

Foreign Investment and Corporate Social Responsibility in an Emerging Market: Impacts and Mechanisms*

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Abstract

We examine the causal effect and underlying mechanisms of foreign investment on social norms in an emerging market. Increased foreign investment in Chinese firms under the Shanghai and Shenzhen Stock Connect programs increases firms' environmental and social (ES) performance. To isolate underlying mechanisms, we develop an instrumental-variable approach and find causal evidence that supports two theories: foreign investors push firms to improve ES performance and firms enhance ES performance to signal trustworthiness to investors. Improved ES performance and increased foreign shareholding are therefore self-reinforcing, and exogenous changes in either have long-run effects that exceed short-run by about 77%. Foreign investment can play an important and lasting role in convergence of social norms across countries.

Keywords: corporate social responsibility, foreign investment, social norms, emerging markets

JEL Classifications: G15, G23, G30, M14, F21

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1 Introduction

Economic convergence across countries and foreign capital's role in facilitating it are central concerns in economics. Research has demonstrated that foreign investment in emerging markets can promote economic convergence by enhancing the efficiency of targeted firms (Matthias Arnold and Javorcik, 2009) and improving their financial condition and export capabilities (Wang and Wang, 2015).¹ Conversely, foreign divestment has been shown to reduce firm efficiency (Javorcik and Poelhekke, 2017). Beyond market mechanisms, foreign capital flows may impact emerging markets through non-market channels, such as externalities and cultural changes, although these areas have been less studied.² For externalities, Brucal, Javorcik and Love (2019) finds that foreign investment reduces the energy intensity of plants, while divestment increases it. For cultural changes, Tang and Zhang (2021) shows that foreign affiliates employ more women and appoint more female managers, leading to a positive spillover effect on female employment within industry and city.³

This paper contributes to these few results on non-market convergence. We examine the influence of foreign investment, via stock holdings, on firms' corporate social responsibility (CSR) performance in an emerging economy. The contribution is two-fold. First, although previous studies have examined how investors influence firms' CSR performance, these consider almost exclusively intra-country investing or investing between advanced economies and therefore are not directly relevant to cross-country convergence. Assessing the role of foreign investors in facilitating CSR is important in understanding non-market mechanisms for cross-country convergence because foreign investment has been shown to exert outsized influence on market outcomes in emerging markets. Foreign investment can exert more pressure on firm performance in an emerging market than does domestic investment (Ferreira and Matos, 2008) and foreign investment improves corporate governance in countries with weak corporate governance, especially if the source country has strong protections (Aggarwal, Erel, Ferreira and Matos, 2011). We examine whether this outsized influence carries over to non-market outcomes.

Second, previous literature identifies two possible mechanisms by which investment

¹Wang and Wang (2015) finds that while foreign acquisitions lead to productivity improvements in target firms, it does not offer additional productivity gains compared to domestic acquisitions.

²Trade liberalization can also have non-market effects. For example, exporters reduce emissions intensity in response to liberalization (Cherniwchan, Copeland and Taylor, 2017). Foreign trade reforms are associated with improved corporate transparency in industries that rely more on external financing (Tong and Wei, 2014).

³Alfaro, Kalemli-Ozcan and Volosovych (2008) shows that institutional quality is crucial for poor countries to attract foreign investment from wealthy countries.

could affect CSR: firms may invest in CSR as a quality signal to attract investors and investors may directly influence firms to enhance their CSR practices. However, these studies examine each mechanism in isolation even though they may occur simultaneously. We develop a method to disentangle these mechanisms and quantify their individual impacts in the context of foreign investment in an emerging market.⁴ Isolating and quantifying these mechanisms is crucial for understanding the pathways through which cross-county convergence can occur. If the influence mechanism plays a role, foreign investors from developed countries can directly shape CSR performance in emerging markets. Conversely, if the signaling mechanism is at play, foreign investors exert influence only indirectly. Additionally, since these mechanisms are mutually reinforcing, isolating them allows us to quantify the long-term effects and their persistence in response to an exogenous increase in either.

