Understanding China's environmental governance: An investigation of the central-local government interactions in policy implementation

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Abstract

In recent years China has formulated a complex environmental policy mix consisting of diverse policy instruments. While China's central government has a green policy agenda, local policy implementations are crucial for making substantive progress on reducing emissions and enhancing environmental quality. The conventional understanding is that the command-and-control approach dominates China's environmental governance. Nonetheless, local governments have varying degrees of discretion to implement different environmental policy instruments in adaptation to local contexts, while the central government only to some extent has control over local implementations. This study investigates the vertical central-local government interactions when implementing different types of environmental policy instruments. Based on an extensive review of government policy documents and by capitalizing on existing literature, this study compares three types of policy instruments: pollutant discharge fee, environmental target system, and policy experimentation of carbon dioxide emission trading scheme. Findings show that the three policy instruments work through different mechanisms and involve diverse central-local dynamics at the implementation stage. Information asymmetry is a common implementation obstacle in all three cases. The central government has established six environmental supervision bureaus to enhance central control following the traditional command-and-control approach and taken advantage of innovative information and communication technologies measures to enhance environmental information disclosure and public participation in environmental policy processes.

Keywords: pollutant discharge fee; policy experimentation; emission trading schemes; environmental target system; central-local relation; information asymmetry; China

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1 Introduction

Studies have observed that China is transitioning to a sustainable and low-carbon economy (Guo et al., 2013; Yuan and Zuo, 2011; Zhang, 2010). Environmental protection and climate action have been on the national policy agenda (Li and Taeihagh, 2020). The Chinese government used to employ command-and-control policy measures to attain environmental goals (e.g., reducing emissions or lowering energy consumption), but is shifting towards adopting and implementing a mix of various types of policy measures (Mol and Carter, 2006). For instance, in addition to command-and-control measures like shutting down emission-intensive power plants, the Chinese government also imposes charges or taxes on emissions (Lu et al., 2019). For greenhouse gas (GHG) emission reduction, the central government asked some cities and provinces to establish policy pilots of carbon trading schemes (Fan and Todorova, 2017) and low-carbon cities (Cai et al., 2017). Informational policy measures are also implemented, exemplified by applying energy efficiency labelling (Zhou et al., 2010), and setting a National Low-carbon Day and holding public information campaigns on that day (Li and Taeihagh, 2020). Moreover, there are an increasing number of environmental projects developed through public-private partnerships (Xu et al., 2015).

While the central government has a green policy agenda, environmental policy implementations at the local level are not always effective (Sun et al., 2021). Environmental protection and climate change mitigation require collective actions of all provinces and cities. Environmental and climate policies are to maintain sustainable development and benefit the whole society. Nonetheless, environmental policy measures in many cases clash with the near-term interests of local government officials (Heilmann, 2008b). In their terms of office, local government officials tend to give greater weight to the near-term costs of environmental policy implementation than to the long-term sustainability (Levin et al., 2012). Enforcing stringent environmental policy measures, such as phasing out heavily polluting industrial units (e.g., inefficient iron and steel industrial plants), brings costs to a city's economy.

Moreover, implementation costs of environmental policy measures happen in a city, but the benefit is shared by the whole society (Wong and Karplus, 2017). Furthermore, a city investing a lot in environmental protection may still suffer from emissions from the neighbouring cities as GHG and air pollutants travel widely across jurisdictions. Therefore, a local government is often not interested in taking ambitious environmental and climate actions unless given other incentives.

For a long time, environmental policy implementation obstacles at the local level have decreased policy effectiveness and efficiency, which caused attention from China's central government (Sun et al., 2021). To enforce subnational environmental policy implementation, the central government has taken many approaches, exemplified by

establishing the environmental supervision system (*huan bao du cha*) since 2008. The central government designated six regional environmental supervision centres (*du cha zhong xin*) to oversee performances of local governments in the environmental protection field, which added pressures on local governments to strengthen environmental policy implementation and launched the environmental supervision information chain to decrease information asymmetry between the central and local governments (ibid). In 2011, the central government further upgraded the six centres to regional environmental supervision bureaus (*du cha ju*) who have greater powers to ensure local governments' accountability to environmental protection and report to the Central Ecological and Environmental Supervision Office under the Ministry of Ecology and Environment. Despite these efforts from the central government, implementation barriers at the local level continue to negatively affect environmental policy effectiveness in China. Further research is needed to understand environmental policy implementation processes in China and to identify the major local implementation barriers.

