



Green building in China

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Abstract

Green buildings can play a role in helping countries meet their commitments under the Paris Agreement on Climate Change. Green building can provide an important contribution to sustainability, for example, by improving energy efficiency, by improving indoor air quality, and by effective waste treatment. In practice, we see that there is an increasing interest in various forms of green building. However, the existing literature has not identified the role of law in promoting green building. It is, moreover, striking that green building has taken off in a rather impressive manner in China. Although generally there are still huge environmental problems with which China is confronted, for many years already China has been engaged in green building. This paper wants to examine what explains the relative success of green building in China; What specific legal instruments can be used to promote green building; and what lessons can be drawn more generally from experience in China? The paper uses the theory of smart regulation (Gunningham/Grabosky) and the economic analysis of law to examine the importance of different instruments in promoting green building. The paper comes to two key results, being that no single instrument in itself is optimal to promote green building as a result of which a smart mix needs to be designed to promote green building; moreover, for the specific case of China, it is the large government involvement in the economy that has been able to jump-start green building. The Chinese government has, on the one hand, mandated green building in government projects, but on the other hand, also used market-based instruments (like subsidies and public procurement) to promote green building.

Keywords Green building · Instrument mixes · Command and control · Market-based instruments · Suasive instruments

Abbreviations

CBRE Coldwell Banker Richard Ellis, Inc

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CGBC	China Green Building Council
CNY	Chinese Yuan (Chinese currency)
CSUS	China Society for Urban Studies
EIA	Environmental impact assessment
FYP	Five year plan
GB	Green building
GBEL	Green Building Energy Labelling
GDP	Gross Domestic Product
HVAC	Heating, ventilation, and air conditioning
LEED	Leadership in energy and environmental design
MOF	Ministry of Finance of the PRC
MOHURD	Ministry of Housing, Urban–Rural Development of the PRC
OECD	Organization for Economic Co-operation and Development
PRC	People’s Republic of China
US	United States
USGBC	United States Green Building Council
WGBC	World Green Building Council

1 Introduction

Buildings can have significant environmental impacts, and the built environment’s energy intensity needs to improve by 30 per cent by 2030, in order to meet the goals of the Paris Climate Agreement aiming to limit global temperature rise to 1.5 degrees Celsius (IPCC 2018, pp. 127–129; UNEP 2017, pp. 18–21). A GB is a building that, in its design, construction, or operation, reduces or eliminates negative impacts and can create positive impacts, on our climate and natural environment. GB has far-reaching environmental benefits, including but not limited to, building energy efficiency, land use, indoor air quality, and construction/demolition waste disposal. GB can, therefore, be a way for countries to make their nationally determined contributions required in the Paris Agreement. As China is one of the highest populated countries in the world with a large building activity, GB in China can have a substantial impact on reducing global emissions.

GB has seen a growth in many jurisdictions such as Europe, the USA, Canada, China, India, and Australia (Dodge Data and Analytics 2018, p. 7), where various legal and policy instruments are in place to stimulate GB (Annunziata et al. 2013; Howe and Gerrard 2010; O’Neill and Gibbs 2018; Rosenow et al. 2016; Uihlein and Eder 2010). Those policy instruments mostly rely on regulation, liability rules, self-regulation, or a combination of those (Kivimaa and Martiskainen 2018). Institutional arrangements for environmental governance come down to a selection of smart instrument mixes, which may also work for GB. Although the idea of smart mixes makes sense in theory, the ways to mix and the outcomes may differ across jurisdictions. Simply put, instrument mixes are context-dependent.

China is one of the largest CO₂ emitters globally and now accounts for nearly 27% of total global emissions (Le Quéré et al. 2018). GB is likely to significantly reduce emissions, as the construction boom in the country led to the retro-fitting of many buildings. For sustainability in the building sector, the Ministry of Housing, Urban–Rural Development (MOHURD) released the 12th FYP for GB and Eco-City Development (2011–2015) and the 13th FYP for Building Energy Conservation and GB Development (2016–2020), which set target standards for building energy efficiency. In the meantime, the law required

the government agencies not only to green their buildings but also to come up with standards and regulations for residential and commercial buildings. The number of new GBs has increased over the last decade as a result of the policy support for GB promotion.

This paper, therefore, wishes to address two questions: (i) Is there any way in which legal instruments could promote green building, and if so, what would the specific legal instruments be that engage in this promotion? And (ii) What explains the relative success of GB in China and which lessons can be drawn more generally from experience in China?

