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The analyses, opinions and findings of these papers represent the views of the authors, they are not necessarily those of the Banco de Portugal or the Eurosystem.

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Does Green Transition promote Green Innovation and Technological Acquisitions?

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Abstract
This analysis explores the implications of technological shifts towards greener and sustainable innovations on acquisition propensity between firms with different technological capacities. Using a dataset of completed control acquisition deals over the period of 2009-2020 from 23 OECD countries, we find that innovative firms are more likely to acquire innovative target companies. We also find that green acquirors (i.e. firms with green patents) are more inclined to enter into acquisition deals with green firms, possibly due to their technological proximity and informational advantages which further enhances their post-acquisition green innovation performances. Our results also show an increase in green acquisitions after the Paris Agreement by non-green acquiror firms, and these are more pronounced for acquirors in climate policy-relevant sectors and countries with low environmental standards than their counterparts. However, green acquisitions after the Paris Agreement do not show any significant impact on their post-acquisition innovation performances, raising concerns related to greenwashing behaviour by investing firms.

JEL: G34, 030; Q54; Q55

Keywords: Acquisitions, Green patents, Firm Innovation, Paris Agreement, Green Transition.

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1. Introduction

Climate change is increasingly impacting people's lives, disrupting national economies and transforming ecosystems. The need for strong and co-operative action based on mutual trust and understanding has never been higher. Recent OECD estimates indicate that around USD 6.3 trillion of infrastructure investment is needed each year till 2030 to meet development goals and increasing to USD 6.9 trillion a year to make this investment compatible with the goals of the Paris Agreement (OECD (2018)). In this context, corporate takeovers may foster the green transition as it allows firms to acquire external technological resources, complement internal research and development (R&D) projects, and accelerate the innovation process (Cassiman and Veugelers (2006); Grimpe and Hussinger (2014); Karim and Mitchell (2000)). Such technological resources include scientists, patent rights, and tacit knowledge embedded in organizational processes and routines (Grimpe and Hussinger (2014); Puranam and Srikanth (2007)). However, due to information-related frictions, technology acquirors face considerable challenges in identifying suitable target firms and in valuing their resources and synergy potential, particularly in deals which are outside their core areas of expertise (Gans *et al.* (2008); Reuer and Ragozzino (2008)). These challenges raise concerns about adverse selection and can result in profitable deals to unravel (Agrawal *et al.* (2015); Arora *et al.* (2004)).

In this paper, we study the implications of technological shifts towards greener and sustainable innovations on acquisition propensity between firms with different technological capacities, using a sample of completed control acquisition deals from 23 OECD countries over the period of 2009-2020. In our study, we focus on the OECD countries as CO_2 emissions in these countries have been slowly declining in recent years as compared to other countries in the World (as shown in Figure 1). However, the rate of progress in reducing emissions varies significantly across individual OECD countries (OECD (2022)). In addition, OECD countries also represent the vast majority of worldwide patents on climate change mitigation technologies. As per OECD (2022), the share of "high-value" climate change mitigation inventions (filed for protection in at least two jurisdictions) in all technologies has increased from around 4% in the early 1990s to over 9% in latest years. In line with this, our dataset also shows similar evidence of an increasing trend in the evolution of patenting activity in Figure 2. It provides the yearly percentage of firms in our sample with patenting activity (i.e., innovative) and green patenting for target firms (panel a) and acquiror firms (panel b). For both types of innovation activity, we find an increasing trend over time across target and acquiror firms, especially after the Paris Agreement in 2016 (represented by the vertical line). Finally, the launch of OECD International Programme for Action on Climate in May 2021 led the OECD countries to strengthen and coordinate their climate actions to ensure progress towards net-zero greenhouse gas by 2050, based on best practices and timely evaluations about the advancement through monitoring and policy evaluation.[1]

Our paper majorly contributes to three separate literatures. First, we start by contributing to the growing literature on green innovation, which has become an important strategic tool used by high-tech firms to foster sustainable development (Chen (2008); Huang and Li (2017)). Green innovation indicates green product and process to modify an existing product design to mitigate any negative impact on the environment during any stage of a product's life cycle (Chen *et al.* (2006)). Green process innovation indicates a firm's ability to improve existing processes and develop new processes that create energy savings, pollution prevention, waste recycling, or less toxicity in innovation processes (Chen *et al.* (2006); Chen (2008)). Companies can enhance their environmental vigour by complying with international environmental conventions and applying new scientific and technological breakthroughs in ways that strengthen green innovation (Chen (2008)). Many green innovation studies highlight the importance of incremental innovations such as products, processes, marketing methods, organizations, and institutions (OECD (2010)); OECD (2012). Green innovation plays a key role in moving industries toward sustainable production, and the evolution of sustainable manufacturing initiatives has been facilitated by green innovation. Green innovation also substantially benefits the firms to enhance business performance and competitive advantage (Peng and Lin (2008); Huang and Li (2017)) and further enhances corporate reputation and image (Chen (2008)).

Second, our paper adds to the extant literature on information frictions and corporate technological acquisitions. Efficient corporate acquisitions are important drivers of aggregate economic growth, output and consumption (Levine (2017); David (2021)). However, a recent work by Cunningham *et al.* (2021) documents that some firms acquire innovative targets to prevent future competition (i.e., killer acquisition), while Celik *et al.* (2022) identifies information asymmetry as an important friction in acquiring innovation. Technological overlap helps to overcome such information asymmetry in corporate acquisitions. Intellectual property and technological know how are more difficult to evaluate than tangible assets and hence, an acquiror may fail to accurately value a target firm. If the acquiror and the target firm are familiar with each other's technologies, then information asymmetry between merger participants is mitigated (Kaplan (2000); Higgins and Rodriguez (2006); Phillips and Zhdanov (2013)). Technological overlap can also lead to economies of scale and scope in innovation through reduction in duplicate R&D efforts (Sevilir and Tian (2012); Bena and Li (2014)). Finally, one merger partner's technology may fill gaps in the other's patent portfolio, resulting in strengthened innovation processes and more competitive positioning (Cassiman and Colombo (2006); Cassiman and Veugelers (2006)). Hence, acquiror firms

1. See: `https://www.oecd.org/climate-action/ipac/`.

that buy technologically proximate firms benefit from informational advantages (Bena and Li (2014); Chondrakis *et al.* (2021)). We contribute to this literature by studying the role of green innovations and how such technological shifts have implications on acquisition probability between acquirors and targets with different intellectual property portfolios and their post-acquisition innovation performances. Our results show that innovative acquiror firms have a higher propensity to acquire innovative target firms. We also find that acquiror firms with green innovation are more likely to acquire green target firms. The overlapping green innovation further helps acquirors in enhancing their post-acquisition green patenting activity. Further, we tackle the potential endogeneity and self-selection bias in innovation decisions, weighting the regressions estimated using inverse probability weighs (IPW), which are built based on computed propensity scores.

Third, our paper also contributes to the growing literature on the impacts of climate policies and environmental policies on different corporate outcomes. Existing research has studied the implications of these policies on asset pricing (Bolton and Kacperczyk (2022)), shareholders' investment decisions (Krueger *et al.* (2020)), corporate behaviour Ben-David *et al.* (2021)), innovation strategies (Dai *et al.* (2021)), capital structure (Dang *et al.* (2022)) and R&D expenditures (Brown *et al.* (2022)). We instead focus on acquisition likelihood between innovative firms and their post-acquisition innovation performance after the Paris Agreement. Our results show an increase in green acquisitions[2] by non-green investors after the Paris Agreement, and this is more pronounced for firms in climate policy-relevant sectors and countries with low environmental standards. A study which is closely related to ours is Li *et al.* (2022), where results suggest that adoption of climate laws in the target country reduces cross-border mergers and acquisitions, and this is especially true for firms in countries with stronger legal enforcement, and after the Stern Review and the Paris Agreement. However, they do not study how technological innovations can influence corporate acquisitions, especially after the Paris Agreement.

The evidence provided in this study can be of interest to policymakers, as achieving net-zero emissions requires rapid economic, social and technological transformations. Although many countries are taking action, further progress is needed to achieve the goals of the Paris Agreement and keep the global average temperature increase below 2°C as compared to pre-industrial levels. This study suggests that the green momentum can be fostered by green acquisitions, as we find that non-green investors increased their propensity to acquire green firms after

2. Green acquisitions are acquisitions by heavy polluters with the purpose of energy conservation, emission reduction and environmental protection, including acquisition of energy-saving or emission reduction technologies and transitions to low-pollution, low energy- consuming industries (Li *et al.* (2020)). In our paper, we refer to green acquisitions as acquisition deals when non-green firms acquire green target firms.

the Paris Agreement. However, green acquisitions after the Paris Agreement do not show any significant impact on their post-acquisition innovation performances raising concerns related to greenwashing behaviour by investing firms. Hence, policymakers may foster the green transition by incentivising firms' green innovative power through the introduction of specific measures, such as green investment tax credit or green innovation grants. In addition, a particular attention should be placed on potential greenwashing behaviours that may undermine the green transition process.

The remainder of this paper is organized as follows. In Section 2 we discuss the relevant literature and frame the research hypotheses, while we provide the data and summary statistics in Section 3. In Section 4 we describe our empirical methodology and present the empirical results. In Section 5 we report some robustness checks, and Section 6 concludes the paper.