Literature on central-local government relations has contributed to the understanding of policy implementation (Laffin, 2009; Page, 1985; Rhodes, 1999). A few studies have examined China's central-local government relations in the environmental policy field (Heberer and Senz, 2011; Kostka and Nahm, 2017; Sun et al., 2021). China's environmental governance engages multi-level governments, including national, provincial, municipal, counties and urban districts. Heberer and Senz (2011) describe that China's central government fosters local environmental policy implementation through communications, incentives, and control and leaves room for local governments to manoeuvre and adjust policy implementation to local contexts. Kostka and Nahm (2017) state that simply increasing central control cannot foster environmental policy implementation in every case, and attention should be given to policy designs and building capacities and interests of governments at different levels. Sun et al. (2021) demonstrate that payoffs affect how the central and local governments behave in environmental governance, and rewards and punishments on local governments affect their decision-making. Rather than focusing on purely administrative aspects of policy implementation, policy instrument studies consider implementation as an attempt to apply various policy tools to concrete contexts (Acciai and Giliberto, 2020; Hood and Margetts, 2007; Li and Taeihagh, 2020; Salamon, 2002).

In China, environmental policy implementation barriers at the local level continue to hinder China's transition towards a sustainable and low-carbon economy. A gap exists between national environmental policy goals and local implementation effectiveness. More central control may lead to better results in some cases, but it is not a panacea. Rather than simply using command-and-control approaches, the central government has brought variety to the environmental policy types. A comparative analysis of Chinese central-local government interactions when implementing various environmental policy measures is yet to be taken. Taking a case of three different policy measures – charges/fees imposed on

emissions, mandatory environmental targets imposed on local governments and policy experimentation of emission trading schemes, this study investigates how the central and local government interact during environmental policy implementations and examines how the central-local dynamics differ when applying different types of policy measures. This research seeks to advance the understanding of China's central and local governments' roles in environmental policy processes considering the complex mix of multiple environmental policy measures in contemporary China and unfold barriers impeding implementation effectiveness at the local level.

2 Methods

This study uses the case study approach, focusing on three policy implementation cases to elucidate features of China's environmental policy implementation, exploring the policy implementation processes, and highlighting the gap between national policy goals and local implementation effectiveness.

As to the case selection, we adopted a purposive selection approach (Seawright, 2006). This study utilized the diverse-case selection method, which requires selecting cases (at least two) representing a range of variations along some dimensions (ibid). We focus on the implementation of three different policy instruments: 1) pollutant discharge fee, a type of charges imposed on emissions; 2) environmental target system, where the central government imposes mandatory environmental targets on local governments; 3) policy experimentation of emission trading schemes (ETS) for carbon dioxide (CO_2) emissions. In the present study, the three policy instruments being examined fall into different policy instrument categories. Analysis of each case was based on an extensive review of 186 government policy documents and relevant literature.

Salamon (2000, 2002) argues that policy instruments can be classified and compared according to four classification criteria: coercion, directness, automaticity, and visibility. Coercion refers to "the extent to which a tool restricts individual or group behaviour instead of merely encouraging or discouraging it" (Salamon 2002, p.25). Directness reflects the extent to which an entity is involved in the authorization, finance, and execution of a public activity (Salamon 2002, p.29). Automaticity refers to the extent to which a policy instrument utilizes an existing administrative structure for it to be implemented and take effect (Salamon 2002, p.32). Visibility refers to the appearance and salience of an instrument's implementation cost in the regular government budgeting and policy review processes (Salamon 2002, p.35). There are other typologies of policy instruments, but we utilize Salamon (2000, 2002)'s typology as it focuses on policy implementation and public management perspectives.