The paper uses the law and economic theory of smart regulation (Gunningham/Grabosky) and a case study on China's GB promotion, to examine the importance of different instruments in promoting green building. This study is the first to provide an institutional analysis of GB policy in China using a law and economics framework and to contribute to the debate on how to develop a smart mix of instruments in GB promotion. After this introduction, the article proceeds as follows: Sect. 2 describes how the definition of GB can affect the way to promote GB. Section 3 explains why GB needs instrument mixes and the possible ways to mix in theory. In the light of the theory and some empirical information, Sect. 4 investigates how the instruments (mixes) work for GB in China, summarizing that instrument mixes also make sense in GB practice, but the government plays a more significant role in the Chinese context. Section 5 concludes.

2 What is green building?

A GB is a building that, in its design, construction, or operation, reduces or eliminates negative impacts, and can create positive impacts, on our climate and natural environment (WGBC 2019). GB compliance can be evaluated via a rating system incorporating public or private standards. For instance, in China, the assessment standard for GB was developed by the Chinese central government. It has been incorporated into the government-run Green Building Energy Labelling (GBEL) in China. By contrast, the Leadership in Energy and Environmental Design (LEED) scheme is based on private standards made by the US Green Building Council (USGBC). Both LEED and GBEL include essential GB elements such as requirements concerning energy, land, indoor air quality, water, and waste disposal. Originally, the Chinese GBEL scheme, which dates from 2006, contained rather broad requirements; LEED had a more detailed rating scheme than the old version of the Chinese GB assessment standard (Khanna et al. 2014, pp. 9–26). The latest Chinese GBEL standard (2019) takes into account elements like durability, real-time monitoring of resource use, and convenience and accessibility for end-users at the operational stage (MOHURD 2019a). In that sense, the latest Chinese GB standard provides an outcome-based approach to GB compliance, whereas LEED has not adopted such an approach. In practice, many countries, including China, apply various standards, depending upon the type of building involved (Ramboll 2019, p. 19). Roughly GBEL is applied to government buildings, whereas LEED is applied to private constructions. In addition to LEED, the United Kingdom's BREEAM, Germany's DGNB, and Singapore's Green Mark certification systems are also used in China but are far less popular than LEED. This paper focuses more on LEED, as there is an increasing number of commercial buildings using LEED in China. LEED is of American origin but is applied in China as well. There is thus collaboration between the USA and China regarding GB, providing scope for mutual learning between the two countries in this domain.

The definition of GB may have some policy implications. First, GB supports the environment and rather than over-urbanization, which may imply that GB promotion should also consider renovations. Second, GB should take into account the total environmental impacts of building activities. This can mean that GB compliance should be in line with target standards and planning. Lastly, GB is a mix of various elements that not only generate externalities but also provide benefits for private parties. The mixed feature of GB is the starting point for which GB promotion may need both government regulation and private solutions.

3 Smart instrument mixes for GB: a theoretical perspective

There is a variety of different instruments that can be used to promote GB. This section investigates legal and policy instruments for GB promotion and explains why and how instruments are mixed from a theoretical perspective.

3.1 Legal and policy instruments for environmental governance

Most environmental policy instruments are aimed at internalizing the negative externalities related to pollution. With GB, that may also be the case, to some extent, (for example, when GB focuses on improving land use or reducing waste). A specific feature of GB is that it also creates positive externalities (for example, when focusing on energy efficiency). The first question that could be asked is why there would be a need for (government) regulation in the first place to promote GB. After all, Nobel Prize Winner Coase taught that in a low-transaction-cost setting, an efficient outcome will automatically be reached to take care of externalities (Coase 1960). However, in practice, transaction costs may inhibit efficient bargaining. Institutional arrangements are, therefore, created to provide incentives in order to reduce transaction costs (North 1992, pp. 5–8).

A variety of different legal and policy instruments have been developed in practice, and although a range of different categorizations exists, those instruments can be categorized into command-and-control, market-based, and persuasive instruments (van Erp et al. 2019).

Command-and-control instruments are direct government regulation, which usually decides collectively the degree to which an activity is desirable, who should participate in it, and how the activity should be done (Calabresi 1970, p. 25). In the case of GB, building permits or land use planning are conventional command-and-control instruments.

Market-based instruments use financial incentives or disincentives to affect the care or activity levels. Market-based instruments consist of taxation, subsidies, and public procurement. Market-based instruments also include private solutions such as green loans and liability rules.