2. Background literature and hypotheses development

2.1. Green innovation and corporate acquisitions

Technological acquisitions provide an opportunity for firms to avoid the uncertain process of internal technology development, to gain access to technological resources developed externally (Karim and Mitchell (2000); Phillips and Zhdanov (2013)), to replace internal R&D and also to match complementary resources (Cassiman and Veugelers (2006); Higgins and Rodriguez (2006)). Acquisitions create value by bringing together related knowledge bases, overlapping patent portfolios, or necessary complementary assets (Chondrakis (2016); Sears and Hoetker (2014)). A well-functioning market for corporate control is essential for such gains to be achieved. However, much like the broader market for licensing and trading technologies (Agrawal *et al.* (2015)), the market for acquiring technology intensive companies is also hindered by information frictions. Information asymmetries between potential acquirors and targets give rise to fundamental concerns of inefficient trading and adverse selection (Akerlof (1978); Reuer and Ragozzino (2008)). As target firms are often better informed about their own technology stock and development and the competing approaches of others, acquirors struggle to discern the real value of technological resources to be acquired (Schildt and Laamanen (2006)). There is evidence that the diffusion of confidential information during acquisitions can hurt inventive output (Aggarwal and Hsu 2014) and asymmetric information can divert acquirors from their best possible matches by discounting the amount they are willing to pay, causing promising deals to derail (Capron and Shen (2007); Ragozzino and Reuer (2007)).

There is empirical evidence that acquirors may avoid targets with unfamiliar technologies to lessen frictions in the market for corporate control, and prefer to acquire technologically proximate firms (Bena and Li (2014); Chondrakis (2016); Schildt and Laamanen (2006); Sears and Hoetker (2014); Chondrakis *et al.* (2021)). Hall (1988) shows that firms prefer to acquire other firms that are similar to themselves, especially with respect to R&D intensity. Seru (2014) shows that, relative to failed targets, firms acquired in diversifying mergers produce fewer and less novel patents. Bena and Li (2014) show that technological overlap between two firms increases the likelihood of their merger and conclude that the expected synergies from the combination of technology-related innovation capabilities are key drivers of acquisitions. Frésard *et al.* (2020) show that firms in industries with more patents are more (less) likely to become targets or acquirors in vertical acquisitions (non-vertical acquisitions). Wu and Chung (2019) show that firms with larger innovation outputs and R&D investments are more likely to be acquired, receive unsolicited and multiple bids. In addition, there are features specific to green technologies that may further incentivise the acquisition of green targets by green investors. Green technology is characterized by a higher level of complexity, when compared to non-green technologies, since they typically have a larger range of objectives, and in addition, it is generally deemed to be more novel. This way, the lack of previous knowledge upon which green innovation can be built, makes the green innovation process more challenging and knowledge specific than that for non-green innovation (De Marchi 2012; Barbieri *et al.* 2020). For these reasons, acquisitions between firms with overlapping green technologies might be more likely.

In line with the above arguments, our first set of hypotheses are as follows:

Hypothesis 1a: Innovative acquiror firms are more likely to acquire innovative target firms.

Hypothesis 1b: Green acquiror firms (i.e., firms with green innovation) are more likely to acquire green target firms due to their overlapping green innovation.

2.2. Green acquisitions and the Paris Agreement

The urgency of international cooperative action to fight climate change and foster green transition has been underlined by the Paris Agreement, a legally binding international treaty which was adopted on 12 December 2015, and came into force on 4 November 2016. For the first time 196 countries, contributing about 98% of global greenhouse gas emissions, agreed to limit global warming below 2 (preferably to 1.5) degrees Celsius compared to pre-industrial levels. The Paris Agreement is a landmark in the multilateral climate change mitigation process and, while it implies global long-term goals, both public and private ambitious efforts and actions are expected to take place as soon as possible to achieve a climate neutral world by mid-century.[3] For instance, the transition from oil to electric vehicles, or from carbon to renewable energy, requires new legislative frameworks and significant increase in investments by firms and households, which are often accompanied by public subsidies. The Paris Agreement has been fostering public and private actions to sustain this green transition, especially for non-green firms and supporting green-led economic growth[4] using several measures such as government subsidies, environmental regulations, and low-carbon initiatives (see, among others, Kern and Rogge (2016); Monasterolo and Raberto (2019); Fang *et al.* (2021); Khan *et al.* (2022)). This acceleration towards a greener economy is likely to encourage non-green firms to adopt more sustainable forms of technology to continue their businesses by acquiring green target firms, in order to remain aligned with the related economic and political momentum. The specificities that characterize green innovation have been highlighted in the literature before, for example in Barbieri *et al.* (2020), who noted that it typically represents the technological frontier (Cainelli *et al.* 2015). This frontier characterization of green innovation also implies that for firms, even innovative ones, who wish to delve into green innovation require specific skills, which, often, are outside the non-green firm's knowledge domain (De Marchi 2012), are required to master new knowledge, linked to alternative production processes (Horbach *et al.* 2013), and the adoption of inputs associated to relatively new technological solutions. In addition, there is additional value from a non-green firm acquiring a green firm, as Barbieri *et al.* (2020) found that green technologies (defined as patents with at least one classification code belonging to the OECD Env-Tech classification) differ from non-green ones, as they are more complex, novel, and produce greater knowledge spillovers. They also found that green technologies have a greater impact on subsequent technological developments compared to non-green patents.

Following this argument, we frame hypothesis 2a as follows:

Hypothesis 2a: After the introduction of Paris Agreement, non-green acquiror firms are more likely to acquire green target firms.

The Paris Agreement majorly focuses on reducing global emissions, and legislative actions are encouraged especially targeting heavy polluting firms.[5] It is often the case that after the implementation of new polices and regulations on climate, firms in the most polluting sectors face higher costs related to pollution abatement projects, as compared to other firms (Chen and Montes-Sancho (2017); Cadez and Guilding (2017)). There is also evidence of how a new policy on climate

3. More details can be found here: `https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement`.

4. For further details on green growth, see: `https://www.oecd.org/greengrowth/`.

5. Further details can be found here: `https://ec.europa.eu/clima/eu-action/international-action-climate-change/climate-negotiations/paris-agreement_en`.

change can affect sector-by-sector market values, of which the Paris Agreement is no exception (Birindelli and Chiappini (2021)). Zhang *et al.* (2022) shows an increase in green merger and acquisitions by firms in high-carbon sectors in the recent years contributing to higher green innovation performance. Further, De Haas and Popov (2022) shows that deeper stock markets are associated with greener patenting in carbon-intensive industries and that this patenting effect is strongest for inventions to increase the energy efficiency of industrial production. Hence, considering that firms in high-carbon sectors encounter higher costs as compared to firms in less-polluting sectors, non-green firms in high-carbon sectors are more likely to acquire green firms to accelerate the transition process by exploiting ready-to-use green technologies.

Further, at the country-level, the nexus between environmental standards and FDI flows can be explained through two main channels, the "pollution halo hypothesis" and the "pollution haven hypothesis". In the former, a multinational firm with advanced technology and management skills invests in a country with strict environmental laws and standards, leading to high environmental and governance practices in the host country, and transforming environmental degradation into environmental sustainability (Zarsky (1999); Saini and Singhania (2018)). On the other hand, the "pollution haven hypothesis" believes that countries with lower environmental standards often have lower environmental costs and are thus, more attractive to foreign investors. As firms in relatively low innovation countries face higher barriers to obtain the human capital necessary to generate innovation (Keller (2004)), it is comparatively more difficult for the firms to generate internal innovation with domestic resources. Further, acquiring external innovation opportunities by domestic acquisition can prove difficult as low innovation countries are likely to have fewer targets that are both synergistic and innovative, so a firm in a low innovation country can benefit more by engaging in cross-border takeovers to acquire innovation. Also, firms located in lower innovation countries face poor intellectual property (IP) protection rights and barriers to enforcing those rights (He and Su (2013)) and hence, acquiring an innovative firm from a country with greater IP protection rights can help to reduce the risk of expropriation (Branstetter *et al.* (2006); Branstetter *et al.* (2011)). Therefore, a country's institutional framework quality and environmental standards play a central role in fostering inward sustainable FDI (Sauvant and Mann (2019)). In addition, firms based in countries with low environmental standards may increase acquisitions of green firms to promote green innovation efficiency (Feng *et al.* (2018)). Hence, in line with the above arguments, our hypothesis 2b is as follows:

Hypothesis 2b: After the introduction of the Paris Agreement, non-green acquiror firms in high-carbon sectors and countries with low environmental standards are more likely to acquire green target firms.

2.3. Post-acquisition green innovation performance and the Paris Agreement

While knowledge similarity between the acquiring and target firms enhances exploitation and therefore innovation productivity, knowledge complementarities help to facilitate a process of exploration through experimentation with new competencies and technologies (March (1991)). Thus, acquiring complementary knowledge helps extend the scope of invention search, which in turn contributes to richer inventions. In the context of innovation activities, these may include complementarities in research output, know-how, or patents. Even if pre-acquisition R&D activities in acquiring and target firms are heterogeneous and complementary, one entity's innovation activities might be (partly) relocated post-acquisition to exploit economies of scale and scope in R&D through geographic concentration (Sanna-Randaccio and Veugelers (2007); Kumar (2001)). Further, when the acquiring and target firms have knowledge complementarities, they have common knowledge in broad areas that facilitate communication and coordination between the units from the two firms after a merger or acquisition (Makri *et al.* (2010)). These conditions facilitate the integration of their two complementary knowledge stocks in the merged or target firm, contributing to increased innovation productivity. Rothaermel *et al.* (2006) found that firms able to integrate complementary knowledge from internal and external sources (through strategic alliances) increased the number of related new products introduced to the market. High knowledge complementarities between the acquiring and target firms enhance the merged or acquired firm's ability to use new information effectively. In this way, the common general knowledge stocks increase the probability of success in the innovation development processes (Makri *et al.* (2010)). Thus, complementarities in innovative assets imply positive effects on post-acquisition innovation and invention productivity which are concentrated among firm-pairs in which both acquirors and targets have been active in innovation pre-acquisition (Stiebale (2016)). Following this argument, we frame the third hypothesis as follows:

Hypothesis 3a: Acquiror and target firms with overlapping green innovation are more likely to increase their post-acquisition green innovations.