We follow Salamon (2000, 2002)'s typology of policy measures, classifying the three policy instruments of China as shown in Table 1. Pollutant discharge fee, referred to as "corrective charges or fees" by Salamon (2002, p.32), is used to correct environmental externality of polluting behaviour, with a medium level of coercion and directness, but a high level of automaticity because it makes use of the market, and a high level of visibility because its collected fees will show up in the regular government budgeting. The environmental target system has a high level of coercion, directness, and visibility but a low level of automaticity as it relies highly on the administrative mechanism rather than the market mechanism. In contrast, CO_2 ETS exhibits a low level of coercion, directness, and visibility, but it has a high automaticity because it relies on the market mechanism by creating a new market for emission permits. Table 1 displays that the three policy instruments have considerable differences from one another.

Table 1. Classification of the three policy instruments

Instrument	Coercion	Directness	Automaticity	Visibility
Pollutant discharge fee	Medium	Medium	High	High
Environmental target system	High	High	Low	High
CO_2 ETS	Low	Low	High	Low

3 Analysis of the design and implementation of the three policy measures

This section examines the policy design and implementation of the three policy measures – pollutant discharge fee, environmental target system and policy experimentation of ETS. For each case, we investigate the roles of central and local governments and the implementation barriers that divert policy implementation away from the central policy goals.

3.1 Pollutant discharge fee

Emission charges are a common environmental policy measure used by many countries globally (Goulder and Parry, 2008; Stavins and Whitehead, 1992). They levy charges on each unit of emissions into the environment to increase emitters' production/operating costs and motivate them to reduce emissions. The pollutant discharge fee (translated from *pai wu fei*) used by the Chinese government falls into this policy

measure (Ren et al., 2018; Watkins et al., 2017; Xie et al., 2017). The charging rate on each unit of emissions affects the policy implementation effectiveness. When the marginal cost of emission reduction is relatively higher than the emission charging rate, emitters tend to pay the charges/fees instead of emission reduction actions such as installing emission control devices, enhancing energy efficiency, or substituting emission-intensive fuels with cleaner fuels.

The policy measure was introduced in 1982 following the *Interim Measures on the Collection of Pollutant Discharge Fee* endorsed by the State Council of China (i.e., the main administrative body). The pollutant discharge fee was initially applied in a few policy pilots, targeting emissions of particulate matters (PM) and sulphur dioxide (SO_2) (SEPA et al., 1992). The policy measure started to be widely implemented in 1998 in jurisdictions within the acid rain and SO_2 emission control zones, which were defined by the State Council and the State Environmental Protection Administration (SEPA) and accounted for around 11.4% of China's land area (SEPA et al., 1998; State Council of China, 1998).

The central government set the charging rate on SO_2 emissions as a minimum of 0.2 yuan/kg emissions and left space for local governments to use a higher charging rate according to local contexts (Li and Taeihagh, 2020). In addition to deciding on the charging rate, local governments also have great discretion when interpreting the *Interim Measures on the Collection of Pollutant Discharge Fee*: they have the right to evaluate the categories and quantities of emissions and decide on whether/how much they should collect pollutant discharge fees from a firm in specific settings (Huang et al., 2020).

One barrier to the implementation of the pollutant discharge fee is that local governments, in some cases, found ways to waive pollutant discharge fees to protect local enterprises that generated high profit and tax (Zheng et al., 2016). This local protectionism took advantage of the unclarity and ambiguity of the rules in the *Interim Measures on the Collection of Pollutant Discharge Fee*. Realising these issues, in 2003, the State Council promulgated the *Regulation on the Collection, Use and Management of Pollutant Discharge Fees* to supersede the *Interim Measures on the Collection of Pollutant Discharge Fee*. The new regulation stipulated more detailed procedural measures about how local EPBs should levy the pollutant discharge fees, specified circumstances when pollutant discharge fee should be imposed, and stated that any revenue from the pollutant discharge fees should be used for environmental protection purposes, and added more specific punishments on the violence of the regulation.