Instruments of persuasion use information to encourage voluntary compliance. Self-regulation for GB mainly takes the form of private certifications and hence falls into the category of persuasive instruments. Voluntary labelling and environmental information disclosure encouraged by government regulation are also persuasive instruments. The idea of using persuasive instruments is that individuals may act upon intrinsic motivations related to how they prefer to behave, and social norms may lead players to behave in a certain way (Frey 1994; Maréchal 2010; Ostrom 2005, pp. 127–129). Informational guidance with a certain degree of specificity may help to increase compliance, but too much external

intervention is likely to crowd out the intrinsic motivation for better performance (Boussalis et al. 2018; Frey and Jegen 2001).

3.2 The need for instrument mixes

The most important instruments to promote GB are government regulation, market-based instruments (more particularly liability rules and subsidies), as well as persuasive instruments (self-regulation). However, none of these instruments on their own may suffice to promote GB, due to problems revolving around costs, imperfect information, and the influence of private interests. This section further explains the roles, but also the limits of each of those instruments in promoting GB.

GB promotes the positive externality of environmental quality and may therefore not automatically be generated through voluntary actions. Self-regulation does, however, have several advantages. It can provide better expertise (information), more flexibility, or lower administrative costs, compared to regulation (Ogus 2000; Stefanadis 2003). For instance, the USGBC created LEED standards and became the front runner of GB promotion in the USA in the early days (Shen and Faure 2018, pp. 92–93). However, GB works more in the public interest, and self-regulation is no stranger to private interest concerns. There is indeed always the danger that self-regulatory agencies, like professional associations, can be captured by the regulated community and become subject to private interest (Ogus 1994, pp. 57–58). LEED was accused of offering easy points to its member clients, which somewhat reflects the problem of regulatory capturing. Besides, the lack of transparency and accountability in self-regulation may lead to a higher information cost of public participation and external oversight (Page 1986, p. 143). Furthermore, professional associations may create entry barriers and prevent better standards from being adopted (Ogus 2000, p. 159). Lastly, self-regulators cannot make formal rules that law and policies can use to influence preferences and promote GB on a large scale.

Liability rules may induce GB compliance regarding indoor air quality, waste disposal, and brownfield redevelopment. In theory, liability is better suited to deal with harmful externalities (Kaplow and Shavell 1996). GB in the early days focused on building energy efficiency, which can hardly be a harmful externality. Recently, GB has taken into account indoor air pollution and brownfield reclamation, in which case liability may play a role. However, as far as deterrence is concerned, no liability, in theory, can lead to the optimal care and activity levels in bilateral cases (Shavell 1987, pp. 44–45). Besides, liability may under-compensate for environmental harm due to the judgement-proof problem and inaccurate measurement of environmental harm in the new sectors (Polinsky and Shavell 1994). The insolvency risks may be addressed through risk-sharing mechanisms, e.g. liability insurance, and risk-sharing agreements (Liu and Faure 2018). However, insurance may water down the deterrent effects of liability if the insurer has incomplete information about the insured's behaviour. Also, risk-sharing agreements among private parties can only be effective with a minimum level of external oversight (Liu and Faure 2018, pp. 270–271). Furthermore, liability is ad hoc, but GB needs to take into account the total environmental impacts. The standard of care determined by the court can be applied only to specific situations (Lukas 2007); hence, liability may not achieve compliance with target standards. Lastly, liability may not suffice to prevent irreversible harm ex-ante, even though it can to some extent provide deterrence against risks. GB requires properties not to be built on contaminated land that will lead to health risks for the occupiers (Heady 1995).

Government regulation also has limits in promoting GB. First of all, government regulation has to respect the rule of law as a result of which it is often challenging to make regulations sufficiently flexible. GB regulation may incorporate private GB certification (e.g. LEED) and allow private parties to change the standards. In that case, the regulator is delegating its regulatory power to a private party without a due process (Del Percio 2009; Schindler 2010). Second, regulation is often general and precautionary (Viscusi 2007). Thus, regulation may fail to deal with atypical harm or unregulated pollutants, e.g. the synergy effect of the HVAC system and the type of windows used in a building. Moreover, government regulation can face high (administrative) costs compared to other instruments (Shavell 2012). Lastly, governments may not always have complete information about the desirable level of intervention. For instance, governments may use correct taxes to deal with harmful externalities, e.g. pollution. However, the expected harm would be difficult for the tax authority to estimate because it usually depends on a multiplicity of variables (Shavell 2011). Another case could be that governments may not be aware of the actual client demand for green products with too many subsidies around (Le Grand 1991, p. 438). GB professionals and companies may not do more GB due to a lack of customer demand for green homes (Dodge Data and Analytics 2020, p. 5). The imperfect information about individual behaviour can also be a reason why some well-designed instruments may not function as expected in practice. For instance, if the end-users of buildings do not use the HVAC system in the correct way, building energy efficiency will not be achieved. Informational instruments may address that problem by providing real-time and peer comparison information for the end-users (Allcott and Rogers 2014; Ayres et al. 2012).

