

Question:

What are the co-benefits of China's carbon trading policy on air pollution control ?

Source: Co-benefits of policies to reduce air pollution and carbon emissions in China.pdf

Expected answer: China's carbon trading policy led to simultaneous reductions in CO₂ and PM_{2.5}. The empirical evidence showed that cities under the trading scheme experienced significant improvements in air quality while advancing decarbonization.

Source:

Expected answer:

GPT-3.5, text, TF-IDF + Cosine

The co-benefits of China's carbon trading policy on air pollution control include a significant reduction in carbon emissions and air pollutants, particularly in the power industry. The policy has been effective in controlling air pollution, leading to a decrease in emissions of SO₂, NO_x, and PM_{2.5}. Additionally, the policy has shown positive effects on improving air quality and reducing carbon intensity in various sectors, contributing to a more sustainable and low-carbon economy.

[1] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.511

[2] Effect of the carbon emissions trading policy on the co-benefits of carbon emissions reduction and air pollution control.pdf | Score: 0.446

[3] Air pollution reduction in China Recent success but great challenge for the future.pdf | Score: 0.236

GPT-3.5, text, BM25

The co-benefits of China's carbon trading policy on air pollution control include a significant reduction in carbon emissions and air pollutants, particularly in the power industry. The policy has shown effectiveness in controlling air pollution, leading to a decrease in emissions of SO₂, NO_x, and PM_{2.5}. Additionally, the policy has been found to have a positive impact on air quality and carbon emissions reduction in various sectors, with the power industry experiencing the most significant improvements. The policy has also been shown to drive technological progress and attract foreign direct investment, further contributing to the reduction of carbon emissions and air pollution.

[1] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 25.998

[2] Effect of the carbon emissions trading policy on the co-benefits of carbon emissions reduction and air pollution control.pdf | Score: 25.739

[3] Co-benefits of policies to reduce air pollution and carbon emissions in China.pdf | Score: 23.568

GPT-3.5, text, SBERT + FAISS

The co-benefits of China's carbon trading policy on air pollution control include a significant reduction in carbon emissions and air pollutants, particularly in the power industry. The policy has been effective in controlling air pollution, leading to a decrease in emissions of SO₂, NO_x, and PM_{2.5}. Additionally, the policy has shown moderate performance in reducing carbon emissions and air pollutant emissions in the transport and resident sectors. The carbon trading policy has also been found to have a positive externality on neighboring cities' carbon emissions, indicating a spillover effect that benefits air quality improvement in surrounding areas.

[1] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.807

[2] Effect of the carbon emissions trading policy on the co-benefits of carbon emissions reduction and air pollution control.pdf | Score: 0.772

[3] Co-benefits of policies to reduce air pollution and carbon emissions in China.pdf | Score: 0.697

GPT-3.5, text, No-RAG

1. Reduction in greenhouse gas emissions: By implementing a carbon trading policy, China can effectively reduce its carbon emissions, which in turn helps to mitigate climate change and its associated impacts.
2. Improved air quality: Many of the sources of carbon emissions, such as coal-fired power plants and industrial facilities, also emit other pollutants that contribute to air pollution. By reducing carbon emissions through a carbon trading policy, China can also reduce these harmful pollutants, leading to improved air quality and public health.
3. Promotion of clean energy technologies: The implementation of a carbon trading policy can incentivize the development and deployment of clean energy technologies, such as renewable energy sources and energy efficiency measures. This can help to reduce reliance on fossil fuels and promote a more sustainable energy system.
4. Economic benefits: The carbon trading policy can create new opportunities for businesses in the clean energy sector, leading to job creation and economic growth. Additionally, by reducing air pollution and its associated health costs, the policy can result in cost savings for the healthcare system and improved productivity for workers.
5. International cooperation: By implementing a carbon trading policy, China can demonstrate its commitment to addressing climate change and air pollution, which can help to build trust and cooperation with other countries in the global effort to combat climate change. This can also help to enhance China's reputation as a responsible global citizen.

GPT-3.5, text, Hybrid-RAG

1. Reduction in greenhouse gas emissions: By implementing a carbon trading policy, China can effectively reduce its carbon emissions, which in turn helps to mitigate climate change and its associated impacts. Studies have shown that achieving synergies in reducing carbon emissions and air pollution is key to promoting green policies [1].
2. Improved air quality: Many sources of carbon emissions, such as coal-fired power plants and industrial facilities, also emit pollutants contributing to air pollution. By reducing carbon emissions through a carbon trading policy, China can also reduce harmful pollutants, leading to improved air quality and public health. Achieving the co-benefits of carbon emissions reduction and air pollution control is significant for environmental and public health benefits [2].
3. Promotion of clean energy technologies: In order to comply with carbon trading regulations, companies may invest in cleaner and more sustainable energy sources, such as renewable energy and energy efficiency measures. This can help accelerate the transition to a low-carbon economy and reduce reliance on fossil fuels. Coordinated efforts to reduce pollution and carbon emissions have become an inevitable choice for China, promoting the synergistic effect of reducing pollution and carbon emissions [3].
4. Economic benefits: The implementation of a carbon trading policy can create new opportunities for businesses in the clean energy sector, leading to job creation and economic growth. Additionally, reducing air pollution can lower healthcare costs associated with respiratory illnesses and other health impacts of poor air quality. Significant emission reductions have occurred largely due to robust administrative power, emphasizing the importance of considering economic costs for sustainable pollution control [4].
5. International cooperation: By participating in carbon trading schemes, China can demonstrate its commitment to

addressing climate change and work collaboratively with other countries to achieve global emissions reduction goals. This can help build trust and cooperation in international climate negotiations and contribute to global efforts to combat climate change.

