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Whether the ETS in China affects its regional Industrial GDP Increment

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Abstract:

Due to the intense global warming, many countries have formed their emission trading system (ETS) to limit carbon emissions. China also started its own ETS because it is believed to be the most effective system for limiting carbon emissions. In this research, I will examine the effect of the ETS on China using the difference in difference model, the parallel trend test, and the placebo test to ensure robustness. The result shows a negative impact on the increase in industrial production. Thus, more emissions should be allowed if industrial production needs faster growth.

Keywords: ETS, DID, Secondary Industry Increment, test point cites, parallel trend test, placebo test.

1. Introduction

Carbon emission is one of the topics most discussed when people talk about global warming. One significant reason is that it is believed to be the most critical factor for global warming (Xu & Lin, 2018). Since the industrialization revolution, people's carbon emission rate has been growing. A study shows that from 1970, the global average temperature was 0.8 degrees Celcius to 1.2 degrees Celcius, higher than the pre-industrial level (ipcc, 2015). Without a doubt, global warming is a harmful event that affects every human being, and indeed, it is happening (UNCC, 2023). This is also the reason that more and more countries in the world are trying to limit carbon emissions in various ways.

The emission trading system (ETS) is commonly believed to be the most effective method to limit carbon Emissions. The system assigns the companies a certain amount of carbon credits, which means the permitted amount of permission. If the companies permit less, they can sell the credits left to other companies that need to allow more for profit. Starting in 2013, China also tried to use ETS to reach the goal of peak carbon emission before 2030.

However, although the system is improving, Chinese ETS still needs to mature. Some of its impact on the secondary industry still needs to be clarified. In this paper, I will use mathematical models like the difference in difference model (DID) to evaluate whether the ETS in China is affecting its GDP. Through this research, we can better understand ETS in China and ETS in the rest of the world.

2. Literature Review

One of the efforts to limit or slow down the rate of global warming was to slow down the carbon emission rate. There are three main ways to limit carbon emissions. One is to add a quota to limit carbon emissions. Another is to impose a carbon emission per unit tax. Lastly, an emission trading system (ETS) should be set up that allows companies to trade their carbon credits freely. Among the three policies, ETS

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is considered the most efficient method to limit carbon emissions in the long run, and here are the following reasons. If a carbon emission tax is imposed, and the tax is low, companies might ignore the tax if it is more profitable than making changes. Also, the uncertainty of imposing a carbon emission tax may cause companies not to invest in cleaner ways of production but to wait and see if the tax will last long enough (Umit & Schaffer, 2020). Setting quotas is inefficient and complex when allocating quotas because many firms in the industry have different sizes. Thus, both carbon quota and carbon tax are significantly considered regressive (Jiang & Shao, 2014).

In comparison, ETS is a much more efficient system. While other methods have failed to limit carbon emission rate, ETS has successfully made it. (Gao et al., 2020, Haites, 2018). Furthermore, the trading system may allow companies to profit from developing green technologies, creating higher incentives (Calel & Dechezleprêtre, 2016). China has once been an excellent carbon emitter. The CO2 emissions in the country have increased from 1538.313 Mton CO2 eq/yr in 1970 to 10433 Mton CO2 eq/yr in 2016(Joint Research Centre (European Commission) et al., 1970). To reduce carbon emissions and reach peak carbon emissions in 2030, China has also founded its ETS. With development, Chinese ETS became the world's second-largest ETS(Chen et al., 2016).

Although ETS is considered the most efficient trading system, it has some adverse side effects. Once the ETS appears in Europe, the cost for European manufacture becomes higher. In 2015, due to the regulation, fuel became much more expensive. Low-sulfur fuel is 70% to 80% more expensive(ESMA, 2010). This leads to problems the market will be less competitive because the cost for a new firm to enter the industry becomes higher(Lähteenmäki-Uutela et al., 2017). This may also increase unemployment because some firms want to regulate increased costs by lowering wages or stopping hiring workers(Walker, 2013). The ETS cost increase may also cause firms to be less competitive in the international markets. When ETS is applied in the EU, firms that produce outside the EU may gain higher shares, and therefore, some firms may choose to relocate to other countries, causing a decrease in productivity(Naegele & Zaklan, 2019). Also, due to the difference in costs, firms located in non-ETS countries may export more to Europe, and European firms may export less. (Wang & Kuusi, 2024, Lähteenmäki-Uutela et al., 2017)