Further, as the Paris Agreement highlighted the willingness of the society to move towards a more sustainable world, non-green businesses feel the increasing pressure to disclose information about their environmental-friendly production processes and environmental-friendly products. Sustainable green development requires firms to keep making capital investments on R&D, which adds to their operational and management cost creating a financial burden (Zhang (2022)). Furthermore, green technology and products require verified evaluation standards, so greenwashing behaviour that could "rapidly improve" economic effects and the corporate image without taking up too much capital turns into a shortcut for some enterprises to implement "green development" (Zhang and Jin (2021);

Zhang (2022)). The phenomenon of greenwashing among businesses can be defined as a discrepancy between words and deeds, which combines poor environmental performance and positive communication about the environmental performance (Guo *et al.* (2017)).

The empirical literature studying the relationship between environmental regulation and enterprises' product quality in the green transformation period found mixed evidence. On the one hand, environmental regulation could boost firms' innovation activity and technology improvement. The financial cost could be reduced through the R&D of new products and processes, so environmental regulation could become an "anti-driving mechanism" for firms to raise green production efficiency to improve the quality of their products (Zhang and Jin (2021)). On the other hand, environmental regulation mainly refers to the control, limitation, and punishment of firms by the government. The increase in R&D activity comes with uncertainty and higher risk for firms (Zhang (2022)), which then face a huge financing pressure to "crowd out" the capital for innovative R&D activities (Zhang and Kong (2021); Zhang and Kong (2022)). Li (2022) highlights that adaptation to climate risks for firms is a decision based on cost-benefit, which is a complex process that involves perceiving the impacts of climate risks and making changes over time. This may further affect their motivation to greenwash, as the firms would adjust their own strategic behaviour to meet changes in the external environment when facing the pressure from government and competitors in the industry. Hence, we are interested in investigating the post-acquisition innovation performance when non-green firms acquire green target firms after the Paris Agreement. We frame an additional hypothesis 3b as follows:

Hypothesis 3b: After the introduction of Paris Agreement, non-green firms that acquired green target firms may not increase their post-acquisition green innovations.

3. Data and summary statistics

3.1. Data

The rich and granular firm-level dataset used in this study is compiled from three databases provided by Bureau van Dijk namely Orbis, Zephyr, and Orbis Intellectual Property (IP). We obtain information on completed (and confirmed) control acquisition deals (i.e., with a final stake of the target company above 50%),[6] which took place between 2009 and 2020 from the Zephyr database. We include both domestic (defined as those where acquiror and target firms originate

6. We drop minority FDI acquisitions (if the final stake is below 50% but the acquired stake is less than 10%) and portfolio investments (if the acquired stake is below 10%). We exclude from our

in the same country) and cross-border (defined as those where the Global Ultimate Owner of the acquiror and the target originate in different countries) acquisitions in our sample. In addition to deal information, Zephyr provides additional data about the acquiror and target firms, such as their ownership and sector classifications corresponding to the year in which the deal was completed. We include target and acquiror firms classified as "companies" in Zephyr (excluding for example, funds, individuals, or government entities).

We obtain information regarding patents directly owned (at the time of the acquisition) by acquiror and target firms identified in Zephyr from the Orbis IP database. We include live patents (both granted and pending, but with an already published application available for public view), and exclude expired, withdrawn or abandoned ones. This database also provides detailed information about the patent classification, among other characteristics, which we exploit in order to build an indicator of "green" patents. More specifically, we exploit the Cooperative Patent Classification (CPC), managed by the European Patent Office (EPO) and the US Patent and Trademark Office.[7] The CPC includes nine sections (identified with letters A to H, plus an additional section Y), which are each further split into several classes, sub-classes, groups and sub-groups. The Y section of the CPC is used since 2013 to tag existing patents which are considered to be "new technological developments". We identify "green" patents for both target and acquiror firms if they are classified under the Y-02 category (De Haas and Popov (2022)).[8] This class includes technologies aimed at controlling, reducing or preventing anthropogenic GHG emissions, in the framework of the Kyoto Protocol and the Paris Agreement, and also technologies which allow adapting to the adverse effects of climate change.[9] Next, we further complement the acquisitions and patent data with Orbis balance sheet information for both the acquiror and target firms, referred to the year before the acquisition completion. Using the unique identifier for each firm, we merge these three sources of data on a firm-by-firm basis obtaining a cross-sectional[10] dataset of roughly 15,400 completed deals (with sufficient firm level financial information) over the period of 2009-2020 with target firms located in

sample other types of deals such as management buy-ins or buy-outs, demergers, joint ventures, share buy-backs, and mergers.

7. See for details: `https://www.cooperativepatentclassification.org/home`.

8. Patents can be classified into more than one technical areas (i.e., there is a main and also additional classification codes). In this analysis, we consider patents as green if Y-02 is found in either the main CPC classification code, or in the next five additional CPC classification codes (Makri *et al.* (2010)).

9. Details on the CPC categorisation of green patents can be found in the following link- `https://www.uspto.gov/web/patents/classification/cpc/html/cpc-Y.html`.

10. Other studies such as Del Bo *et al.* (2017), Clò *et al.* (2017) and Hsu *et al.* (2021) also use similar cross-sectional datasets for their analyses.

23 OECD countries.[11] Finally, we complement the merged firm-level data with country-level macroeconomic indicators taken from the World Bank database.

3.2. Summary statistics

Table 1 provides summary statistics of the firm characteristics for target and acquiror firms in panels A and B, respectively. We split these firms in three different groups based on their patenting activities as non-innovative i.e., firms with no patents (in columns 1-3), innovative i.e., firms with non-green patents (in columns 4-6) and green innovative i.e., firms with green patenting activity (in columns 7-9), and report p-values from the test of equality of means (in columns 10-12).

We find that both non-innovative target and acquiror firms are on average smaller in size than their innovative counterparts in the year of acquisition deal. With respect to green target and acquiror firms, these firms have a larger average size than their non-green innovative counterparts. In terms of the financial ratios, innovative and green target and acquiror firms have higher average cash and debt ratios and lower average turnover ratio, than their non-innovative counterparts. The tests of equality or means show a significant difference at the 1% level for the majority firm level characteristics of non-innovative, innovative and green innovative firms. Finally, the correlations displayed in Appendix B indicate that correlation is not an issue among the firm level variables used in the analysis.

4. Empirical methodology and results

4.1. Green innovation and corporate acquisitions

In this section, we start by studying whether innovative investors have a higher likelihood to acquire innovative target firms due to their technology proximity as set out in hypothesis H1a. Next, we also examine the likelihood of an acquisition deal between investor and target firms which have overlapping "green" technology as stated in hypothesis H1b. We employ a cross-sectional linear probability model where the unit of analysis are individual deals. The empirical econometric exploration of the hypotheses set out in section 2 require the definition of a series of dependent variable of interest that relate to the innovation decisions of investor and target firms (i.e., innovative investors, green investors, etc.). The literature has pointed out several aspects of this decision that might raise to potential

11. See Appendix A for the full list of OECD target countries included in the sample, as well as the distribution of deals by target country. We restrict the sample of target firms' countries to OECD to obtain a more homogeneous pool of countries but do not apply such restriction to the country of origin of the acquirors. An equivalent table for acquirors' countries can also be found in Appendix A.

endogeneity and self-selection biases in the econometric estimations performed. Despite controlling for target and acquiror firm level characteristics as well as for a variety of fixed effects and macroeconomic characteristics, there is still the possibility that unobserved factors such as market or technology shocks experienced by firms might affect the probability of innovation taking place (Stiebale (2016)). In addition, acquiror firms are able to anticipate the decision to acquire another firm, thus affecting their innovation decisions. Therefore, new innovation decisions are potentially endogenous to acquirors' acquisition decision (Van Beveren and Vandenbussche, 2010).

To tackle these potential biases in innovation decisions, we apply a propensity score (PS) reweighting approach called IP weighting. PS reweighting based approaches have also been applied in past empirical analyses exploring a variety of research quesitons, for example, Desyllas and Hughes (2010), Stiebale (2016) or Gu and Qian (2019). We start by estimating the firm specific PS, which summarises the information contained in a set of one-year lagged firm controls (Rosenbaum and Rubin (1983)). These PS measure the conditional probability of treatment (i.e., innovation decision) given this set of pre-treatment firm level characteristics. They are obtained through the estimation a series of probit regressions that model the probability of firms innovating (i.e., producing patents),[12] based on lagged firm characteristics (i.e., firm level balance sheet information and year, sector and country fixed effects). Then the estimated PS are used to compute inverse probability of treatment weights. For firms in the treated (innovators) group, the assigned weight is $w_{it} = 1/PS_{it}$,[13] while for firms in the control group (non-innovators) the assigned weight is calculated as $w_{it} = 1/(1 - PS_{it})$. Despite large differences across groups in unmatched samples as shown in Table 1, the firm level characteristics used appear more balanced after matching as documented in Appendix C.

