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The Economics Behind Climate Change Mitigation: Assessing the Potential Impacts on Different Sectors

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The article starts off by giving a general summary of the economic justification for mitigating climate change, highlighting the significance of agriculture, industry, infrastructure and energy. The secondary data is used from 1980 to 2022 by engaging Johnson co-integration and ECM. In addition, the paper assesses how climate change mitigation may affect several economic sectors. It explores the benefits and problems that potential mitigation methods may present for the energy, agricultural, transportation, and industrial sectors. The analysis covers prospective changes to employment dynamics, investment patterns, and market competitiveness within these industries. The article also highlights the importance of captivating distributional effects and equity considerations while analyzing the financial implications of climate change alleviation. It emphasizes the need for inclusive and equitable policy measures by drawing attention to potential discrepancies that could exist among regions, income categories, and vulnerable populations. It draws attention to potential inequalities that could exist among geographic areas, socioeconomic classes, and vulnerable populations, highlighting the necessity of inclusive and fair policy frameworks. This article offers a thorough explanation of the economics underlying the prevention of climate change, illuminating the potential effects on many economic sectors. It contributes to the continuing discussion on developing effective and sustainable mitigation methods in response to climate change problems by analyzing the costs and advantages as well as the distributional factors.

Introduction

According to the empirical findings, deregulation encourages innovation after the natural sector was liberalized, indicating this may encourage the course of change in climate. The writers often discover, the OECD nations with comparatively less natural gas parameters, net exporters of natural gas, and strong action of modernization performance in the global innovation ranking are the ones with the greatest effects of deregulation on innovation. (Stephen & Boqiang, 2023). Digitalization, which has the potential to promote societies and urban settings that are friendly to the environment, can help progress socio-economic dynamics of cities in a sustainable manner. As the fourth industrial revolution has begun, digitalization has become more widely used in a variety of fields and at various levels (Abdul et al., 2020). The world is faced with the scary task of mitigating climate change while still maintaining economic growth. The Paris Agreement, which was validated by 195 nations in 2015, sets a goal about keeping global warming below 2°C by 2100. In order to achieve this target, large-scale changes will need to be made across all sectors of the economy (Copeland et al., 2022*)*.

The use of hydrogen as a fuel enables the DE carbonization of transportation, industry, cosmos warming and the deficiency of erratic replenish energy sources as well. The study aimed at to evaluate the technical potential for hydrogen in the future for offer guidance on areas of studies to assist minimizes financial barriers to use of hydrogen. Top-level system models were developed for this study based on the energy needs of end-use services. Four case studies that offer a worldwide perspective improved with particular nationwide instances were investigated using those models (Andrew et al., 2019). It is difficult to differ the idea with Nordhaus that the crucial concerns about climate change strategy—"how much, how fast, and how closely"—continue unresolved despite the wealth of study on the economics of climate change (Nordhaus, 2007). In other sense, reports like the Stern Review (Stern, 2006) call for swift action to sharply reduce carbon emissions and make use of recently made climate scientific discoveries. However, the use of traditional economic analysis (Nordhaus, 2007, Nordhaus, 2008) demonstrates that such a quick and drastic GHG reduction is not profitable. According to Nordhaus (2007), "[The Stern Review's] radical revision of the economics of climate change does not result from any new economics, science, or modelling." somewhat, it is based upon the specific utility function and assumption of a time bargaining rate that is near to zero.

Simply put, the Stern Review's 0.1% or 0.15% discount rate is too low. The analysis is more open to criticism as a result of this effort to "correct" the traditional NPV-based estimated value method and downplays significant findings as of the area of climate change science. This study goes over and above the conventional NPV examination and provides a various procedure for an assimilated evaluation of climate policy that might offer a uniform base for settling the disagreement amongst Stern and Nordhaus favorers and, in addition to this, might suggest complementary tools for climate policy analysis. An approach of straight method that emphases an estimated value method, otherwise known as anticipated utility in the literature, might not be the greatest method to comprehend the advantages of climate policy because Damage avoidance (directly beneficial impacts on the economy) would materialize Simply in the far future, it is highly disregarded in computations. Mitigation costs are a burden on the economy now. Additionally, because the estimated value technique extracts out different climate effects, it might not be the best tool for a precise description, of permanent processes and their results that follow heavy-tailed distributions. Negative occurrences that because severe damage is still likely to occur, despite their low chance. Low likelihood will "balance" high damage within the anticipated value framework, and this damage will be further discounted.