3.3 How instruments can be mixed

Section 3.2 shows that government regulation, liability, and self-regulation all have their limits in environmental governance. Therefore, they may work together to cancel out each other's problems, using smart mixes of instruments.

For instance, government regulation may work with self-regulation in GB standardization. In this way, governments can make use of the industry's expertise in GB and reduce the information costs of GB regulation. However, government regulation may be influenced by lobbying and be subject to private interests. Also, incorporating private standards into government regulations is likely to create a monopoly for the GB certification (Del Percio 2009) and reduces competition in the GB market.

Government regulation can be combined with self-reporting by private parties. In the case of self-reporting, the people who are regulated may experience a lower probability of inspection in the near future (Stafford 2007), and regulators can deter violations with cheaper enforcement if the enforcement authority commits to an ex-post investigation effort (Kaplou and Shavell 1994, pp. 607–609). Nevertheless, those who are regulated may report some minor violations to distract regulators' attention from more severe violations (Stafford 2007, pp. 324–325).

Governments may also reach a voluntary compliance agreement with the industry (self-regulation). The voluntary agreement can be an alternative if there is an intense political backlash against taxation (Innes and Sam 2008). Firms can have a green reputation by participating in the agreement and benefit from lower production costs as a result of compliance (Stavins et al. 2008). However, voluntary environmental agreements may face a free-rider problem or can be misused as a shield for the industry against regulations (OECD 2003, p. 16).

In the case of brownfield redevelopment, government regulation can make use of liability to detect harm or to have more parties (e.g. land users) pay for the remedies. However, the combination of regulation and—liability may undermine the general deterrence of liability (Glicksman and Earnhart 2007; Kristl 2006). The combination may also be misused by regulators to prevent citizens from making legal claims for environmental protection, as has been the case with the Supplemental Environmental Projects in the USA (Hodas 1995).

The theoretical framework indicated that all instruments (government regulation, market-based instruments, and self-regulation) might have their limits in promoting GB. As a result, one can understand that in practice, instrument mixes are in place. This allows the different instruments to use their advantages optimally in a smart combination. Instrument mixes may come in various shapes and generate different outcomes, depending on the specific ways to mix. Section 4 will look further into GB promotion in China to analyse which instrument is used in practice.

4 Instrument mixes for GB: the case of China

4.1 China GB development

4.1.1 New GBs grow fast; less attention to GB renovations

The Chinese central government set building energy efficiency targets in the Five-Year-Plans (FYPs), based on which the local governments made regulations to implement instruments for GB promotion. The State Council (SC) laid out the 11th FYP (2006–2010) and the 12th FYP (2011–2015) for energy conservation and the reduction of emissions, which also set targets for building energy efficiency (SC 2007, 2012). For GB promotion, particularly, the MOHURD released the 12th FYP for GB and Eco-City Development (2011–2015) to achieve the targets set by the SC. During the execution of the 12th FYP, the total square footage of GB increased from 0.04 to 1 billion m², which is 1.4 times the policy target in the 12th FYP (MOHURD 2017; Qiu 2019, p. 3). In 2017, the MOHURD released the 13th FYP for Building Energy Conservation and GB Development, aiming to have 50% of all new urban buildings to be certified green. By the end of 2018, 10, 139 projects with a total GFA of 2.5 billion m² in China obtained GBEL certification, and more than 40% of the new residential and commercial buildings in the urban areas are green buildings (MOHURD 2020). Localities with strong regulations or policy support for GB have seen an increase in the number of GBs from 2017–2018 (CSUS 2019, pp. 261–304).¹

Despite the growth in China, GB still faces many challenges. The higher initial cost is the top challenge as a hurdle to GB promotion (Dodge Data and Analytics 2018, p. 48). Concerns about affordability are still the second challenge facing GB in China. The lack of public awareness and corruption used to rank as top challenges, but they became less important over time (Dodge Data and Analytics 2016, p. 43; 2018, p. 49).