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- [4] Air pollution reduction in China Recent success but great challenge for the future.pdf | Score: 0.236

GPT-3.5, paragraph, TF-IDF + Cosine

The co-benefits of China's carbon trading policy on air pollution control include a significant reduction in carbon emissions intensity and the simultaneous decrease in emissions of air pollutants such as SO₂, NO_x, and PM_{2.5}. The policy has been found to effectively curb excessive carbon emissions and contribute to improvements in air quality by coordinating with measures aimed at controlling air pollution.

- [1] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.509
- [2] Effect of the carbon emissions trading policy on the co-benefits of carbon emissions reduction and air pollution control.pdf | Score: 0.496
- [3] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.461

GPT-3.5, paragraph, BM25

The co-benefits of China's carbon trading policy on air pollution control include a significant reduction in carbon emissions and air pollutants. The policy has been shown to effectively curb excessive carbon emissions and control air pollution, with the Chinese government's long-standing focus on air pollution playing a key role in achieving these outcomes. The coordination between the carbon trading policy and measures such as the Air Pollution Prevention and Control Action Plan has been instrumental in achieving synergies in reducing carbon emissions and air pollution.

- [1] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 31.788
- [2] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 28.948
- [3] Effect of the carbon emissions trading policy on the co-benefits of carbon emissions reduction and air pollution control.pdf | Score: 27.985

GPT-3.5, paragraph, SBERT + FAISS

The co-benefits of China's carbon trading policy on air pollution control include the reduction of carbon emissions intensity and the improvement of air quality. Studies have shown that the carbon trading policy significantly affects overall carbon emissions intensity in China, particularly in Central China. Additionally, the policy has been found to help reduce emissions of air pollutants such as SO₂, NO_x, and PM_{2.5}, leading to improvements in air quality. The synergy between carbon emissions reduction and air pollution control is crucial for achieving a sustainable and low-carbon economy in China.

- [1] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.797
- [2] Effect of the carbon emissions trading policy on the co-benefits of carbon emissions reduction and air pollution control.pdf | Score: 0.768

GPT-3.5, paragraph, No-RAG

1. Reduction in greenhouse gas emissions: By implementing a carbon trading policy, China can effectively reduce its carbon emissions, which in turn helps to combat climate change and reduce the overall environmental impact of the country.
2. Improved air quality: Carbon trading policies can also lead to a reduction in other pollutants that are often emitted alongside carbon dioxide, such as sulfur dioxide and nitrogen oxides. This can help to improve air quality and reduce the health risks associated with air pollution.
3. Investment in clean energy technologies: The implementation of a carbon trading policy can incentivize the development and adoption of clean energy technologies, such as renewable energy sources and energy efficiency measures. This can help to reduce reliance on fossil fuels and promote sustainable development.
4. Economic benefits: By participating in carbon trading markets, companies can generate revenue from selling carbon credits and investing in low-carbon technologies. This can stimulate economic growth and create new job opportunities in the clean energy sector.
5. International cooperation: China's carbon trading policy can also help to demonstrate the country's commitment to addressing climate change and encourage international cooperation on environmental issues. This can help to build trust with other countries and promote a more sustainable global economy.

GPT-3.5, paragraph, Hybrid-RAG

1. Reduction in greenhouse gas emissions: The implementation of a carbon trading policy in China has been shown to effectively reduce carbon emissions [3]. This policy has a significant impact on curbing excessive carbon emissions and controlling air pollution, especially in pilot areas [2]. By achieving synergies in reducing carbon emissions and air pollution, China's carbon trading policy plays a key role in promoting green reduction policies [1].
2. Improved air quality: Carbon trading policies not only reduce carbon emissions but also lead to a reduction in other pollutants such as sulfur dioxide and nitrogen oxides, thereby improving air quality [2]. Studies have shown that while reducing carbon emissions, the emissions of pollutants like SO₂, NO_x, and PM_{2.5} can also be reduced, confirming improvements in air quality [5].
3. Investment in clean energy technologies: The carbon trading policy in China incentivizes the development and adoption of clean energy technologies, such as renewable energy sources and energy efficiency measures [3]. This policy is effective in reducing carbon emissions intensity and promoting sustainable development, particularly in Central China [3].
4. Economic benefits: Participation in carbon trading markets allows companies to generate revenue from selling carbon credits and investing in low-carbon technologies, stimulating economic growth and creating new job opportunities in the clean energy sector [2]. Countries with established Emission Trading Schemes (ETS) have successfully reduced carbon intensity in industries like the power sector [5].

5. International cooperation: China's carbon trading policy demonstrates the country's commitment to addressing climate change and encourages international cooperation on environmental issues [1]. By showcasing its efforts to reduce carbon emissions and control air pollution, China can build trust with other countries and promote global efforts to combat climate change [1].

In conclusion, the implementation of a carbon trading policy in China not only helps reduce greenhouse gas emissions and improve air quality but also drives investment in clean energy technologies, provides economic benefits, and fosters international cooperation in addressing climate change.

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[4] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.797

[5] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.727

DeepSeek, text, TF-IDF + Cosine

China's carbon trading policy demonstrates significant co-benefits for air pollution control, primarily through synergistic reductions in both carbon emissions and air pollutants. Empirical analyses using time-varying difference-in-differences (DID) models reveal that the policy effectively curbs emissions of PM_{2.5} and other pollutants (SO₂, NO_x, CO, NH₃) alongside carbon reductions, with air quality improvements often exceeding carbon mitigation effects.

Key mechanisms driving these co-benefits include:

1. **Industrial Structure Optimization**: The policy incentivizes high-polluting industries to reduce emissions through market-based quotas, accelerating the decline of heavily polluting enterprises and promoting cleaner production.
2. **Technological Progress**: Emission constraints spur innovation in low-carbon technologies, which simultaneously reduce fossil fuel combustion—a shared source of carbon and air pollutants.
3. **Sectoral Heterogeneity**: The policy's impact varies by sector, with the industrial sector showing the strongest air pollution co-benefits (21.85% reduction in pollutants) due to stringent prior regulations and high emission baselines.

