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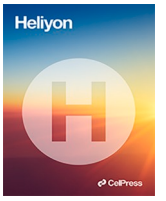

Research article

A conceptional game theory analysis of environmental public interest litigation of China

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ABSTRACT

China introduced civil and administrative public interest litigation (PIL) through a series of pilot projects and legislative revisions in recent years. Now a procuratorate has the standing to bring civil PIL cases against polluters and administrative PIL cases against administrative agencies in its jurisdictions while a qualified non-governmental organization (NGO) has no geographic limits and may bring civil PIL cases against polluters anywhere in mainland China. Previous literature focused on the use of PIL for redressing environmental damages in individual cases. This paper studies the function of PIL beyond individual cases with game theory. This paper uses data collected through autoethnography, interviews, databases of judgements, statistics, and previous literature. This paper finds that local procuratorates and NGOs brought a large number of environmental PIL cases and changed the behavior patterns of local governments and their environmental protection agencies as well as that of polluters. Before the introduction of PIL rules, governmental officers of local governments and their environmental protection agencies were more discretionary and selective in environmental law enforcement and were more cooperative with polluters. After the law introduced PIL rules, they are now less discretionary in environmental law enforcement, less cooperative with polluters, and more likely to strictly enforce the environmental law. This paper models the interaction between local governments and polluters before the introduction of environmental PIL as an infinitely repeated game and reveals the ensuing cooperation. This infinitely repeated game was broken by new players introduced by the PIL, i.e., the procuratorate, NGOs, and the court, which changed the behavior patterns of the local government and its environmental protection agencies as well as that of polluters. This paper concludes that the function of PIL beyond individual cases lies in that it breaks the chain of infinitely repeated game between the local government and polluters and thus changes their behavior patterns.

1. Introduction

China suffered serious pollution in the latter half of the last century, particularly after the 1970s, when China sped up its industrial development and urbanization [1]. China begun to adopt environmental rules since the 1970s. However, environmental protection

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rules were quite sparse before 1979. The Standing Committee of the National People's Congress (NPC), the national legislative body, adopted the Environmental Protection Law of the People's Republic of China (for trial implementation) in 1979 (the 1979 trial EPL), then replaced the 1979 trial EPL with the Environmental Protection Law of the People's Republic of China in 1989 (the 1989 EPL), and further revised the 1989 EPL in 2014 (the 2014 revised EPL) [2–4]. The EPL is a kind of framework legislation. Besides the EPL, the NPC Standing Committee also adopted laws controlling water pollution, air pollution, noises, and other pollution as well as laws on water, grassland, and other natural resources [5]. The State Council, the top administrative body, adopted administrative regulations to enforce environmental legislations of the NPC Standing Committee. Various ministries and commissions under the State Council also adopted a large number of ministerial rules on environmental protection [5]. Furthermore, local congresses and administrative agencies made a large number of local environmental protection rules [5]. However, the environment still deteriorated until recently [1,6].

Environmental public interest litigation (PIL) is a mechanism allowing plaintiffs to sue polluters or administrative agencies in a court for the public environmental interests [7]. Faced with the dilemma of increasing environmental law rules and deteriorating environment, some academics advocated the notion of environmental PIL [8–11]. Later some public officials also expressed their support for environmental PIL [12–14]. They first advocated civil PIL [8,9], and later also advocated administrative PIL [10]. Rules on environmental PIL were adopted and experimented through a series of pilot projects first at local levels and later at the national level [7,9,15–17]. After these pilot projects, the NPC Standing Committee revised the Civil Procedure Law of the People's Republic of China (CPL) in 2012 and 2017 [18–20], the EPL in 2014 [2,21], and the Administrative Procedure Law of the People's Republic of China (APL) in 2017 [18,22], to formally establish the procedures of civil PIL and administrative PIL for environmental protection. The NPC Standing Committee further revised the CPL in 2021 [23] and 2023 [24] but these later revisions do not affect the civil PIL. As the 2023 revised CPL will come into effect on January 1, 2024, this paper refers to the currently effective version, i.e., the 2021 revised CPL. According to Article 58 of the 2021 revised CPL, a civil PIL case is one where a public interest plaintiff sues a polluter for civil remedies [23]. According to Article 25(4) of the 2017 revised APL, an administrative PIL case is one where a public interest plaintiff sues an administrative agency for its failure to enforce environmental law or its improper exercise of authority under the environmental law [22]. Table 1 compares environmental civil PIL and environmental administrative PIL.

To facilitate the handling of PIL cases, the Supreme People's Court (SPC) further specified rules with a series of judicial interpretations [25–28] and model cases [29–51]. The SPC and the Supreme People's Procuratorate (SPP) also jointly issued detailed rules on how to initiate and handle environmental PIL cases [52]. So far, a large number of civil and administrative PIL cases have been initiated and heard [53–56]. This contributed significantly to environmental protection [6]. Nevertheless, environmental law enforcement is still mostly the responsibility of administrative agencies concerned.

The research question of this paper is to find the function of PIL beyond individual cases with game theory. To be specific, this paper uses game theory to find how and why environmental PIL changed the behavior patterns of local governments and their environmental protection agencies in enforcing environmental rules.

The significance of this paper is to find the function of PIL beyond individual cases, to further prove the rationale behind environmental PIL, and to rationally recognize the limits of environmental PIL. This research is valuable for the environmental governance and sustainable development of China as well as other countries.

The workflow of this paper is presented in Fig. 1 and includes the following steps: (1) introduces to background information; (2) reviews literature; (3) identifies the research gap; (4) proposes the research question; (5) presents findings; (6) interprets findings with game theory; and (7) draws a conclusion to answer the research question and fill the research gap.

2. Literature review

The literature pertinent to this paper mainly includes environmental PIL and game theory analysis of law.

Table 1
Comparison of environmental civil PIL and environmental administrative PIL.

	Environmental civil PIL	Environmental administrative PIL
Legislations	Article 58 of the 2021 revised CPL; Article 58 of the 2014 revised EPL	Article 25(4) of the 2017 revised APL
Procedures	Civil procedure	Administrative procedure
Plaintiffs	Non-governmental organizations (NGOs) and procuratorates	Procuratorates
Limits on plaintiffs	An NGO may sue anywhere in mainland China; A procuratorate may only sue within its jurisdiction	A procuratorate may only sue within its jurisdiction
Defendants	Polluters	Administrative agencies with regulatory authority over polluters
Remedies	Monetary damages, injunctive relief, environmental restitution	Proper enforcement of environmental law, mainly including cancellation of unlawful or improper administrative acts and remaking administrative acts

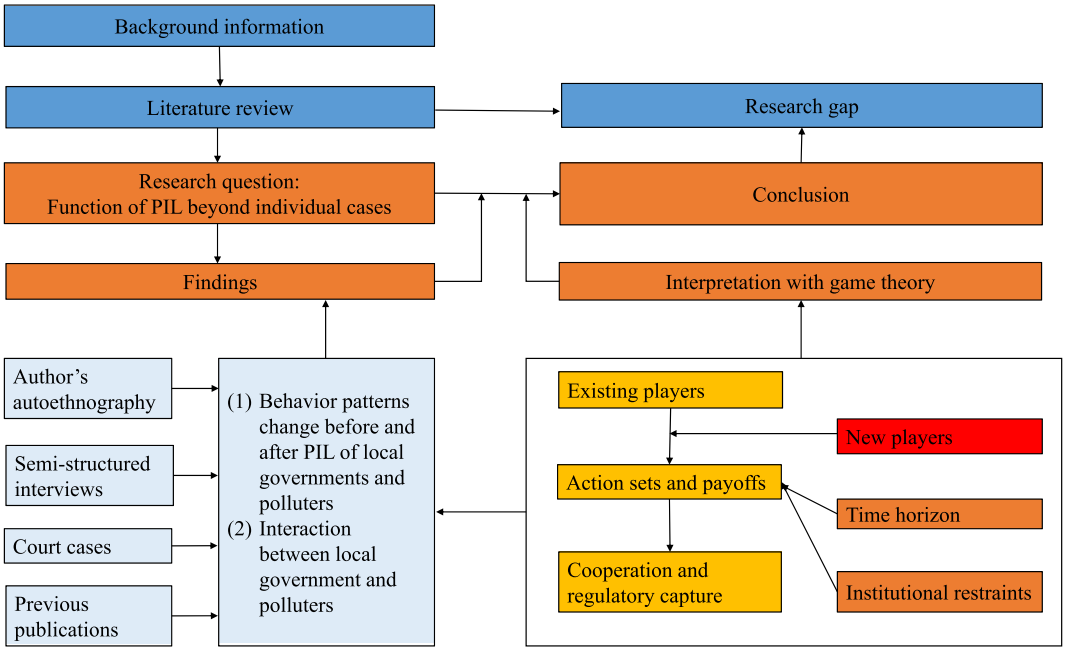

Fig. 1. Workflow.

2.1. Environmental PIL

The environmental PIL in China drew extensive attention of researchers in Chinese literature e.g., [9, 15, 16], as well as in English literature e.g., [7,57–64]. Many previous publications focused on the standing issue. Many commentators such as Zhongmei Lyu and Mingde Cao advocated relaxing the standing requirements so that environmental non-governmental organizations (NGOs) could have the standing to bring lawsuits for public interests. They also reported the progress in relaxing the standing requirements and cases brought by NGOs [9,57]. Some other authors reviewed the development and theoretical basis of environmental PIL brought by the procuratorate [65]. Besides procedural issues, some previous publications studied the substantive basis of environmental PIL in China [64,66]. Some commentators noticed the monitoring function of civil environmental PIL [60] and its contribution to law enforcement [62], but limited the discussion to environmental law enforcement. Benjamin van Rooij et al. pointed out that the PIL offered citizens, civic organizations, procurators, and courts a new regulatory tool, but their roles, functions, and relationship with the State needed further study [61]. As to the future of environmental PIL, Carpenter-Gold and some commentators are more pessimistic [60], while some others are more optimistic [57,65]. Environmental PIL also developed in India [67], Pakistan [68], Ethiopia [69], and other jurisdictions [70]. Literature on environmental PIL of other jurisdictions also help the study of Chinese environmental PIL.

2.2. Game theory analysis of (environmental) law enforcement

Game theory is a branch of mathematics that can be used to understand the behaviors of interacting decision-makers [71]. A vast body of literature on game theory evolved since the seminal works of Von Neumann [72] and Nash [73]. Game theory was applied in various fields of study, particularly in international relations and economies. As to game theory analysis of law, Baird et al. generally analyzed the law with game theory [74], Li analyzed institutional incentives, game equilibrium, and social justice for the development of a pure jurisprudence [75], Shafi et al. analyzed the logic of illegitimate behavior during litigation with the example of land conflict litigation in urban and peri-urban areas of Pakistan [76]. For issues related to environment and natural resources, game theory was used to study land development [77] and the sustaining of urban commons [78]. As to environmental issues in China, game theory was used to analyze water resources management [79], the expropriation of rural land [80], the recycling of used electric vehicle batteries [81], and the role of social media [82], but these publications focused more on management than legal rules.

2.3. Research gap

The previous literature on PIL focused on the use of PIL for redressing environmental damages in individual cases. There is a need to find the function of PIL beyond individual cases. Game theory is a promising theory for this purpose. Compared with other fields such as economics, game theory analysis of law is still under-developed and the application of game theory to environmental law is even less developed. In particular, previous literature on game theory generally pays insufficient attention to the possible cooperation between local law enforcement agencies and polluters. Therefore, this paper uses game theory to find the function of PIL beyond individual

cases.

3. Methodology and materials

3.1. Game theory analysis

This paper uses game theory as the main research method but only in a non-technical and conceptional manner. Game theory offers a conceptional and mathematical toolkit for the study of interaction among parties [83]. It was widely used to study issues related to development, such as corruption [84], resistance to institutional change [85], collective action on groundwater [86], and constitutional structure [87], to name just a few. Because straightforward and nontechnical application of the core concepts of game theory can also make in-depth interpretation and provide counterintuitive insights [83,88–90], this paper leaves out technical details and focuses on the conceptional application of game theory. This paper also uses typical cases to demonstrate the conceptional game analysis.

