How Best To Co-control Pollution? – A Case Study From China

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China is currently facing a major air pollution challenge and must make significant reductions in its emissions of conventional air pollutants (AP) and greenhouse gases (GHGs). This is especially the case for the iron and steel sector, which is one of the country's biggest polluters. To help find the best way to address this problem, a new EEPSEA study has looked at policies that will help reduce both GHGs and APs at the same →

A summary of EEPSEA Research Report No. 2011-RR6: 'Co-control of Air Pollution and GHGs in China's Iron and Steel Sector: an Integrated Modeling Assessment of Policy and Technology Options' by LIU Zhaoyang, MAO Xianqiang,, LIU Shengqiang, Kevin Jianjun TU, School of Environment, Beijing Normal University, Beijing, China. Postal Code: 100875.
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significant enough if carbon taxation rates were lower than 100 CNY/ton CO_2. Overall, the effects of carbon taxation on the economy, on technology development, on energy use and on the environment would become more significant the higher the tax rate imposed.

Do End of Pipe Policies Bring Co-benefits?

A GDP loss would be expected under the Command and Control - End of Pipe (CAC-EOP) policies. This loss would be comparable in scale with that caused by CTS-A and CTS-B. Overall, CAC-EOP policies would bring down the economic welfare of the society. What's more, they would not significantly accelerate production technology substitution.

From an environmental point of view, CAC-EOP policies would have conflicting effects on different pollutant emissions, reducing some while increasing others. Because of this, if different EOP technologies and different pollutions are considered as a whole, their environmental welfare benefits are much less than expected.

Additionally, some other problems have been observed during the implementation of CAC-EOP policies in the past. For instance, due to flawed policy enforcement and supervision, together with weak penalty mechanisms, it is relatively easy for enterprises to violate CAC-EOP policies. They are therefore reluctant to equip and operate EOP pollution control technologies. Moreover, CAC-EOP policies have already been implemented in China for some years, and the potential for future pollution abatement via this mechanism is decreasing.

Carbon Taxes the Better Option

When carbon tax and EOP policies are compared, it can be safely concluded that a carbon tax regime can reduce both carbon and local pollutants and achieve significant co-benefits. It is also clear that CAC-EOP policies cannot deliver significant co-control effects because of the conflicting effects they produce in the reduction of local pollutants and CO_2.

On a policy level, it is clear that market-based policy instruments, such as a carbon tax, have the potential to produce improvements in both economic and environmental welfare. These benefits include the 'co-reduction' of different pollutant emissions, along with higher levels of economic development, technology substitution, energy security and environmental protection. Moreover, a carbon tax provides a possible solution to the threat of a carbon tariff proposed by the US and could benefit the international trade interests of China.

On a technology level, iron and steel production in China has been evolving towards larger scale plants and higher energy efficiencies. This direction of development would be accelerated under economic incentives such as a carbon tax. Indeed, technology substitution and resource managements will be more effective if small-scale plants are shut down and merged into large ones.

Higher Taxes Needed

In light of its findings the study concludes that policy makers should look at accelerating the implementation of a carbon tax, within a framework of environmental tax reform. It recommends that this carbon tax should be imposed at a sufficiently high enough level to have the required impact. Any CAC-EOP policies should be prudently designed and lessons from the past (and from the current study) should be taken into account.

In order to cushion the negative impacts on certain industries, any carbon tax should be implemented with other complementary policies such as discriminated tax rates for different industries and governmental guidance on energy price agreements among different energy sectors. Last but not least, as a carbon tax might increase energy prices and intensify inflation, complementary fiscal and monetary policies should be developed to counteract these negative impacts.

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"carbon tax policies would bring ... about synergetic reductions."

Group	Scenario	Tax rate (CNY/ton CO_2)	Tax revenue expense	Attached tax reform
CTS_A	CTS_A1	10	Government consumption	NA
	CTS_A2	100	Government consumption	NA
CTS_B	CTS_B1	10	Refund to household	NA
	CTS_B2	100	Refund to household	NA
CTS_C	CTS_C1	10	Refund to household	VAT abatement
	CTS_C2	100	Refund to household	VAT abatement

Carbon tax scenario (CTS) design

time – so called, co-control policies.

The study is the work of a team led by Liu Zhaoyang from the School of Environment, Beijing Normal University. It finds that a carbon tax regime can reduce both carbon and local pollutants from the iron and steel sector (and so deliver maximum benefits). However, it finds that Command and Control and End of Pipe policies produce conflicting effects in the reduction of local pollutants and CO_2. It recommends that a high-rate carbon tax should be brought in. This should be done within a framework of environmental tax reform and alongside other policy measures to reduce any negative impacts the move might have on businesses and society.

The Iron and Steel Challenge

In terms of the nation's industrial pollution, the iron and steel sector is responsible for 9.2% of CO_2 emissions, 7% of SO_2 emissions and 15% of PM emissions. One of the key challenges facing the sector is the fact that some emission control technologies seem to result in a conflict between CO_2 and AP emission reductions. This is particularly true for end-of-pipe (EOP) control measures. For instance, the operation of desulphurization facilities in iron and steel plants result in a massive consumption of electric power. This, in turn, results in large-scale CO_2 emissions. Results of a survey in 2008 indicate that 90% of China's enterprises acknowledge the existence of this type of pollution control problem.