To identify the causal effect of foreign investment on CSR in an emerging market, we leverage the relaxation of capital controls—a policy more common in emerging markets than in advanced ones. We focus on the Shanghai and Shenzhen Connect programs, which expanded Hong Kong/foreign (HKF) investment in China, known as "northbound shareholdings."⁵ This is an attractive setting in which to test the effects of foreign investment on CSR in an emerging market. Entering a Connect program was based entirely on inclusion in stock indexes, which depended on market capitalization and stock trading volumes — factors not directly related to a firm's ES performance. We use a difference-in-differences (DD) approach, with firms joining the Connect program as the treatment group and those not as the control group. To avoid problems arising from staggered DD estimation, we focus first on the initial cohort of Shanghai Connect firms.

Joining the Connect program has a positive impact on firms' Environmental and Social (ES) performance, two important components of CSR.⁶ ES ratings increased 16.3% in the first year and 11.5% per year in subsequent years for firms joining the program relative to those not. The effects are heterogeneous. After the program begins, private-owned enterprises (POEs) experienced the fastest rise in ES rating (12.3% per year). ES ratings for state-owned enterprises (SOEs) also trended up but at a slower pace (6.9% per

⁴We focus on the signalling and influence theories, as they are the most prominent, but this does not preclude other possible explanations.

⁵Cheng, Jiang, Kong and Vigne (2024) also examines the effect of foreign investment on CSR using the Connect program. Their study differs in that it only utilizes the Shanghai Connect program in a staggered difference-in-differences (DD) estimation, which may lead to biased estimates, and it relies on contemporaneous CSR measures that could be influenced by the inclusion in the Connect program or have been subject to conflicts of interest or firm influence. The paper also does not address the underlying mechanisms.

⁶Following Dyck, Lins, Roth and Wagner (2019) and He, Kahraman and Lowry (2023a), we focus on the environmental and social sub-ratings and construct an ES rating with equal weights. All results hold if we also include the governance sub-rating of ESG.

year). Ratings for foreign-owned enterprises (FOEs) did not significantly change, perhaps because foreign influence predated the Connect program. We then extend our analysis by adding the initial cohort of firms in the Shenzhen Connect program using methods robust to staggered DD estimation. The effects on ES performance are similar to those for the Shanghai Connect program alone.

The ES increases likely reflect actual improvement, as the ratings are derived from tangible, measurable outcomes. Moreover, the ratings were assigned retroactively many years later, eliminating the possibility that ES ratings directly influenced a stock's inclusion in a Connect program, that firms artificially manipulated their performance to influence the ratings, or that distortions in ratings resulted from conflicts of interest for the rating agency. Inclusion in the Connect program also significantly affects independent, direct measures of environmental outcomes: Connect firms reduced their carbon emissions and filed more applications for "green" patents relative to non-Connect firms after joining. This is evidence that the effects are not due to "greenwashing". Since being in the Connect programs depended on inclusion in stock indexes, index inclusion itself may have increased ES performance.⁷ To address this, we exclude firms added to the index when the Connect program begins and the results remain. The retroactive ES measures are also unrelated to future stock performance - evidence that foreign investment response to ES performance is not confounded by firm financial performance.

Having found significant increases in ES performance, we identify underlying mechanisms. Previous literature identifies two potential ways in which investments may influence CSR performance: firm signalling and investor influence. The signaling theory (Lins, Servaes and Tamayo, 2017) argues that firms invest in ES as a signal to investors of their trustworthiness in order to maintain investor confidence in times of crisis. An extension of their argument is that investors may proactively invest more in such firms to protect themselves in the event of future possible crises. In the context of capital controls, foreign investors face a knowledge gap about domestic firms when controls are initially loosened, and firms may increase ES activities to signal trustworthiness and reduce asymmetric information.⁸ The influence theory (Ferreira and Matos, 2008; Aggarwal, Erel, Ferreira and Matos, 2011; Ferrell, Liang and Renneboog, 2016; Liang and Renneboog, 2017; Dyck, Lins, Roth and Wagner, 2019; Chen, Dong and Lin, 2020; Bisetti, She and

⁷Some studies examine the effect of index inclusion on ES performance with mixed results. Chen, Dong and Lin (2020) find that increases in institutional ownership improve CSR performance while Cheong, Choi, Ha and Oh (2023) find that inclusion in the MSCI Emerging Market and China indexes increases emissions intensity.