Key concepts of game theory used in this paper are players, time horizon, action set, payoffs, and institutional restraint. "Players" are those actors who make decisions [91,92]. This paper refers both "regulator" and "regulated party" as "players". The term "players" implies that neither the regulator nor the regulated polluters can do whatever they want without considering the other party. In this sense, they have a certain degree of equality even though they are not equal in legal rules. Time horizon differentiates games into static and dynamic games and further differentiates dynamic games into finite and infinite games. The action set of a player includes all actions that a player can take. "Action set" and "action space" can be used synonymously although the latter is more often used for infinite number of actions. A particular combination of actions leads to the outcome of the game. The payoff of a player is the utility derived from an outcome of a game, which depends on a player's cost and benefit in the game. Institutional restraints refer to institutional background of players and their choice of actions [71,91,92].

3.2. Existing players in the environmental law enforcement game

Before the introduction of environmental PIL, the existing players were on 2 sides (Fig. 2). The players on the one side of the game are polluters. Typical polluters are those engaged in industrial production generating air pollutants, wastewater, solid wastes, and noises. They can be roughly called industrial polluters. Another type of polluters are pollutant treatment facilities, including waste treatment and disposal facilities, such as sewage treatment facilities, industrial wastewater treatment facilities, and solid waste disposal facilities. The rapid industrialization and urbanization make such service providers an important category of polluters.

The players on the other side of the game are local governments and their environmental protection agencies. Chinese local governments have 4 levels, i.e., province-, city-, county-, and township-levels from the highest to the lowest. The term "local government" includes both a local people's government and its commissions, offices, and bureaus, which altogether form the local government in a broader sense. For example, the local government of a county includes both the mayor and mayor's office staff as well as its financial bureau, bureau of public security (police bureau), bureau of human resources and social security, etc. Among commissions and bureaus, environmental protection agencies are the principal agencies for enforcing environmental rules. However, the court and the procuratorate are not part of the local government. They report their work to the local people's congress just like the local government. Furthermore, "local governments" in this paper mainly refer to governments at the county level for mostly rural areas, or governments at the city level for mostly urbanized areas, because they and their environmental protection agencies shoulder most of the responsibilities of environmental law enforcement.

This paper differentiates different levels of government and focuses on local governments for the following 2 reasons. First, the pervasive combination of "good environmental laws and poor environmental performance" in China is mainly because of weak enforcement at local levels [93]. Second, differentiation between the central and local governments is the precondition for discussing

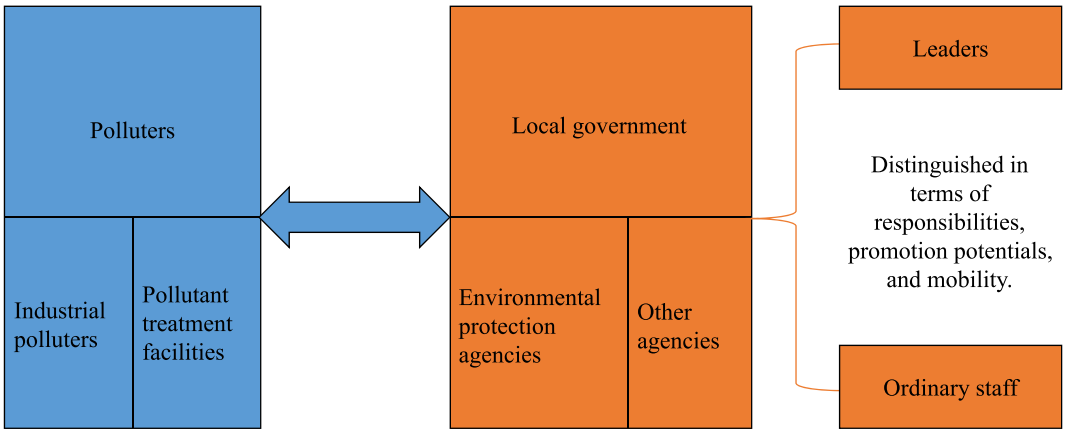

Fig. 2. Existing players of the environmental law enforcement at local level.

the relationship between the central government and local governments. Treating the central and local governments as a whole simplifies the game theory analysis on enforcement stringency [94], but leaves out the relationship between the central and local governments and some other factors important to legal studies.

3.3. Sources of data

Data were collected through autoethnography from July 2020 to June 2021, consented interviews conducted from July 2020 to August 2022 as well as databases of judgements, official statistics, and previous literature covering the period from 2014 to 2022. These sources triangulate with each other and their combination makes the sources deep and wide.

One of the authors worked in a county-level environmental protection agency for 1 year from July 2020 to June 2021 under a program to make college professors help local governments and gain practical experience. This county is in the central part of China. It is quite average in terms of economic development, population, and environment. It is not well developed like Shanghai or other coastal provinces and not so under-developed like hinterlands in western China. It has a population of approximately 0.8 million. About 20 % of adults aged 20–50 years old are migrant workers working in Guangdong, Zhejiang, and other more developed areas, which is quite normal for counties that are mostly rural. Its GDP hit 45 billion Yuan (around 6 billion US dollars). The first industry accounted 17 % of GDP, the second industry 42 %, and the third industry 41 % in 2022 [95,96]. A small part of the mountainous areas is subject to special protection [97]. The most important natural resource is granite. There is a granite industry park where granite is extracted and manufactured into building materials of different sizes (Author's autoethnography record #003). In sum, this county is quite typical and representative of Chinese counties that are still mostly rural.

Before this 1-year governmental work, the authors planned to produce reports and publications based on this hands-on experience in environmental law enforcement. The authors preliminarily identified the gap between black letter environmental law and actual environmental law enforcement as the research topic. For this purpose, the authors drafted the following research plan: (1) preliminarily identifying research issues; (2) getting familiar with the research site; (3) interviewing officers of environmental protection agencies and the local government, polluters, judges, procurators, and lawyers of the county; (4) recording daily work and reflection; (5) revisiting and reinterviewing after leaving the governmental post; (6) interviewing environmental lawyers, judges, procurators, governmental officers, and polluters of other places; (7) collecting supplementary data from literature, governmental statistics, and other databases; (8) analyzing data; and (9) drafting reports and journal articles. Step (1) was carried out before the 1-year governmental work, steps (2) through (4) were carried during the 1-year governmental work period. Steps (5) to (8) were mainly carried out after the 1-year governmental work. This paper on environmental PIL is part of this research endeavor.

The data collection process met the requirements of autoethnography research. Autoethnography is both a theory and an empirical research method. It draws on and interprets the lived experience of a researcher [98], who is both the researcher and a member of the social world under study [99]. It connects the researcher's personal experience (*auto*) to a wide cultural understanding (*ethno*) through systematic analysis (*graphy*) [100]. Governmental personnel and academicians have different professional subculture even though they study, teach, or enforce the same black letter laws. The authors are primarily academics and planned to further their environmental law research with this governmental work opportunity. By temporarily joining the government and working with governmental personnel, the author experienced a cultural shock and temporarily shared the subculture of governmental personnel. Personal reflection is an essential data for autoethnography. The author made a detailed record of daily work and his personal reflection from the perspective of a governmental officer and a university professor. The record is in Chinese and follows the general format of Supplementary Materials #1. This paper just uses a portion of the autoethnographic records because these records covered a wide range of environmental law enforcement issues and many issues are not addressed in this paper.

The authors conducted consented semi-structured interviews of governmental officers in and out of the environmental agencies, judges, polluters, (potential) victims, NGOs, public interest lawyers, lawyers representing polluters, and lawyers representing NGOs. Potential victims were farmers and residents within 2 km from major polluters or within 1 km from other polluters. Actual victims were those who filed a complaint against pollution with the environmental protection agencies or the court. Major polluters are those provided in Article 42(3) of the 2014 revised EPL [4].

Table 2
Coding of interviewees.

#	Categories of interviewees	Code of interviewees	# of interviewees
1	Leaders of the local environmental protection agency where the author worked	EL	9
2	Ordinary officers of the local environmental protection agency where the author worked	EO	87
3	Leaders of environmental protection agencies at superior levels	SEL	65
4	Ordinary officers of environmental protection agencies at superior levels	SEO	50
5	Governmental leaders	GL	20
6	Local polluters in the county where the author worked	LP	93
7	Polluters in other places	OP	200
8	Environmental lawyers regularly representing NGOs	EnLawyer	30
9	Judges	Judge	60
10	Procurators	Procurator	100
11	NGOs	NGO	30
12	Lawyers representing polluters	PoLawyer	100

In the county where the author worked as an environmental protection officer, the interviewees included governmental officers in and out of the government, polluters, judges, and (potential) victims, with the interview of environmental law enforcement officers as the key part. This author first took 2 months to get familiar with governmental officers of the environmental bureau, polluters under his authority, some officers of other governmental agencies, some judges, some procurators, and some local lawyers, then took the governmental work opportunity to interview them. The author reinterviewed some interviewees 1 year after this temporary governmental work.

The authors jointly interviewed polluters and officers of environmental protection agencies in 3 other neighboring counties from July 2020 to August 2022. These 3 counties are of the same province and are similar in social and economic development [95,96]. The authors interviewed most of environmental lawyers in China who actively represented environmental NGOs in environmental PIL. Currently such environmental lawyers are quite limited in number. The authors also interviewed lawyers who represented polluters in environmental PIL cases.

Interviewees are coded according to their social roles. Table 2 lists the categories, codes, and numbers of interviewees.

The authors further supplement the data with court cases, statistics, and publications covering the period from 2014 to 2022. Court cases are retrieved from the SPC's official database of judgements, WKINFO (a paid database for legal professionals), ITSLAW (the database managed by Tiantong Law Firm), and PKULAW (the database managed by Peking University). The authors retrieved all civil and administrative PIL cases. In addition to environmental PIL cases, the authors also retrieved criminal cases of 2 crimes, i.e., the crime of polluting the environment and the crime of neglecting environmental law enforcement duties. These two crimes are provided in Article 338 and Article 408 of the current Criminal Law of the People's Republic of China respectively [101]. Statistics include those released by the National Bureau of Statistics (NBS), the Ministry of Ecology and Environment (MEE), the SPC, and the SPP. The authors searched these statistics with keywords "public interest litigation", "public interest case", "civil public interest case", "administrative public interest case" and "environmental public interest case". Data from publications are referenced in this paper.

The data collection process followed legal rules and ethical requirements. Wenzhou University School of Law gave authors prior research ethics approval and authorized the authors to conduct research through autoethnography or other research methods involving human participants, and to publish the research as journal papers or books. The government also encouraged authors to conduct research and produce publications with the aid of this 1-year governmental work. The government authorized research in workplace, including autoethnography and other research methods involving human participants. No data collected are within the scope of "state secrets" under the Chinese law. No interview questions and answers are prohibited by the Chinese law. Samples of interview questions are attached as Supplementary Materials #2. The interviewees were informed of the research and planned publication and gave their informed consent. The authors made detailed interview records in Chinese to document every interview. However, the authors did not take photos or audio records for 2 reasons. First, taking photos or audio records was against the social etiquette in the subculture of governmental personnel. Second, taking photos or audio records might affect interviewees' candor in response. The authors initially planned to conduct a major research and produce a series of publications, so the data collection process covered many issues not addressed in this paper. The authors only use related records for this paper and keep other records for future use.