Because of the enormous levels of pollution produced by the iron and steel sector and the conflict that exists between current GHGs and AP emission abatement mechanisms, there is a need for more effective policies to bring down the sector's GHGs and AP emissions.

The Promise of Co-Control

Many types of AP and GHGs have common sources. For instance, fossil fuel combustion typically results in emissions of both CO_2 and other pollutants such as SO_2. What is more, these emissions interact in the atmosphere and cause a variety of environmental effects at the local, regional and global level. This is why it is often feasible to address the two problems simultaneously through a single set of policies or technologies. Such co-control policies for AP and GHGs emissions are generally thought to be cost-effective because they cause reductions to a range of different pollutants simultaneously and therefore produce a range of co-benefits.

Recently the concept of integrating the control of AP and GHGs has become more popular and the approach is being highlighted in current national regulations and international treaties. For example, the Integrated Environmental Strategies (IES) operated by US EPA is designed to build capacity to conceptualize co-control measures, analyze their potential co-benefits and encourage the implementation of promising policy instruments in developing countries. However, despite benefiting from international experience in integrated management, China is still at an early stage of implementing the co-control concept.

Looking at the Impact of Co-control Policies

To help drive the development of co-control policies in China, and provide environment and industry policy suggestions for China's 12th and 13th Five Year Period (2011-2020), Liu Zhaoyang and his team evaluated and compared a number of key co-control policy options for the iron and steel sector. Unlike many previous studies, their work looks at how to achieve pollution control with cost-effective co-control policies and technologies. It also differs from most previous studies in that it focuses on a specific sphere of industry.

In their research, the team first identified a number of feasible co-control policy options. Next, they collected statistics relating to the national economy, to the production of the iron and steel sector, to energy consumption and to pollution emissions. This information was used to establish a database for the modeling work that followed. The co-control policy options were then evaluated and compared. Particular emphasis was placed on an assessment of the impact of the different policies on China's economy, its environment and the development of technology in the iron and steel sector.

Potential Policy Options for Pollution Co-Control

The policy options that the study assessed included three different carbon tax scenarios (each with tax rates from 10-100 CNY/ton CO_2). In Carbon Tax Scenario A (CTS-A), it was assumed that the government would take all the carbon tax revenues. In Scenario B (CTS-B), it was assumed that all such revenues would be refunded to households. In Scenario C (CTS-C), it was assumed that the government would impose a carbon tax and cut VAT rates in such a way that the baseline total tax revenue would remain unchanged. In Scenario C all the carbon tax revenues would be refunded to households.

Three categories of Command and Control - End of Pipe (CAC-EOP) policy scenarios were also assessed. Each specified different mandatory application rates of EOP control technologies for CO_2, SO_2 and NO_x pollution. EOP Scenario A (EOP-A) involved the use of only Ammonium Phosphate Process Flue Gas Desulphurization (PAFP-FGD) technology. EOP Scenario B (EOP-B) involved the use of only Carbon Capture and Storage (CCS) technology. The two technologies were combined in EOP Scenario C (EOP-C).

Evaluating the Effects of the Different Policies

These CTS and CAC-EOP policies were assessed using an Integrated Assessment Model (IAM). This combined a Computable General Equilibrium (CGE) model and a Canadian Integrated Modeling System (CIMS) model. The CGE sub-model was used for the simulation of economic effects, such as variations in production scales and energy prices. It used a 2007 Social Accounting Matrix (SAM) of China as its database. The CIMS sub-model was focused on the technology details of the iron and steel sector. It modeled six production processes and 37 technologies.

To do the assessment the CGE sub-model was first run using the different policies - the outputs from this step represented the policies' economic effects at both the national and sectoral levels. Next, some of these outputs were fed into CIMS sub-model. The CIMS sub-model then ran simulations under the same policy scenarios. Its outputs represented the policies' effects on the iron and steel sectors' technology substitutions, energy consumptions and AP and GHG emissions.

Which is the Best Carbon Tax Scenario?

The study found that social economic welfare would be enhanced by CTS-C, and reduced by CTS-A and CTS-B. Overall, CTS-C would be the most cost-effective of the three, and would be generally more suitable than the other carbon tax scenarios. Carbon taxation would also accelerate technology evolution in the iron and steel sector. Under higher carbon taxation rates, more energy efficient technology would have a larger market share and make a larger contribution to energy conservation and pollution reduction.

From an environmental point of view carbon tax policies would bring about synergetic reductions of CO_2, NO_x, PM and SO_2 emissions. However the reduction rates (except for PM emissions) would not be

	CTS_A1	CTS_A2	CTS_B1	CTS_B2	CTS_C1	CTS_C2
Energy consumption	-0.52	-2.78	-0.49	-2.42	-0.38	-1.40
CO_2 emission	-0.51	-2.76	-0.48	-2.40	-0.38	-1.38
NOx emission	-0.59	-3.24	-0.56	-2.88	-0.45	-1.86
PM emission	-3.58	-13.42	-3.55	-13.10	-3.45	-12.19
SO_2 emission	-0.59	-3.27	-0.55	-2.91	-0.45	-1.90
Emission index	-0.61	-3.17	-0.58	-2.81	-0.48	-1.79

2020 energy consumption and emission variation rates (%) in iron and steel related sectors among different scenarios