⁸This is consistent with Cingano and Pinotti (2016), which finds that high-trust regions and countries exhibit larger value-added and export shares in industries that require more interpersonal trust.

Zaldokas, 2023) argues that foreign investors exert pressure on firms to invest in ES performance because investors intrinsically value it. In the context of the Connect program, either or both of these theories could apply. We substantiate that foreign investors care more about ES performance than domestic investors in China. This means that increased foreign investment under the Connect program could both increase the signaling value of ES investments and increase foreign-investor influence on ES performance.

To disentangle and separately quantify the contribution of these two mechanisms, which are not mutually exclusive, we develop an instrumental variable approach that takes advantage of the different directions of causality: ES performance increases foreign shareholdings under the signaling theory; while under the influence theory, the reverse occurs. We identify instrumental variables that exogenously shift ES ratings and foreign investment, respectively, to eliminate the simultaneity bias and estimate causal effects. To identify the causal role of signaling, we use the change in firms' environmental performance under a major regulatory change as an instrument for ES ratings. We provide evidence that this instrument is relevant and strong, and find that foreign investors reward a one percent rise in ES ratings with increased holdings of 2.0 basis points a year later. The average annual increase in ES ratings before the Connect programs would lead to an 18.1% increase in average northbound shareholdings. We show that the instrument is unrelated to stock market performance, evidence that foreign investors' responses to CSR are not confounded by firm financial performance. To identify the causal role of influence, we use a quadratic function of the elapsed time since joining a Connect program as an instrument for northbound shareholding. We provide evidence that elapsed time has nonlinear effects on ES ratings for Connect firms, but not for non-Connect firms. A one percentage point increase in northbound shares increases ES ratings in the following year by 22.3%. These findings are consistent with a role for both mechanisms and suggest that firm ES investments and foreign investment are self-reinforcing — an exogenous increase in either will lead to long-term effects that are 77% greater than short-run.

Our results contribute to three strands of literature. The first is the few papers on the role of foreign investment in cross-country convergence of non-market outcomes. There are papers that provide causal empirical evidence of the effect of investment on CSR performance but these have focused mainly on effects within advanced economies or pooled samples of advanced and emerging economies without distinguishing which investors and target firms originate from.⁹ There are a few exceptions that examine effects across

⁹These include Ferreira and Matos (2008), Hong and Kacperczyk (2009), Aggarwal, Erel, Ferreira and Matos (2011), Chava (2014), Dimson, Karakaş and Li (2015), McCahery, Sautner and Starks (2016), Ferrell, Liang and Renneboog (2016), Liang and Renneboog (2017), Krueger, Sautner and Starks (2020), Chen, Dong and Lin (2020), Azar, Duro, Kadach and Ormazabal (2021).

developed and emerging markets. Besides [Brucal, Javorcik and Love \(2019\)](#) and [Tang and Zhang \(2021\)](#), [Kim, Sung and Wei \(2011\)](#) examines how disparity between ownership and control rights in an investor's source country affects their choice of a target firm's disparity in an emerging market. [Cai, Lu, Wu and Yu \(2016\)](#) document how foreign multinational investments in China are influenced by the severity of China's environmental protections vis-a-vis the strength of protections in the multinational's home country.

The second strand of literature examines the underlying mechanisms for investment's influence on firms' CSR performance. We contribute to this area by examining the simultaneous influence of both the signalling and influence theories of foreign investment on CSR performance. For the signalling theory our results complement [Lins, Servaes and Tamayo \(2017\)](#), which finds that firms with better CSR scores outperform during crises of trust. We find that improvements in ES performance increase foreign shareholdings even in the absence of crises, perhaps in anticipation of them occurring in the future or as a signal of other aspects of trustworthiness. For the influence theory our results are consistent with [Aggarwal, Erel, Ferreira and Matos \(2011\)](#), [Dyck, Lins, Roth and Wagner \(2019\)](#), and [Chen, Dong and Lin \(2020\)](#), which find that higher foreign ownership increases future ES performance consistent with foreign investors valuing ES performance more than domestic investors and exerting pressure on them.

