribute to economic growth and in the long run standard of living. The industry of tradable products, which includes tourism, financial services, and information technology, may grow as trade openness rises. As a result, there will be more options for employment, particularly for women entering the workforce (Cooray et al., 2017; Ghosh, 2021; I. Gaddis & Klasen, 2014). But Mujahid et al. (2013). Recognize that the inclusion of women in Pakistan is badly impacted by trade openness. With the addition of women, life expectancy, a gauge of the general health of a population and economy increases. Healthy population implies healthy supply of labour force. Thus, as there is high level of sound health among the general population, there is increased healthy supply of female labour into the economy. GDP per capita reduces the level of female inclusion. Thus, at high level of economic boom, the level of female employment drops while at low levels of economic growth the level of female employment increases. This result is at contradiction with those of Ghosh (2021) and Muhammed and Noman (2013), who find that female inclusion in Pakistan's economy boosts economic growth. Energy usage, according to Lechman and Kaur (2015), raises the rate of female unemployment. The results of this study demonstrate that, energy usage rises as labour force participation does, countering their conclusions

## 6. Conclusion

The nexus between environmental taxation, carbon emissions, and female economic inclusion is a complex and multifaceted issue that requires careful consideration by policymakers, industry stakeholders, and civil society organizations. This paper has provided an overview of the regulatory, reform, and policy issues and developments within the context.

The findings of this research indicate that environmental taxation can be an effective tool for reducing carbon emissions and promoting sustainable development. However, policymakers must ensure that environmental tax policies are equitable and progressive and do not place an undue burden on vulnerable groups. Furthermore, promoting female economic inclusion is crucial for achieving sustainable development and reducing poverty and inequality.

This research makes several contributions to the literature. Firstly, it provides a comprehensive overview of the nexus between environmental taxation, carbon emissions, and female economic inclusion. Secondly, it highlights the importance of adopting a coordinated approach to

**Table 3. Regression results**

**Table 3** presents the result for the joint impact of carbon emission and environmental tax on female inclusion using a dynamic two step system GMM, Windmeijer-corrected standard error, small sample adjustment and orthogonal deviation. The dependent variable is Female inclusion which is measured as Female labour participation rate. Environmental tax is environmental tax revenue as a percentage of GDP. Carbon emission is carbon emission per capita(kt) Population Growth is the exponential percentage growth in total population. Trade is Trade as a percentage of GDP. Life expectancy is the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life. Energy Consumption is the GDP per kilogram of oil equivalent of energy use. GDP per Capita is gdp as a percentage of total population. Standard errors are in parentheses; \*\*\*, \*\* and \* indicate statistical significance at 1%, 5% and 10% respectively. Diagnostic tests: (1) number of observations, (2) The instrument count, (3) the Arellano-Bond (AB2) test for first and second order serial correlations in the residuals with a null hypothesis of no second order serial correlation, (4) The Hansen test for over identifying restrictions with the null hypothesis of exogenous instruments, (5) the F-test for joint significance of instruments

Variables	(1) Female Inclusion	(2) Female Inclusion	(3) Female Inclusion
Female Inclusion	0.290***	1.025***	0.870***
	0.0679	0.0336	0.0963
Ent tax		0.171*	12.54**
		0.0912	4.768
Carbon Emission	2.351		1.909
	3.112		1.221
Ent tax*CO2			-1.141**
			0.433
Population growth	-0.0650	0.182*	0.0983
	0.277	0.105	0.154
Trade	0.00978	0.00205*	0.0153**
	0.0115	0.00109	0.00630
Life Expectancy	0.409***	-0.0167	0.0767
	0.124	0.0125	0.129
Energy Consumption	0.587***	0.0477***	0.00819
	0.179	0.0178	0.115
GDP per Capita	-1.804*	-0.0289	0.0765
	1.020	0.193	0.447
Constant	-2.243	-0.690	-21.11
	26.04	0.583	13.66
Observations	1,253	1,183	1,183
Number of groups	63	63	63
No. of instruments.	9	16	23
AB2	-1.139	0.0871	0.836
P-value	0.255	0.931	0.403
Hansen's Test	0.324	1.934	19.00
P-value	0.569	0.983	0.123
F-test	449.9	384646	4601
P-value	0.000	0.000	0.000

environmental taxation at the global level to mitigate the risk of carbon leakage. Thirdly, it emphasizes the need for policymakers to adopt policies and programs that promote gender equality in the labor market and ensure that women have access to economic resources.

The implications of this research are significant for policymakers, industry stakeholders, and civil society organizations. The findings suggest that environmental taxation policies must be designed carefully to ensure that they do not place an undue burden on vulnerable groups, and that promoting female economic inclusion is crucial for achieving sustainable development.

However, there are several limitations to this research that should be considered. Firstly, the research only sampled two theories for the study, and thus, there may be a limitation to the study. Secondly, the research focuses on the nexus between environmental taxation, carbon emissions, and female economic inclusion and does not consider other factors that may affect sustainable development. Lastly, the research only considers 64 countries for the analysis of the nexus between environmental taxation, carbon emissions, and female economic inclusion.

Further research is needed to address these limitations and deepen our understanding of the nexus between environmental taxation, carbon emissions, and female economic inclusion. Future research could focus on conducting empirical studies to analyze the effectiveness of environmental taxation policies in reducing carbon emissions and promoting sustainable development. Moreover, future research could explore the potential for environmental taxation policies to impact gender equality and female economic inclusion broadly.

Overall, this research highlights the importance of adopting a comprehensive and coordinated approach to promote sustainable development while ensuring that vulnerable groups, such as low-income households and women, are not disproportionately affected.

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