Numerous endeavors to improve the projected value approach can be found in the literature. Although it is outside the purview of this study, certain pertinent work must be acknowledged. The occurrence of edges in the focused-response task and the possibility of catastrophic global climate proceedings, which, despite having a small possibility of occurring, may cause major economic impairment, are not considered by the traditional methodology. It has been noted in the literature. Tol (2003) highlighted the significant drawbacks of traditional cost-advantage analysis centered on predicted NPV. The FUND model's numerical spur showed that the range of economic harm caused by climate change could be unlimited. In the event of a fat-tailed distribution of climate damage, Weitzman (2007) suggested an analytical solution. Weitzman puts out fresh theoretical ideas that hold true under conditions of severe relative risk aversion and possibly limitless exposure as represented by a fat-tailed distribution. Researcher shows the traditional anticipated utility theory cannot be used to analyses the economic effects of disasters. In the perspective of climate policy, both works by Tol (2003) and Weitzman (2007) make a compelling situation for emphasizing the significant drawbacks of cost-advantage analysis centered on the estimated rate calculation.

It is anticipated by 2030, the decision-makers would be gained supplementary knowledge on climate sensitivity and might be prepared to frame the resulting oriented climate policy choice. The NPV of climate policy estimated taking up in 2030 is equivalent to $70 trillion (this NPV and other factors in the computation illustration are all bargain-basement back to 2010). If in 2030 the climate sensitivity is equal to 5 and the regulator maintains the 450-ppm objective. Let's say that the odds of the prime consequence, S=5, are 0.4 and the odds of the second occurrence, S=2, are 0.6. $10 trillion will be spent on climate policies between 2010 and 2030. In this instance, the 450-ppm target's anticipated value for 2010 is equal to almost $12 trillion. The preference rate to maintain the 450-ppm trajectory by 2030 is equal to $28 trillion (ROV=0.470=28). It may take until 2050 to address the climate uncertainties. The regulator may then think about purchasing a different alternative while maintaining the freedom to choose a climate policy in the end until 2050. We utilise probabilities of 20% when the climate sensitivity is equal to 5, 30% when the climate sensitivity is equivalent to 2, and 50% when the uncertainty is still unresolved. In the first scenario (S=5), a long-term climate strategy with a stabilization goal of 450 ppm or less will be chosen in 2030.

1.1 Climate Change Mitigation

Climate change alleviation is a process of decreasing greenhouse gas releases in respect to reduce the volume of global warming. There are a variety of methods that can be used to achieve this, comprising renewable energy, energy efficiency, and carbon capture and storing. The most important thing to remember about climate change mitigation is that it is an investment. In other words, the upfront costs may be high, but they will pay off in the long run by preventing damage from climate change. Additionally, different areas of the economy would be impacted differently by changing in climate mitigation measures. For example, the transportation sector is likely to see higher costs associated with transitioning to low-emissions vehicles, while the agriculture sector may benefit from new practices that help to sequester carbon in the soil. Ultimately, climate change mitigation is essential for protecting our planet and its inhabitants from the least desirable effects of change in climate. By taking action now, we can avoid costly damages down the road and create a prosperous future for future generations.

1.2 Economic Costs of Climate Change Mitigation

To prevent the worst effects of climate change, it will be necessary to take drastic measures to reduce greenhouse gas emissions. This will come at an economic cost, which will impact different areas of the economy in other manners. The most obvious cost will be the direct cost of implementing mitigation measures, such as investing in renewable energy sources or carbon capture and storage technologies. These upfront costs can be significant, but they are often outweighed by the long-term savings that come from avoided damage from climate change. Additionally, indirect expenses related to climate change mitigation, such as the impact on trade or the depletion of certain industries that are unable to function in a low-carbon economy. These impacts can be difficult to predict and quantify, but they could have significant implications for economic growth and employment. The expenditures of climate change mitigation will vary depending on the specific measures taken and the sectors of the economy most affected. However, taking action now to reduce emissions is essential to avoid even more costly consequences down the road.

1.3 Assessing the Benefits and Impacts of Climate Change Mitigation

Climate change alleviation is a process that involves reducing emissions of greenhouse gases and increasing sinks to remove them from the atmosphere. Reduce the rate and severity of climate change is the aim of climate change alleviation, including the associated impacts on society and the natural world. A wide range of actions can be taken to mitigate climate change. Some of these actions, such as using renewable energy instead of fossil fuels, are generally seen as beneficial regardless of their impact on climate change. Others, such as planting trees to create new carbon sinks, have more specific benefits and impacts that must be considered before deciding whether or not to take action.