4. Findings

This paper finds that environmental PIL does not cover all violations and environmental damages. A comparison between the nationwide governmental statistics on environmental PIL cases and environmental violations indicates that environmental violations far outnumbered environmental PIL cases. In the 5 years from 2013 through 2017, Chinese courts at all levels heard 1383 environmental PIL cases brought by the procuratorates and 252 environmental PIL cases brought by NGOs [53]. Then in the single year of 2018, courts at all levels accepted 1802 environmental PIL cases, almost 9 times that of 2017 [102]. The number of PIL cases reached 5267 in 2021 [54], and 5885 in 2022 [55], and is expected to further increase in the coming years. Among these cases, the procuratorate initiated 24202 environmental PIL cases during 2018 through 2022 [56]. This indicates that the number of environmental PIL cases initiated by the procuratorate increased much faster than those initiated by NGOs [103]. However, the total number of environmental PIL cases brought by the procuratorate and NGOs is still far below that of environmental violations and damages. For instance, environmental protection agencies of all levels imposed 133000 administrative penalties in 2021 according to the MEE's statistics [104]. Although not all violations of the environmental law warranted a PIL case, interviews and autoethnography indicated

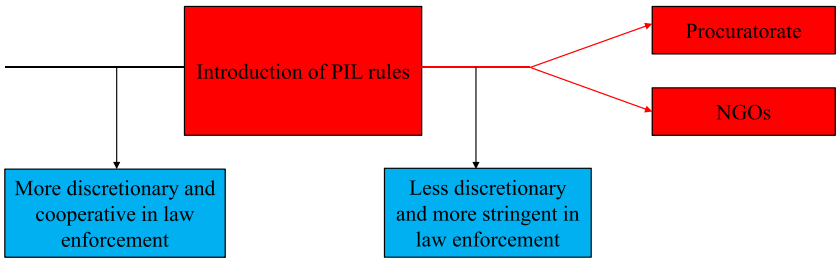

Fig. 3. Change of local agencies' behavior pattern.

that a large percentage of potential PIL cases were not actually initiated as PIL cases. For instance, the environmental protection agencies where the author worked imposed more than 100 administrative penalties on polluters for their violation of environmental law during the author's 1-year work period, but no PIL cases was initiated during that period and only 3 environmental PIL cases were initiated there so far (Author's autoethnography #607).

This paper also finds that governmental officers in local environmental protection agencies changed their behavior pattern after the law introduced rules on PIL, had preferences as to PIL cases initiated by the procuratorate or NGOs, and chose different strategies for procuratorates and NGOs, as presented in Fig. 3.

Before the introduction of PIL rules, governmental officers of local governments and their environmental protection agencies thought they had discretion and in fact exercised more discretion in environmental law enforcement. Interviewee EL002 said, "we need to consider our county's general economic situation and select cases." Interviewee EL 003 said, "we are state functionaries but not machines, we should not mechanically enforce the law." Interviewee LP005 said, "they have much power to choose cases so I told them how I tried to reduce pollution, the bad market situation of my products, the high cost of labor, so that they would do me a favor."

After the law introduced PIL rules, interviewees thought they still had the same discretion but chose to voluntarily limit their exercise of discretion. Interviewee EO004 said, "this is a small case and within my authority. If this case happened 2 years ago, I could make the decision on the spot. But now I do not want to make the decision." Now, they are more inclined to report the case to higher authorities or have the agency hold a committee meeting to make the decision rather than make the decision by themselves. Interviewee EL002 complained, "the subordinates are just shunning their responsibilities. They submitted too many things to the bureau leaders. I also do not want to make the decision. I will ask the mayor next week." It is a typical strategy of individual governmental officers to reduce their personal responsibilities by submitting the case to a committee and have the decision made in the committee meeting. Resorting to this strategy means individual governmental officers voluntarily limit their discretion.

Officers of local governments and their environmental protection agencies have different preferences as to the procuratorate and NGOs. Between PIL brought by procuratorate and NGOs, they prefer procuratorates over NGOs. EL003 said, "I do not know how to communicate with environmental NGOs. As to the procuratorate, I think I can talk with them." Interviewee EL004 said, "environmental NGOs are from other places and mostly from big cities. They do not understand the hard life in our small cities."

The introduction of PIL also changed the expectation of polluters, including their attitudes towards pollution control and their decisions on investments. Polluters still hope to deal with governmental officers of local governments and their environmental protection agencies and try to avoid being found and sued by the procuratorate or NGOs. They think officers of local governments and their environmental protection agencies can better understand polluters' hardship and achievements in controlling pollution and remediating environmental damages. Interviewee LP052 said, "I keep my pollution control facilities running all the time. The procuratorate and some environmental NGOs all keep an eye on me. If I am sued, you guys in environmental protection agency cannot help me."

Polluters also preferred local procuratorates over environmental NGOs although they welcome neither procuratorates nor NGOs. Interviewee LP009 said, "procuratorates are our local residents. They know how much I tried to control pollution. Environmental NGOs are from other places, they just do not understand us. They just know big factories, but mine is just a small factory and does not have the money to buy fancy pollution control facilities." Interviewee OP006 said, "I was sued by an environmental NGO. They claimed environmental damages, and also their attorney fees and travelling costs. This is even worse. The procuratorate would not claim attorney fees and travelling costs." Interviewee OP043 said, "local procuratorate can better understand us. I do not want to deal with environmental NGOs from other places."

Some polluters reported that officers of local environmental protection agencies are facilitative in upgrading pollution control facilities, finding cost-effective measures, relocating worksites, providing subsidies, and in various other ways. Interviewee LP037 said, "the environmental protection agency introduced me to a company in Wuhan, which sold me a new chemical to neutralize my pollutants. This saved me much costs."

When the local environmental agency is sued by the procuratorate in an administrative PIL, many polluters choose to voluntarily make corrections even though they are not sued by the procuratorate. The author noticed that a granite products company purchased new pollution control facilities after the environmental protection agency had a conference with the local procuratorate as to the pollution from the granite industry park (Author's autoethnography record #079). The author interviewed the boss of this company and he said, "we heard you would be sued. They may sue both you and me," (Interviewee with LP028).

5. Discussion

5.1. Players' action sets and payoff

Players can take different actions. For instance, the local government and its environmental protection agencies may take actions such as checking a polluter's environmental pollution control facilities, testing the quantity and concentration of pollutants, and imposing penalties on violations. A polluter may take actions such as installing environmental pollution control facilities, putting such facilities into operation, or idling such facilities. This paper separately analyzes the action set and payoff of polluters and local governments.

5.1.1. Polluters

A polluter's benefit from complying with environmental protection requirements mainly lies in the normal and uninterrupted operation of its business. A polluter's costs mainly include infrastructural costs and operational costs. The former refers to the costs to

install environmental protection facilities and the latter electricity, water, inputs, human resources, and other costs for the normal operation of pollution control facilities. If a polluter contracts out all or part of its pollutants to an environmental services provider for proper treatment and disposal, it converts all or part of its infrastructural costs into operational costs. Similarly, such service providers also have infrastructural costs and operational costs for the treatment and disposal of pollutants. A polluter's action set for infrastructure costs is finite or discrete because it has only 2 choices: install or not to install the prescribed environmental protection facilities. However, its action set for operational costs is infinite: the lower bound being the complete idleness of pollution control facilities and the upper bound being the full operation of pollution control facilities. Between the lower bound and the upper bound, different operation levels of pollution control facilities correspond with different levels of pollution and operational costs. "The main cost for my environmental control facilities are electricity, water, and chemical inputs. The facilities were not very expensive but the operational costs are too much," (Interview with P0035).

A polluter's compliance with the law may be roughly differentiated into 3 levels: complete compliance, selective compliance, and non-compliance. Complete compliance means a polluter installs the pollution control facilities and fully operates them. Selective compliance means a polluter installs the pollution control facilities but does not fully operate them. Non-compliance means a polluter does not install pollution control facilities or contract out its pollution control obligations. This is a complete violation of the law.

5.1.2. The local government

Costs of enforcing environmental law mainly include enforcement costs (direct costs) and opportunity costs (indirect costs). The former mainly includes equipment and the salary of law enforcement personnel. The latter mainly includes losses in local employment, taxes, and investment, both the escape of extant investment and deterrence to potential investment.

The action set of a local government is generally infinite. The upper bound of the local government's action set is enforcing the law to the letters and to all polluters while the lower bound is the complete non-enforcement of the law. Between the upper bound and the lower bound, the local government and its environmental protection agencies have *de jure* and *de facto* discretion to selectively enforce the law by relaxing law enforcement to certain degrees or to certain polluters. The degree of law enforcement of a local government and its environmental protection agencies may be roughly differentiated into 3 levels: strict enforcement, selective enforcement, and non-enforcement.

When the local government and its environmental protection agencies strictly enforce the law, the benefit mainly lies in the proper performance of its responsibilities in law enforcement and the protected environment. According to the law, local governments are responsible for the environmental quality of its administrative region, local governments and their environmental protection agencies shall enforce environmental protection rules and standards. The proper enforcement of environmental law may win performance credits and avoid disciplinary punishments or legal liabilities. The protected environment contributes to the welfare of local people and may also contribute to the local economy such as tourism, real estate market, and saved future costs of environment remediation [105, 106].

The non-enforcement is the situation where the local government and its environmental protection agencies completely abandon law enforcement. In this situation, the local government and its environmental protection agencies completely lose credit as governmental bodies and the environment is severely hurt.

Selective enforcement is between strict enforcement and non-enforcement. A local government may choose to balance the achievement of environmental protection goals with other goals and selectively enforce the environmental law. In the unitary hierarchy of Chinese government, lower governments are responsible to meet certain targets assigned by the immediate higher government, which decomposes the targets set by its own immediate higher government, ultimately the State Council [107]. Therefore, the local government has many other duties and responsibilities besides environmental protection. "A county is like a small country. We need to take care of many things, public education, agriculture, industries, employment, infrastructure, too many things," (Interview with GL005). In addition to environmental protection, a local government needs to attain goals in economic development, social welfare, and many others. The goals and performance indicators of different responsibilities may potentially conflict with each other. "This is a hard year for our county, we need money to pay salaries to teachers of our middle schools and primary schools and governmental functionaries. Some polluting factories may bring a lot of tax money but I am afraid somebody may complain," (Interview with GL005). As far as environmental protection is concerned, a major conflict is between environmental protection and short-term economic development. Strict enforcement of environment law may deter investment and hurt short-term economic development. An important indicator of short-term economic development is the increase of GDP. For many years, GDP was used as an important indicator, if not the most important indicator, for evaluating the performance of local governments. The local government also needs tax money and jobs. Without sufficient tax money, the local government cannot finance local social welfare, improve local municipal infrastructure, or pay for the remediation of existing environmental pollution. In contrast, environmental protection was not as important as economic development in the governmental performance evaluation for many years in the past. Only recently, the State Council changed the performance evaluation policies applicable to environmentally important or fragile areas. These new policies are embodied in several documents issued by the State Council or the Communist Party of China (CPC) [108–111]. For example, *the Measures for Appraisal and Assessment of Targets for the Development of Ecological Civilization* issued on December 22, 2016 stressed environmental protection work in the career development of governmental officers [110]. For local governments of environmentally important or fragile areas, the utility of environmental protection is increased but economic development is still quite important. For these reasons, it is understandable that the local government values economic development much more than environmental protection (Author's autoethnography record #5). "Thanks to the policy change. The county leaders pay more attention to our environmental protection work. Environmental performance is a veto now. Our work gets more support and have less obstruction," (Interview with EL004).

The local government has 3 actions: strict enforcement, selective enforcement, and non-enforcement. The polluter also has 3 actions: complete compliance, selective compliance, and non-compliance. They may form into 9 scenarios and give different utilities to the local government and the polluter, as presented in Table 3.