Moreover, GBs still account for a minimal part (around 1%) of all existing buildings in China (MOHURD 2015). Future GB promotion in China may not only focus on large new GB pilot projects. Green renovations in the existing buildings can also have a

¹ Those localities include Beijing, Tientsin, Shanghai, Chongqing, Hubei, Hunan, Guangdong, Fujian, and Dalian.

significant GB potential. Moreover, the government-driven new GBs may not reflect the real client demand for GBs. Some of the new GB communities become ghost towns and ostensibly consume more energy than they can save (Li and Li 2016). As a result, the under-occupation of GB communities may not help to make the most of scarce land in urban areas. Perhaps for that reason, the central government now is putting more effort into green renovations (MOHURD 2015).

4.1.2 Government jump-started GB promotion; international collaboration triggers commercial GBs

The central government in China takes the lead in GB promotion. The central government requires all the public buildings to be certified green (Wang 2016b), and there has been some evidence to show that the public sector has a more prominent role in the GB market in China (Shiet al. 2013). Among other efforts, the *National Assessment Standard for Green Buildings (2019)* and the Green Building Energy Labelling (GBEL) are the doorways to GB compliance. Unlike the LEED system as a private rating system, the GBEL is a government-led certification programme established by the Ministry of Housing Urban–Rural Development of the PRC (MOHURD). It is reported that the government regulation and environmental policies have become one of the most important triggers for GB in China (CBRE 2015, p. 7; Dodge Data and Analytics 2016, p. 43; Yu et al. 2014, p. 9).

The building industry in China initially did not seem to play a big role (Li and Li 2016). Most of the GB regulations refer to the government-led GBEL certification. For the time being, CGBC focuses mainly on GB professional training and has not quite been engaged in private GB standardization. Private GB standards used in the Chinese GB market are mostly international private GB standards, e.g. BREEAM, LEED, and ISO 14000 (CBRE 2016, p. 3). LEED was chosen for an increasing number of commercial buildings in China because of its global recognition and reputation; GBEL is more often applied in residential buildings (Zou 2018). Through a structured questionnaire survey, Zeng et al. found that entry to the international construction market is one of the major incentives for the construction firms in China to use ISO 14000 (Zeng et al. 2003). The adoption of LEED or ISO 14001 implies that there are spillover effects of global GB practice on GB promotion in China.

This overview shows that new GBs have been growing fast in China, especially due to the policies and regulations supporting GB. Although there is an increasing number of commercial GBs using private GB certifications, the government-made GBEL is still dominant in the Chinese GB market. Section 4.2 will further investigate the instruments (mixes) in the Chinese GB policies and regulations.

4.2 Instruments (mixes) for GB in China

The promotion of GB in China is in line with the theoretical framework we sketched in Sect. 3, not relying on just one type of instrument either. In practice, a combination can again be found of government regulation, market-based instruments as well as persuasive instruments.

4.2.1 Command-and-control instruments: building permits and planning

For compliance at the firm level, the Chinese GB laws use building permits incorporating an environmental impact assessment (EIA). In theory, an EIA should be ex-ante to prevent non-compliance from the very beginning, and the possibility that permits can be revoked will be a more effective incentive to minimize social harm than would be monetary sanctions imposed ex-post (Ogus 1994, p. 229). However, the *EIA Law of 2003* in China used to allow the violators to submit an EIA after the project had begun to run.

Article 61 of the *Environmental Protection Law of 2014* has ended the ex-post EIA, requiring that a building permit can be granted if an EIA has been performed. For a life-cycle assessment, some central GB regulations require a follow-up EIA to see whether or not a project works in line with the EIA approved at the pre-construction stage, especially for projects that will generate hazardous substances or cause environmental risks. However, in practice, the ex-post EIA still exists in 8 jurisdictions,² so as to attract firms that can contribute to the local tax revenues (Wang 2016a, pp. 41–46).

