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# Corporate governance and green innovation ☆

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ABSTRACT

We study the relationship between corporate governance and firms' environmental innovation. Exploiting changes in antitakeover legislation in the US, we show that worse governed firms generate fewer green patents relative to all their innovations. This negative effect is greater for firms with a smaller share of institutional ownership, with a smaller stock of green patents, and with more binding financial constraints. Investigating regulatory and industry variations, we also find more pronounced effects for firms operating in states with lower pollution abatement costs, and in sectors less dependent on energy inputs. Overall, our results suggest that ineffective corporate governance may constitute a major obstacle to environmental efficiency.



## Introduction

Global climate change is one of the greatest economic and social challenges that humanity faces in the foreseeable future. At the same time, environmental regulations to fight climate change can entail economic costs, which have long been under scrutiny. These considerations motivate expanding interests in the linkages between environmental regulation and industry competitiveness (e.g. Jaffe et al., 1995; Greenstone et al., 2012), and in corporate social responsibility (Reinhardt et al., 2008; Kitzmueller and Shimshack, 2012). Focusing more specifically on the *determinants* of environmental efficiency, researchers have stressed the importance of public policies (e.g. Jaffe et al., 2002; Johnstone et al., 2010; Martin et al., 2014; Nesta et al., 2014), energy prices and technology (e.g. Popp, 2002; Martin, 2010); however, there is still much variation across firms that remains unexplained.

To fill this gap, scholars have recently begun paying attention to the role played by organizational structures (e.g. De Canio, 1998; De Canio and Watkins, 1998; Cole et al., 2007). Previous works in this area have documented a positive effect of management (Bloom et al., 2010; Martin et al., 2012) and governance systems (Aggarwal and Dow, 2012; Kock et al., 2012) on environmental

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efficiency. Yet, as some have acknowledged (Bloom et al., 2010), it has been difficult to tease out the causal direction in the relationship between organizational structures and environmental activities.

We contribute to this literature by empirically showing that the worse corporate governance, as proxied by the enactment of antitakeover laws in the US, reduces firms' environmental innovations, a category of innovative projects that is currently receiving great attention from both policy-makers and academic scholars due to its potential to reduce greenhouse gas emissions (e.g. Aghion et al., 2015; Veugelers, 2012).

Following a common approach in innovation economics (e.g. Griliches, 1990), we use patent data to measure innovation activities. This approach is subject to well-known limitations, the most prominent being that patents only cover *patentable* and *patented* inventions. However, there are several important advantages of using patent data, such as the fact that patents are clearly measurable and widespread across industries and time (Hall et al., 2005). Moreover, contrary to standard accounting items on R&D expenditures, patent applications provide detailed information on key features of the underlying invention, which are useful to classify innovations according to their technological content.

Linking US Compustat firms with the patent dataset provided by the National Bureau of Economic Research (NBER), we exploit information on the technological class of patents to identify environment-related (green) innovations (e.g. Jaffe and Palmer, 1997; Brunnermeier and Cohen, 2003; Carrion-Flores and Innes, 2010; Dechezlepretre et al., 2013a, 2013b). There are several reasons that make green innovation an interesting research domain. First, green patents represent a central aspect of organizational knowledge in the area of environmental technologies; as such, they not only reduce pollution outcomes (Carrion-Flores and Innes, 2010) but also have a potential to affect the entire trajectory of corporate innovation (Aghion et al., 2015). Second, green patents can potentially generate positive externalities in the form of knowledge spillovers and thus facilitate the adoption and diffusion of environmental technologies at the industry and country level. Third, green patents have distinctive features, e.g. they have more general applications, are cited more frequently than non-green patents (Dechezlepretre et al., 2013b) and receive citations from a wider array of technological classes (Popp and Newell, 2012). Fourth, companies are subject to growing stakeholder and institutional pressures towards environmentally responsible behavior (e.g. Kock et al., 2012) that may have distinct impacts on green innovation activities (Berrone et al., 2013).

Despite these important features, the effect of corporate governance on green patenting activities remains unexplored. A few studies have analyzed the effect of takeover pressures on general innovation, reaching mixed conclusions. For instance, it has been shown that weaker takeover pressures can (1) decrease innovation due to moral hazard (Atanassov, 2013), (2) increase innovation by insulating managers from short-term pressures (Chemmanur and Tian, 2013), but also that (3) the governance-innovation relationship is U-shaped (Sapra et al., 2014) or that (4) it differs by firm and state-level provisions (Becker-Blease, 2011). These empirical ambiguities (also due to methodological issues with the use of antitakeover laws in causality tests, which we address following Karpoff and Wittry, 2014) preclude us from using existing results to draw conclusions on the potential effect of takeover pressures on green patenting. Moreover, the above-discussed uniqueness of green patents in terms of technological novelty and complexity further hinders the ability to generalize to green patenting the previous results obtained on the general population of patents.

We investigate the relationship between corporate governance and green innovation by estimating difference-in-differences models based on the passage of business combination (BC) laws in US states during the second half of the 1980s (e.g. Atanassov, 2013; Bertrand and Mullainathan, 2003; Karpoff and Malatesta, 1989; Giroud and Mueller, 2010). This approach rests on the long-running argument that an effective market for corporate control mitigates agency conflicts between managers and shareholders (Manne, 1965; Shleifer and Vishny, 1997). This is due to the fact that, by lowering a firm's market value, managerial actions that generate private benefits at the expenses of shareholder returns would invite hostile takeovers (after which the manager of the inefficient firm is usually fired); by increasing the threat of hostile takeovers targeted to badly managed firms, an efficient market for corporate control can effectively align shareholders and managers' interests.

Introducing obstacles to the transfer of assets from target firms to acquirers, BC laws hampered the effectiveness of this mechanism, and thus made firms incorporated in the legislating states less subject to the disciplining threat of hostile takeovers. Empirically, the staggered law passage across US states provides geographic and time variations that help us mitigate endogeneity concerns.[1] Moreover, given that BC laws affected firms in their state of incorporation, we can exploit the typical discrepancy between a firm's state of headquarter and state of incorporation to control for geographic effects.

Our main finding is that, following the passage of BC laws, firms experienced on average a 13% reduction of green patents in their patent portfolio (i.e. after explicitly taking into account the generalized effect of BC laws on *all* patents; Atanassov, 2013). We validate this finding using several tests to reduce concerns of confounding factors, endogeneity, outliers and sample selection. Our result is broadly consistent with the notion that entrenched managers will extract personal rent by engaging less in initiatives that require major effort and organizational change.

We proceed by deriving various results that illustrate the heterogeneity behind the average impact of worse governance on green patenting. First, consistent with the argument of technological lock-in put forward by Aghion et al. (2015), we find that a larger stock of green innovations reduces the drop in green patents induced by the governance shock. Second, in line with the presence of important opportunity costs of reducing green innovation, we find that the effect of worse governance

[1] Due to these advantages, several works have exploited the passage of antitakeover laws to establish changes in corporate governance (e.g. Atanassov, 2013; Amore and Zaldokas, 2015; Bertrand and Mullainathan, 2003; Francis et al., 2010; Giroud and Mueller, 2010).