The potential advantages and impacts of mitigation of climate change rely upon a various possible dynamic, comprising the types of measures taken, how they are implemented, and who bears the costs and benefits. In general, however, climate change mitigation can provide a range of benefits, including improved public health, jobs and economic growth, food security, and ecosystem protection. Additionally, taking action on climate change can help build resilience to future shocks and stresses caused by severe weather occasions or other changes into environment. Of course, no single action will be perfect and some mitigation efforts may cause unintended consequences that must be carefully considered before taking further action. For example, biofuels have been touted as a way to reduce emissions while simultaneously providing an alternative to fossil fuels. However, if biofuels are not produced sustainably, they can lead to deforestation and habitat loss – potentially negating

1.4 Analyzing Different Sectors Impacted by Climate Change Mitigation

There is not just single silver bullet for climate change mitigation – instead, a variety of sectors need to work together to reduce greenhouse gas emissions. Depending on the approach taken, different sectors may be more or less impacted by climate change mitigation efforts. For example, if renewable energy is heavily incentivized as part of a climate change mitigation strategy, then the renewable energy sector will see significant growth. This in turn will have ripple effects throughout the economy – for example, increased demand for renewable energy technologies will create jobs in manufacturing and installation. The expansion of the renewable energy sector will also spur innovation and bring down costs, making renewables more competitive with other forms of energy.

On the other hand, if carbon pricing is implemented as part of a climate change mitigation strategy, then sectors that are intensive users of fossil fuels – such as transportation and industry – will be most affected. Businesses that produce a lot of carbon may need to make a lot of capital to comply with new rules, which might hurt their lowermost line. Consumers may also see greater values for goods and services as businesses permit on the cost of carbon pricing to consumers. A well-designed climate change mitigation strategy will take into account the potential impacts on different sectors and seek to minimize negative impacts while maximizing positive ones. By doing so, we can build a cleaner, healthier future for all.

When it comes to climate change mitigation, businesses have a lot at stake. Not only do they have to contend with the possible effects of climate change itself, but also with the regulatory and financial implications of climate change prevention measures. Fortunately, there are a different ways the businesses can adapt to the changing climate and mitigate their impact on the environment. Here are a few key considerations for businesses: 1. Increase energy efficiency: the simplest and most efficient ways for businesses to diminish their carbon footmark is to increase energy efficiency. It could be done by using a number of measures, like, upgrading to more well-organized equipment, retrofitting buildings for better insulation, and using renewable energy sources. 2. Invest in low-carbon technologies: Another way businesses can reduce their emissions is by investing in low-carbon technologies. This can range from electric cars and green buildings to solar panels and windmills. 3. Change business practices: Sometimes, the best way for businesses to reduce their environmental impact is simply by changing their practices. This could involve anything from switching to recycled materials to investing in more sustainable supply chains. 4. Engage employees: One of the most important things businesses can do when it comes to climate change is engaged their employees. After all, it's employees who will be implementing many of these changes within the company. By communicating the importance of climate change mitigation and involving employees in decision-making, businesses can ensure that everyone is on. Following are research questions which are address for conducting this research.

1. What is impact of agriculture on climate change?
2. What is impact of industrial production on climate change?
3. What is impact of energy on industrial production?
4. What is impact of infrastructure on agriculture?

2. Literature Review

According to the empirical findings, deregulation encourages innovation after the natural sector was liberalized, indicating this may encourage the course of change in climate. The writers often discover, the OECD nations with comparatively less natural gas parameters, net exporters of natural gas, and strong action of modernization performance in the global innovation ranking are the ones with the greatest effects of deregulation on innovation. (Stephen and Boqiang, 2023). The world is faced with the daunting task of mitigating climate change while still maintaining economic growth. The Paris Accord that was inked by 195 nations in 2016 sets the goal of keeping global warming below 2°C by 2100. In order to achieve this target, large-scale changes will need to be made across all sectors of the economy (Copeland et al., 2022). With the aid of digitalization, which has the power to promote societies and urban settings that are friendly to the environment, socio-economic dynamics of cities may be developed sustainably. As the fourth industrial revolution has begun, digitalization has become more widely used in a variety of fields and at various levels (Abdul et al., 2020). It is difficult to differ the idea with Nordhaus that the crucial concerns about climate change strategy—"how much, how fast, and how closely"—continue unresolved despite the wealth of study on the economics of climate change (Nordhaus, 2007). In other sense, reports like the Stern Review (Stern, 2006) and AR4 (IPCC, 2007a, IPCC, 2007b) call for swift action to sharply reduce carbon emissions and make use of recently made climate scientific discoveries.