To test hypothesis 1a (equation (1)) and 1b (equation (2)), we estimate (IPW weighted) probit regressions of the following form for all acquisition deals in our sample:

$$Pr(InnovativeDeal_{ijt}) = \beta_0 + \beta_1 InnovativeA_{it} + \beta_2 Z_{it-1} + \beta_3 X_{it-1} + \lambda_{ct} + \rho_{ft} + \sigma_c + \delta_f + \tau_c + \upsilon_f + \phi_t + e_{ijt} \quad (1)$$

12. We estimate separated probit regressions for hypothesis H1a (using a dummy indicating whether the acquiror firm is innovative as the probit dependent variable), H1b (using a dummy indicating whether the acquiror firm has done green innovation as the probit dependent variable), H2 (using a dummy indicating if the acquiror firm is non-green as the probit dependent variable), H3a (using a dummy indicating whether the acquisition is between green acquiror and target firms as the probit dependent variable); and H3b (using a dummy indicating whether the acquisition is between a non-green acquiror and a green target firms as the probit dependent variable).

13. Further details on this reweighting approach can be found, e.g., in Robins *et al.* (2000).

$$Pr(GreenDeal_{ijt}) = \alpha_0 + \alpha_1 GreenA_{it} + \alpha_2 Z_{it-1} + \alpha_3 X_{it-1} + \lambda_{ct} + \rho_{ft} + \sigma_c + \delta_f + \tau_c + \upsilon_f + \phi_t + e_{ijt} \quad (2)$$

The dependent variable, $InnovativeDeal_{ijt}$, in equation (1) is a dummy variable for an acquisition deal that takes the value of one if a firm i acquires a target firm j with at least one patent (granted or published) in the acquisition year t or the years before acquisition, and zero otherwise. The dependent variable, $GreenDeal_{ijt}$, in equation (2) is a dummy variable for an acquisition deal that takes the value of one if a firm i acquires a target firm j with at least one green patent (also granted or published) in year t or the years before acquisition, and zero otherwise.[14] $InnovativeA_{it}$ (or $GreenA_{it}$) are acquiror-level dummy variables that take the value of one if the investor firm has at least one patent (or at least one green patent) in year t or the years pre-acquisition, and zero otherwise. Z is a vector of firm controls at the target-level such as firm size measured as the natural logarithm of total assets, cash ratio calculated as the ratio of total cash and cash equivalents to total assets, debt ratio is the ratio of total debt to total assets and turnover ratio measured as the ratio of operating revenue to total assets. X is a vector of same firm-level controls at the acquiror-level. Both sets of target and acquiror firm-level controls are lagged by one year to avoid simultaneity bias. We also include macroeconomic controls for both investor country (λ) and target country (ρ) such as GDP per capita and currency appreciation (REER). Finally, we include investor-country (σ_c), target-country (δ_f), investor-sector (τ_c), target-sector (υ_f), and year (ϕ_t) fixed effects to mitigate concerns of unobserved country-level and industry-level characteristics or specialization that may influence the acquisition activities (see e.g., Frésard *et al.* (2017); Hsu *et al.* (2021)).

We estimate the above (IPW weighted) probit regression models and report the average marginal effects in Table 2. Column 1 provides the results of equation (1) followed by the results of equation (2) in column 2. In column 1, we find that innovative acquiror firms have a positive and significant likelihood to acquire innovative target firms. In terms of the economic magnitudes, innovative investors are 6.3 percentage point more likely to engage in acquisition deals with innovative target firms. Further, in column 2, we find that green investor firms have a higher and significant likelihood to acquire target firms with similar green innovation. In terms of the economic magnitudes, green investors are 1.3 percentage point more

14. Following Kruse *et al.* (2020), we also use an alternative measure of green patent intensity of target firms, defined as the ratio of live "green" Y02-patents to total number of patents directly owned by a target firm pre-acquisition. The regression results are qualitatively and quantitatively similar to the main results. We do not report these results for brevity, but they are available upon request from the authors.

likely to engage in acquisition deals with green target firms. Overall, these results lend support to our proposed hypotheses 1a-1b.

With respect to the control variables, we find that target firm's size and cash ratio have a positive and significant impact on the likelihood of being acquired, while turnover has a negative impact, on the likelihood of being acquired which impliesy that target firms which are in better financial conditions are more likely to be acquired. Further, we also find that investor firm's size, cash ratio and turnover ratio haves a significant impact on the likelihood of acquisition. To be more specific, investors whichwith have a higher cash ratio and lower profitability are more likely to acquire innovative target firms. Finally, these regressions also take into accountcontrol for macroeconomic controls at both investor- and target-levels which do not show any significant impact on the probability of acquisitions and hence, are not reported in the results tables for brevity.

4.2. Green acquisitions and the Paris Agreement

In this section, we focus on the introduction of Paris Agreement and its impact on green acquisitions by non-green acquiror firms as outlined in hypothesis 2a by estimating the following (IPW weighted) probit model:

$$\begin{aligned} Pr(GreenDeal_{ijt}) = \alpha_0 + \alpha_1 NonGreenA_{it} * COP21_t + \alpha_2 NonGreenA_{it} + \\ \alpha_3 Z_{it-1} + \alpha_4 X_{it-1} + \lambda_{ct} + \rho_{ft} + \sigma_c + \delta_f + \tau_c + \upsilon_f + \\ \phi_t + e_{ijt} \end{aligned} \quad (3)$$

The dependent variable, $GreenDeal_{ijt}$, is a dummy variable for an acquisition deal that takes the value of one if a firm i acquires a target firm j with at least one green patent (granted or published) in acquisition year t or the years before acquisition, and zero otherwise. $NonGreenA_{it}$ is a dummy variable equal to one if the investor does not have green patents pre-acquisition, and zero otherwise. We capture the impact of Paris Agreement using a time dummy of COP21, which takes the value of one for the period of 2016-2020, and zero otherwise. The other control variables and fixed effects are in line with those described as included in equations (1) and (2).

Next, we study the implications of sector-level and country-level environmental standards and characteristics on green acquisitions, as discussed in hypothesis 2b. We re-run the model shown in equation (3) by disaggregating the sample into groups based on different sector-level and country-level measures for acquiror firms. We use two alternative classifications. First, we define economic sectors that are deemed high or low carbon sectors based on the sectoral classification used in Battiston et al. (2017) which is defined at the two-digit NACE Rev. 2 code classification. Battiston *et al.* (2017) considered climate-policy relevant sectors as those related to fossil-fuels, utilities, housing, transport, and energy-intensive activities. Therefore, we consider these climate-policy relevant sectors as sectors likely to also engage in high carbon emitting activities (i.e., proxing high carbon sectors). For details regarding the specific NACE codes included in each category we refer the reader to the description outlined in Battiston *et al.* (2017). Second, we proxy the acquiror firms' country-level environmental standards using country-specific environmental policy stringency index computed by the OECD (Botta (2014)). It is an internationally comparable measure of the stringency of environmental policy, defined as the degree to which environmental policies put a price on polluting or environmentally harmful behaviour (considering 14 environmental policy instruments, primarily related to climate and air pollution). The index takes value between from 0 and to 6 (with 6 being the highest degree of stringency). We then divide countries in two groups of low and high country-level environmental standards using the 50th percentile as a cut-off point. Thus, an acquiror firm belongs to a country with higher (or lower) environmental regulations if the acquiror country's environmental regulations are above (or below) the sample median of the entire distribution. Since we have cross-sectional data, we use the average of this index by country sourced from the World Bank to compute the aforementioned median value.

We estimate the regression models for hypothesis 2a and 2b and report the average marginal effects in Table 3. Column 1 of Table 3 provides the results for the whole sample, followed by the results of climate policy-relevant or non-climate policy-relevant sectors in columns 2 and 3, and low/high country-level environmental standards in columns 4 and 5. The results in column 1 show that non-green acquiror firms ($NonGreenA$) are on an average less likely to acquire green target firms, which is in line with the results shown in Table 2 and discussed in the previous section. However, we observe that this phenomenon reverses after the introduction of the Paris Agreement which is captured by the interaction term of $NonGreenA * COP21$ (i.e. hypothesis 2a). More specifically, we find that after the Paris Agreement non-green firms are more likely to acquire green target firms as highlighted in hypothesis 2a. In terms of the economic magnitudes, non-green acquirors are 1.1 percentage point more likely to engage in acquisition deals with green target firms after the Paris Agreement.

Next, the results of the interaction $NonGreenA * COP21$ in columns 2 to 5 of Table 3 (i.e. hypothesis 2b) show that after the introduction of the Paris Agreement, non-green acquiror firms in climate-policy relevant sectors and countries with low environmental standards are more likely to acquire green target firms. However, the impact of the policy on non-green acquiror firms in non climate-policy relevant sectors is only statistically significant at the 10% level, and there is no significant impact of the policy in countries with high environmental standards. In terms of the economic magnitudes, non-green investors in climate-policy relevant sectors and countries with low environmental standards are more likely to engage in green acquisitions after the Paris Agreement by 2.6 and 2 percentage points, respectively. Finally, other control variables behave as conjectured. It could be the case that some of the findings relating to hypothesis 2b, particularly those in columns 4 and 5, relate particularly to cross-border acquisitions, since non-green investors located in countries with lower environmental standards acquiring green target firms are more likely to search for them in countries with higher environmental standards, and hence higher incentive to carry our research leading to green patents. This aspect is further investigated in the robustness checks section.