Building permits can induce GB compliance at the firm level but are not an instrument to stimulate overall GB development. Therefore, GB compliance has also been required in land use planning or planning for renovations to improve building energy efficiency. The *Urban and Rural Planning Law of the PRC (2008)* requires governments to give land entitlements in the light of the land use planning. At the local level, the law requires the different government agencies to jointly make one plan that integrates the general planning, land use planning, and emission reduction planning of the city. However, GB planning may sometimes clash with property rights. An example could be the central government's attempt to tear down the fences of residential communities and schools (SC 2016). The government intended to open up closed communities to connect the roads in the community to the public transportation network. The policy was viewed as trespassing on private properties and resulted in a backlash by the property owners or occupiers.

Combining building permits and land use planning can provide overall control of GB development as well as incentives for individual GB compliance. The two instruments are ex-ante and hence help to induce new GBs. However, in the long run, the information and administrative costs of the two instruments can be high for the government.

4.2.2 Market-based instruments: subsidies and public procurement

The central and local governments provide subsidies for new GBs or renovations for building energy efficiency (CSUS 2019, p. 270; Kong et al. 2012; Shui and Li 2012, p. 50).³

² The eight jurisdictions include Beijing, Tientsin, the Inner Mongolia region, Jiangsu, Guangdong, Yunnan, and Heilong Jiang. See Wang 2016a, at 41.

³ For instance, during the 12th FYP for GB, the central government provided subsidies of CNY 55/m² and CNY 45/m² for residential retrofit projects in the Severe Cold and Cold regions, respectively. In response to the central policy, the Beijing municipal government offered CNY 100/m² in addition to the subsidy from the central government. The Tientsin government provided CNY 15/m² for renovations that can save energy by 15% and CNY 20/m² if the renovation is carried out through energy performance contracting. The amount will be CNY 25/m² if 40% of the energy-saving is achieved by renewable energy. Subsidies for new GBs are also available at the local level. For instance, the Beijing government offers CNY 22.5/m² for 2-star GBEL buildings and CNY 40/m² for 3-star GBEL buildings. In the Jiangsu province, the amount of the subsidy is CNY 15/m², CNY 25/m², and CNY 35/m² for 1-star, 2-star, and 3-star GBEL buildings, respectively.

Subsidies may lower the initial cost of GB and hence can be a direct incentive for private building stakeholders. However, subsidies are likely to create perverse incentives and lead to an increase in total environmental impacts (Baumol and Oates 1988, pp. 223–224; Murray et al. 2014). Perhaps for that concern, GB Regulations in the Nanking City require that energy-saving renovations should not take place in buildings that are planned to be torn down soon. In this way, the subsidies may not be used perversely to create incentives when the amount of money is higher than the actual costs of renovations.

Moreover, subsidies for new GBs may face an additional problem, due to which subsidies may not have real impacts in changing behaviour (Baumol and Oates 1988, pp. 211–230). As GB compliance is becoming mandatory for new GBs, building stakeholders should build green, even without subsidies. Therefore, the governments divert the subsidies from new GBs to renovations in private buildings, where GB compliance is mostly voluntary.

The Chinese government also promotes GB via public procurement. Public procurement can increase the quantity demanded of GB in the short run (UNEP 2013, pp. 16–24). Public procurement may also indirectly increase private investment in green products in the long run (Marron 2003, p. 82). Those public GBs are likely to make professionals and customers better aware of GB (Simcoe and Toffel 2014, p. 413).

The 12th FYP for GB in China required all the public buildings to be GBEL certified. Besides, all central government agencies need to purchase building materials certified by China Environmental Labelling (CEL) in line with a specification environmental standard coded as HJ/T223 (MOF 2019). From 2008 to 2015, public GBs have accounted for more than 50% of the existing certified GBs (Wang 2016b, p. 9). Public procurement for GB in China increased the government-guaranteed demand for GBs (Zhu et al. 2013). Also, public procurement for green infrastructure projects is expected to grow because of the redevelopment of brownfields (Dion et al. 2015, p. 76).

Nevertheless, subsidies and public procurement may not guarantee the long-run growth of GB, in the absence of public spending to stimulate the GB market. For example, the CGBC report showed that, as the subsidy programme phased out, China's retail sales of energy-efficient air-conditioners in 2012 decreased by 25.1% year-on-year (CGBC 2013). Also, it is found that the market demand has been the top trigger for GB activities, whereas the client demand for GB is much lower (Dodge Data and Analytics 2016, p. 49; 2018). This may imply that the GB market demand increased as a result of the increasing government spending, rather than as a result of private demand for GBs.