Since 2003, the Chinese central government has upscaled the pollutant discharge fee as a nationwide policy measure. The central government also increased the charging rate on SO_2 emissions in 2003 to a minimum of 0.6 yuan per unit of pollutant equivalent (PE)[2] and

[2] 1 pollutant equivalent (PE) = 0.95 kg SO_2 emission; 1 PE = 0.95 kg NOx emission

started to impose discharge fees on nitrogen oxide (NOx) emissions in 2004 at the rate of 0.6 yuan per unit of PE. Local governments could apply more (but not less) stringent charging rates according to their local circumstances.

A critical implementation barrier that caught attention is the misappropriation of the revenues from collecting the pollutant discharge fees. The *Regulation on the Collection, Use and Management of Pollutant Discharge Fees* stated that the money from pollutant discharge fees should be used only to finance environmental actions. However, misappropriation of the collected fees for purposes irrelevant to the environment was prevalent among local Environmental Protection Bureaus (EPB). The problem attracted attention from both the central government and citizens when a TV show, *Focus Report* (*jiao dian fang tan*), on 23 August 2005, disclosed how a local EPB spent the money from collecting the pollutant discharge fees on affairs such as medical expenses of employees. At the central government level, the SEPA immediately released a notice to ask all local governments to apply a "double-track" system (*shou zhi liang tiao xian*). It means that expenses of a provincial/municipal EPB can only come from the financial department of its provincial/municipal government; revenues from the pollutant discharge fee should be submitted to the central government (10%) and the financial department of the provincial/municipal government (90%).

Despite the incremental policy changes to enhance policy implementation at the local level, environmental policy enforcement continued to give way to economic development projects supported by local government agencies representing economic interests (Francesch-Huidobro et al., 2012). At the provincial/municipal level, EPBs' financial resources and personnel appointments are all determined by the provincial/municipal governments. Provincial/municipal government agencies such as Finance Bureaus or Development and Reform commissions (DRCs) representing economic interests and having greater administrative power may lobby against stricter enforcement of environmental policy measures like pollutant discharge fees and affect EPBs' influencing EPBs personnel appointment decisions.

3.2 Environmental target system

The environmental target system is a type of "*mu biao ze ren zhi"* that can be translated as the target responsibility system or target-oriented accountability system in literature (Lo, 2020; Qi, 2013). It works by integrating environmental targets (e.g., reduction of SO_2 emissions) into China's pre-existing nomenklatura-based cadre system where a government official's position or promotion is decided by his/her superior official, and using compliance with environmental targets as part of the indicators to assess the performance of local government officials (Burns, 1994; Gao, 2015; Liang and Langbein, 2015). In this way,

compliance with environmental targets would affect the career promotion and bonuses of the local government officials (Gao, 2015). To decide on the environmental targets, the central government would negotiate with provincial governments about the environmental targets and then sign contracts to specify the targets that they both agree on, while the provincial governments would further distribute the targets to city governments and leave spaces for bargaining between the provincial and city governments (Chan and Gao, 2009; Gao, 2009). In jurisdictions failing to reach the committed environmental targets, local government officials, especially those working in local EPBs, may face punishments such as salary cuts, disqualification from promotion or bonuses, deployment to a remote locality or even expulsion. Therefore, this policy measure of the environmental target system gives local governments a political incentive to strengthen environmental policy implementation (Kostka, 2016).

In 2002, the SEPA of the central government endorsed the *10th FYP (2001-2005) for Preventing Acid Rain and SO_2 Pollution in the Two Control Zones*, bringing in the idea of integrating environmental target accomplishment into the evaluation of local governments' performance. However, the details on how the environmental targets should be distributed and evaluated were not discussed (Schreifels et al., 2012; X. Zhang, 2017). The 11th FYP (2006-2010) indicated the national environmental goals are to achieve a 10% reduction of annual SO_2 emissions relative to the 2005 level. To reach the national policy goals, the MEP and NDRC negotiated and signed contracts with provincial vice governors to determine provincial emission reduction targets (Xu, 2011). The provincial governments further disaggregated the targets to municipal governments. Achieving these environmental targets was given veto power, meaning that failure to meet environmental targets would surely jeopardize the local government officials' promotion (Chan and Gao, 2009).