Due to the similarity of the ETS in Europe and China, it is reasonable to believe that Chinese Industrial production will also be affected. Therefore, this paper digs deeper into the effect of ETS on Chinese industrial production. So far, few papers have researched ETS's impact on Chinese GDP, especially industrial production.

3. Background

In 2011, the national government decided to start preparing to construct the ETS. The central government instructed Cities like Beijing, Tianjin, Shanghai, and Chongqing, and provinces like Guangdong and Hubei to set up carbon markets, examine reasonable amount of emission standards and carbon credits, and how to secure the trade to happen(National Development and Reform Commission General Office, 2011).

4. Methodology

The main idea of this paper comes from two concepts from the Neoclassical economics. The first important concept concerns the free-market system and the coarse system. The free-market system is believed to be the fastest way for companies to grow economically. If only looking at the market, any intervention will create a deadweight loss and slow economic growth. Therefore, the government intervening in the industry is believed to slow economic development.

The second key concept is negative externalities. The course system also claims that negative externalities are controllable. However, the situation for coarse theory to run perfectly is too ideal for real life. Therefore, some policies are needed to limit negative externalities.

5. Key concept

5.1 . Test point cities.

China started the Emission Trading system in 2013 with several test point cities. These cities are the cities employed by the ETS. This will be the treatment group in this study.

5.2 . Secondary Industry

Among the three primary industries, the Secondary Industry is the most affected. This is because the secondary industry often generates the most carbon emissions. Therefore, we use the increment of the secondary sector as the explanatory variable.

5.3 . GDP Increment

GDP is the measure of economic growth. Therefore, this will be the explanatory variable of this study.

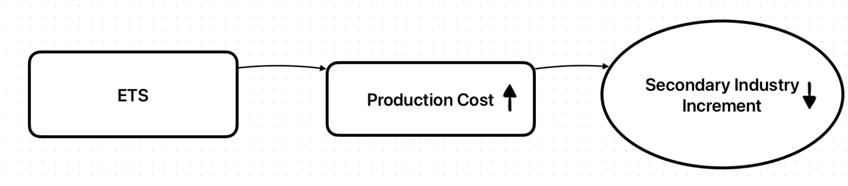

Fig. 1 Line of Reasoning of ETS

As shown in Figure 1, according to economic theories, the ETS will increase industries' production costs and slow the GDP increase.

The null hypothesis is that the ETS does not affect economic growth. The alternative hypothesis is that there are adverse effects on GDP.

6. Data and Testing Using the Model

6.1 . DID Model

The DID model used for this study evaluates treatments' effect on the explanatory variable by comparing the trend before and after the policy was added.

The explanatory variable of this experiment will be the lnGDP Increment of the secondary industry. This is because some specific cities in China have much greater production scales than the rest.

Therefore, I will use GDP instead of GDP as the explanatory variable to limit the skewness.

In 2013, seven cities were designated as test point cities; the ETS will start to function in these cities. These seven cities will be the treatment group in this experiment.

Since this act started in 2013, the post variable will depend on whether the period is before or after 2013.

DID variable is the product of the treat variable and post variable.

Because other factors affecting the secondary industry could be challenging to clarify, we use them to represent the random error.

Some control variables were also added to the model to increase reliability and robustness. Xk is used as the symbol for the control variables in the model.

Through these coefficients and variables, we can analyze the effect of ETS on Industrial production and GDP.

The complete DID model

$$lnGDP\_se = \beta 0 + \beta 1*Treat + \beta 2*Post + \beta 3*DID + \Sigma \beta k*Xk + \varepsilon$$

6.2 . Parallel Trend Test

Performing the parallel Trend test after running the DID model is imperative. If the null hypothesis is true, the trends for the treatment and control groups should be parallel.