However, the use of traditional economic analysis (Nordhaus, 2007, Nordhaus, 2008) demonstrates that such a quick and drastic GHG reduction is not profitable. The use of hydrogen as a fuel enables to prevent carbonization of transportation, business, cosmos heating, and the storing of erratic regenerated energy sources. The research goal is to evaluate the technical strength for hydrogen in the future and to offer guidance on sectors of studies to assist minimize financial barricades to use of hydrogen. Top-level system models were developed for this study based on the energy needs of end-use services. Few researches that offer a worldwide perspective supported with targeted nationwide instances were investigated using those models (Andrew et al. 2019). This is usually the most straightforward strategy to decrease output. By putting a price on carbon dioxide emissions, we give businesses and consumers an incentive to find ways to emitting less CO2. Carbon pricing can take the form of a tax on emissions, or a cap-and-business ways where organizations can procure and sale allow to exclude greenhouse gases (Goulder et al., 1999).

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We anticipate by 2030, the decision-makers would be gained supplementary knowledge on climate sensitivity and might be prepared to frame the resulting oriented climate policy choice. The NPV of climate policy estimated taking up in 2030 is equivalent to $70 trillion (this NPV and other factors in the computation illustration are all bargain-basement back to 2010). If in 2030 the climate sensitivity is equal to 5 and the regulator maintains the 450-ppm objective. Let's say that the odds of the prime consequence, S=5, are 0.4 and the odds of the second occurrence, S=2, are 0.6. $10 trillion will be spent on climate policies between 2010 and 2030. In this instance, the 450-ppm target's anticipated value for 2010 is equal to almost $12 trillion. The preference rate to maintain the 450-ppm trajectory by 2030 is equal to $28 trillion (ROV=0.470=28).

According to Nordhaus (2007), "[The Stern Review's] radical revision of the economics of climate change does not result from any new economics, science, or modelling." One of the most cost-effective ways to reduce emissions is simply by using less energy. That's where efficiency standards come in. These standards set minimum requirements for the efficiency of appliances, buildings, cars, etc., which reduces the amount of energy we need to use overall (Mendelsohn, Robert, William D. Nordhaus, and Daigee Shaw, 1994). Another way to incentivize the shift to clean energy is through renewable energy standards (RES). Under an RES, The amount of electricity that utilities must produce from renewable resources like solar and wind energy is capped at a specific proportion. This policy provides a market for renewable energy technologies and drives down the cost of these technologies over time (Newell, Richard G., and Soren T. Anderson, 2004). The prim thing to mitigate climate change is to reduce our emissions of greenhouse gases. There are many ways to approach this problem, and no one silver bullet. We need a suite of policies that work together to create incentives for individuals, businesses, and society as a whole to reduce their emissions (Barretto et al., 2004).

A detailed cost-benefit analysis is beyond the scope of this article. However, it is clear that there are significant economic benefits to be gained from taking action on climate change. In addition to avoiding the risks of catastrophic temperature rises (which would have huge economic costs), mitigation efforts can lead to more efficient use of resources, improved public health and greater food security. Given all these potential benefits. (Aldy et al., 2003). The effects of climatic stimulus mitigation measures on various areas vary widely. Some sectors, such as renewable energy and low-carbon development, stand to benefit greatly from the transition to a low-carbon economy. Others, however, such as fossil fuels and conventional agriculture, will be negatively affected. It is therefore essential that any climate change mitigation strategy takes into account the potential impacts on all sectors of the economy (Carraro, 2003). In terms of specific measures, countries have pledged to reduce their greenhouse gas emissions in a variety of ways, including through promoting renewable energy, energy efficiency, low-carbon development and other climate-friendly technologies. Many governments are also providing financial support for climate change mitigation efforts, both within their own borders and internationally (Bovenberg, et al., 2001).

Governments around the world are slowly but surely beginning to wake up to the reality of climate change and the need for action to mitigate its effects. The Paris Agreement, signed by 195 countries in 2016, was a major step forward in this regard, committing signatories to take steps to keep global temperature rise this century well below 2°C above pre-industrial levels (McFarland et al., 2004). Both individuals and businesses can play a role in mitigating climate change. For example, individuals can make choices about their consumption habits, such as choosing to drive less or purchase green power. Businesses can invest in green technologies or adopt sustainable practices. Policymakers also have an important role to play in mitigating climate change. They can set emission targets and create incentives for businesses and individuals to reduce their emissions.