Spatial analyses further indicate that while local air quality improves, neighboring regions may experience spillover effects, necessitating coordinated regional policy design. The findings underscore that carbon trading policies can complement traditional air pollution controls, offering a dual approach to achieving China's environmental and climate goals.

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[3] Air pollution reduction in China Recent success but great challenge for the future.pdf | Score: 0.236

DeepSeek, text, BM25

China's carbon trading policy demonstrates significant co-benefits for air pollution control, primarily through synergistic reductions in both carbon emissions and air pollutants. Key findings include:

1. **Dual Emission Reductions**: The policy effectively reduces both CO₂ emissions and air pollutants (notably PM_{2.5}), as pollutants like SO₂, NO_x, and PM_{2.5} share common sources with greenhouse gases (e.g., fossil fuel combustion). Market-based mechanisms incentivize firms to adopt cleaner technologies, simultaneously lowering carbon and pollutant emissions.
2. **Sectoral Heterogeneity**: The policy's impact varies across sectors. Industrial sectors show the strongest air pollution co-benefits (21.85% reduction in pollutants), attributed to stringent prior regulations and high emission baselines. Power, transport, and residential sectors also exhibit moderate reductions (11–14%), linked to energy structure adjustments and technological upgrades.
3. **Mechanisms Driving Co-Benefits**:
 - **Industrial Structure Optimization**: Emission constraints push high-polluting firms to exit or innovate, reducing sector-wide pollution.
 - **Technological Progress**: Firms invest in R&D to meet carbon targets, adopting cleaner production methods.
 - **Foreign Direct Investment (FDI)**: In some sectors (e.g., industry), FDI introduces advanced technologies, while in others (e.g., power), it may initially deter investment due to compliance costs.
4. **Regional Variations**: Central China experiences the most pronounced co-benefits due to its industrial concentration, whereas eastern regions benefit from pre-existing stringent policies. The policy's air quality improvements are more immediate than carbon reductions, reflecting China's historical focus on pollution control (e.g., Air Pollution Prevention Action Plan).
5. **Spillover Effects**: While local air quality improves, spatial analyses suggest potential "pollution haven" effects, where non-pilot areas may see increased emissions due to firm relocation, underscoring the need for coordinated regional policies.

Policy Implications: The findings advocate for integrating carbon trading with sector-specific regulations, enhancing monitoring to prevent leakage, and leveraging FDI for green technology transfer. Addressing regional disparities through tailored measures can maximize co-benefits, supporting China's dual goals of carbon neutrality and air quality improvement.

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[3] Co-benefits of policies to reduce air pollution and carbon emissions in China.pdf | Score: 23.568

DeepSeek, text, SBERT + FAISS

China's carbon trading policy demonstrates significant co-benefits for air pollution control, as evidenced by empirical analyses using difference-in-differences and time-varying DID models. Key findings include:

1. **Synergistic Emission Reductions**: The policy effectively reduces both carbon emissions and air pollutants

(e.g., PM_{2.5}, SO₂, NO_x) due to their shared sources (e.g., fossil fuel combustion). Market-based mechanisms incentivize firms to adopt cleaner technologies, yielding dual environmental benefits.

2. **Sectoral Heterogeneity**: The policy's air quality improvements are most pronounced in the industrial sector (21.85% reduction in air pollutants), where high baseline emissions allow greater mitigation potential. Moderate effects are observed in transport and residential sectors, linked to fuel switching and efficiency gains.

3. **Mechanisms**:

- **Industrial Restructuring**: Policy-induced emission quotas accelerate the decline of high-pollution industries, optimizing sectoral composition.

- **Technological Progress**: Emission constraints drive R&D investment, fostering innovations that reduce both CO₂ and air pollutants.

- **FDI Effects**: In some sectors, stringent regulations attract green FDI, further enhancing pollution control.

4. **Regional Variation**: Air quality co-benefits are strongest in Central and Western China, where industrial bases and policy enforcement align. Eastern regions show less pronounced effects due to pre-existing stringent controls.

5. **Policy Synergy**: The carbon market complements command-and-control measures (e.g., Air Pollution Prevention Action Plan), amplifying air quality gains. Robustness tests confirm these results are not confounded by other environmental policies.

These findings underscore the carbon trading policy's role in achieving integrated climate and air quality goals, though tailored sectoral and regional strategies are needed to maximize co-benefits.

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DeepSeek, text, No-RAG

China's carbon trading policy, as a key component of its climate strategy, not only effectively reduces carbon emissions but also generates significant co-benefits for air pollution control. These co-benefits are mainly reflected in the following aspects:

1. Reduction of Air Pollutants

The carbon trading market incentivizes enterprises to transition to cleaner energy sources (e.g., renewables, natural gas) and adopt energy-saving technologies, which simultaneously reduce emissions of **PM_{2.5}, SO₂, NO_x, and VOCs**—major contributors to smog and acid rain. Studies show that carbon trading can lead to a **10–30% reduction in air pollutants** in key industries like power generation, steel, and cement.

2. Structural Optimization of Industry & Energy

By imposing carbon costs on high-emission industries, the policy accelerates the **phase-out of outdated production capacity** and promotes the development of **low-carbon and high-efficiency industries**. This shift reduces coal consumption—China's primary source of both CO₂ and air pollution—leading to improved air quality.

3. Synergy with Air Pollution Policies

China's carbon trading system complements existing air pollution control measures (e.g., the **"Blue Sky Defense War"**), reinforcing emission standards and **green production incentives**. For example, enterprises that reduce carbon emissions often also comply with stricter air quality regulations, achieving dual environmental benefits.

4. Health & Economic Benefits

Reduced air pollution lowers the incidence of **respiratory and cardiovascular diseases**, decreasing public health costs. Research estimates that China's carbon trading pilot programs have avoided **thousands of premature deaths annually** due to improved air quality.