The SEPA stated the criteria to evaluate local governments' performance in environmental policy implementation, containing i) attainment of SO_2 emission reduction targets, ii) enforcement of environmental policy measures and technologies, and iii) tracking progress in emission reduction work (SEPA, 2007). To further incentivise local governments to reduce emissions, the *11th FYP for the Environmental Protection* enacted in November 2007 stated that the central government would assess and disclose provincial/municipal progress toward reaching their environmental targets every six months, and also conduct mid-term and final assessments separately in 2008 and 2010 (State Council of China, 2007a).

The policy measure of the environmental target system continues to be an integral part of the complex environmental policy mix in China. Nonetheless, the policy implementation faces many challenges in allocating suitable targets to provincial/municipal governments adapting to local contexts and verifying local environmental performance in every jurisdiction (Gao, 2015; Kostka, 2016; Wong and Karplus, 2017; X. Zhang, 2017). Although provincial (or municipal) governments, to some extent, can negotiate the

environmental targets with the central government (or the provincial government), local governments may still find the targets too costly to achieve or to clash with other targets. To each the environmental targets, local governments are inclined to emphasise short-term accountability more than long-term sustainability (Chan and Gao, 2009). There were cases where local governments temporarily cut off the electricity to reach the allocated emission reduction targets (Chan and Gao, 2009). Difficulties in verifying the environmental data reported by local governments is also a major implementation obstacle. Local governments, in many cases, adopted pernicious gaming strategies to fake achievements in reducing emissions, while the central government has limited capacity to detect dishonest data reporting (Gao, 2015).

To mitigate the information asymmetry between the central government and the local governments, the six regional environmental supervision bureaus and the Central Ecological and Environmental Supervision Office invested many resources in conducting field trips to verify provincial/municipal environmental performance. They also strengthened the vertical linkages between the Ministry of Ecology and Environment and local EPBs, making it harder to falsify environmental achievements (Sun et al., 2021). However, these environmental supervision activities are very costly. More efficient measures should be taken to enhance environmental data transparency and information symmetry between central and local governments.

3.3 Policy experimentation of ETS

Policy experimentation is a policy measure frequently used by the Chinese government to accelerate policy innovations and institutional changes in many domains such as the environmental, economic and health sectors while avoiding reformist leaps in the dark (Cao et al., 1999; Heilmann, 2008a; Miao and Lang, 2015; Rawski, 2018). Policy experimentation can stimulate trial-and-error policy learnings and inject local knowledge into policy processes at the central level (ibid). It differs from other methods such as theoretical or model simulation analysis to inform policy making (Mosteller and Mosteller, 2006: 487). A feature of the Chinese style of policy experimentation-informed policymaking is implementation preceding legislation (Heilmann, 2008b, 2008a). Policy experiments in a few pilots can gradually build up political support, with the possibility to be upscaled to the national level or even reach legislation processes with strong supports from higher administrative-level governments. Heilmann (2008a, 2008b) describes Chinese-style policy experiments as "experimentation under the hierarchy", involving top-down and bottom-up policy implementation processes. At the bottom level, provinces/cities establish policy pilots and accumulate local knowledge. High-level policy patrons may identify successful local policy experiments and integrate local experiences into national policymaking. At the national level, the central government, in many cases, brings in the idea of policy

experiments, asks if some provinces/cities would like to launch the policy pilots, and maintains leadership and interventions during policy experimentation. Local government officials running policy pilots are incentivized by probable job promotion and preferential treatment from the central government (Montinola et al., 1995).

Here we use policy experimentation of ETS (*tan pai fang quan jiao yi*) in China as an exemplary case. ETS is a market-based policy measure, distinct from the Chinese conventional command-and-control approach. ETS limits the emission levels of the regulated firms, and each firm is allocated some amount of CO_2 emission allowances at the beginning. ETS build a market to sell or buy emission allowances, and firms who emit beyond what they are allowed can buy emission allowances from the market (Li and Taeihagh, 2020). So, the ETS market imposes a price on CO_2 emissions. Before applying this policy measure nationwide, a few provinces and cities established policy pilots of ETS (Li, 2018; Li and Taeihagh, 2020). In 2011, NDRC endorsed a *Notice on Piloting CO_2 ETS* to designate Beijing, Shanghai, Shenzhen, Chongqing and Tianjin, and provinces of Guangdong and Hubei to establish policy pilots of ETS (Li and Taeihagh, 2020, 2019). Shenzhen then established the first ETS policy pilot in June 2013. Soon after that, Shanghai, Beijing, Guangdong, Tianjin, Hubei, and Chongqing subsequentially established the ETS policy pilots from 2013 to 2014.