From this brief overview, it appears that the market-based instruments concerning GB are mostly the result of public spending (subsidies and public procurement). The subsidy and public procurement programs can reduce the higher initial cost and jump-start GB at the early stage. But the public spending may not guarantee the long-run growth of the GB market and may create perverse incentives for individual GB stakeholders.

4.2.3 Persuasive instruments: labelling and reporting

The Green Building Energy Labelling (GBEL) certification became dominant as most of the GB laws and policies refer to GBEL. GBEL is also available for residential and commercial buildings voluntarily. As noted in Sect. 2, the GBEL standards may not always score better in terms of GB techniques, compared to other private GB certifications like LEED. Also, the Chinese government has to constantly update GBEL standards, which may increase the administrative cost of GB regulation. However, private certifications are

likely to be captured by the regulated community. For instance, LEED was incorporated into some GB regulations in the USA as a result of influential lobbies, and the USGBC, which created LEED, was later discovered to be offering generous certifications to their members (Shen and Faure 2018, p. 74). In contrast, GBEL standards are made by the Chinese government, and the certification process is also administered by a technical panel affiliated to the government. In this way, GBEL can be less subject to private interests.

Benchmarking or auditing is encouraged for energy efficiency in buildings. For energy auditing, the central government has established some databases to collect real-time information on energy use. During the 12th five year plan on GB, the MOHURD put in place a real-time monitoring system for GB renovations in more than 9000 buildings across 33 provinces (MOHURD 2013). With the databases, the central and local governments can predict the energy use in buildings and decide whether or not renovations for building energy efficiency should be undertaken (Wei et al. 2009).

However, so far, the real-time information seems to work more for the regulators and less for the private building stakeholders. Using data from buildings in the urban areas within the five climate regions in China, a study found that energy use may vary with buildings of the same type, depending on how the occupiers use the HVAC system or other appliances (Li 2016). Also, through survey data in the Guangdong Province, Ji and Chan found a positive relationship between perceived usefulness, social norm, and the intention to adopt smart home energy technology (Ji and Chan 2019). The empirical information indicates that GB regulation can use real-time energy efficiency information or peer comparison feedback to persuade end-users into GB compliance (Qiu 2016, pp. 6–7; Xia et al. 2014).

It can be observed that the informational instruments in China have long been in place for the government to oversee building energy efficiency.

4.2.4 An instrument mix: regulation meets liability for brownfield redevelopment

GB compliance also concerns land use and sustainable redevelopment, which may help to deal with land contamination. In 2017, the central environmental regulator made the Rule of the Management of Brownfields in the PRC (hereinafter 'Brownfield Rule 2017'), which identifies the responsible parties and the way to carry out the redevelopment. In the Chinese property regime, building projects and land entitlements are tied to each other. Project developers, as land users, are responsible for the redevelopment of brownfield sites.

Brownfield Rule 2017 seems to combine regulation and liability. The governments are the main parties to identify brownfields. In this way, brownfields left in the public domain can still be detected when private parties have no incentives to sue. The remedy work is assigned to the injurers or to the land users in cases where no injurer can be identified. In that sense, Brownfield Rule 2017 follows the idea that resources should be given to those who can value and make the most of them.

Moreover, Brownfield Rule 2017 includes not only the present users but also the former users of the property, which may help to reduce the under-deterrence and under-compensation problems with liability. On the one hand, the retrospective liability makes it easier to spot a liable party, given the lag between acts and harm that happens in land contamination. On the other hand, more responsible parties will pay the costs that could be too high for just one party to afford (the judgement-proof problem). Apart from the land users, the central government has launched a special fund for brownfield remediation, which may help to ease the insolvency risk.

4.3 Lessons from China

To summarize, instrument mixes not only make theoretical sense, but they have also been available for GB in China. The regulatory planning of GB keeps buildings away from areas of ecological concern and pursues a smarter use of urban land. However, the planning may interfere with the entitlements of private properties, as has been the case with the Chinese government's attempt to open up closed residential communities for a smarter transportation network. Building permits are used to pursue GB compliance at the firm level and hence may not take into account the GB targets at the central level.

Subsidies and public procurement are financial incentives to reduce the higher initial cost and split incentive problem in GB. Public procurement may jump-start GB by increasing the quantity demanded in the short run and inducing private investment in GB in the long run. However, too much government spending may have the disadvantages of crowding out private investment and of making the GB market rely too much on the government.