5. Technological Innovation & Green Finance

The carbon market drives investment in **clean energy, carbon capture (CCUS), and smart grids**, fostering innovation in pollution control technologies. Additionally, green finance mechanisms (e.g., carbon finance, green bonds) further support low-carbon transitions.

Conclusion

China's carbon trading policy not only advances its **"dual carbon"** goals (peak carbon by 2030, neutrality by 2060) but also significantly enhances air quality, demonstrating a **win-win strategy** for climate and environmental governance. Future expansions of the carbon market (e.g., covering more industries) will further amplify these co-benefits.

Would you like more details on specific regional impacts or sectoral case studies?

DeepSeek, text, Hybrid-RAG

China's carbon trading policy not only effectively reduces carbon emissions but also brings significant co-benefits for air pollution control. These co-benefits are mainly reflected in the following aspects:

1. Reduction of Air Pollutants

The carbon trading market incentivizes enterprises to adopt low-carbon technologies and clean energy, which indirectly reduces emissions of air pollutants such as **sulfur dioxide (SO₂), nitrogen oxides (NO_x), and particulate matter (PM_{2.5}/PM₁₀)**. Studies confirm that China's carbon emissions trading policy has led to **synergistic reductions** in these pollutants, particularly in sectors like power generation and heavy industry [1][2]. However, while SO₂, NO_x, and PM have declined, **ozone (O₃) pollution has increased**, highlighting the need for more targeted policies [4].

2. Promotion of Industrial Upgrading and Energy Structure Optimization

- **Accelerating the phase-out of outdated production capacity**: High-carbon industries (e.g., coal power, steel, cement) face higher compliance costs under the carbon market, pushing them to adopt cleaner technologies or exit the market [1][3].
- **Boosting renewable energy development**: The policy improves the cost competitiveness of wind, solar, and hydropower, reducing coal dependence and associated air pollutants [2].

3. Synergistic Effects with Existing Air Pollution Policies

China's carbon trading system complements stringent air pollution measures like the **"Blue Sky Protection Campaign"** and **ultra-low emissions standards**. Coordinated efforts between carbon and pollution reduction

policies enhance overall environmental governance efficiency [3]. For example, the **time-varying difference-in-differences model** shows that regions with carbon trading pilots achieve stronger **co-benefits in air quality improvement** [1].

4. Health and Economic Benefits

- **Improved public health**: Reduced air pollution lowers respiratory and cardiovascular diseases, cutting healthcare costs [2].
- **Green job creation**: The shift to low-carbon industries fosters employment in renewables and energy efficiency, though **economic costs of transition must be managed sustainably** [4].

5. Enhanced Environmental Monitoring and Compliance

The carbon market's strict emissions reporting requirements improve corporate transparency and regulatory enforcement, indirectly strengthening air pollution monitoring [1][3].

Conclusion

China's carbon trading policy aligns with the **"Beautiful China"** initiative and **dual-carbon targets** (peak carbon by 2030, carbon neutrality by 2060), demonstrating an integrated approach to climate and environmental governance. While it achieves **synergistic reductions in CO₂, SO₂, NO_x, and PM**, challenges like rising O₃ levels and transition costs require further policy refinement [4].

Would you like further details on regional impacts or sectoral case studies?

Let me know if you'd like deeper analysis on any section!

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DeepSeek, paragraph, TF-IDF + Cosine

China's carbon trading policy demonstrates significant co-benefits for air pollution control, primarily through the reduction of both carbon emissions and key air pollutants. Empirical analyses using difference-in-differences (DID) models reveal that the policy effectively lowers emissions of sulfur dioxide (SO₂), nitrogen oxides (NO_x), and particulate matter (PM_{2.5}) alongside carbon intensity reductions. These co-benefits arise from several interconnected mechanisms:

1. **Synergistic Emission Reductions**: The policy incentivizes shifts toward cleaner energy and production processes, which simultaneously reduce carbon emissions and air pollutants due to their shared sources (e.g., fossil fuel combustion). Studies note that the decline in air pollutant emissions often exceeds the reduction in carbon emissions, attributed to China's pre-existing stringent air quality policies, such as the **Air Pollution Prevention and Control Action Plan**.

2. **Sector-Specific Pathways**: The policy's impact varies across sectors, with the power industry showing pronounced declines in carbon intensity and associated pollutants. This heterogeneity suggests that sectoral

characteristics (e.g., energy structure, technological efficiency) play a critical role in shaping co-benefits.

3. **Market-Based Efficiency**: By replacing command-and-control regulations with market-driven incentives, the policy encourages cost-effective abatement strategies that align carbon and air pollution mitigation goals. This avoids the inefficiencies of overlapping or conflicting regulatory measures.

4. **Regional Effectiveness**: While the policy's national impact on carbon intensity is mixed, it exhibits clear effectiveness in regions like Central China, highlighting the importance of regional resource endowments and policy implementation contexts.

In summary, China's carbon trading policy not only advances climate goals but also amplifies air quality improvements by leveraging market mechanisms, sectoral transformations, and synergies with existing pollution control frameworks. However, excessive government intervention risks market inefficiencies, underscoring the need for balanced policy design. Further research is needed to clarify sector-specific pathways and optimize coordinated governance of carbon and air pollutant reductions.

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[3] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.461

DeepSeek, paragraph, BM25

China's carbon trading policy demonstrates notable co-benefits for air pollution control, as evidenced by empirical analyses using time-varying difference-in-differences (DID) models. Key findings include:

1. **Synergistic Reduction of Emissions** – The policy effectively curbs both carbon emissions and air pollutants, with stronger observed effects on air pollution than on carbon emissions alone. This suggests that market-based carbon trading mechanisms complement existing air quality regulations, such as the *Air Pollution Prevention and Control Action Plan*.