(1) In the scenario where the local government strictly enforces the law and the polluter completely complies with the law, the local government gets its regular rewards from higher authorities and local residents. The value of this payoff may be set as 2. "I wish we could just enforce the law without considering any other factors. If all polluters voluntarily comply with the law, this world is perfect," (Joint interview with EL005 and SEL003).
(2) In the scenario where the local government selectively enforces the law and the polluter completely complies with the law, both the local government and the polluter get the same payoff as in Scenario 1. "If all polluters voluntarily comply with the law, we can just randomly check their performance to let them know we are working," (Joint interview with EL005 and SEL003).
(3) In the scenario where the local government neglects law enforcement and the polluter completely complies with the law, the local government saves enforcement costs and gets extra utility. The value of the local government's payoff may be set at 3. The value of payoff to the polluter is still 2. "We would save a lot of money if polluters would comply with the law without our pressure on them," (Interview with GL002).
(4) In the scenario where the local government strictly enforces the law and the polluter selectively complies with the law, the value of payoff to the local government is still 2, but the polluter just gets a payoff with the value of 1 because its partial non-compliance will be found and punished by the local government. "The recent test results of the air were not quite good. We need to find some polluters and punish them." "A polluter idled its air pollutant control facilities for about a month during the night," (Author's autoethnography records # 95 and #103).
(5) In the scenario where the local government selectively enforces the law and the polluter selectively complies with the law, the local government may get extra reward in the form of more investment and other utility, the polluter also gets more utility in the form of reduced operational costs. The value of their payoff may be both set at 3. "Doing business in a county depends on friends in the system. We need to make sure they can pass the scrutiny of superior agencies and they would not be so strict with us," (Joint interview with LP113 and OP332).
(6) In the scenario where the local government neglects law enforcement and the polluter selectively complies with the law, the local government may still get extra utility of saved enforcement costs and the value of its payoff is 3 while the value of the polluter's payoff is also 3. However, this scenario is quite unstable because the polluter has no incentive to keep selective compliance and may switch to non-compliance. "We should always keep an eye on polluters. Even if we do not impose penalties, we still need to make polluters know we are working and know their environmental performance," (Joint interview with EL003 and EO017).
(7) In the scenario where the local government strictly enforces the law and the polluter completely violates the law, the local government still gets a payoff of 2 while the polluter will be heavily punished and gets no utility. "We recently finished a case of discharging hazardous wastes by a truck. This truck is not qualified for transporting hazardous wastes but the driver illegally engaged in this business. The driver paid for a heavy fine and the cleaning costs. The driver said his insurance company refused to pay because he violated the law," (Author's autoethnography record #73).
(8) In the scenario where the local government selectively enforces the law and the polluter completely violates the law, the local government gets no utility while the polluter may get a payoff of 4. "We need to be strict with their installation of environmental pollution facilities. If they do not buy facilities, we cannot let them pass, otherwise, they would cause a lot of pollution and we would have a big trouble in the future," (Joint interview with EL003 and EO017).
(9) In the scenario where the local government does not enforce the law and the polluter completely violates the law, the payoffs are the same as in scenario 8. "We need to prove that we worked. Otherwise, we will be in a big trouble if a polluter violated the law and is found by the remote sensing system of the superior environmental agencies," (Interview with EL003).

In sum, whether the polluter completely complies with the law, selectively complies with law, or completely violates the law, the payoff is the same to the local government when it strictly enforces the law. When the local government selectively enforces the law, the polluter has no incentive to completely comply with the law. When the polluter completely violates the law, the local government has no incentive to enforce law selectively. When the local government completely neglects law enforcement, the polluter also has no incentive to completely or selectively comply with the law. If the local government does not strictly enforce the law when the polluter completely violates the law, the local government will get a payoff of zero.

Scenario 1 is the best for the environment while scenarios 8 and 9 are the worst for the environment. The local government will certainly reject scenarios 8 and 9 because of their worst payoff. The local government is likely to reject scenario 1 because it cannot get the best payoff. The local government gets the same payoff in scenarios 3, 5, and 6 but may choose just one of them. This paper will

Table 3
Aggregated payoff of a local government and a polluter.

Polluter \ Local government	Strict enforcement	Selective enforcement	Non-enforcement
Complete compliance	2,2 (1)	2,2 (2)	2,3 (3)
Selective compliance	1,2 (4)	3,3 (5)	3,3 (6)
Non-compliance	0,2 (7)	4,0 (8)	4,0 (9)

further analyze the local government's choices in light of institutional restraints, time horizon, and other factors.

5.2. Institutional restraints

The institutional framework sets restraints on the game between local governments and polluters and affects their payoffs and choices. The institutional framework is mainly established by the law, so this paper here analyzes relevant legal rules and court cases to reveal the institutional restraints.

First, the law limits the choices (action set) of local governments. The 2014 revised EPL, the Law on the Prevention and Control of Water Pollution of the People's Republic of China [112], the Law on the Prevention and Control of Air Pollution of the People's Republic of China [113], and other sectoral environmental laws all require the making and enforcement of pollutant discharge standards. The MEE and its predecessors have made more than 100 pollutant discharge standards [114]. These laws and pollutant discharge standards put requirements on pollution control facilities as to installation, quality, and normal operation, and affect both infrastructural costs and operational costs of polluters. They also impose law enforcement responsibilities on local governments and their environmental protection agencies. Local governments must establish their environmental protection agencies. The law gives the local government and their environmental protection agencies some discretion in law enforcement but does not allow them to totally abandon their law enforcement duties. If a local government refuses to enforce environmental law, the higher authorities may punish local governmental officials. One example of such punishment is the environmental law enforcement inspection by the national environmental protection agencies. Another example is the Central Environmental Protection Inspection (*Zhongyang Huanbao Ducha*) started in July 2015 [115]. Both inspections led to the demotion, removal from office, and even criminal penalties of a large number of local officials, mostly leaders of local environmental protection agencies [116]. For instance, the SPC's database of judgements contains more than 50 criminal cases of environmental protection officials liable for the crime of neglecting environmental law enforcement duties. This means the payoff of non-enforcement is zero for local government. This also means the local government has to incur costs in law enforcement but does not completely exclude the local government's incentive to save law enforcement costs.

Second, polluters need to disclose certain environmental information to the public according to Article 55 of the 2014 revised EPL [117–119]. A polluter certainly does not want to tell the public it violated the law. If a polluter violated the law but dishonestly claims it complied with the law in its public disclosure, it violates requirements on environmental information disclosure provided in Articles 55 and 62 of the 2014 revised EPL [4]. In sum, the disclosure requirement limits the polluter's action set.

Third, the local government also needs to disclose certain information to the public according to Articles 53 and 54 of the 2014 revised EPL and the Regulations on Open Governmental Information of the People's Republic of China promulgated by the State Council [120]. If the disclosure is found untruthful by the public, the local government will be held accountable. If the local government discloses truthfully that a polluter violated the law, it needs to demonstrate what enforcement action it has taken or plans to take. The local government needs to maintain an image that it diligently enforces the law and needs to report achievements in environmental protection. In sum, the disclosure requirement also limits the action set of local governments.

Fourth, a tacit restraint lies in the potential conflicts between the local government and its environmental protection agencies as well as the potential conflicts between leaders and ordinary staff. The local government, the environmental protection agencies, their leaders, and ordinary staff have different utility and payoff in environmental protection and law enforcement. The local government has overall responsibilities. In contrast, the environmental protection agencies are mainly responsible for environmental issues. The improvement or deterioration of the environment affects the utility and payoff of the environmental protection agencies much more than the local government as a whole. Therefore, the environmental protection agencies have more incentive to enforce the environmental law. Governmental officers of local governments generally consist of ordinary staff and leaders. Leaders, such as the mayor of a county or city, have the authority to make policy choices and key decisions as to economic development and environmental protection, and they do make such choices and decisions. They are more affected by the performance evaluation of local governments because such performance evaluation is to a large extent an evaluation of leaders and significantly affects their promotion and career life [121]. They are more likely to prioritize economic development over environmental protection at least for the following 3 reasons. First, indicators of economic development have more weight in performance evaluation, as aforementioned. Second, indicators of economic development can be achieved faster than indicators of environmental improvement. A local leader's regular term of office is 5 years. They generally hope to get a promotion at the end of their term or even during their term. Therefore, it is rational for them to make short-term plans and give more weight to economic development [122]. Third, leaders are less likely to suffer deteriorated environment. Leaders just live in a place for a short period of time during their term of office. For anti-corruption purposes, most leaders of local governments are not local residents. They come when they take office and leave when they are promoted to higher positions or transferred to a similar position at the end of their terms of office. For instance, on a revisit to the county environmental protection agency, the author found that 2 county leaders were promoted to other cities, 2 county leaders were transferred to other counties, 1 leader of the county environmental protection agency was promoted to the provincial environmental protection agency (Separate interviews with GL004, GL006, and EL002). In contrast, ordinary staff are more likely to be local residents or at least expect to be local residents in the future. For instance, the author met most of the ordinary staff on revisit (Author's autoethnography record 576).

> The above are just 4 of many institutional restraints. They further explain the payoff of each scenario. They also explain that the local government will not choose scenarios 3 and 6 even though their payoff is the same as in scenario 5.

5.3. Time horizon

In terms of time horizon, the game between a local government and polluters thereunder is typically an infinitely repeated game. On the one hand, the polluter incurs much sunk costs in establishing production facilities and pollution control facilities and naturally hopes to operate infinitely. It is subject to administrative powers of the local government and cannot avoid interaction with the local government. LP011, the boss of a chemical company, told the author that most of his facilities are immovable because of the environmental risks in dismantling and the features of the facilities. "I have to be careful in site selection. I cannot relocate easily. I must make sure that the local leaders treat me fairly," (Interview with LP011). On the other hand, the local government cannot abandon its administrative responsibility on polluters and cannot avoid interaction with polluters, either. "We must make records that we enforced the law, so that we will not be personally liable if the polluters are found violating the environmental law by the superiors or the public," (Author's autoethnography record # 003). For the above reasons, it is reasonable to model the game between polluters and local governments as an infinitely repeated game. In an infinitely repeated game, a player needs to make the other player know that it may resort to punishment if the other player defects. This also explains why the local government will not choose non-enforcement and exclude scenarios 3, 6, and 9.

5.4. Cooperation and regulatory capture

As Robert Axelrod rightly pointed out, infinitely repeated game may lead to foresight and cooperation with or without friendship between players [123]. Indeed, both local governments and polluters hope to cooperate with each other for their own interests. Local governments are responsible for local development and environmental protection. They should respond to the performance and demands of regulated firms [124]. They may hope polluters to bring economic development and help local governments improve indicators of economic development such as investments, GDP, employment, and taxes. At the same time, they may hope polluters not to cause trouble and not to violate environmental law, labor law, and other legal rules. "The government must check the environmental protection record of incoming investors," (Author's autoethnography record #3). Polluters may hope local governments to provide public safety, policy support, economic support, preferential tax treatment and not to stringently enforce environmental law or labor law. Major polluters have a particularly strong incentive to cultivate good relationships with the government for lax regulation [125]. "If the local government is hard to deal with, I certainly would not make investment here," (Interview with LP011). Therefore, the cooperation between polluters and local governments are not only a result of infinitely repeated game but also the hope of polluters and local governments. The above analysis of payoffs and action sets reveals that the game between local government and polluters is not necessarily a constant-sum game where one player can only gain at the expense of the other player, but can be a variable-sum game, which helps foster cooperation.

The authors' observation and previous literature [126–129] indicate that the cooperation between polluters and local governments is not necessarily bad. On the one hand, polluters are also enterprises valuable to the society and their investment may even contribute to energy efficiency and environmental protection [130]. For example, a building material company invested in a new type of bricks (aeriated bricks) which used recycled materials after the government banned red-bricks made of clay. This new product met the market demand and saved natural resources and energy (Interview with LP041). On the other hand, their cooperation may help prevent environmental pollution, take more effective measures to eliminate the existing pollutants, or restore the polluted environment. For instance, the aeriated brick maker used the solid waste of the granite industry as one of its raw materials and helped the local government as to the disposal of such solid waste and the well development of the granite industry. For this reason, the local government subsidized this aeriated brick maker (Interview with LP041 and Author's autoethnography record #83). Furthermore, their cooperation may help the government better understand the regulatory effects on innovation and productivity and adopt more appropriate regulation [129]. The author visited the regulated polluters to seek their feedback on environmental law enforcement and confirmed this finding (Author's autoethnography records #26–29). The law in fact encourages or even requires cooperation beneficial to the environment. For example, Article 23 of the 2014 revised EPL requires the government to provide polluters financial support for upgrading production processes and pollution control facilities [4]. The same legal rule requires the government to provide financial support to industrial polluter if they relocate from urbanized residential areas to suburban industrial parks [4]. Article 22 of the 2014 revised EPL also allows local governments to provide certain rewards to polluters who reduce their pollutant discharge to a degree more stringent than mandatory requirements [4].