The third strand of literature is studies that examine the development of China's financial system and its role in economic growth.¹⁰ [Ma, Rogers and Zhou \(2021\)](#) analyze stock market performance and investment after the Shanghai Connect program begins. We complement this by showing significant improvements in ES performance from the Connect programs. [Giannetti, Liao and Yu \(2015\)](#) find that hiring directors with foreign experience significantly improves firm performance because of their ability in corporate governance and exposure to foreign markets. Relatedly, we find that HKF investors influence domestic firms' behaviors by reshaping their ES activities. [Li, Brockman and Zurbruegg \(2015\)](#) find that Chinese firms dual-listed in mainland China and Hong Kong improve corporate governance due to stricter listing rules, stronger investor protection, and foreign investors' information access. Similarly, we find that firms strengthen their ES performance after exposure to HKF investors. Finally, northbound trading under the Connect program makes the stock market more informative ([Chen, Wang and Zhu, 2019](#); [Lundblad, Shi, Zhang and Zhang, 2022](#); [Bian, Chan, Han and Shi, 2023](#); [He, Wang and Zhu, 2023b](#)). Our findings show that the Connect firms increase their ES activities to overcome information asymmetry and signal trustworthiness to foreign investors.

¹⁰[Allen, Qian and Gu \(2017\)](#), [Carpenter and Whitelaw \(2017\)](#), [Song and Xiong \(2018\)](#), [Allen, Qian and Qian \(2019a\)](#), and [He and Wei \(2022\)](#) provide surveys.

The remainder of the paper is organized as follows. Section 2 discusses the institutional background. Section 3 reports the data source and sample selection. Section 4 explains the empirical strategy and Section 5 presents the results. Section 6 provides evidence for the two main mechanisms and Section 7 concludes.

2 Institutional Background

Since its Economic Reform and Opening in 1978, China has managed its capital flows following a learning-by-doing approach. Promoting foreign direct investment has been a part of its development strategy as it facilitates access to foreign management expertise, foreign technology, and export markets. China has frequently fine-tuned restrictions on investment flows but has generally tightly restricted them. In 1992, shortly after the Shanghai Stock Exchange (SSE) launched in December 1990 and the Shenzhen Stock Exchange (SZSE) in April 1991, a special market was established for foreign investment in domestically-listed shares, commonly termed the B-share market. These shares are of companies incorporated in mainland China, denominated in Renminbi (RMB), and traded on the SSE in US dollars or the SZSE in Hong Kong dollars. The initial intention of the B-share market was for foreign investors to invest using foreign currency. However, as a practical matter, it was difficult because it required foreign investors to deposit foreign currency in a domestic bank account and trade through a domestic broker. Although the B-share market was extended to domestic investors in February 2001, uptake remained low.¹¹

The Qualified Foreign Institutional Investor (QFII) program was introduced in 2002, allowing foreign institutional investors to invest in SSE- and SZSE-listed firms. The China Securities Regulatory Commission (CSRC) granted a license, required for trading, to institutions based on their reputation and financial soundness. Once licensed, foreign investors could trade subject to capital controls and maximum trading quotas, which varied by investor. Over two decades, the quotas and license requirements were steadily eased. In 2019, the CSRC announced simplified rules and, in 2020, canceled the quotas. As of October 2022, the CSRC had approved 726 foreign investors for the QFII program.