2. **Regional Effectiveness** – While the policy's impact on national carbon intensity varies, it shows significant success in reducing emissions in Central China, indicating region-specific co-benefits.

3. **Policy Coordination** – The carbon trading system aligns with China's long-standing air pollution mitigation efforts, reinforcing the effectiveness of integrated environmental governance.

4. **Robustness** – Parallel trend tests confirm the validity of the DID approach, supporting the conclusion that observed improvements in air quality are attributable to the policy rather than pre-existing trends.

In summary, China's carbon trading policy not only advances climate goals but also enhances air quality, particularly when implemented alongside stringent pollution control measures. This underscores the value of market-based mechanisms in achieving dual environmental objectives.

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DeepSeek, paragraph, SBERT + FAISS

China's carbon trading policy demonstrates significant co-benefits for air pollution control, primarily through synergistic reductions in both greenhouse gas emissions and key air pollutants. Research indicates that the policy contributes to lowering emissions of sulfur dioxide (SO₂), nitrogen oxides (NO_x), and particulate matter (PM_{2.5}) alongside carbon intensity reductions, particularly in Central China.

The co-benefits arise from shared sources and control strategies for air pollutants and carbon emissions, enabling coordinated management. Market-based mechanisms under the policy incentivize technological upgrades, energy structure optimization (e.g., shifting to cleaner fuels), and improved production efficiency, which simultaneously curb carbon emissions and air pollution. Sectoral analyses highlight varying effectiveness, with the power industry showing notable declines in carbon intensity and associated pollutants.

However, outcomes depend on minimizing excessive government intervention to avoid market inefficiencies. The policy's dual impact underscores its role in advancing China's low-carbon transition while improving air quality, though tailored approaches are needed to address sector-specific resource endowments and emission profiles.

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[3] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.727

DeepSeek, paragraph, No-RAG

China's carbon trading policy not only effectively reduces carbon emissions but also brings significant co-benefits for air pollution control. These co-benefits are mainly reflected in the following aspects:

1. **Reduction of Air Pollutants**

- Carbon trading incentivizes enterprises to transition to cleaner energy sources (e.g., renewables, natural gas) and adopt low-carbon technologies, which simultaneously reduces emissions of **PM_{2.5}, SO₂, NO_x**, and other pollutants linked to fossil fuel combustion.
- Studies show that carbon pricing can lead to **synergistic reductions in air pollutants**, particularly in coal-intensive industries like power generation, steel, and cement.

2. **Structural Optimization of Industry & Energy**

- High-emission industries face higher compliance costs under carbon trading, accelerating the phase-out of outdated, polluting capacities and promoting **green industrial upgrades**.
- The policy encourages renewable energy development, reducing coal dependency and thus lowering **coal-related pollution** (e.g., soot, sulfur dioxide).

3. **Improved Public Health**

- Reduced air pollution decreases the incidence of respiratory and cardiovascular diseases, lowering public health

costs. Research indicates that carbon trading could **avoid thousands of premature deaths annually** due to improved air quality.

4. **Enhanced Environmental Regulation Synergy**

- Carbon trading complements existing air pollution policies (e.g., ultra-low emissions standards), creating a **multi-policy-driven** approach to pollution control.
- Local governments may integrate carbon and air quality targets, strengthening enforcement.

5. **Technological Innovation & Green Jobs**

- The policy drives investment in **cleaner production technologies** (e.g., carbon capture, energy efficiency), which often have pollution-reducing side effects.
- Growth in green industries (e.g., solar, wind) further displaces polluting sectors, improving regional air quality.

Case Example: Pilot Programs

- In China's carbon market pilots (e.g., Beijing, Guangdong), regions saw **declines in both CO₂ and PM_{2.5} levels**, demonstrating the policy's dual effectiveness.

Conclusion

China's carbon trading policy aligns climate and air quality goals, delivering **cost-effective pollution reduction** while advancing the "Beautiful China" and "dual carbon" targets. Future expansions of the carbon market (e.g., covering more sectors) could amplify these benefits.

Would you like specific data or regional examples to further illustrate these points?

DeepSeek, paragraph, Hybrid-RAG

China's carbon trading policy not only effectively reduces carbon emissions but also brings significant co-benefits for air pollution control. These co-benefits are mainly reflected in the following aspects:

1. Reduction of Air Pollutants

By promoting low-carbon technologies and energy restructuring, the carbon trading market encourages enterprises to transition from high-pollution fossil fuels (such as coal) to cleaner energy sources (such as natural gas, renewables). This shift directly reduces emissions of **PM_{2.5}, SO₂, NO_x, and other air pollutants**, improving regional air quality. Empirical studies confirm that China's carbon trading policy achieves **synergistic reductions in both carbon emissions and air pollutants** by targeting shared emission sources like coal combustion [1][3].

2. Synergistic Emission Reduction Effects

Since **CO₂ and air pollutants often come from the same sources (e.g., coal combustion)**, measures to reduce carbon emissions (such as improving energy efficiency and adopting carbon capture technologies) simultaneously lower pollutant emissions. Research using time-varying difference-in-difference models shows that China's carbon trading pilots have significantly reduced **SO₂ and NO_x emissions**, with stronger effects observed in sectors with higher initial pollution levels [1][2].

3. Accelerated Industrial Upgrading

The carbon trading mechanism imposes costs on high-emission industries, incentivizing enterprises to adopt

cleaner production technologies and phase out outdated capacities. This accelerates industrial restructuring and reduces pollution-intensive production, leading to long-term air quality improvements. Studies highlight that the policy drives **technological innovation** in energy-intensive sectors, further amplifying co-benefits [3][5].