4.3. Post-acquisition green innovation performance and the Paris Agreement

This section explores the post-acquisition green innovation performance for both acquiror and target firms as outlined in hypothesis 3a. We implement the following IPW weighted OLS model:

$$\begin{aligned} Y_{ijt} = \alpha_0 + \alpha_1 GreenTechOverlap_{ijt} + \alpha_2 GreenA_{it} + \alpha_4 GreenT_{jt} + \\ \alpha_4 Z_{it-1} + \alpha_5 X_{it-1} + \lambda_{ct} + \rho_{ft} + \sigma_c + a_f + \tau_c + \upsilon_f + \phi_t + e_{ijt} \end{aligned} \quad (4)$$

The dependent variable Y_{ijt} denotes the post-acquisition green innovation performance, which is measured by two indicators. First, we use the log of total number of green patents, and second, we use the log of the ratio of the total number of forward citations of green patents over the total number of green patents for each firm. In both cases, the green patents considered are those granted or published post-acquisition, for each acquiror and target firm. $GreenA$ is a dummy variable that takes the value of one if the acquiror firm has at least one green patent in acquisition year t or the years before acquisition, and zero otherwise. $GreenT$ is a dummy variable equal to one if the target firm has at least one green patent in acquisition year t or the years before acquisition, and zero otherwise. The main variable of interest is $GreenTechOverlap_{ijt}$ that captures the effect of acquisition deal between a green acquiror and a green target firm ($GreenA * GreenT$) on their post-acquisition green innovation performance.

We estimate the regression model in equation (4) and report the results in Table 4. The results for post-acquisition number of green patents are reported in columns 1-2 and post-acquisition green patent citations ratios are reported in columns 3-4 of Table 4. In columns 1-2, we find a positive and significant impact of the variable $GreenTechOverlap_{ijt}$ on post-acquisition green patents for both acquiror and target firms suggesting that acquisition deal between green firms are more likely to increase their post-acquisition green outputs. In terms of the economic magnitudes, we find that acquisition deal between green firms is 112.6 percentage point and 131.2 percentage point more likely to increase the number of green patents post-acquisition for acquiror and target firms, respectively. Further, in columns 3-4, we find a positive and significant impact of the variable $GreenTechOverlap_{ijt}$ on post-acquisition green patent citations for target firms while there is no significant impact on acquirors. In terms of the economic magnitudes, we find that acquisition deal between green firms is 40.7 percentage point more likely to increase the citations of green patents post-acquisition for target firms. Overall, these results provide support to our hypothesis 3a that suggests that acquiror and target firms with overlapping green innovation are more likely to increase their post-acquisition green innovation performance.

Next, we study the post-acquisition green innovation performance for both acquiror and target firms after the Paris Agreement as outlined in hypothesis 3b using the following (IPW weighted) OLS model:

$$
\begin{aligned}
Y_{ijt} = {} & \alpha_0 + \alpha_1 Greenacquisition_{ijt} * COP21_t + \alpha_2 Greenacquisition_{ijt} + \\
& \alpha_3 NonGreenA_{it} + \alpha_4 NonGreenA_{it} * COP21_t + \alpha_5 GreenT_{jt} + \\
& \alpha_6 GreenT_{jt} * COP21_t + \alpha_7 Z_{it-1} + \alpha_8 X_{it-1} + \lambda_{ct} + \rho_{ft} + \sigma_c + \delta_f + \\
& \tau_c + \upsilon_f + \phi_t + e_{ijt}
\end{aligned} \tag{5}
$$

The variable $Greenacquisition_{ijt}$ captures the effect of acquisition deal between a non-green acquiror and a green target firm ($NonGreenA * GreenT$) on their post-acquisition green innovation performances. The main variable of interest in equation (5) is the interaction term of $Greenacquisition_{ijt} * COP21_t$ that captures the effect of green acquisition deals on the post-acquisition green innovation performances of acquiror and target firms after the introduction of Paris Agreement.

We estimate the regression model in equation (5) and report the results in Table 5. The results for post-acquisition green patents are reported in columns 1-2 in Table 5. We do not find any significant impact of the interaction term $Greenacquisition_{ijt} * COP21_t$ on the number of green patents and green patent citations post-acquisition for both acquirors and target firms after the Paris Agreement. Overall, green acquisitions after the Paris Agreement do not show any significant impact on post-acquisition innovation performances raising concerns related to greenwashing behaviour by firms as highlighted in hypothesis 3b. This result could also be indicative of a lack of complementarity between the investor and the target firm, which would explain a reduced number of green innovations post-acquisition.

5. Robustness checks

This section discusses a series of robustness checks implemented to validate our results, as reported in Table 6. These checks are performed separately for both innovative (specifications from 1 to 5) and green deals (specifications 6 to 10).

First, global financial crisis years are excluded, to assess the extent to which results are driven by this rare event, which may affect investment decisions. Considering that the crisis exacerbated in 2008-2009, and effects may last longer, the robustness focuses on the years 2011-2020, as shown in specifications 1 and 6. Second, results are tested for deals where the target company is based in Europe. While the baseline sample cover OECD countries, our datasets have a better coverage for EU countries and this test would reinforce the main findings for one of the key geopolitical areas of the world (specifications 2 and 7). Third, we include further controls in the econometric specifications, namely two dummy variables capturing whether target and acquiror firms are public companies, to explore whether the estimates are dependent on the set control variables used (specifications 3 and 8). Fourth, for hypothesis 1a, 1b and 2, we apply the alternative probabilistic regression estimation method logit, to assess the sensitivity of the estimates (specifications 4 and 9). Finally, we exclude from the sample all domestic deals, in order to focus on cross-border acquisitions (specifications 5 and 10). All these robustness checks are reported in Table 6 showing average marginal effects, and they confirm our main findings discussed in the previous section.

Note that for the particular robustness check exploring cross-border acquisitions, the estimates obtained for cross-border acquisitions in relation to hypothesis 2b (see Panel C in Table 6) confirm the estimates obtained in Table 3 in relation to the high/low environmental standards breakdown. This suggests that non-green acquiror firms in countries with low environmental standards are also more likely to acquire green target firms abroad (i.e. through a cross-border acquisition) after the implementation of the Paris Agreement.

6. Conclusion

In this paper we examine how the technological shifts towards greener and sustainable innovations can influence the likelihood of acquisition between firms with different technological capacities. Exploiting a dataset of completed control acquisition deals over the period of 2009-2020 from 23 OECD countries, and using an IPW weighted technique (based on PS) to correct for endogeneity, we find that innovative firms have a higher probability to acquire innovative target firms. We also find that acquiror firms with green innovation enter into acquisition deals with target firms with overlapping green innovation possibly due to their technological proximity and informational advantages which further enhances their post-acquisition green innovation performances. In addition, we find an increase in green acquisitions by non-green acquirors after the Paris Agreement, and this is more pronounced for firms in climate policy-relevant sectors and countries with low environmental standards. However, green acquisitions after the Paris Agreement do not show any significant impact on post-acquisition innovation performances raising concerns related to greenwashing behaviour by investing firms.

Given that green innovation is a strategic tool through which firms can achieve sustainable development (Huang and Li (2017)), our findings support the view that corporate takeovers can foster green transition, as firms acquire external technological sources that help to accelerate the innovation process (Grimpe and Hussinger (2014)). In particular, it is likely that the Paris Agreement helped to raise interest of non-green investors in green acquisitions in the short-term to achieve a higher green momentum in the long-term. However, the policy discussions highlighting a general concern of greenwashing behaviour by businesses after the Paris Agreement also cannot be refuted. Therefore, these findings are policy relevant and they can encourage policymakers to enhance green transition implementing a carrot and stick approach. On one side, policies able to foster green innovation, such as targeted fiscal incentives would be beneficial. On the other side, the possibility of greenwashing behaviours should be taken into account and disincentivised, also posing attention on the green taxonomy, to avoid that the green transition process is undermined.

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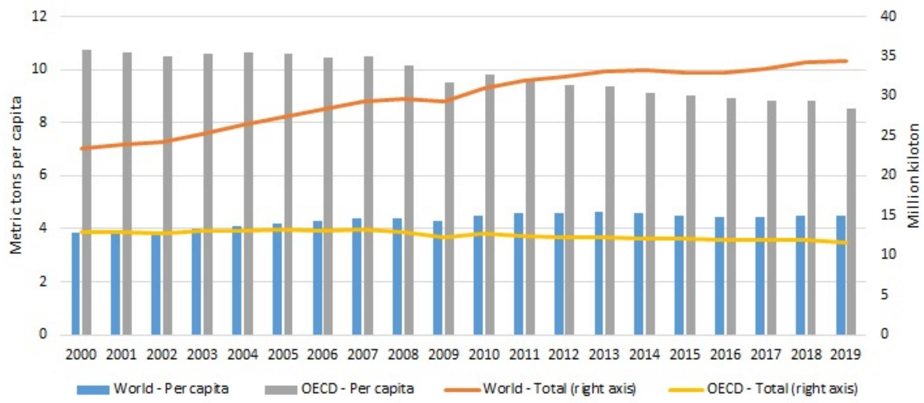
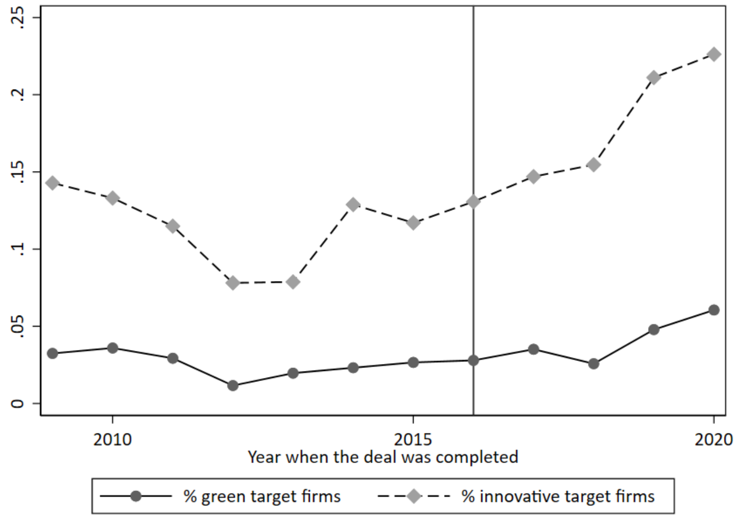
Figure 1: CO_2 emissions trends