The Shanghai and Shenzhen Connect programs were further moves to relax restrictions on foreign investors participating in the Chinese stock market. The Shanghai Connect program was launched in November 2014, and the Shenzhen program in December 2016. The programs allowed two-way trading: HKF investors could trade A-share stocks

¹¹Additional B-share issuance ceased when the QFII program was established in 2002. By the end of 2022, only 44 (42) firms were listed on the SSE (SZSE) B-share markets.

of eligible firms on the SSE and SZSE through the Stock Exchange of Hong Kong (HKEX), and investors from mainland China could trade eligible stocks on the HKEX through the SSE or SZSE. Northbound trading – that conducted by HKF investors – was open to all eligible individual and institutional investors.¹²

The SZSE and SSE instituted other initiatives concerning CSR, but their starting times do not coincide with the Connect programs. In 2006, the SZSE published an initiative urging all its listed firms to become actively involved in CSR, establish a system to promote CSR activities, and disclose information related to CSR activities. Since then, the SZSE has periodically inspected and assessed how listed firms perform on CSR. In 2008, the SSE launched a campaign encouraging listed firms to disclose environmental assessments in their annual reports and requiring them to disclose an environmental incident if it would affect their stock price or if an environmental authority lists them as a seriously polluting enterprise. In 2018, the CSRC mandated all listed firms (not just those in the Connect program) to provide ESG information in their annual reports (we show that the Connect program affected ES ratings prior to this, ruling out better availability of CSR information in 2018 as a confounding factor).

3 Data

3.1 Sample selection of Connect firms

Our data spans the years 2009 to 2021 – five years before the beginning of the Shanghai Connect program and five years after the Shenzhen Connect program commenced. Our data include information on firms’ ES ratings and financial performance. Since the launch of the Connect programs, their respective selection criteria have remained the same. The Shanghai Connect program includes SSE 180 Index and SSE 380 Index constituents and dual-listed firms on the SSE and HKEX, excluding those not traded in RMB or under “special treatment” (ST).¹³ The Shenzhen Connect program includes the SZSE Component Index and Small/Mid-Cap Innovation Index constituents (except those with market capitalization below 6 billion RMB or under ST). Once a stock is removed from these indexes it can be sold, but not bought, through the Connect program. We include all

¹²Eligibility depended on information technology capability and risk management procedures specified by the exchange or clearing house. For specifics on eligibility see https://www.hkex.com.hk/Services/Clearing/Securities/Overview/Clearing-Services?sc_lang=en.

¹³Some shares are placed under ST by SSE or SZSE (e.g., those of firms subject to possible delisting or which have been suspended by SSE or SZSE). For details, refer to the SSE Listing Rules at <http://www.sse.com.cn/lawandrules/sserules/listing/stock/> and the SZSE Listing Rules at <http://www.szse.cn/lawrules/index.html>.

Connect stocks that are never dual-listed because these may have already been exposed to foreign investors before the Connect programs. Therefore, the sample of Connect firms is determined by the criteria for inclusion in these indexes. Importantly for identification, index construction depends on financial characteristics (market capitalization and trading volume) unrelated to firms' ES ratings (details are in Appendix A.1). Each index is re-constituted twice a year. This means that firms not only enter a program at different times, but also some firms exit a program at different times.¹⁴

Due to possible heterogeneous treatment effects over time, we first focus on the initial cohort (stocks available to HKF investors on the program's first day) of the Shanghai Connect.¹⁵ We then extend the analysis by adding the initial cohort of the Shenzhen Connect program using methods robust to staggered DD. When forced to use annual data, as we must with ES data, we treat firms entering a program in the last quarter of a year as if they enter the next year.¹⁶ Since the first firms entered the Shanghai Connect program in November 2014 and the Shenzhen Connect program in December 2016, we measure the programs as beginning in 2015 and 2017, respectively.

3.2 Bloomberg ESG database

We obtain proprietary ESG ratings and three sub-ratings from Bloomberg, which began publishing them for listed firms in 2020. Bloomberg used historical data to provide retroactive ratings back to 2007, a year after the SZSE's initiative to promote CSR activities in annual reports.¹⁷ The ratings are based on over 600 company-reported and derived indicators (Appendix A.2 has details). The environmental (ENV) sub-rating includes measures of the emissions and waste produced during the firm's operations, including air quality, wastewater, energy use, and material use, and general environmental impacts, such as climate change and ecological and biodiversity impact. The social (SOC) sub-rating focuses on firms' actions toward their employees, clients, and partners regarding diversity, ethics, health, safety, and human capital. The governance (GOV) sub-rating considers the accounting oversight and corporate governance of board members and executives, including composition, diversity, compensation, independence, nomina-

¹⁴If a firm enters a program more than once, we include only the period with the longest duration.