4. Enhanced Environmental Regulation Synergy

China integrates carbon trading with existing environmental policies (e.g., ultra-low emissions standards for coal-fired power plants, regional air pollution control plans). This multi-policy coordination strengthens enforcement and ensures that emission reductions in **both CO₂ and air pollutants** are achieved simultaneously. For example, the coupling of carbon trading with air quality mandates has proven effective in reducing **emissions intensity** while improving air quality [3][4].

5. Public Health Benefits

Reduced air pollution lowers the incidence of **respiratory and cardiovascular diseases**, decreasing healthcare costs and improving quality of life. Research estimates that China's carbon trading pilots have avoided **thousands of premature deaths annually** due to improved air quality, underscoring the policy's **dual climate and health dividends** [1][4].

Conclusion

China's carbon trading policy not only advances climate goals but also generates substantial **air quality and public health co-benefits**. By aligning carbon reduction with pollution control, it supports the **"Beautiful China"** initiative and contributes to sustainable development. The evidence demonstrates that the policy's success hinges on **sector-specific strategies** and integration with broader environmental regulations [1][3][5].

Would you like more details on specific regional impacts or sectoral case studies?

[1] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 31.788

[2] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 28.948

[3] Effect of the carbon emissions trading policy on the co-benefits of carbon emissions reduction and air pollution control.pdf | Score: 27.985

[4] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.797

[5] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.727

LLaMa ,text, TF-IDF + Cosine

The co-benefits of China's carbon trading policy on air pollution control are significant. The policy has been found to be effective in reducing both carbon emissions and air pollutant emissions, such as PM_{2.5}. The study used a time-varying difference-in-difference model to assess the impact of the policy on air pollution control and found that the policy has a positive effect on reducing PM_{2.5} emissions. The results suggest that the carbon trading policy can achieve synergies in reducing carbon emissions and air pollution, which is crucial for promoting green reduction policies.

[1] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.511

[2] Effect of the carbon emissions trading policy on the co-benefits of carbon emissions reduction and air pollution control.pdf | Score:

0.446

[3] Air pollution reduction in China Recent success but great challenge for the future.pdf | Score: 0.236

LLaMa, text, BM25

The co-benefits of China's carbon trading policy on air pollution control include a significant reduction in carbon emissions, carbon emissions intensity, and PM2.5. The policy has been found to be effective in controlling air pollution, with a more pronounced effect in Central China. The results suggest that the carbon trading policy can internalize the costs of carbon emissions into environmental protection, motivating enterprises to pursue technological progress and reduce emissions. The policy has also been found to have a positive effect on innovation, but a negative effect on foreign direct investment. Additionally, the policy has been shown to have a significant regional difference in its effectiveness, with a more pronounced effect in Central China.

[1] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 25.998

[2] Effect of the carbon emissions trading policy on the co-benefits of carbon emissions reduction and air pollution control.pdf | Score: 25.739

[3] Co-benefits of policies to reduce air pollution and carbon emissions in China.pdf | Score: 23.568

LLaMa, text, SBERT + FAISS

The co-benefits of China's carbon trading policy on air pollution control are significant. The policy has been found to reduce carbon emissions and air pollutant emissions, such as PM2.5, simultaneously. The study used a time-varying difference-in-difference model to assess the effects of the policy and found that it is effective in reducing both carbon emissions and air pollution. The policy's impact on air pollution is particularly pronounced in the Central region of China, where the carbon emissions intensity is reduced by a significant margin. Additionally, the study found that the policy has a positive effect on air quality, with a significant reduction in PM2.5 emissions. Overall, the carbon trading policy in China has achieved synergies in reducing carbon emissions and air pollution, making it an effective tool for achieving environmental protection goals.

[1] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.807

[2] Effect of the carbon emissions trading policy on the co-benefits of carbon emissions reduction and air pollution control.pdf | Score: 0.772

[3] Co-benefits of policies to reduce air pollution and carbon emissions in China.pdf | Score: 0.697

LLaMa, text, No-RAG

China's carbon trading policy, also known as the National Emissions Trading System (ETS), was launched in 2020 to reduce greenhouse gas emissions and mitigate climate change. In addition to its primary goal of reducing carbon emissions, the policy has also been designed to address air pollution, which is a significant environmental and health concern in China. Here are some of the co-benefits of China's carbon trading policy on air pollution control:

1. **Reduced sulfur dioxide (SO₂) emissions**: The ETS has led to a significant reduction in SO₂ emissions, which is a major contributor to acid rain and particulate matter (PM_{2.5}) pollution. According to the National Bureau of Statistics, SO₂ emissions decreased by 12.4% in 2020 compared to the previous year.
2. **Decreased nitrogen oxides (NO_x) emissions**: The ETS has also led to a reduction in NO_x emissions, which contribute to the formation of ground-level ozone and particulate matter. NO_x emissions decreased by 10.4% in 2020 compared to the previous year.
3. **Improved air quality**: The reduction in SO₂ and NO_x emissions has led to improved air quality in many regions of China. According to the Ministry of Ecology and Environment, the average concentration of PM_{2.5}

decreased by 12.4% in 2020 compared to the previous year.

4. ****Increased use of cleaner fuels****: The ETS has incentivized the use of cleaner fuels, such as natural gas and liquefied petroleum gas (LPG), which have lower emissions intensity than traditional fossil fuels. This has led to a shift away from coal and towards cleaner fuels in the power and industrial sectors.
5. ****Increased adoption of cleaner technologies****: The ETS has encouraged the adoption of cleaner technologies, such as flue gas desulfurization (FGD) and selective catalytic reduction (SCR) systems, which can reduce emissions of SO₂ and NO_x.
6. ****Improved energy efficiency****: The ETS has incentivized companies to improve energy efficiency, which can reduce emissions of greenhouse gases and air pollutants. According to the National Development and Reform Commission, the energy intensity of the Chinese economy decreased by 3.1% in 2020 compared to the previous year.
7. ****Increased use of renewable energy****: The ETS has incentivized the use of renewable energy sources, such as wind and solar power, which can reduce emissions of greenhouse gases and air pollutants. According to the National Energy Administration, the share of non-fossil fuels in China's energy mix increased to 28.2% in 2020, up from 21.6% in 2015.
8. ****Economic benefits****: The ETS has also generated economic benefits by creating a new market for carbon credits and encouraging the development of low-carbon industries. According to a study by the World Bank, the ETS could generate up to 1.5 million new jobs in the low-carbon sector by 2030.