Interviews, autoethnography, and previous publications [126] indicate that both local governments and polluters are likely to choose scenario 5 for most of the time. In this scenario, the government does not strictly enforce the law but in a selective or cooperative manner. The government understands the hardship of polluters, knows the polluter's potential and costs in environmental compliance, and select a level of stringency acceptable to both. The polluter knows its obligations in environmental compliance, understands the local government's duty and expectation in environmental protection, takes efforts to comply with most requirements of the environmental law, and makes the local government avoid punishment from institutional restraints. If the environmental enforcement is not too harsh, a polluter-investor is more likely to make more investment at this place. More importantly, the polluter will spread words to other potential investors, which is exactly what the local government expects. In this way, the local government can attract more investment and develop local economy faster. In fact, the boss of the chemical company the authors interviewed made his investment decision because his friend, another investor, told him how investors were treated here (Interview with LP011).

However, scenario 5 is not the best for the environment. It is in effect a regulatory capture [94]. The term "regulatory capture" refers to a situation where regulation serves private interests rather than the public good [131,132]. This term is used to depict legislations or enforcement of legislations that deviate from public interests. Even if the legislation serves public interests, the

government or its officers may choose not to enforce it or not fully enforce it after weighing benefits and costs. Therefore, regulatory capture can happen at institutional and individual levels. At the institutional level, the local government may over-emphasize local economic development and under-emphasize long-term public environmental interests. At the individual level, both local leaders and ordinary governmental staff may choose to cooperate with polluters and may be captured. When there is a regulatory capture, the local government or its officers may pretend the pollution is invisible and may even help or protect the polluters in the name of "public interests" [94,133]. The more than 50 criminal judgements retrieved from the SPC's database of judgement revealed that regulatory capture was part of the causes for neglect in environmental law enforcement. The institutional framework can prevent some but not all cooperation that hurts the environment. One reason is that some forms of cooperation are not totally illegal but within the "gray area". Another reason is that the restraints do not necessarily work in every situation even if the cooperation is illegal. It is costly for higher authorities or the public to find certain illegal cooperation. Some illegal or environmentally unfriendly cooperation do not leave clear evidence. For example, it is more difficult to prove the discharge of certain air pollutants in violation of pollutant discharge standards than to prove the failure to install pollution control facilities. Therefore, a local government may choose to be strict with the installation of the legally required pollution control facilities but flexible to pollutant discharge, especially invisible pollutants (Author's autoethnography record #23). As a result, it is easier for a polluter to save operational costs than infrastructural costs by capturing the local government and/or its officials. This may lead to a scenario of selective compliance where the polluter installs infrastructure but selectively operates such infrastructure only when it is necessary for the local government to pass the scrutiny of higher authorities. In this scenario, the polluter may get more benefit permitted by the law. The local government can find out this kind of selective compliance but may choose not to punish the polluter if it is captured and takes a more selective and cooperative attitudes in law enforcement.

5.5. Adding new players with environmental PIL

5.5.1. NGOs as new players in civil PIL cases

According to the CPL, for an NGO to become a new player through civil PIL, it needs the standing to initiate civil PIL cases. This standing issue was solved through a complicated and time-consuming legislative process.

The 1991 CPL set stringent requirements on the plaintiff's standing and limited the plaintiff to those with direct interest in the case [134]. The NPC Standing Committee could ease the standing requirements in 2007 when it revised the CPL. However, the 2007 revision of the CPL left this provision intact despite of strong calls for easing the standing requirements [9]. Finally, the 2012 revision added a new Article 55 to accommodate PIL [19,135]. Nevertheless, the new Article 55 still had ambiguities and needed clarification. The ambiguities were finally clarified with Article 58 of the 2014 revised EPL [21]. Now all NGOs that meet the following conditions may initiate an environmental public interest lawsuit: (1) legally registered with the civil affairs department of a people's government at or above the level of a districted city; and (2) having specifically engaged in the public interest activities of environmental protection for 5 or more consecutive years without any recorded violation of law [4]. The awkward term "the level of a districted city" means the level immediate higher than the county level. A district of Beijing, Shanghai, Tianjin, or Chongqing is at or above the level of a districted city because these cities are directly under the State Council and are at the provincial level. The result is that All-China Environment Federation (ACEF), Beijing Chaoyang Friends of Nature Environmental Research Institute (FON), China Biodiversity Conservation and Green Development Foundation (CBCGDF), Fujian Green Home, and some other NGOs met the qualification requirements. According to the databases of court cases, ACEF, FON, Fujian Green Home, and CBCGDF are active and brought most of the PIL cases initiated by NGOs.

A qualified NGO may bring public interest lawsuits anywhere in mainland China because neither the CPL or the EPL set geographic limits on NGOs' standing to bring PIL cases. This makes it almost impossible for any local government or polluter to "capture" all qualified NGOs. This explains why local governments and polluters think it is more difficult to deal with NGOs.

5.5.2. Procuratorates as new players in civil PIL cases and incidental civil cases

The procuratorate got the standing to bring civil PIL cases against polluters after a time-consuming legislative process. This idea was proposed before the 2012 revision of the CPL but was declined by the NPC Standing Committee [7]. After this setback, the procuratorate conducted a series of pilot projects and finally got the standing to bring civil PIL cases through another revision of the CPL in June 2017 [18,20]. This revision added a new second paragraph to Article 55. The newly added Article 55(2) provides that the procuratorate may bring a PIL lawsuit if there is no legally provided organs or NGOs, or the legally provided organs or NGOs failed to do so [20]. The same article also provides that the procuratorate may support PIL lawsuits brought by legally provided organs or NGOs [20]. Literally, this provision means that the procuratorate's standing is secondary and supplementary to NGOs' standing. People may think that the procuratorate's secondary position would significantly reduce its chances to bring civil PIL cases because at least one NGO is able to respond and bring the proposed PIL case. In practice, however, few if any NGOs are willing to respond and take the procuratorate's opportunity to bring an environmental PIL case. The understandable reason is that the procuratorate is part of the establishment and has NGOs' deference. Therefore, "it is just a formality for a procuratorate to make the legally required public notice, " (Interview with EnLawyer003).

In addition, a procuratorate may claim civil damages through an incidental civil action in a criminal case against the accused/defendant. Article 101 of the Criminal Procedure Law of the People's Republic of China allows a victim to bring a civil case if he/she suffered any material loss as a result of the defendant's crime [136]. Such a case is called an incidental civil case or a civil case incidental to a criminal case. A retrieval of judgement databases indicates that the procuratorates brought a significant number of environmental PIL cases in the form of incidental civil cases.

In contrast with NGOs, the CPL only allows a procuratorate to bring civil PIL cases within its jurisdiction [23]. This makes it easier for polluters to establish a kind of relationship with the procuratorate than with NGOs. In other word, the procuratorate is a new player, but not as new as NGOs. This explains why polluters prefer the local procuratorate over NGOs.

5.5.3. Procuratorates as new players in administrative PIL cases

The procuratorate may also sue or press the local government and their environmental protection agencies. The NPC Standing Commission revised the APL in 2017 by adding Article 25(4) to allow the procuratorate to bring administrative PIL cases against the local government and its environmental protection agencies if it thinks they failed to perform their duties or illegally exercised their authority and thus jeopardized the public environmental interests [18,22].

According to Article 25(4) of the 2017 revised APL, the procuratorate shall follow certain procedural rules before filing an administrative PIL case. The procuratorate shall send a "procurator's suggestion" to an administrative agency before initiating an administrative PIL case against it. The "procurator's suggestion" lists the wrongful act or omission and the public environmental interests concerned [22]. The administrative agency may submit an answer to defend itself within the specified period of time. It may also make corrections and report to the procuratorate within the specified period of time. The procuratorate will drop the case if it is satisfied with the administrative agency. It may initiate the case if the administrative agency did not answer or still failed to perform its responsibility for environmental protection. The county environmental protection agency the author worked made necessary corrections and reported the correctional efforts right after receiving a procurator's suggestion, so the procuratorate dropped the case (Author's autoethnography records #56). In contrast, a district environmental protection agency in Wuhan neither made necessary corrections nor answered the procurator's suggestion, then the procuratorate initiated the administrative PIL and won the case (Judgement 001 retrieved from WKINFO database).

Fig. 4 presents players of the environmental law enforcement at local level after introducing PIL rules.

5.5.4. The court as a new player

The above analysis treated the procuratorate and NGOs as new players, but the court is also a new player for environmental regulation. Although the court has judicial review power over specific acts of administrative agencies in administrative lawsuits, databases of judgements indicate that the court did not hear many administrative cases on environmental issues. The environmental administrative PIL makes the court review the reasonableness of administrative acts of administrative agencies even if the administrative act under review is not obviously unfair [22]. In environmental civil PIL cases, the court may indirectly review the administrative act of responsible administrative agencies if this civil PIL can be restructured into an administrative PIL case.

Judgements of environmental cases revealed that the court takes a pro-active and facilitative attitude toward environmental cases in general and PIL environmental cases in particular [137]. The pro-active and facilitative attitude of the court can be demonstrated in the following 2 aspects: the scope of participants in judicial processes and factors considered by the court.

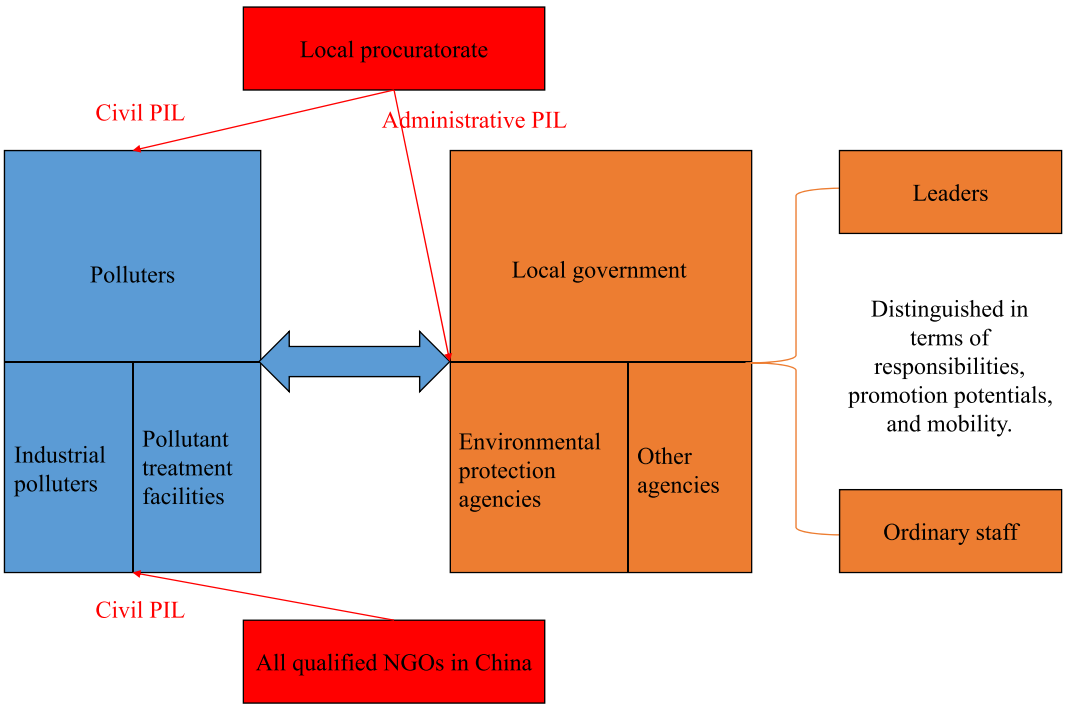

Fig. 4. Players of the environmental law enforcement at local level after introducing PIL.