To do so, we must set up a hypothetical time point and an interaction item for the DID model. The coefficient of the interaction item is crucial.

D_pre identifies which individuals belong to the treatment group and which belong to the control group before the hypothetical policy implementation. Unlike the original treatment group dummy variable D, D_pre is set up before the policy implementation.

D_pre*T is the interaction between D_pre and the time variable. It reflects the trend difference between the treatment group and the control group before the policy implementation. If the coefficient of this interaction term, β5, is not statistically significant, it indicates that the parallel trends assumption is satisfied.

The complete parallel trend test model:

$$lnGDP\_se = \beta 0 + \beta 1*Treat + \beta 2*Post + \beta 3*DID + \beta 4*D\_pre + \beta 5*D\_pre*T \Sigma \beta k*Xk + \varepsilon$$

6.3 . Placebo Test

A placebo test confirms the robustness of the DID model. In this test, the GDP increment of the primary industry will be used as the placebo because the ETS does not significantly affect those businesses.

To do the test, we replaced the lnGDP increment of the secondary industry with that of the primary industry since the increment of the primary sector can also represent economic growth. However, it is not strongly affected by the ETS.

$$lnGDP\_pr = \beta 0 + \beta 1*D + \beta 2*T + \beta 3*D*T + \Sigma \beta k*Xk + \varepsilon$$

6.4 . Data

The secondary and primary industry increment data comes from China's National Bureau of Statistics from 2000 to 2022. The information on the treatment group comes from the published government document.

For the control variables, financial institution deposits (Yuan, 2013), telecommunication businesses (Liu, 2004), city resident consumption (yjbys, 2020), local general expenditures (Zhao, 2021), total investment in fixed assets (Assbring, 2012), and total energy consumption (Wu et al., 2014) are selected as they all influence Industrial production. These data come from the sources that are discussing them.

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7. Result and Discussion

HDFE Linear regression
Absorbing 2 HDFE groups

Number of obs	=	3,490
F(11, 3194)	=	206.73
Prob > F	=	0.0000
R-squared	=	0.9766
Adj R-squared	=	0.9744
Within R-sq.	=	0.4159
Root MSE	=	0.1709

ln_SecIndIncreasing	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
DID	.137005	.0182264	7.52	0.000	.1012684	.1727415
ln_LocalGeneralExpenditures	.265176	.0241823	10.97	0.000	.2177617	.3125903
ln_CityResidentSpending	.541029	.0484852	11.16	0.000	.4459637	.6360943
ln_EnergyConsumption	.1911199	.0188722	10.13	0.000	.154117	.2281227
ln_InvestmentInFixedAssets	.1498223	.0083066	18.04	0.000	.1335354	.1661091
ln_telecommunications	.0279288	.0078224	3.57	0.000	.0125914	.0432662
ln_netImportAndExport	-.0209593	.0436735	-0.48	0.631	-.1065902	.0646716
ln_Import	.0314959	.0108548	2.90	0.004	.0102129	.0527789
ln_Export	.0600355	.0443672	1.35	0.176	-.0269556	.1470265
ln_netExport	-.0097258	.0084802	-1.15	0.252	-.026353	.0069014
ln_busInstSaving	.2422756	.0327348	7.40	0.000	.1780923	.3064589
_cons	-2.894677	.6313377	-4.58	0.000	-4.132545	-1.656809

Absorbed degrees of freedom:

Absorbed FE	Categories	- Redundant	= Num. Coefs
id	270	0	270
year	16	1	15

Fig.2 Result of DID analysis

As shown in Figure 2, the result of the DID analysis demonstrated that the emission trading system in China has had a significant negative effect on its secondary industry.