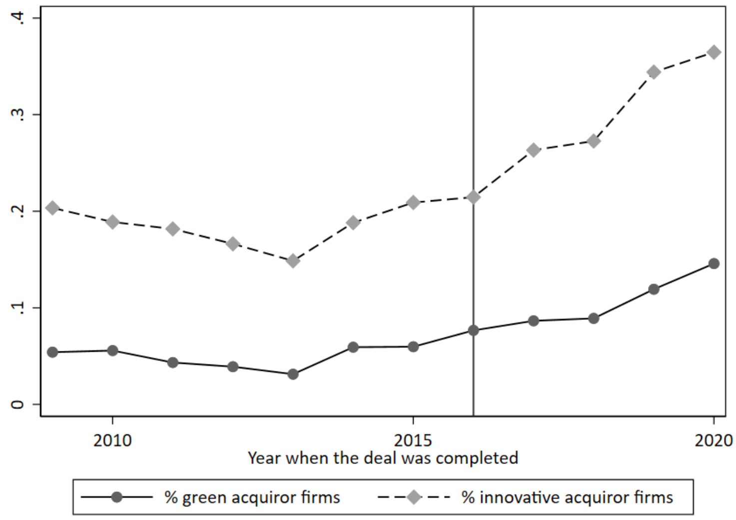
Notes: The figure shows the trend of carbon emissions across the World and OECD countries. Authors' elaboration based on World Bank data (`https://data.worldbank.org/indicator/EN.ATM.CO2E.KT?view=chart`).

Figure 2: Firm level patenting activity

(a) Target firms



(b) Acquiror firms



Notes: Authors' elaboration based on Orbis data. The figure shows the trend of patenting activity among target firms (in panel a) and acquiror firms (in panel b). The vertical line depicts the onset of Paris Agreement from 2016 onwards.

Table 1. Summary statistics

Panel A:	*Target firms*											
	Non-innovative firms			*Innovative firms*			*Green firms*			*Test of equality of means (p-values)*		
	(1) Mean	(2) Median	(3) Std. Dev.	(4) Mean	(5) Median	(6) Std. Dev.	(7) Mean	(8) Median	(9) Std. Dev.	(10) Columns 1 and 4	(11) Columns 1 and 7	(12) Columns 4 and 7
ln(TotalAssets)	15.080	14.982	2.23	16.691	16.561	2.075	18.107	18.225	2.276	0.000	0.000	0.000
ln(Cash/TA)	0.137	0.071	0.159	0.142	0.084	0.154	0.129	0.066	0.148	0.000	0.600	0.210
ln(Debt/TA)	0.160	0.047	0.256	0.189	0.128	0.242	0.202	0.155	0.249	0.000	0.000	0.320
ln(Turnover/TA)	0.808	0.817	0.560	0.712	0.724	0.384	0.616	0.605	0.351	0.000	0.000	0.000
Observations		10,304			1,263			357				

Panel B:	*Acquiror firms*											
	Non-innovative firms			*Innovative firms*			*Green firms*			*Test of equality of means (p-values)*		
	(1) Mean	(2) Median	(3) Std. Dev.	(4) Mean	(5) Median	(6) Std. Dev.	(7) Mean	(8) Median	(9) Std. Dev.	(10) Columns 1 and 4	(11) Columns 1 and 7	(12) Columns 4 and 7
ln(TotalAssets)	16.774	16.654	2.399	18.290	18.121	2.142	20.038	20.165	2.201	0.000	0.000	0.000
ln(Cash/TA)	0.100	0.045	0.134	0.115	0.065	0.138	0.100	0.065	0.116	0.000	0.000	0.090
ln(Debt/TA)	0.160	0.091	0.214	0.168	0.128	0.191	0.177	0.166	0.161	0.000	0.000	0.000
ln(Turnover/TA)	0.616	0.588	0.518	0.612	0.612	0.384	0.528	0.509	0.319	0.050	0.010	0.000
Observations		9,200			1,871			853				

Notes: The table presents sample means, median and standard deviations for target and acquiror firms. The firms are split into three different groups based on their patenting activities as non-innovative i.e., firms with no patents (in columns 1-3), innovative i.e., firms with non-green patents (in columns 4-6) and green innovative i.e., firms with green patents (in columns 7-9), and report the p-values of tests of equalities of means between non-innovative, innovative and green firms (in columns 10-12).

Table 2. Green innovation and corporate acquisitions

Dependent variable:	*Innovative deal$_{ijt}$*	*Green deal$_{ijt}$*
	(1)	(2)
InnovativeA_i	0.063^{***}	
	(0.008)	
GreenA_i		0.013^{***}
		(0.002)
Target firm level controls:		
$\ln(\text{TotalAssets})_{j,t-1}$	0.026^{***}	0.005^{***}
	(0.003)	(0.001)
$\ln(\text{Cash/TA})_{j,t-1}$	0.050^{*}	0.026^{***}
	(0.026)	(0.008)
$\ln(\text{Debt/TA})_{j,t-1}$	0.011	0.003
	(0.013)	(0.003)
$\ln(\text{Turnover/TA})_{j,t-1}$	-0.023^{**}	-0.007^{***}
	(0.010)	(0.001)
Acquiror firm level controls:		
$\ln(\text{TotalAssets})_{i,t-1}$	-0.010^{***}	-0.002^{***}
	(0.002)	(0.000)
$\ln(\text{Cash/TA})_{i,t-1}$	0.088^{***}	0.000
	(0.027)	(0.007)
$\ln(\text{Debt/TA})_{i,t-1}$	0.013	-0.005^{**}
	(0.016)	(0.002)
$\ln(\text{Turnover/TA})_{i,t-1}$	-0.071^{***}	-0.006^{***}
	(0.014)	(0.002)
Observations	15,370	11,924
Pseudo-R^2	0.546	0.901
Macro controls	Yes	Yes
Year FE	Yes	Yes
Target sector FE	Yes	Yes
Acquiror sector FE	Yes	Yes
Target country FE	Yes	Yes
Acquiror country FE	Yes	Yes

Notes: The table reports average marginal effects obtained after the IPW probit regressions for a cross-sectional sample of acquisition deals. The dependent variable 'Innovative deal' in column (1) is a dummy variable for an acquisition deal that takes the value of one if a firm i acquires a target firm j with at least one patent (granted or published) in the year t or the years before acquisition, and zero otherwise. The dependent variable 'Green deal' in column (2) is a dummy variable for an acquisition deal that takes the value of one if a firm i acquires a target firm j with at least one green patent (also granted or published) in year t or the years before acquisition, and zero otherwise. Pseudo-R^2 is calculated as suggested by McFadden (1974). Robust standard errors are clustered at the acquiror and target country-pair level and are reported in the parenthesis. Statistical significance is denoted at 1% (***), 5% (**), and 10% (*).

Table 3. Green acquisitions and the Paris Agreement

Dependent variable:	*Green deal$_{ijt}$*				
	(1) Full sample	(2) Climate-policy-relevant sector	(3) Non climate-policy-relevant sectors	(4) Environmental Standards - High	(5) Environmental Standards - Low
COP21*NonGreenA$_i$	0.011***	0.026***	0.022*	-0.008	0.020***
	(0.003)	(0.006)	(0.012)	(0.012)	(0.006)
NonGreenA$_i$	-0.019***	-0.033***	-0.046***	-0.005	-0.036***
	(0.003)	(0.004)	(0.010)	(0.011)	(0.003)
Target firm level controls:					
ln(TotalAssets)$_{j,t-1}$	0.005***	0.009***	0.018***	0.019***	0.008***
	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)
ln(Cash/TA)$_{j,t-1}$	0.026***	0.034**	0.050**	0.041*	0.020***
	(0.008)	(0.015)	(0.023)	(0.024)	(0.007)
ln(Debt/TA)$_{j,t-1}$	0.003	0.004	0.015*	0.015*	0.003
	(0.003)	(0.009)	(0.007)	(0.009)	(0.006)
ln(Turnover/TA)$_{j,t-1}$	-0.007***	-0.011*	0.015**	0.006	-0.010***
	(0.001)	(0.006)	(0.006)	(0.010)	(0.003)
Acquiror firm level controls:					
ln(TotalAssets)$_{i,t-1}$	-0.002***	-0.002**	-0.002	0.000	-0.002***
	(0.000)	(0.001)	(0.003)	(0.001)	(0.001)
ln(Cash/TA)$_{i,t-1}$	0.001	0.018	-0.029	0.003	-0.003
	(0.007)	(0.011)	(0.032)	(0.027)	(0.010)
ln(Debt/TA)$_{i,t-1}$	-0.005**	-0.006	-0.004	-0.013	-0.003
	(0.002)	(0.008)	(0.012)	(0.021)	(0.004)
ln(Turnover/TA)$_{i,t-1}$	-0.005***	-0.020***	0.006	0.002	-0.004
	(0.002)	(0.006)	(0.007)	(0.007)	(0.003)
Observations	11,924	4,605	5,437	4,684	4,781
Pseudo-R^2	0.902	0.912	0.554	0.490	0.938
Macro controls	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Target sector FE	Yes	Yes	Yes	Yes	Yes
Acquiror sector FE	Yes	Yes	Yes	Yes	Yes
Target country FE	Yes	Yes	Yes	Yes	Yes
Acquiror country FE	Yes	Yes	Yes	Yes	Yes

Notes: The table reports average marginal effects obtained after IPW probit regressions for a cross-sectional sample of acquisition deals. The dependent variable 'Green deal' is a dummy variable for an acquisition deal that takes the value of one if a firm i acquires a target firm j with at least one green patent (also granted or published) in year t or the years before acquisition, and zero otherwise. 'NonGreenA' is a dummy variable equal to one if the investor has no green patents pre-acquisition, and zero otherwise. The impact of Paris Agreement is captured using a time dummy of 'COP21', which takes the value of one for the period of 2016-2020, and zero otherwise. Firms are divided into climate-policy vs non climate-policy relevant sectors using the classification in Battiston et al. (2017). Further, an acquiror firm belongs to a country with higher (or lower) environmental standards if the acquiror country's environmental policy stringency index is above (or below) the sample median of the entire distribution. Pseudo-R^2 is calculated as suggested by McFadden (1974). Robust standard errors are clustered at the acquiror and target country-pair level and are reported in the parenthesis. Statistical significance is denoted at 1% (***), 5% (**), and 10% (*).