As to the scope of participants in judicial processes, the court takes more than those expressly provided in the CPL and the APL into judicial processes. The court may allow stakeholders to participate in court processes although they are not qualified for participation in other regular types of cases. These stakeholders may participate the whole process or just part of the process, in the court hearing or in conference rooms. Their participation helps the court to find a win-win solution but their work may not be recorded in the judgment or the settlement agreement. This makes outsiders overlook their participation and contribution (Interview with judge 039). An example is *ACEF v. Zhenhua Company*, a civil PIL lawsuit against air pollution heard by the Intermediate People's Court of Dezhou City, Shandong Province. In the end, the defendant relocated from a densely populated area to a suburban industrial park with the assistance of local government, local residents got a better environment, and the local government won performance credits for solving a big environmental problem. This win-win result was unachievable without the participation of the local government, its environmental protection agencies, and other participants. The local government provided financial assistance and other assistance to help the defendant relocate. This relocation not only helped the defendant move away from potential victims but also provided an opportunity for the defendant to install more environment-friendly production equipment. Besides, this industrial park has a wastewater disposal company and other environmental service providers. They provide services to all companies in the industrial park and have the economy of scale. This helped improve the defendant's cost-effectiveness in pollution control. As the government controls the land and has zoning authority, this relocation could not be accomplished without the consent and active participation of local governments (Interview with EnLawyer047). In terms of game theory, this relocation was not in the action set of either the polluter or the victim if the case was brought by the victims as a regular civil case, not to mention the payoff of this choice. From the perspective of game theory, this may be interpreted that the addition of new players diversified and enlarged players' action sets and payoffs and helped change a confrontational constant-sum game into a cooperative variable-sum game and facilitated the solution of environmental problems. Besides, facing the high publicity and social pressure brought about by the environmental PIL, players are more willing to cooperate to find a solution and end the litigation, similar to the emergence of egalitarian behavior among players who faced a potentially despotic payoff structure [138].

As to factors considered in hearing PIL cases, the court may consider factors that otherwise might not be considered in a regular lawsuit. China witnessed rapid industrialization and urbanization in the past 40 years. Industrialization and urbanization are intertwined and may jointly contribute to environmental pollution [139,140]. The pollution may be exacerbated by inappropriate zoning for industrial development, inappropriate industrial policies, and promises previously made by local leaders and governmental officers when they sought investment [2]. The defendants may use these factors as defenses. Although they may not be supported by the black letter law, these defenses are understandable in the Chinese legal culture. The consideration of these factors makes the judgment and solution more acceptable to the defendants, potential investors, and the society at large. In *ACEF v. Zhenhua Company*, the site was a sparsely populated rural area when the defendant established its factory but now surrounded by condominium blocks (Interview with EnLawyer001). In *Fujian Green Home v. Lan Wenfu*, a civil PIL lawsuit against water pollution, the defendant was an operator of a large-scale pigsty. About 10 years ago, the local county government encouraged farmers to construct pigsties and breed livestock to meet the market demand for meat. Now the same local county government requested pigsty owners to demolish pigsties for environmental protection (Judgement 005 and Interview with EnLawyer001). In these 2 PIL cases, the governmental assistance for defendants could be understood as an equitable compensation in consideration of their particular situations. The game theory interpretation is that the action sets and payoffs of new players make the court notice and accommodate factors that otherwise would not be considered in a regular lawsuit.

5.6. New players' effects on the cooperation between local governments and polluters

According to game theory, the addition of new players may break the infinite chain, significantly change an existing game, and change the behavior pattern of existing players [123]. This is true for both civil PIL and administrative PIL. The introduction of new players pluralized the Chinese environmental regulation and restrains the cooperation between local governments and polluters at least in the following 3 ways.

First, new players can restrain or even stop the cooperation of individual cases. The cooperation between local government and polluters developed in the infinitely repeated game depends on the stability of players and the credibility of their promises and threats [141]. Before the introduction of PIL, environmental victims were weak and seldom brought lawsuits in a court of law. Local governments and their environmental protection agencies in effect monopolized the power to determine the validity of polluters' behaviors [1]. From the perspective of polluters, promises and threats of local governments and their environmental protection agencies were credible. However, the PIL implicitly changed the power of local governments and their environmental protection agencies by introducing new players. These new players may bring a PIL case against a polluter, a local government, or an environmental protection agency. Once the court finds that the polluter is liable for environmental damages or the administrative agency failed to properly enforce the law, the polluter has to stop the sued activities and the administrative agency has to enforce the law. In either case, the PIL stops the cooperation between the local government and the polluter that is unfriendly to the environment. Backed up with the authority to bring PIL cases, the procuratorate can even stop the cooperation with "procuratorate suggestions" stating its intention to bring a PIL case. For instance, Dr. Hu, an officer of the SPP, reported that during the period from July 2015 through June 2016, the first year of the 2-year pilot project, the administrative agencies made corrections or performed their duties after receipt of "procuratorate suggestions" in 814 of 916 cases, a percentage of 88.86 % [142].

Second, the PIL has a deterrence effect. PIL cases are special and newsworthy. They are widely reported by newspapers, TV programs, websites, and social media. Even if no PIL cases have been brought at a place, reports of PIL cases of other places make all polluters and local governments aware that they are monitored by NGOs and procuratorates. This makes local governments less likely

to collude with polluters and reduces polluters' expectation on possible collusion with local governments (Author's autoethnography record #153).

Third, local governments may voluntarily use PIL as a way to stop the cooperation with polluters. For instance, the new leaders of a local government may openly welcome or tacitly allow PIL in order to stop the cooperation between this local government and polluters established during the term of former leaders. At a time when they face more pressure on environmental protection, local governments are more inclined to take this option (Separate interviews with SEL036 and EnLawyer001).

In sum, PIL makes the payoff of scenario 5 no longer credible, changes the expectations and behavior patterns of polluters as well as local governments and their environmental protection agencies. In this way, PIL restrains or even stops the cooperation between the local government and polluters and reduces regulatory capture of the local government and environmental protection agencies by polluters.

5.7. Possible limits on PIL

PIL means there are 2 parallel games for redressing environmental problems: one being PIL while the other being the regular administrative enforcement. If competent administrative agencies act properly, there is no need for new players to take a PIL; if competent administrative agencies do not act properly, new players will come in through PIL cases. By adding a strong parallel game, the PIL incentivizes competent administrative agencies to act and subtly redistributes the power. In this sense, PIL is more a monitoring mechanism than a dispute resolution mechanism [60]. However, once administrative agencies, particularly local governments and their environmental protection agencies, set a different value to their utility and payoff, change their behavior patterns, and properly enforce the environmental law, there would be little left for PIL. Therefore, the possible limit of PIL is where local governments and their environmental protection agencies can achieve.

6. Conclusion and recommendations

China introduced PIL rules after a series of pilot projects and legislative revisions. Now both procuratorates and NGOs may bring civil PIL cases against polluters while a procuratorate also has the authority to bring administrative PIL cases against the corresponding local government and its environmental protection agencies. With autoethnography, interviews, official statistics, databases of judgements, and previous literature, this paper finds that environmental PIL is useful beyond individual cases because it changed the behavior patterns of local government and its environmental agencies as well as polluters. Before the introduction of PIL by the law, the local government and its environmental protection agencies enforced the law more selectively and had a more cooperative relationship with polluters. After the introduction of PIL rules, they changed their behavior patterns. They are now less cooperative with polluters and are more likely to strictly enforce the environmental law. Polluters also changed their expectation in the local government and their environmental protection agencies and get prepared for more strict enforcement of environmental law. Between the procuratorate and NGOs, the former is more acceptable to the local governments, their environmental protection agencies, and polluters.

This paper interprets these findings with game theory. This paper models the relationship between the local government and polluters before the introduction of PIL rules as an infinitely repeated game, which may lead to cooperation without friendship between players. This paper points out that PIL introduces new players, i.e., the procuratorate, NGOs, and the court. A procuratorate may only bring environmental PIL cases locally but an NGO may bring environmental PIL cases everywhere in mainland China. The court are both pro-active and facilitative as a new player in environmental PIL. According to game theory, the function of environmental PIL beyond individual cases mainly lies in that new players make previous promises and threats of local governments and their environmental protection agencies less credible and restrain or even stop the ensuing cooperation between the local government and polluters. This interpretation with game theory finds the function of environmental PIL beyond individual cases and further proves the rationale of introducing PIL into China.

However, the PIL also has its limits and side-effects. Firstly, environmental PIL is still supplementary. Environmental law enforcement of the local governments and their environmental protection agencies is still the most important for environmental protection. Environmental PIL supplements and enhances administrative enforcement but cannot replace it. Secondly, environmental PIL may make local governments and their environmental protection agencies less likely to take facilitative measures to promote environmental protection and economic development. Thirdly, clearer legal rules and guidelines are needed to make officials of local governments and their environmental protection agencies more confident that they will be immune from possible liabilities arising from taking reasonable facilitative measures.

This research also has its limits. Firstly, game theory is just one of many theories. It presumes that players are rational and understands their payoffs. However, this presumption is not necessarily true for every situation. Secondly, this paper just uses game theory in a non-technical manner. This paper sets the payoffs in a simplified manner and limits the discussion to a conceptual analysis. Thirdly, this study is mainly based on autoethnography and interviews. Even with the aid of supplementary data, these data collection methods still limit the data coverage. More studies are definitely needed to understand environmental PIL in China. Fourthly, the role of local people's congresses in environmental protection is increasing and may affect the future operation of PIL. Fifthly, this research was conducted when new players were enthusiastic after the introduction of environmental PIL. As time goes by, the initial enthusiasm on PIL will fade and PIL will gradually become routine work for the court, the procuratorate, and NGOs. There is a need to further evaluate the sense and sensibility of PIL in the future. Future research should use other theories in addition to game theory, and should use new data collected when PIL has become a daily work.

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Data availability statement

Data will be made available on request.

CRediT authorship contribution statement

Haijing Wang: Writing - review & editing, Writing - original draft, Visualization, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Mingqing You:** Writing - review & editing, Writing - original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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Appendix A. Supplementary data

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References

[1] R. Ran, Chinese Local Environmental Politics, Central Compilation and Translation Press, China, Beijing, 2015.
[2] M. You, Changes and challenges of the 2014 revised Environmental Protection Law in the context of China's five fundamental transitions, Hong Kong Law J. 45 (2) (2015) 621–649.
[3] B. Zhang, et al., A new Environmental Protection Law, many old problems? Challenges to environmental governance in China, Oxford Journal of Environmental Law 28 (2) (2016) 325–335.
[4] NPC Standing Committee, Environmental Protection Law of the People's Republic of China, 2014. Available from: https://flk.npc.gov.cn/detail2.html?MmM5MDlmZGQ2NzhiZjE3OTAxNjc4YmY3NmMxZDA3MTc%3D.
[5] Y. Zhao, Chinese Environmental Law, Cambridge University Press, UK: Cambridge, 2021.
[6] The State Council Information Office of the PRC, *China's Green Development in the New Era*, 2023.
[7] X. Wang, X. Zhao, N. McNamara, Environmental Public Interest Litigation in China, 2023.
[8] Z. Han, Public interest litigation as a new way for citizens to participate in the management of state affairs, Chinese Lawyers (10) (1999) 52–54.
[9] Z. Lyu, Deliberation on environmental public interest litigation, Stud. Law Bus. 2008 (6) (2008) 131–137.
[10] T. Wang, On administrative public interest litigation, Chinese Journal of Law (Faxue Yanjiu) 24 (5) (2002) 42.
[11] H. Zhao, Comparative study and enlightenment of foreign public interest litigation mechanism, J. Polit. Sci. Law 2002 (5) (2002) 22–25.
[12] T. Bie, Urgent to Establish Public Environmental Lawsuits, in Legal Daily, Beijing, 2004.
[13] T. Bie, Environmental public interests calls for public interest lawsuits, Environ. Econ. 2004 (9) (2004) 38–41.
[14] G. Wu, Active Exploration of the Mechanism of Public Interest Litigation, in Procuratorate Daily, Beijing, 2002.
[15] Z. Lyu, The rationality of environmental adjudication shall not end at sky-high damages, Chinese Legal Science 2016 (3) (2016) 244–264.
[16] F. Ge, History of Chinese environmental public interest litigation and typical cases, Social Governance 2018 (2) (2018) 51–63.
[17] L. Shi, The historical development of environmental public interest litigation and the position of procuratorate, J. Guangxi Normal Univ. 36 (2) (2015) 152–156.
[18] M. You, Annual review of Chinese environmental law developments: 2017, Environ. Law Rep. 48 (5) (2018) 10389–10393.
[19] N.P.C. Civil, Procedure Law of the People's Republic of China, 2012. Available from: https://flk.npc.gov.cn/detail2.html?MmM5MDlmZGQ2NzhiZjE3OTAxNjc4YmY3M2IwOTA2M2I%3D.