Additionally, they can fund research and development for new clean technologies (Newell et al., 2004). One way to reduce emissions is by increasing energy efficiency. This can be done through a variety of measures, such as investing in new technologies or changing building codes to require more efficient construction. Another option is to switch from high-emitting fossil fuels to low-emitting energy sources like renewable energy or nuclear power. The economics behind climate change mitigation are complex.

There are many different ways that different sectors of the economy can contribute to reducing emissions. The most effective approach will likely involve a mix of policies, regulations, and voluntary actions from businesses and individuals (Heal et al, 2002). A well-designed climate change mitigation strategy will take into account the potential impacts on different sectors and seek to minimize negative impacts while maximizing positive ones. By doing so, we can build a cleaner, healthier future for all. When it comes to climate change mitigation, businesses have a lot at stake. Not only do they have to contend with the potential impacts of climate change itself, but also with the regulatory and financial implications of climate change mitigation policies. Fortunately, there are a number of ways that businesses can adapt to the changing climate and mitigate their impact on the environment. Here are a few key considerations for businesses (Arrow et al., 1996).

3. Data and Methodology:

The data is used in secondary form for the 1980–2022-time span in this analysis. Natural log format is used to transform the listed indicators. While the short run analysis is examined using the Vector Error Correction Model (VECM), the coherence of the variables is examined using the Johnson co-integration method.

3.1 Data and Sources

Following are the secondary data source.

- Climate Change: WDI
- Agr: (IFS-IMF) various issues
- Ind: State Bank of Pakistan
- Energy: Economic Survey of Pakistan.
- INFRA: (Method of Principal Component by Researcher)

3.2 Model Specification

$$CC = \alpha 1 + ß1AGR + ß2IND + ß3EN + ß4INFRA + \sum t$$

CC= Climate Change

AGR= Agriculture

IND= Industry

INFRA= Infrastructure

EN= Energy

4. Results

All variables are confirmed to be non-stationary using the Augmented Dicky Fuller Unit Root test because doing estimation on non-stationary data will lead to overestimated findings.

Table No 01: The Results of ADF

Variables	Level (with intercepts &Trend)	First Difference (with intercepts &Trend)
AGR	3.156 (0)	3.613* (2)
IND	1.516 (1)	2.2751*(1)
INFRA	6.458 (0)	1.361* (4)
EN	-5.345 (2)	-4.244* (1)

*Significance at 5% level.

When the first difference is applied, the values in the preceding table that were derived using the Augmented Dicky Fuller Unit Root test are discovered to be non-stationary after level.

Table No 02: Johnson Co-Integration Test (Maximum trace Value)

Null Hypothesis	Alternative Hypothesis	Maximum Trace Statistics	Critical value at 5%
r=0	r=1	77.224	53.212
r=1	r=2	56.11	49.151
r=2	r=3	32.221	31.17
r=3	r=4	21.330	20.12
r=4	r=5	11.921	11.12

*Significance at 5% level.

In the analysis above, we used a five-vector model to analyze Johnson co-integration on the basis of maximum trace values. The short-listing method is employed, which shows us that the variables are strongly related.

Table No 03: The Results of Normalized Equation on Vector (1^{st})

Variables	Agr	IND	INFRA	EN
Coefficient	5.315*	11.223*	8.443*	-5.16*
t-value	3.20	9.13	10.165	4.45

*Significance at 5% level.

The coefficients of variables clearly demonstrate that whereas EN has a detrimental impact on Pakistan's climate, AGR, INFRA, and IND have positive effects.

Table No 04: The Results ECM

Variables	AGR	IND	INFRA	EN	C	ECM
Coefficient	6.222	2.506	4.534	-4.852	-46.61	-0.391
SE	1.55	0.812	1.334	0.869	0.17	-0.066
t-statistics	2.75	2.12	3.12	1.61	0.33	-5.33
Probab	0.0312	0.0113	0.0028	0.071	0.62	0.0002

*Significance at 5% level.

The ECM results demonstrated that the analysis performed for this research is desirable, as suggested by the error correction model coefficients.

5. Conclusion

The economics of climate change mitigation is an increasingly important topic as we must assess the potential impacts on different sectors in order to make informed

decisions. Combining traditional economic models with data from natural sciences can help us better understand how our actions are impacting global warming and what measures need to be taken to reduce its harmful effects through different sectors as agriculture, industry, infrastructure and energy. It's essential that governments around the world commit to reducing emissions and investing in green technology, both of which will help safeguard our planet for generations to come for better climatic conditions.

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