Table 4. Post-acquisition green innovation performance

Dependent variable:	*ln(Number GP, post-acq.)*		*ln(Citation ratio GP, post-acq.)*	
	(1)	(2)	(3)	(4)
	Acquiror	Target	Acquiror	Target
$GreenTechOverlap_{ij}$	1.126***	1.312***	0.078	0.407***
	(0.209)	(0.220)	(0.048)	(0.085)
$GreenT_j$	-0.005	0.389**	0.001	0.063**
	(0.012)	(0.193)	(0.001)	(0.029)
$GreenA_i$	1.675***	0.018	0.191***	0.005
	(0.094)	(0.031)	(0.019)	(0.009)
Post-acq. length	-0.001	-0.002	0.000	0.000
	(0.002)	(0.002)	(0.000)	(0.000)
Target firm level controls:				
$ln(TotalAssets)_{j,t-1}$	-0.000	0.001	0.000	0.000
	(0.001)	(0.001)	(0.000)	(0.000)
$ln(Cash/TA)_{j,t-1}$	0.010	0.020	-0.001	0.001
	(0.015)	(0.013)	(0.001)	(0.001)
$ln(Debt/TA)_{j,t-1}$	-0.008	-0.011*	-0.000	-0.001*
	(0.005)	(0.006)	(0.000)	(0.001)
$ln(Turnover/TA)_{j,t-1}$	-0.004	-0.003	0.000	-0.000
	(0.005)	(0.005)	(0.000)	(0.000)
Acquiror firm level controls:				
$ln(TotalAssets)_{i,t-1}$	0.002***	0.000	0.000***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
$ln(Cash/TA)_{i,t-1}$	0.018	0.011	0.001	-0.000
	(0.014)	(0.013)	(0.001)	(0.001)
$ln(Debt/TA)_{i,t-1}$	-0.012	-0.018	0.000	-0.001*
	(0.011)	(0.012)	(0.000)	(0.001)
$ln(Turnover/TA)_{i,t-1}$	-0.000	-0.001	0.000	0.000
	(0.003)	(0.002)	(0.000)	(0.000)
Observations	13,406	13,406	13,406	13,406
R^2	0.057	0.223	0.025	0.079
Macro controls	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Target sector FE	Yes	Yes	Yes	Yes
Acquiror sector FE	Yes	Yes	Yes	Yes
Target country FE	Yes	Yes	Yes	Yes
Acquiror country FE	Yes	Yes	Yes	Yes

Notes: This table reports coefficient values after the IPW OLS regressions for a cross-sectional sample of acquisition deals. In columns 1-2, the dependent variable is the logarithm of total number of green patents post-acquisition. In columns 3-4, the dependent variable is the logarithm of forward citation ratio post-acquisition. The variable 'GreenTechOverlap' captures the effect of acquisition deal between a green acquiror and a green target firm on their post-acquisition green innovation performance. 'COP21' is a time dummy that takes the value of one for the period of Paris Agreement from 2016-2020, and zero otherwise. Robust standard errors are clustered at the acquiror and target country-pair level and are reported in the parenthesis. Statistical significance is denoted at 1% (***), 5% (**), and 10% (*).

Table 5. Post-acquisition green innovation performance and Paris Agreement

Dependent variable:	*ln(Number GP, post-acq.)*		*ln(Citation ratio GP, post-acq.)*	
	(1)	(2)	(3)	(4)
	Acquiror	Target	Acquiror	Target
COP21*Green acquisition$_{ij}$	0.242	0.006	0.070	0.100
	(0.328)	(0.376)	(0.138)	(0.151)
Green acquisition$_{ij}$	-1.234***	-0.825***	-0.129	-0.356**
	(0.307)	(0.275)	(0.135)	(0.148)
NonGreenA$_i$	-2.029***	-0.022	-0.376***	-0.002
	(0.138)	(0.014)	(0.052)	(0.003)
COP21*NonGreenA$_i$	0.667***	0.013	0.354***	0.002
	(0.141)	(0.013)	(0.054)	(0.003)
GreenT$_j$	1.318***	2.042***	0.148	0.769***
	(0.309)	(0.166)	(0.132)	(0.102)
COP21*GreenT$_j$	-0.333	-0.573**	-0.083	-0.488***
	(0.323)	(0.285)	(0.132)	(0.098)
Post-acq. length	0.063***	0.001	0.036***	0.000
	(0.012)	(0.001)	(0.006)	(0.000)
Target firm level controls:				
ln(TotalAssets)$_{j,t-1}$	0.001	0.000	-0.002	0.000
	(0.002)	(0.000)	(0.001)	(0.000)
ln(Cash/TA)$_{j,t-1}$	-0.012	0.007	0.008	0.000
	(0.016)	(0.005)	(0.008)	(0.001)
ln(Debt/TA)$_{j,t-1}$	-0.014**	-0.003	0.002	-0.000
	(0.006)	(0.004)	(0.005)	(0.000)
ln(Turnover/TA)$_{j,t-1}$	0.003	-0.001	0.003	0.000**
	(0.002)	(0.001)	(0.002)	(0.000)
Acquiror firm level controls:				
ln(TotalAssets)$_{i,t-1}$	0.003**	0.000	0.003	0.000
	(0.001)	(0.001)	(0.002)	(0.000)
ln(Cash/TA)$_{i,t-1}$	0.012	0.002	-0.005	0.000
	(0.018)	(0.005)	(0.011)	(0.001)
ln(Debt/TA)$_{i,t-1}$	0.009	-0.005	0.008	-0.000
	(0.012)	(0.006)	(0.009)	(0.001)
ln(Turnover/TA)$_{i,t-1}$	-0.002	0.001	0.002	-0.000*
	(0.006)	(0.002)	(0.002)	(0.000)
Observations	15,401	15,401	15,401	15,401
R^2	0.105	0.336	0.597	0.200
Macro controls	Yes	Yes	Yes	Yes

Year FE	Yes	Yes	Yes	Yes
Target sector FE	Yes	Yes	Yes	Yes
Acquiror sector FE	Yes	Yes	Yes	Yes
Target country FE	Yes	Yes	Yes	Yes
Acquiror country FE	Yes	Yes	Yes	Yes

Notes: This table reports coefficient values after the IPW OLS regressions for a cross-sectional sample of acquisition deals. In columns 1-2, the dependent variable is the logarithm of total number of green patents post-acquisition. In columns 3-4, the dependent variable is the logarithm of forward citation ratio post-acquisition. The variable 'Green acquisition' captures the effect of acquisition deal between a non-green acquiror and a green target firm on their post-acquisition green innovation performances. 'COP21' is a time dummy that takes the value of one for the period of Paris Agreement from 2016-2020, and zero otherwise. Robust standard errors are clustered at the acquiror and target country-pair level and are reported in the parenthesis. Statistical significance is denoted at 1% (***), 5% (**), and 10% (*).