[20] NPC Standing Committee, Civil Procedure Law of the People's Republic of China, 2017. Available from: https://flk.npc.gov.cn/detail2.html?MmM5MDlmZGQ2NzhiZjE3OTAxNjc4YmY4NTY5MTBhMDU%3D.
[21] M. You, Y. Wang, Annual review of Chinese environmental law developments: 2014, Environ. Law Rep. 45 (5) (2015) 10419–10425.
[22] NPC Standing Committee, Administrative Procedure Law of the People's Republic of China, 2017. Available from: https://flk.npc.gov.cn/detail2.html?MmM5MDlmZGQ2NzhiZjE3OTAxNjc4YmY4NTg1NTBhMGY%3D.
[23] NPC Standing Committee, Civil Procedure Law of the People's Republic of China, 2021. Available from: https://flk.npc.gov.cn/detail2.html?ZmY4MDgxODE3ZWQ3NjZlYTAxN2VlNmFiOTlhZDFjYmM%3D.
[24] NPC Standing Committee, Civil procedural law of the people's Republic of China, Gazette of the NPC Standing Committee (6) (2023) 640–671.
[25] S.P.C. Spc's, Rules on the Participation of Peopple's Jurors with Special Knowledge in the Handling of Environmental and Resources Cases, 2023. Available from: https://www.court.gov.cn/fabu/xiangqing/407232.html.
[26] S.P.C. Interpretation, On the Application of Law in the Handling of Environmental PIL Cases (2020 Revised Version), 2020. Available from: https://flk.npc.gov.cn/detail2.html?ZmY4MDgxODE3OTlkZjYxNDAxNzliMTljMmYxNzJlZDQ.
[27] SPC. Rules Evidences in Civil Cases of Environmental and Ecological Torts. 2023; Available from: https://www.court.gov.cn/fabu/xiangqing/408942.html.
[28] S.P.C. Interpretations, On the Application of Law in the Handling of Environmental and Ecological Tort Liability Disputes, 2023. Available from: https://www.court.gov.cn/fabu/xiangqing/408932.html.
[29] SPC. Guiding Case No. 75: *Environmental Pollution Public Interest Case "China Biodiversity Conservation and Green Development Foundation (CBCGDF) V. Ningxia Ruitai Technology Corporation"*, 2017. Available from: https://www.court.gov.cn/shenpan/xiangqing/34322.html.
[30] SPC. Guiding Case No. *130*: *Environmental and Ecological Compensation and Environmental Civil PIL Case "Chongqing Municipal People's Government and Chongqing Liangjiang Voluntary Service Development Center V. Chongqing Cangjinge Property Management Company and Chongqing Shouxu Environmental Science and Technology Company"*, 2019. Available from: https://www.court.gov.cn/shenpan/xiangqing/216921.html.
[31] SPC. Guiding Case No. *131*: *Air Pollution Tort Liability PIL Case "All-China Environment Federation (ACEF) V*, Dezhou Jinghua Group Zhenghua Company Ltd, 2019. Available from: https://www.court.gov.cn/shenpan/xiangqing/216931.html.
[32] SPC. Guiding Case No. *132*: *Air Pollution Tort Liability Civil PIL Case "China Biodiversity Conservation and Green Development Foundation (CBCGDF) V. Qinghuangdao Fangyuan Packaging Glass Company"*, 2019. Available from: https://www.court.gov.cn/shenpan/xiangqing/216941.html.
[33] SPC. Guiding *case 133: environmental civil PIL "Shandong Yantai municipal people's procuratorate v. Wang Zhengdian and Ma Qunkai"*. https://www.court.gov.cn/shenpan/xiangqing/216941.html, 2019.
[34] SPC. Guiding *case 134: water pollution civil PIL case "chongqing green volunteers alliance v. Enshi autonomous prefecture jianshi huangchangping minerals company"*. https://www.court.gov.cn/shenpan/xiangqing/216961.html, 2019.
[35] S.P.C. Guiding, Case 135: Environmental Civil PIL Case "Jiangsu Xuzhou Municipal People's Procuratorate V, Suzhou Qi'an Artwork Company et al, 2019. Available from: https://www.court.gov.cn/shenpan/xiangqing/216971.html.
[36] SPC. Guiding Case No. *136*: *Environmental PIL Case "Baishan Municipal People's Procuratorate V*, Baishan Municipal Bureau of Health and Family Planning and Baishan Jiangyuan District Chinese Hospital", 2019. Available from: https://www.court.gov.cn/shenpan/xiangqing/216981.html.
[37] SPC. Guiding *Case No. 137: Environmental Administrative PIL Case "Yunnan Jianchuan County People's Procuratorate V. Jianchuan County Bureau of Forestry Public Security"*, 2019. Available from: https://www.court.gov.cn/shenpan/xiangqing/216991.html.
[38] SPC. Guiding Case No. *172*: *Environmental Incidental PIL Case "Qin Jiaxue Criminal Illegal Logging Crime"*, 2021. Available from: https://www.court.gov.cn/shenpan/xiangqing/334681.html.
[39] SPC. Guiding Case No. *173*: *Environmental Civil PIL Case "Beijing Friends Of Nature V*, Chinese Hydropower Consultancy Group Company Xinping Development Company and China Electricity Development Group Kunming Survey and Design Academy Company", 2021. Available from: https://www.court.gov.cn/shenpan/xiangqing/334691.html.
[40] SPC. Guiding Case No. *174*: "*China Biodiversity Conservation and Green Development Foundation (CBCGDF) V Yalong River Valley Hydropower Development Company"*, 2021. Available from: https://www.court.gov.cn/shenpan/xiangqing/334701.html.
[41] SPC. Guiding Case No. *175*: *Environmental PIL Case "Jiangsu Taizhou Municipal People's Procuratorate v. Wang Xiaopeng* et al.*"*, 2021. Available from: https://www.court.gov.cn/shenpan/xiangqing/334711.html.
[42] SPC. Guiding Case No. *176*: *Environmental PIL Case "Hunan Yiyang Municipal People's Procuratorate v. Xia Shunan* et al.*"*, 2021. Available from: https://www.court.gov.cn/shenpan/xiangqing/334721.html.
[43] SPC. Guiding Case No. *202*: *Incidental Civil PIL Case "Wuhan Zhuohang Jianghai Trading Company, Xiangyang,* et al. *Environmental Pollution Crime"*, 2022. Available from: https://www.court.gov.cn/shenpan/xiangqing/386131.html.
[44] SPC. Guiding Case No. *203*: *Incidental Civil PIL Case "Zuo Yong and Xu He Environmental Pollution Crime Case"*, 2022. Available from: https://www.court.gov.cn/shenpan/xiangqing/386141.html.
[45] SPC. Guiding Case No. *204*: *Environmental Civil PIL Case "Chongqing Municipal People's Procuratorate the Fifth Branch V. Chongqing Yuhuang Eletric Equipment Manufacturing Company"*, 2022. Available from: https://www.court.gov.cn/shenpan/xiangqing/386151.html.
[46] SPC. Guiding Case No. *205*: *Environmental Civil PIL Case "Shanghai People's Procuratorate the Third Branch V. Langxi Huayuan Solid Wastes Disposal Company, Ningbo High-Tech District Mitai Trading Company, Huang Deting, and Xue Qiang"*, 2022. Available from: https://www.court.gov.cn/shenpan/xiangqing/386161.html.
[47] SPC. Guiding case No. *206*: *environmental civil PIL case "beijing municipal people's Procuratorate the fourth branch v. Zhu Qingliang and zhu qingtao"*. https://www.court.gov.cn/shenpan/xiangqing/386171.html, 2022.
[48] SPC. Guiding case No. *207*: *ecological disruption civil PIL case "jiangsu nanjing municipal people's procuratorate v. Wang yulin"*. https://www.court.gov.cn/shenpan/xiangqing/386181.html, 2022.
[49] SPC. Guiding case No. *208*: *ecological disruption civil PIL case "jiangxi shangrao municipal Procuratorate v. zhang yongmin, zhang Lu, and mao weiming"*. https://www.court.gov.cn/shenpan/xiangqing/386191.html, 2022.
[50] SPC. Guiding *case No. 209: ecological disruption civil PIL case "Zhejiang suichang county people's procuratorate v. Ye jicheng"*. https://www.court.gov.cn/shenpan/xiangqing/386201.html, 2022.
[51] SPC. Guiding Case No. *211*: *Administrative PIL Case "Tongren Municipal People's Procuratorate V. Tongren Municipal Forestry Burea" (Non-performance of Duty)*, 2022. Available from: https://www.court.gov.cn/shenpan/xiangqing/386221.html.
[52] SPC and SPP. Joint interpretations of the SPC and SPP on the application of law in public interest cases initiated by the procuratorate (2020 revised version). https://www.spp.gov.cn/xwfbh/wsfbt/202012/t20201230_504430.shtml#2, 2020.
[53] Q. Zhou, Report of the Supreme People's Court, 2018.
[54] SPC. *Report of Chinese environmental adjudication 2021*. https://www.court.gov.cn/zixun-xiangqing-361361.html, 2022.
[55] W. Qiao, Providing quality judicial services for achieving the modernization based on harmonized co-existence of human and nature, in: *People's Court Daily*. 2023, Chinese SPC, Beijing, 2023, p. 1.
[56] SPP, the Procuratorate Whitebook on the Protection of Ecological Environmental and Resources, 2023. China: Beijing.
[57] M. Cao, F. Wang, *Environmental public interest litigation in China.* Asia Pacific L, Rev 19 (2) (2011) 217–235.
[58] R.E. Stern, From dispute to decision: suing polluters in China, China Q. 206 (2011) 294–312.
[59] J. Liu, Environmental justice with Chinese characteristics: recent developments in using environmental public interest litigation to strengthen access to environmental justice, Florida Agricultural and Mechanical University Law Review 7 (2012) 229–260.
[60] D. Carpenter-Gold, Castles made of sand: public-interest litigation and China's new environmental protection law, Harv. Environ. Law Rev. 39 (2015) 241–274.
[61] B. van Rooij, R.E. Stern, K. Fürst, The authoritarian logic of regulatory pluralism: understanding China's new environmental actors, Regulation & Governance 10 (1) (2016) 3–13.