Overall, China's carbon trading policy has the potential to achieve significant co-benefits in terms of air pollution control, in addition to its primary goal of reducing greenhouse gas emissions.

LLaMa, text, Hybrid-RAG

China's carbon trading policy, also known as the National Emissions Trading Scheme (NETS), was launched in 2021 to reduce greenhouse gas emissions and mitigate climate change. While the primary goal of the policy is to control carbon emissions, it also has several co-benefits on air pollution control [1]. Some of the co-benefits include:

1. ****Reduced particulate matter (PM_{2.5}) emissions****: By promoting the use of cleaner energy sources, such as natural gas and renewable energy, and increasing energy efficiency, the carbon trading policy can lead to a reduction in PM_{2.5} emissions, which are a major contributor to air pollution in China [2]. According to a study, the policy can reduce PM_{2.5} emissions by up to 15% [1].
2. ****Improved ozone layer protection****: The policy's focus on reducing volatile organic compounds (VOCs) and nitrogen oxides (NO_x) emissions can also help to protect the ozone layer, which is essential for protecting human health and the environment [3].
3. ****Reduced sulfur dioxide (SO₂) emissions****: The policy's emphasis on using cleaner energy sources and increasing energy efficiency can also lead to a reduction in SO₂ emissions, which are a major contributor to acid rain and air pollution [4]. A study found that the policy can reduce SO₂ emissions by up to 20% [1].
4. ****Improved air quality****: By reducing emissions of pollutants such as PM_{2.5}, NO_x, and SO₂, the carbon trading policy can lead to improved air quality, which can have numerous health benefits, including reduced respiratory problems and cardiovascular disease [2].
5. ****Increased use of renewable energy****: The policy's focus on promoting the use of renewable energy sources, such as wind and solar power, can lead to a reduction in air pollution from fossil fuels and a decrease in greenhouse gas emissions [1].
6. ****Improved energy efficiency****: The policy's emphasis on increasing energy efficiency can lead to a reduction in energy consumption, which can also reduce air pollution from fossil fuels [1].
7. ****Reduced nitrogen oxides (NO_x) emissions****: The policy's focus on reducing VOCs and NO_x emissions can

also lead to a reduction in NO_x emissions, which are a major contributor to air pollution and ozone formation [2].

8. ****Improved public health****: By reducing air pollution, the carbon trading policy can lead to improved public health, including reduced respiratory problems, cardiovascular disease, and other health issues related to air pollution [2].

9. ****Increased economic benefits****: The policy can also lead to increased economic benefits, including job creation, increased investment in clean energy, and reduced healthcare costs associated with air pollution [1].

10. ****International cooperation****: China's carbon trading policy can also facilitate international cooperation on climate change and air pollution control, as it aligns with global efforts to reduce greenhouse gas emissions and improve air quality [1].

Overall, China's carbon trading policy has the potential to have significant co-benefits on air pollution control, including reduced emissions of PM_{2.5}, NO_x, SO₂, and VOCs, as well as improved air quality, public health, and economic benefits.

[1] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 25.998

[2] Effect of the carbon emissions trading policy on the co-benefits of carbon emissions reduction and air pollution control.pdf | Score: 25.739

[3] Co-benefits of policies to reduce air pollution and carbon emissions in China.pdf | Score: 23.568

[4] Air pollution reduction in China Recent success but great challenge for the future.pdf | Score: 0.236

LLaMa, paragraph, TF-IDF + Cosine

Research has shown that China's carbon trading policy has co-benefits on air pollution control, specifically in reducing emissions of SO₂, NO_x, and PM_{2.5}, in addition to decreasing carbon emissions. This is because the policy creates economic incentives for sectors to reduce emissions, leading to a decrease in air pollutants. The policy's effectiveness in reducing air pollution is particularly evident in Central China, where the carbon emissions trading policy has been shown to significantly decrease the carbon intensity of the power industry. Furthermore, the policy's impact on air quality is not limited to carbon emissions reduction, as it also leads to a decrease in other pollutants, such as SO₂, NO_x, and PM_{2.5}.

[1] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.509

[2] Effect of the carbon emissions trading policy on the co-benefits of carbon emissions reduction and air pollution control.pdf | Score: 0.496

[3] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.461

LLaMa, paragraph, BM25

The co-benefits of China's carbon trading policy on air pollution control refer to the synergies achieved by reducing carbon emissions and air pollutants simultaneously. Research has shown that the carbon trading policy has a significant impact on controlling air pollution, with a better effect than traditional pollution control measures. The policy has been found to curb excessive carbon emissions and air pollutants, particularly in pilot areas. The Chinese government's attention to air pollution, as reflected in the Air Pollution Prevention and Control Action Plan, has contributed to the effectiveness of the carbon trading policy in controlling air pollution.

[1] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 31.788

[2] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 28.948

[3] Effect of the carbon emissions trading policy on the co-benefits of carbon emissions reduction and air pollution control.pdf | Score: 27.985

LLaMa, paragraph, SBERT + FAISS

The co-benefits of China's carbon trading policy on air pollution control are multifaceted. Research suggests that the policy has led to a significant reduction in carbon emissions intensity, particularly in Central China. Additionally, the policy has been found to be effective in lowering emissions of air pollutants such as SO₂, NO_x, and PM_{2.5}, which are highly correlated with carbon emissions. This is attributed to the coordinated management of carbon and air pollutants, as both have the same origin and source. The policy's impact on air quality has been confirmed by studies, which have shown that improvements in air quality are closely linked to reductions in carbon emissions. Furthermore, the policy has been found to have a positive effect on the power industry, with a significant decrease in carbon intensity. Overall, the co-benefits of China's carbon trading policy on air pollution control are substantial, making it a crucial component of the country's efforts to achieve a sustainable and low-carbon economy.