Table 6. Robustness - Alternative classifications

	(1) 2011-2020	(2) EU targets only	(3) Extra controls	(4) Logit	(5) CB deals only	(6) 2011-2020	(7) EU targets only	(8) Extra controls	(9) Logit	(10) CB deals only
Panel A:	*Dependent variable: Innovative deal$_{ijt}$*					*Dependent variable: Green deal$_{ijt}$*				
InnovativeA$_i$	0.063***	0.054***	0.059***	0.066***	0.053***					
	(0.009)	(0.013)	(0.008)	(0.009)	(0.010)					
GreenA$_i$						0.010***	0.015**	0.012***	0.015***	0.036***
						(0.002)	(0.007)	(0.002)	(0.003)	(0.012)
Observations	13,740	10,461	15,361	15,370	4,917	10,601	5,823	11,938	11,944	2,585
Panel B:	*Dependent variable: Green deal$_{ijt}$*									
COP21*NonGreenA$_i$	0.009***	0.026***	0.011***	0.010***	0.021					
	(0.002)	(0.009)	(0.003)	(0.004)	(0.016)					
Observations	10,586	5,817	11,918	11,924	2,583					
Panel C:	*Dependent variable: Green deal$_{ijt}$*									
	Climate-policy-relevant sectors					Non climate-policy-relevant sectors				
COP21*NonGreenA$_i$	0.033***	0.012	0.021***	0.024***	0.028	0.016	0.032***	0.021*	0.027**	0.041
	(0.007)	(0.010)	(0.005)	(0.007)	(0.030)	(0.013)	(0.009)	(0.012)	(0.011)	(0.025)
Observations	4,130	1,682	4,602	4,605	797	4,827	2,949	5,434	5,437	964
	Environmental Standards - High					Environmental Standards - Low				
COP21*NonGreenA$_i$	-0.014	0.009	-0.008	-0.008	-0.022	0.020***	0.060***	0.020***	0.019***	0.150*
	(0.012)	(0.012)	(0.012)	(0.013)	(0.028)	(0.006)	(0.007)	(0.005)	(0.006)	(0.083)
Observations	4,137	2,827	4,681	4,684	1,178	4,324	1,383	4,781	4,781	366
Panel D:	*Dependent variable: ln(number of patents post-acq.) - Acquiror*					*Dependent variable: ln(number of patents post-acq.) - Target*				
GreenTechOverlap$_{ij}$	1.071***	1.440**	1.116***	-	1.101***	1.275***	1.684***	1.300***	-	0.149
	(0.200)	(0.554)	(0.211)		(0.370)	(0.232)	(0.383)	(0.220)		(0.303)
Observations	12,286	9,606	13,397		4,417	12,286	9,606	13,397		4,417
Panel E:	*Dependent variable: ln(citations ratio post-acq.) - Acquiror*					*Dependent variable: ln(citations ratio post-acq.) - Target*				
GreenTechOverlap$_{ij}$	0.085*	0.049	0.078	-	0.008	0.394***	0.550***	0.406***	-	0.282*
	(0.044)	(0.056)	(0.048)		(0.058)	(0.077)	(0.146)	(0.085)		(0.164)
Observations	12,286	9,606	13,397		4,417	12,286	9,606	13,397		4,417
Panel F:	*Dependent variable: ln(number of patents post-acq.) - Acquiror*					*Dependent variable: ln(number of patents post-acq.) - Target*				
COP21*Green acq.$_{ij}$	0.221	0.342	0.243	-	0.473	0.043	-0.482	0.006	-	-0.175
	(0.381)	(0.724)	(0.328)		(0.772)	(0.393)	(0.670)	(0.376)		(0.491)

Observations	14,105	11,387	15,392		5,251	14,105	11,387	15,392		5,251
Panel G:	*Dependent variable: ln(citations ratio post-acq.) - Acquiror*					*Dependent variable: ln(citations ratio post-acq.) - Target*				
COP21*Green acq.$_{ij}$	0.110	0.012	0.076	-	-0.051	0.115	0.229	0.100	-	0.054
	(0.132)	(0.145)	(0.139)		(0.140)	(0.157)	(0.302)	(0.151)		(0.282)
Observations	14,105	11,387	15,392		5,251	14,105	11,387	15,392		5,251

Notes: The table reports average marginal effects obtained after the IPW probit (or logit) and OLS regressions for a cross-sectional sample of acquisition deals. The dependent variable 'Innovative deal' is a dummy variable for an acquisition deal that takes the value of one if a firm i acquires a target firm j with at least one patent (granted or published) in the year t or the years before acquisition, and zero otherwise. The dependent variable 'Green deal' is a dummy variable for an acquisition deal that takes the value of one if a firm i acquires a target firm j with at least one green patent (also granted or published) in year t or the years before acquisition, and zero otherwise. Robust standard errors are clustered at the acquiror and target country-pair level and are reported in the parenthesis. Please see notes to Tables 3-6 for more details. Statistical significance is denoted at 1% (***), 5% (**), and 10% (*).

Appendix A: Distribution of deals by target and acquiror country

Target fimrs (OECD)		
	Freq.	% Deals
ES	2,926	24.54
IT	1,093	9.17
FI	1,088	9.12
UK	1,083	9.08
FR	940	7.88
SE	839	7.04
NO	648	5.43
PL	567	4.76
US	422	3.54
JP	360	3.02
KR	339	2.84
CZ	335	2.81
DE	335	2.81
BE	220	1.85
AU	183	1.53
PT	163	1.37
CA	155	1.3
NL	78	0.65
AT	59	0.49
SK	51	0.43
DK	26	0.22
CL	8	0.07
IL	6	0.05

Acquiror firms		
	Freq.	% Deals
ES	2,315	19.41
FR	1,005	8.43
FI	954	8.00
US	893	7.49
GB	875	7.34
IT	844	7.08
SE	817	6.85
NO	593	4.97
JP	514	4.31
DE	434	3.64
PL	424	3.56
KR	323	2.71
CZ	240	2.01
CA	215	1.80
LU	191	1.60
BE	189	1.59
NL	185	1.55
AU	165	1.38
PT	101	0.85
AT	89	0.75
CH	88	0.74
CN	71	0.60
IE	68	0.57
KY	49	0.41
DK	42	0.35
SK	30	0.25
VG	24	0.20
IN	20	0.17
MX	20	0.17
Other	146	1.28

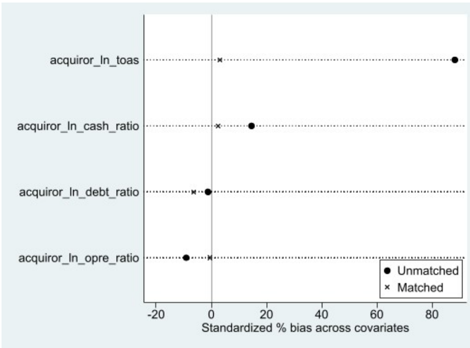
Appendix B: Correlation matrix

		Target firms						*Acquiror firms*					
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Target firms	(1) ln(TotalAssets)	1.00											
	(2) ln(Cash/TA)	-0.26	1.00										
	(3) ln(Debt/TA)	0.06	-0.21	1.00									
	(4) ln(Turnover/TA)	-0.30	0.15	-0.10	1.00								
	(5) ln(GDP per cap.)	0.08	0.14	-0.04	0.09	1.00							
	(6) ln(REER)	0.12	-0.06	0.06	-0.03	0.06	1.00						
Acquiror firms	(1) ln(TotalAssets)	0.64	-0.08	0.04	-0.14	0.09	0.07	1.00					
	(2) ln(Cash/TA)	-0.10	0.27	-0.04	0.05	0.10	0.00	-0.20	1.00				
	(3) ln(Debt/TA)	0.09	-0.11	0.16	-0.06	-0.03	0.05	0.08	-0.20	1.00			
	(4) ln(Turnover/TA)	-0.23	0.09	-0.06	0.40	0.02	-0.02	-0.24	0.10	-0.12	1.00		
	(5) ln(GDP per cap.)	0.09	0.14	-0.04	0.08	0.89	0.05	0.12	0.10	-0.03	0.02	1.00	
	(6) ln(REER)	0.11	-0.05	0.06	-0.03	0.05	0.89	0.07	0.02	0.05	-0.02	0.05	1.00

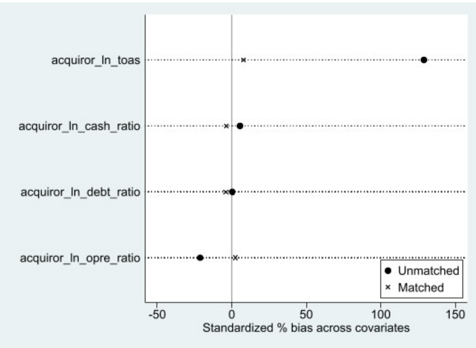
Notes: Firm size is measured as the natural logarithm of total assets. Cash ratio is calculated as the ratio of total cash and cash equivalents to total assets. Debt ratio is the ratio of total debt to total assets. Turnover ratio is measured as the ratio of operating revenue to total assets. GDP per capita is measured as the natural logarithm of gross domestic product divided by midyear population in current US dollars. REER is the real effective exchange rate index (2010 = 100).

Appendix C: Balancing properties

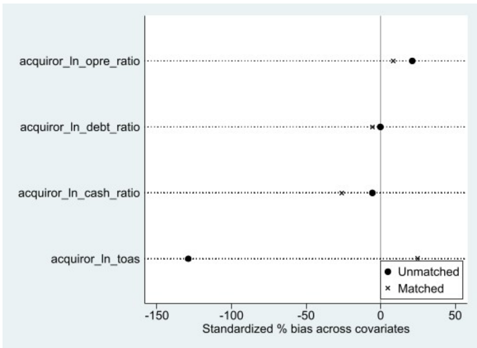
(a) Hypothesis 1a



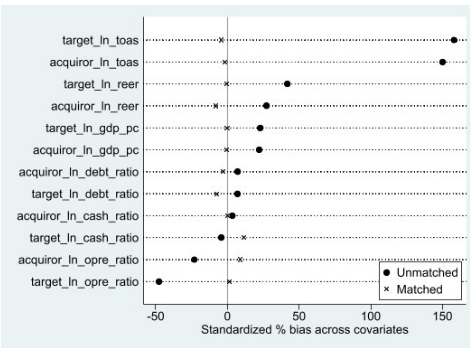
(b) Hypothesis 1b



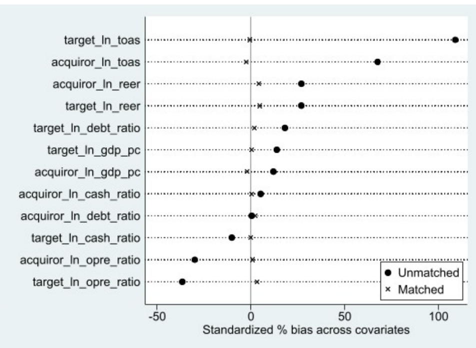
(c) Hypothesis 2



(d) Hypothesis 3a



(e) Hypothesis 3b



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