The provinces and cities experimented with what worked on the ground concerning effective policy design and implementation (Ren et al., 2018). In 2014, NDRC announced the *Interim Measures for the Administration of Carbon Emissions Trading* to set the general rules for ETS policy implementation. Nevertheless, the local governments have great autonomy to calibrate policy design elements and implementation measures with adaptions to local socio-economic and environmental contexts. As a result, the seven policy pilots exhibit variations in the sector coverage, methods for allocating emission allowances, procedural measures of data reporting and verification, and penalties for non-compliance (Chang et al., 2017; Li, 2018; Munnings et al., 2016; D. Zhang et al., 2014; M. Zhang et al., 2017). These policy pilots provided valuable experiences on the ground and successfully reduced CO_2 emissions (Y. Zhang et al., 2020). The policy implementations engage various non-state actors, including consultancies, private businesses and financial institutions (Lo and Chen, 2020). Therefore, the central government decided at the end of 2017 to scale up the policy measure to implement it nationwide. After three-year preparation, the national ETS started to operate in 2021, regulating over 2200 firms in the electricity sector, covering more than four billion tons of CO_2 emissions, and becoming the largest ETS in the world (ICAP, 2021).

Policy experimentation of ETS also encountered a couple of implementation barriers. First, lax enforcement is a problem. For instance, research shows that the Chongqing pilot allocated too many emission allowances to firms, giving them little incentives to reduce emissions (Deng et al., 2018). Tianjin pilot is also criticized for weak policy enforcement

and inactive transactions on the ETS market (Dong et al., 2016; Li, 2018; Tan and Wang, 2017; Z. Zhang, 2015). All policy pilots have not seriously implemented punitive measures for firms that emit beyond their allowances or incorrectly report emissions. Second, monitoring, reporting and verification (MRV) of emission data demand improvement. All policy pilots have made rules for MRV to ensure data reliability, but the MRV rules are still ambiguous and not yet enforced strictly (Deng et al., 2018; Tang et al., 2018).

4 Discussion

This research elaborates implementation of three different environmental policy measures, i) pollutant discharge fee, a policy measure with medium-level coercion and directness, and high-level automaticity and visibility; ii) environmental target system, a policy measure with high coercion, directness, visibility, and low automaticity; iii) policy experimentation of ETS, a policy measure with low coercion, directness, visibility, and high automaticity. The research advances our understanding of the roles and relations of the central and local governments in Chinese environmental governance and policy implementation. It discloses how local implementation processes may differ from the national policy goals and plans.

The three policy measures all face various implementation obstacles at the local level. When implementing the pollutant discharge fee, local governments would find ways to waive the emission fees for firms that yielded high profit and tax or arbitrarily spent the collected fees on items unrelated to environmental protection. For the environmental target system, local governments may fake their achievements in environmental policy implementation or dishonestly report environmental data or take extreme measures such as cutting off electricity to meet their environmental commitments. In policy pilots of CO_2 ETS, allocation of surplus emission allowances, lax enforcement of punitive measures, and ambiguity and inconsistency in MRV rules impede effective policy implementation.

After delving into the policy evolution and implementation, a common thing of the three policy measures is that they all started with “trial and error” policy pilots. To avoid transformative policy changes in the dark, the Chinese government experimented with the three policy measures at a small scale before applying them nationally. These Chinese-style policy experiments involve top-down and bottom-up processes, mobilising local initiatives and eventually informing central policymaking with local knowledge and experiences.