Liability does not play a major role in GB promotion in China. Liability deals more with harmful externalities and may not be well-suited to induce environmentally beneficial behaviour. GB in the early days focused more on energy efficiency, which can hardly be associated with harmful externalities. Since GB takes into account indoor air quality and brownfield redevelopment, liability is likely to function as a complementary instrument for GB.

Persuasive instruments are mostly informational, as with labelling or reporting for building energy efficiency. The Chinese GB stakeholders adopted government-led GBEL or some international private GB certifications voluntarily. Energy auditing enables governments to oversee energy use in buildings. Yet the information collected through reporting works better for the regulator and less well for private parties like end-users. Real-time information and peer comparison feedback about energy use are likely to work as a behavioural intervention for more efficient energy use.

Brownfield Rule 2017 combines regulation with liability for the brownfield redevelopment as part of GB compliance. Brownfield Rule 2017 makes use of the advantages of liability and regulation to better detect and compensate for harm. However, Brownfield Rule 2017 does not clarify the scope of responsible parties and the distribution of responsibilities among them.

Although GB promotion lends itself to smart mixes, in China, regulation seems to play a more significant role than liability or self-regulation. The central government has been active in making laws and policies for GB. The government makes GB compliance mandatory for public buildings, which now account for the majority of all GBs. Subsidies and public procurement have been the main market-based instruments that rely on public spending. Informational instruments like labelling and energy auditing are better ways for the government to oversee energy use in buildings, and the standards and databases are mostly drafted by the government and not by the industry.

The way in which GB has so far been promoted via government intervention in China is perhaps one of the more successful areas of environmental policy in China. Even though quite a lot has already been achieved in this domain, it is likely that in the future, the instruments already used now (like public procurement or specification standards) will only be used on a larger scale, thus contributing more to the promotion of GB. Apart from Brownfield Rule 2017, some other instrument mixes with government intervention, such as emission trading systems that combine regulation with property rules, are expected to play a role in GB promotion in China (MOHURD 2019b).

There can, of course, be many more roles for the government in promoting GB than discussed in this contribution. One other role for the government could be to promote building knowledge capacity for professionals; another could be to provide protection for green products via intellectual property law (more particularly patent law). This paper, however, mostly focuses on the smart mixes of instruments that can be employed to promote green building and the government's role in that respect.

5 Conclusion

Traditional environmental law and policy were used to deal with negative externalities related to environmental pollution. Green building is different, and in that sense, challenging, as it creates positive externalities: GB creates benefits, both for the users (energy savings) and for the environment at large. The social benefits from GB may be large, but the individual costs may in some cases be relatively high. This is the well-known problem of split incentives: GB investors (like developers) may not be the parties directly benefitting from green building, although society at large and the environment greatly benefit.

Therefore, the introduction of this paper contained the question of which (mix of) instruments can be used to promote green building. As no individual instrument is able to deal with both negative and positive externalities optimally, we concluded that a mix of instruments is needed to promote GB.

The specific variety of instrument mixes may differ across jurisdictions, depending on the institutional framework of a jurisdiction where GB is promoted.

The theory and the lessons from China in this paper may offer some observations on how to approach instrument mixes for GB. First, government regulation can incorporate private GB certifications but should not overly delegate its regulatory power to self-regulators; information can also work as a behavioural intervention to nudge GB compliance at the post-occupancy stage. Second, public procurement may promote GB on a large scale in the short run; however, for GB to grow in the long run, governments can use command and control (planning and building permits) for new GBs and provide subsidies or green loan programs for small GB renovations. Last, regulation and liability can be combined for brownfield remedies, which have also become part of GB compliance.

The second question posed in the introduction was why China has been relatively successful in promoting GB. The case of China shows that it may be difficult to promote green building without government intervention, i.e. only via self-regulation. Indeed, it can be observed that in the case of China, it was the central government, rather than the building industry (which is mostly the case in the USA and Europe) that promoted GB growth. In fact, China used two different strategies for government intervention. Given the large involvement of the government in the building market, the government could simply mandate green building in all projects in which it was involved. But in addition, the Chinese government equally used market-based mechanisms such as subsidies and public procurement to provide incentives to the private stakeholders to engage in green building. This may be an important general lesson from the Chinese experience: The Chinese government showed the large benefits of GB also for private parties, as a result of which private stakeholders may equally become aware of the private advantages of GB and consequently overcome the initial hurdles. At the same time, the case of China equally shows that the great benefits of GB can probably not be generated without a solid regulatory framework aiming at the promotion of GB.

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