[62] K. McCallum, Changing landscapes: enforcing environmental laws in China through public interest litigation, Asia Pac. J. Environ. Law 20 (1) (2017) 57–93.
[63] X. Wang, K. Lo, Civil society, environmental litigation, and Confucian energy justice: a case study of an environmental NGO in China, Energy Res. Social Sci. 93 (2022) 102831–102840.
[64] H. Chen, The establishment of punitive damages in environmental public interest litigation, China Legal Science (English version) 7 (6) (2019) 106–122.
[65] Yi Liu, The judicial practice and theoretical exploration of public interest litigation brought by the procuratorate, Journal of National Prosecutors College 25 (2) (2017) 3–18.
[66] Q. Xu, M.I. Khan, Reflections on the environmental damage compensation regime in Chinese civil legislations, Heliyon 9 (4) (2023) e15154.
[67] H. Sato, The universality, peculiarity, and sustainability of Indian public interest litigation reconsidered, World Dev. 100 (2017) 59–68.
[68] M.S. Khan, Genesis and evolution of public interest litigation in the Supreme Court of Pakistan: toward a dynamic theory of judicialization, Temple Int. Comp. Law J. 28 (2) (2015) 284–358.
[69] M. Gebregiorgs, The role of public interest litigation in the achievement of sustainable waste management in Ethiopia, Sustainability 10 (12) (2018) 4735–4754.
[70] N.B. Hashim, Moves towards progressive legal framework and energetic jurisprudential behavioral on the enforcement of public interest litigation in the New Millennium, Procedia - Social and Behavioral Sciences 105 (2013) 484–490.
[71] M.J. Osborne, A. Rubinstein, A Course in Game Theory, The MIT Press, 1994.
[72] J. Von Neumann, O. Morgenstern, Theory of Games and Economic Behavior, Princeton University Press, Princeton, NJ, USA, 1944.
[73] J.F. Nash Jr., The bargaining problem, Econometrica 18 (1950) 155–162.
[74] D.G. Baird, R.H. Gertner, R.C. Picker, Game Theory and the Law, Revised Edition ed., Harvard University Press, Cambridge, MA, USA, 1998, p. 344.
[75] D. Li, Institutional incentives, game equilibrium and social justice: toward a unified theory of pure jurisprudence, Soc. Sci. China 38 (4) (2017) 85–102.
[76] A. Shafi, et al., A game theory approach to the logic of illegitimate behavior induced during land conflict litigation in urban and peri-urban areas of Pakistan, Cities 130 (2022) 103990.
[77] A. Das, S. Roy, The new institutional economic approach to land development game: integrating transaction cost and efficient institutional framework in synergic urban land use-transport development model, Heliyon 9 (1) (2023) e12793.
[78] M. Abubakari, et al., Sustaining the urban commons in Ghana through decentralized planning, Heliyon 9 (5) (2023) e15895.
[79] T. Lv, et al., A game theory-based approach for exploring water resource exploitation behavior in the Poyang Lake Basin, China, Sustainability 11 (22) (2019) 6237–6250.
[80] L. Zhang, H. Du, Y. Zhao, Game behavior analysis between the local government and land-lost peasants in the urbanization process, Sustainability 8 (12) (2016) 1213–1227.
[81] Y. Shao, et al., Optimal battery recycling strategy for electric vehicle under government subsidy in China, Sustainability 10 (12) (2018) 4855–4872.
[82] S. Gao, S. Ling, W. Liu, The role of social media in promoting information disclosure on environmental incidents: an evolutionary game theory perspective, Sustainability 10 (12) (2018) 4372–4390.
[83] A.V. Witteloostuijn, A game-theoretic framework of trust, Int. Stud. Manag. Organ. 33 (3) (2014) 53–71.
[84] J. Macrae, Underdevelopment and the economics of corruption: a game theory approach, World Dev. 10 (8) (1982) 677–687.
[85] A. de Janvry, E. Sadoulet, A study in resistance to institutional change: the lost game of Latin American land reform, World Dev. 17 (9) (1989) 1397–1407.
[86] R. Meinzen-Dick, et al., Playing games to save water: collective action games for groundwater management in Andhra Pradesh, India, World Dev. 107 (2018) 40–53.
[87] R. Myerson, Constitutional structures for a strong democracy: considerations on the Government of Pakistan, World Dev. 53 (2014) 46–54.
[88] A.M. Brandenburger, B.J. Nalebuff, Co-Operation, Crown Business, 2011.
[89] A.K. Dixit, B.J. Nalebuff, Thinking Strategically: the Competitive Edge in Business, Politics, and Everyday Life, W.W. Norton, 1992.
[90] X. Xia, Y.N. Yang, Why are there conflicts of interest? Investigation of teacher exchange within Arts Education Group in China, Heliyon 9 (8) (2023) e18985.
[91] M. Finus, Game Theory and International Environmental Cooperation, Edward Elgar, 2001.
[92] M. Hirsch, Game theory and international environmental cooperation, J. Energy Nat. Resour. Law 27 (3) (2015) 503–510.
[93] R. Mushka, Implementing environmental law in transitional setting: the Chinese experience, South. Calif. Interdiscipl. Law J. 18 (1) (2008) 45–94.
[94] P. Lei, Q. Huang, D. He, Determinants and welfare of the environmental regulatory stringency before and after regulatory capture, J. Clean. Prod. 166 (2017) 107–113.
[95] Hubei provincial bureau of statics. Statistic report of economic and social development of Hubei. https://tjj.hubei.gov.cn/tjsj/tjgb/ndtjgb/qstjgb/202303/t20230316_4587528.shtml, 2022.
[96] Hubei provincial bureau of statics. 2022 statistic yearbook of Hubei province. https://tjj.hubei.gov.cn/tjsj/sjkscx/tjnj/qstjnj/, 2023.
[97] Hubei Provincial People's Government, Notice on the Issuance of Ecological Protection Redlines of Hubei Province (*Ezhengfa [2018]30)*, 2018. Available from: https://www.hubei.gov.cn/zfwj/ezf/201808/t20180803_1712099.shtml.
[98] J. Koay, Self-directed professional development activities: an autoethnography, Teach. Teach. Educ. 133 (2023).
[99] L. Anderson, Analytic autoethnography, J. Contemp. Ethnogr. 35 (4) (2016) 373–395.
[100] M. Haeffner, et al., Expanding collaborative autoethnography into the world of natural science for transdisciplinary teams, One Earth 5 (2) (2022) 157–167.
[101] NPC, The Criminal Law of the People's Republic of China, 2020. Available from: https://flk.npc.gov.cn/detail2.html?ZmY4MDgxODE3OTZhNjM2YTAxNzk4MjJhMTk2NDBjOTI%3D.
[102] SPC, Environmental and Resources Adjudication in China, China Legal Publishing House, 2019.
[103] X. Zhang, Difference between the PIL of China and Western Countries, 2019. Oct. 5, 2019]; Available from: http://www.chinanews.com/gn/2019/02-14/8753824.shtml.
[104] Mee, Annual Ecological and Environmental Statistics of China: 2021, 2023. Beijing, China.
[105] J. Li, Y. Peng, P. Wang, Environmental pollution and migrant settlement decision: evidence from China, Chinese Journal of Population, Resources and Environment 20 (4) (2022) 357–368.
[106] Y. Zhang, et al., Willingness to pay for environmental protection in China: air pollution, perception, and government involvement, Chinese Journal of Population, Resources and Environment 18 (3) (2020) 229–236.
[107] P. Zhang, J. Wu, Performance-based or politic-related decomposition of environmental targets: a multilevel analysis in China, Sustainability 10 (10) (2018) 3410–3425.
[108] National Development and Reform Commission, et al., The Assessment Targets of Ecological Civilization Development, 2016. Available from: https://www.gov.cn/xinwen/2016-12/22/content_5151575.htm.
[109] National Development and Reform Commission, et al., Indicators of Green Development, 2016. Available from: https://www.gov.cn/xinwen/2016-12/22/content_5151575.htm.
[110] General Office of the CPC Central Committee and General Office of the State Council, *Measures For Appraisal And Assessment of Targets for the Development of Ecological Civilization*, 2016.
[111] General office of the Cpc Central Committee, Regulations on the Examination of Leaders of Government and CPC, 2019.
[112] NPC Standing Committee, Law on the Prevention and Control of Water Pollution of the People's Republic of China, 2017. Available from: https://flk.npc.gov.cn/detail2.html?MmM5MDlmZGQ2NzhiZjE3OTAxNjc4YmY4NTA0NTA5ZmI%3D.
[113] NPC Standing Committee, Law on the Prevention and Control of Air Pollution of the People's Republic of China, 2018.
[114] M.E.E. Website, Of Ecological and Environmental Standards, 2023. Available from: https://www.mee.gov.cn/ywgz/fgbz/bz/.
[115] K. Jia, S. Chen, Could campaign-style enforcement improve environmental performance? Evidence from China's central environmental protection inspection, J. Environ. Manag. 245 (2019) 282–290.

[116] M.E.E. Achievements, Of the Central Environmental Protection Inspection, 2022. Available from: https://www.mee.gov.cn/ywdt/zbft/202207/t20220706_987848.shtml.
[117] K. Fang, Q. Wei, K.K. Logan, Protecting the public's environmental right-to-know: developments and challenges in China's legislative system for EEID, 2007-2015, J. Environ. Law 29 (2) (2017) 285–315.
[118] X. Liu, et al., Functional mechanisms of mandatory corporate environmental disclosure: an empirical study in China, J. Clean. Prod. 18 (8) (2010) 823–832.
[119] Y. Liu, An empirical research of awareness, behavior and barriers to enact carbon management of industrial firms in China, Sci. Total Environ. 425 (0) (2012) 1–8.
[120] The State Council, Regulations on Open Governmental Information of the People's Republic of China, 2019. Available from: https://flk.npc.gov.cn/detail2.html?ZmY4MDgwODE2ZjNlOThiZDAxNmY0MWYyODYyZTAyMTE%3D.
[121] A.L. Wang, The search for sustainable legitimacy: environmental law and bureaucracy in China, Harv. Environ. Law Rev. 37 (2013) 365–440.
[122] X. Gao, C. Shi, K. Zhai, An evaluation of environmental governance in urban China based on a hesitant fuzzy linguistic analytic network process, Int. J. Environ. Res. Publ. Health 15 (11) (2018) 2456–2475.
[123] R. Axelrod, The Evolution of Cooperation, Basic Books, Inc, New York, 1984.
[124] J. Zhu, M.R. Chertow, Authoritarian but responsive: local regulation of industrial energy efficiency in Jiangsu, China, Regulation & Governance 13 (3) (2017) 384–404.
[125] M. Tian, G. Xu, L. Zhang, Does environmental inspection led by central government undermine Chinese heavy-polluting firms' stock value? The buffer role of political connection, J. Clean. Prod. 236 (2019) 117695–117709.
[126] L. Liu, Symbiosis, restraint to win-win — the sociological interpretation of a contaminative enterprise's development process in northeast old industrial area, in: College of Philosophy and Sociology, Jilin University, 2016.
[127] C. Liu, Greening the general rules of tort law in the background of ecological civilization, Forum of Law and Politics 2020 (1) (2020) 79–89.
[128] H. Duan, H. Liu, D. Gu, Government-enterprise cooperation in pollution control, Economic Research Reference 40 (7) (2016) 106–109.
[129] B. Yuan, K. Zhang, Can environmental regulation promote industrial innovation and productivity? Based on the strong and weak Porter Hypothesis, Chinese Journal of Population Resources and Environment 15 (4) (2017) 322–336.
[130] J. Huang, S. Yu, Effects of investment on energy intensity: evidence from China, Chinese Journal of Population Resources and Environment 14 (3) (2016) 197–207.
[131] R. Slayton, A. Clark-Ginsberg, Beyond regulatory capture: coproducing expertise for critical infrastructure protection, Regulation & Governance 12 (1) (2018) 115–130.
[132] G.J. Stigler, The theory of economic regulation, Bell J. Econ. Manag. Sci. 2 (1) (1971) 3–21.
[133] R. Steinzor, The case for abolishing centralized white house regulatory review, Michigan Journal of Environmental & Administrative Law 1 (1) (2012) 209–286.
[134] N.P.C. Civil, Procedure Law of the People's Republic of China, 1991. Available from: http://www.law-lib.com/law/law_view.asp?id=7535.
[135] M. You, J. Liu, Annual review of Chinese environmental law developments: 2012, Environ. Law Rep. 43 (5) (2013) 10418–10425.
[136] NPC Standing Committee, Criminal Procedure Law of the People's Republic of China, 2018. Available from: https://flk.npc.gov.cn/detail2.html?ZmY4MDgwODE2ZjEzNWY0NjAxNmYxZDFiODFiMDEzNTE%3D.
[137] T. Qin, Direction of environmental adjudication development in judicial activism, Tsinghua Law Journal 16 (5) (2022) 147–162.
[138] K. Tamura, H. Takikawa, Modelling the emergence of an egalitarian society in the n-player game framework, J. Theor. Biol. 461 (2019) 1–7.
[139] S. Wu, The impact of industrial distribution on the distribution of pollution: evidence from China, Chinese Journal of Population, Resources and Environment 18 (2) (2020) 127–136.
[140] P. Li, Y. Ouyang, D. Shi, The environmental effect of technical Change: a spatial model with city-level data in China, Chinese Journal of Population, Resources and Environment 19 (1) (2021) 22–33.
[141] W. Zhang, Game and Society, Peking University Press, 2013.
[142] W. Hu, X. Chi, Study on the procedure before the administrative public interest litigation, Journal of National Prosecutors College 25 (2) (2017) 30–48.