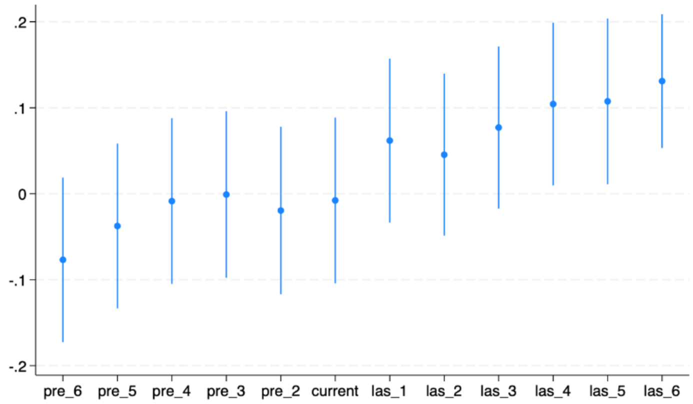

Fig.3 Result of Parallel Trend test

As shown in Figure 3, the result of the parallel trend test can also prove this. Starting from the fourth year after ETS was applied in China, the effect of ETS became significant.

HDFE Linear regression
Absorbing 2 HDFE groups

Number of obs	= 6,610
F(1, 6289)	= 1.98
Prob > F	= 0.1595
R-squared	= 0.9596
Adj R-squared	= 0.9576
Within R-sq.	= 0.0003
Root MSE	= 0.2662

lnGDP	Coefficient	Std. err.	t	P>|t|	[95% conf.	interval]
DID	-.0280484	.0199377	-1.41	0.160	-.067133	.0110363
_cons	6.685888	.0034452	1940.62	0.000	6.679134	6.692642

Absorbed degrees of freedom:

Absorbed FE	Categories	- Redundant	= Num. Coefs
id	298	0	298
year	23	1	22

Fig.4 Result of Placebo Test

As shown in Figure 4, the result of the placebo test stated that the effect of ETS on the Chinese tertiary industry is insignificant, making the result of the DID test more robust.

8. Conclusion

Because of the intense rate of global warming and heavy carbon emissions, many countries and regions have decided to limit their carbon emissions by all methods that limit carbon emissions. ETS is believed to be the most effective system but has the most minor economic side effects. However, its side effect on industrial production remains to be seen. This paper uses the DID model to investigate the impact of ETS on secondary industry GDP increment. To get robust results, we use control variables parallel tend to test and placebo test in this test. The result that passed the parallel trend test and placebo test claims that there is a negative effect on secondary industry increment.

8.1 . Limitations

Although the data are reliable, and different robustness tests have been done, some confounding variables are still hard to quantify. China is a country that depends heavily on government decisions. If the government decides to build a new industry zone in one of the test point cities after the treatment, it may lead to a sudden increase in industrial production in those cities.

8.2 . Inspirations

This paper reveals that there is indeed a negative effect on the secondary industry increment. Therefore, the government must evaluate whether protecting the environment or promoting industrial development is more important. If promoting industrial development is more critical, more emissions should be allowed, and vice versa.

References

[1] Assbring, M. J. (2012). *What Factors Affect Economic Growth in China?*

[2] Calel, R., & Dechezleprêtre, A. (2016). Environmental policy and directed technological change: Evidence from the European Carbon Market. *Review of Economics and Statistics*, *98*(1), 173–191. https://doi.org/10.1162/rest_a_00470

[3] Chen, D., Li, L., Liu, X., & Lobo, G. J. (2016). Social Trust and auditor reporting conservatism. *Journal of Business Ethics*, *153*(4), 1083–1108. https://doi.org/10.1007/s10551-016-3366-5

[4] EMSA. (2010, December 13). The 0.1% sulphur in fuel requirement as from 1 January 2015 ... https://euroshore.com/sites/euroshore.com/files/downloads/report_sulphur_requirement.pdf

[5] Gao, Y., Li, M., Xue, J., & Liu, Y. (2020). Evaluation of effectiveness of China's carbon emissions trading scheme in carbon mitigation. *Energy Economics*, *90*, 104872. https://doi.org/10.1016/j.eneco.2020.104872

[6] Haites, E. (2018). Carbon taxes and greenhouse gas emissions trading systems: What have we learned? *Climate Policy*, *18*(8), 955–966. https://doi.org/10.1080/14693062.2018.1492897