Contemporary implementation studies have discussed solutions to overcome some implementation obstacles (Barrett, 2004; Calvert et al., 2008). According to the principal-agent model, politicians and administrators are in a principal-agent relationship, where the administrators (i.e. the agent) who have a certain degree of discretion may identify more

with the interests of the regulated than with their political principals (Calvert et al., 2008; Howlett et al., 2009). Regarding information asymmetry and principal-agent problems, possible solutions can be a careful choice of policy instruments, manipulating the bureaucrat agents' incentives and the principal's active oversight (Calvert et al., 2008). Environmental information disclosure is found to be crucial for mitigating information asymmetry, and community pressure for a better environmental quality can reinforce the environmental information disclosure (Tian et al., 2016).

In the three policy implementation cases, the central government has made efforts to fix the implementation problems. To solve the abovementioned implementation problems of the pollutant discharge fee, the central government announced more detailed procedural measures for local governments to follow and asked local EPBs to submit the money from collecting the pollutant discharge fees to the financial departments of local governments and the central government. To verify local environmental performance, the central government established the six regional environmental supervision bureaus and given authority and resources to inspect local environmental policy implementation. The central government intervened less with the policy pilots of ETS than in the other two policy implementation cases. However, it promulgated the *Interim Measures for the Administration of Carbon Emissions Trading* to stipulate the general rules (including MRV rules) for policy implementation.

Information asymmetry between the central and local governments is a common issue in all three policy cases. China has taken measures to enhance environmental information disclosure and engage public participation to strengthen environmental policy implementation. In 2007, the MEP enacted the *Environmental Information Disclosure Measures (Trial implementation)*, stipulating that local EPBs should disclosure environmental policies and laws, environmental quality data, emission data of heavily polluting firms, and information about environmental policy implementation such as collected pollutant discharge fees (Lei et al., 2017; Wang, 2018). In 2015, the MEP endorsed the *Interim Measures for Public Participation in Environmental Protection* to encourage public participation (Wang, 2018). MEP also opened a uniform hotline, "12369" for citizens to report environmental pollution or ecological damage issues to local EPBs and the MEP (Zheng and Shi, 2017). Information and communication technologies (ICT) have been applied to enhance how citizens can obtain, produce, and spread environmental information (Lei et al., 2017).

The fundamental problem behind these environmental policy implementation obstacles at the local level is the conflict between local economic growth and environmental sustainability perceived by the local governments. Consequently, local governments are resistant to strictly enforce environmental policy measures, meanwhile coming up with strategies to meet the central government's requirements. To solve this fundamental problem, local governments need to change their mindset to value long-term environmental

sustainability and recognize the risks from environmental damages. Local governments can try to pursue a green and low-carbon development, fostering the phase-out of emission-intensive and inefficient industries and supporting green industries and technologies, such as the new energy vehicles, renewable energy industries and zero-carbon buildings (Li and Taeihagh, 2020; Meckling and Allan, 2017; Wang et al., 2018; H. Zhang et al., 2020).

5 Conclusion

Through a case study approach, this research delves into policy implementation of three different Chinese policy measures, including the pollutant discharge fee, environmental target system and the policy experimentation of ETS. Findings show that the three policy measures all encountered various local implementation barriers. Local governments, in some cases, would not strictly impose pollutant discharge fees on local firms that yielded high profits and tax or arbitrarily spend the collected fees on affairs irrelevant to the environment. When facing environmental targets assigned by the central government, local governments may fake achievements in environmental performance. In policy pilots of ETS, lax enforcement and ambiguous MRV requirements hindered the effective policy implementation. Information asymmetry between the central and local governments is a common implementation issue. The central government has established the six regional environmental supervision bureaus to enhance central control over local EPBs and alleviate the information asymmetry.

Nonetheless, more central control is costly and not a panacea. With the facilitation of ICTs, the central government has taken measures to enhance environmental information disclosure and public participation in environmental policy processes. A fundamental problem behind many environmental policy implementation obstacles at the local level is the trade-off between economic growth and environmental sustainability. Local governments need to realise the necessity to transition from emission-intensive industries and support green and low-carbon industries. These insights into environmental policy implementation can inform policy designers and implementers at different government levels to enhance implementation effectiveness.

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