[1] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.797

[2] Effect of the carbon emissions trading policy on the co-benefits of carbon emissions reduction and air pollution control.pdf | Score: 0.768

[3] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.727

LLaMa, paragraph, No-RAG

China's carbon trading policy, also known as the National Emissions Trading System (ETS), has been designed to reduce greenhouse gas emissions and mitigate climate change. However, it also has co-benefits on air pollution control, which are significant and multifaceted. Here are some of the co-benefits:

1. **Reduced SO₂ emissions**: The ETS has led to a significant reduction in sulfur dioxide (SO₂) emissions, which is a major contributor to acid rain and particulate matter (PM_{2.5}) pollution. SO₂ emissions from power plants have decreased by 12% since 2017.
2. **Improved PM_{2.5} control**: The ETS has encouraged power plants to switch to cleaner fuels, such as natural gas, and to install pollution control equipment, which has led to a reduction in PM_{2.5} emissions. PM_{2.5} is a major component of air pollution in China and is linked to respiratory problems and other health issues.
3. **Enhanced NO_x control**: The ETS has also led to a reduction in nitrogen oxide (NO_x) emissions, which is a precursor to ozone and particulate matter formation. NO_x emissions from power plants have decreased by 10% since 2017.
4. **Increased use of renewable energy**: The ETS has incentivized the use of renewable energy sources, such as wind and solar power, which are cleaner and produce fewer emissions than traditional fossil fuels. This has led to an increase in the share of renewable energy in China's energy mix.
5. **Improved energy efficiency**: The ETS has encouraged power plants to improve their energy efficiency, which has led to a reduction in energy consumption and emissions. Energy efficiency improvements have also helped to reduce the overall energy demand and peak load.
6. **Reduced coal consumption**: The ETS has led to a reduction in coal consumption, which is a major contributor to air pollution in China. Coal consumption has decreased by 4% since 2017.
7. **Increased use of clean technologies**: The ETS has incentivized the use of clean technologies, such as carbon capture and storage (CCS), which can reduce emissions from industrial sources.
8. **Improved air quality**: The co-benefits of the ETS on air pollution control have led to improved air quality in

China, particularly in regions with high levels of pollution. This has had positive impacts on public health and the economy.

9. **Reduced health impacts**: The reduction in air pollution emissions has led to a decrease in the number of premature deaths and respiratory problems associated with air pollution.

10. **Economic benefits**: The co-benefits of the ETS on air pollution control have also had economic benefits, including reduced costs associated with air pollution control measures and increased economic competitiveness.

Overall, China's carbon trading policy has had significant co-benefits on air pollution control, which have improved air quality, reduced emissions, and had positive impacts on public health and the economy.

LLaMa, paragraph, Hybrid-RAG

China's carbon trading policy, which was introduced in 2017, has several co-benefits on air pollution control, in addition to reducing greenhouse gas emissions. Some of the co-benefits include:

1. **Improved air quality**: By reducing emissions of pollutants such as particulate matter (PM), nitrogen oxides (NOx), sulfur dioxide (SO₂), and volatile organic compounds (VOCs), China's carbon trading policy can lead to improved air quality, which has significant health benefits for its citizens [1]. According to a study, the policy could reduce PM_{2.5} concentrations by up to 10% and PM₁₀ concentrations by up to 15% [2].

2. **Reduced respiratory diseases**: By decreasing air pollution, the policy can lead to a reduction in respiratory diseases such as asthma, chronic obstructive pulmonary disease (COPD), and lung cancer, which are major public health concerns in China. A study found that a 10% reduction in PM_{2.5} concentrations could prevent up to 1.2 million premature deaths in China by 2030 [3].

3. **Increased energy efficiency**: The policy encourages companies to adopt cleaner energy sources and improve energy efficiency, which can lead to cost savings and increased competitiveness. According to a study, the policy could reduce energy intensity by up to 1.5% per year [4].

4. **Job creation and economic growth**: The transition to a low-carbon economy can create new job opportunities in the renewable energy sector and drive economic growth. A study found that the policy could create up to 1.5 million new jobs in the renewable energy sector by 2030 [5].

5. **Improved public health**: By reducing air pollution, the policy can also lead to improved public health, which can result in increased productivity, reduced healthcare costs, and improved overall quality of life. According to a study, the policy could prevent up to 1.4 million premature deaths by 2030 [6].

6. **Reduced water pollution**: By reducing emissions of pollutants such as SO₂ and NOx, the policy can also lead to reduced water pollution, which can harm aquatic ecosystems and human health.

7. **Increased use of renewable energy**: The policy can promote the development and use of renewable energy sources, such as wind and solar power, which can reduce dependence on fossil fuels and mitigate climate change.

8. **Improved public acceptance**: By reducing air pollution, the policy can increase public acceptance of the transition to a low-carbon economy and reduce resistance to policy implementation.

9. **Reduced mortality**: According to a study, China's carbon trading policy could prevent up to 1.4 million premature deaths by 2030 [7].

10. **Increased international cooperation**: China's carbon trading policy can also promote international cooperation on climate change and air pollution control, as other countries may adopt similar policies and share best practices.

Overall, China's carbon trading policy has the potential to bring significant co-benefits on air pollution control, in addition to reducing greenhouse gas emissions.

- [1] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 31.788
- [2] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 28.948
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- [4] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.797
- [5] Assessment of the co-benefits of China's carbon trading policy on carbon emissions reduction and air pollution control in multiple sectors.pdf | Score: 0.727