[7] ipcc. (n.d.). *Global Warming of 1.5 oC*. Global warming of 1.5 oc. https://www.ipcc.ch/sr15/

[8] Jiang, Z., & Shao, S. (2014). Distributional effects of a carbon tax on Chinese households: A case of Shanghai. *Energy Policy*, *73*, 269–277. https://doi.org/10.1016/j.enpol.2014.06.005

[9] Joint Research Centre (European Commission), Monforti-

ISSN 2959-6130

Ferrario, Oreggioni, Schaaf, Guizzardi, Olivier, Solazzo, Vullo, L., Crippa, Muntean, & Vignati. (1970, January 1). Fossil CO2 and GHG emissions of All World Countries. Publications Office of the EU. https://dx.doi.org/10.2760/687800

[10] Liu, Y. (2004). An empiricalre search on the influence of telecommunication industry on regional GDP —— with the case of Guangdong Provinceand Qinghai Province as an example. Journal of Beijing University of Posts and Telecommunication. https://doi.org/https://journalsk.bupt.edu.cn/CN/Y2004/V6/I4/5

[11] Lähteenmäki-Uutela, A., Repka, S., Haukioja, T., & Pohjola, T. (2017). How to recognize and measure the economic impacts of environmental regulation: The sulphur emission control area case. Journal of Cleaner Production, 154, 553–565. https://doi.org/10.1016/j.jclepro.2017.03.224

[12] Naegele, H., & Zaklan, A. (2019). Does the EU ETS cause carbon leakage in European manufacturing? *Journal of Environmental Economics and Management*, *93*, 125–147. https://doi.org/10.1016/j.jeem.2018.11.004

[13] Umit, R., & Schaffer, L. M. (2020). Attitudes towards carbon taxes across Europe: The role of perceived uncertainty and self-interest. *Energy Policy*, *140*, 111385. https://doi.org/10.1016/j.enpol.2020.111385

[14] UNCC. (2023, November 4). Unfccc.int. https://unfccc.int/news/new-analysis-of-national-climate-plans-insufficient-progress-made-cop28-must-set-stage-for-immediate

[15] Walker, W. R. (2013). The transitional costs of sectoral reallocation: Evidence from the Clean Air Act and the workforce*. *The Quarterly Journal of Economics*, *128*(4), 1787–1835. https://doi.org/10.1093/qje/qjt022

[16] Wang, M., & Kuusi, T. (2024). Trade flows, carbon leakage, and the EU Emissions Trading System. Energy Economics, 134, 107556. https://doi.org/10.1016/j.eneco.2024.107556

[17] Wu, J., Niu, Y., Peng, J., Wang, Z., & Huang, X. (2014). Research on energy consumption dynamic among prefecture-level cities in China based on DMSP/OLS Nighttime Light. Geographical Research.

[18] Xu, B., & Lin, B. (2018). Investigating the role of high-tech industry in reducing China's CO2 Emissions: A regional perspective. *Journal of Cleaner Production*, *177*, 169–177. https://doi.org/10.1016/j.jclepro.2017.12.174

[19] Yuan, A. (2013). The Empirical Analysis of the Relationship Between Deposit Balances of Financial Institutions and Economic Development: A Case Study of Hainan. *Money China*. (in Chinese)

[20] Zhao, H. (2021). A Quantitative Analysis of the Factors Influencing GDP in China. China Collective Economy. *China Conductive Economy*. (in Chinese)

[21] National Development and Reform Commission General Office. (2011, October 29). Notice on the Implementation of Carbon Emission Trading Pilot Programs. https://fgw.sh.gov.cn/cmsres/02/02822dc41f9c41ec9245eb0cc69770be/99988d7bd5f009b6983ff78d6f9ebf7.pdf (in Chinese)

[22] *Research on the Relationship Between the Growth Rate of Per Capita Disposable Income of Urban and Rural Residents and the Growth Rate of GDP*. Graduates' Network. (2020, August 27). https://www.yjbys.com/biyelunwen/fanwen/jingji/706220.html (in Chinese)