¹⁵In Appendix B.2, we incorporate all Connect firms that entered between 2015 and 2017 and examine the effects of the Connect program using the staggered and stacked methods, following [Cengiz, Dube, Lindner and Zipperer \(2019\)](#) for the latter. Our main results remain similar. We are unable to implement the procedure in [Callaway and Sant'Anna \(2021\)](#) because of the large number of fixed effects required.

¹⁶The results are robust to assigning based on the latter half of the year.

¹⁷[Berg, Fabisik and Sautner \(2020\)](#) document that some vendors may retroactively update ESG ratings to better predict future firm performance. In Appendix A.4, we replicate their analysis and find no significant correlation between Bloomberg ES ratings and subsequent stock returns.

tion, and tenure. The ESG rating is an equal-weighted average of the three sub-ratings. Following [Dyck, Lins, Roth and Wagner \(2019\)](#) and [He, Kahraman and Lowry \(2023a\)](#), we focus on environmental and social sub-ratings and construct an ES rating using a simple average of the two.¹⁸ The Bloomberg ESG database covers more than 11,800 companies worldwide, comprising 88% of global equity market capitalization.¹⁹ As of the end of 2021, 1,549 Chinese firms listed on the SSE or SZSE had ever been rated.

The main challenges in ESG data are the need for more disclosure and standardization. Reporting ESG data is generally not mandatory and there is no common disclosure framework. [Berg, Koelbel and Rigobon \(2022\)](#) compare six prominent ESG ratings and find a large dispersion across them. How aspects of ESG are measured contributes 56% of this divergence, while what aspects are included contributes another 38%. To address these challenges, Bloomberg captures ESG data from company reports, annual general meetings, press releases, policy documents, websites, and other publicly-available documents. Moreover, Bloomberg employs quantitative data standardized to be consistent in units across firms (e.g., the share of women employed instead of the absolute number of women to measure gender equality) to make the data comparable across companies and time.

We divide the sample into two groups: firms joining a Connect program for at least two years versus firms joining for less than two years or not at all.²⁰ We refer throughout the paper to the former as Connect firms and the latter as non-Connect firms.

3.3 Financial variables

We control for an extensive array of variables measuring the firms' financial position and market performance, which we obtain from China Stock Market & Accounting Research Database (CSMAR).²¹ We construct financial variables following [Allen, Qian, Tu and Yu \(2019b\)](#) and [Ma, Rogers and Zhou \(2021\)](#). Combining the ES ratings data with the firm financial data yields 430 firms in 2013, just before the Shanghai Connect began.

Table 1 reports summary statistics of the ES ratings and financial variables prior to 2014 - before the Shanghai Connect program launched in November 2014 (Appendix A.6 provides descriptions of the variables). Connect and non-Connect firms have similar ENV sub-ratings, but lower SOC sub-ratings and ES ratings. Connect firms are larger,

¹⁸All results are robust to using the ESG score instead.

¹⁹For more details, refer to <https://www.bloomberg.com/professional/dataset/global-environmental-social-governance-data/>.

²⁰We test robustness to one- and three-year duration, and the results are very similar.

²¹CSMAR is a widely-used database for public-firm information in China similar to CRSP and Compustat.

more profitable, more leveraged, and experience less insider trading. ES ratings may vary systematically based on these attributes; however, our estimation compares relative ES ratings before versus after the Connect program, so this does not invalidate the identification approach.²² The two groups do not differ in age, proportion of SOEs, sales growth, or cash flows.

3.4 Other CSR outcomes

We examine how the Shanghai Connect program affects two direct measures of ES: carbon emissions and “green” patent applications. Since firm-level carbon emissions data is not available until 2018, we use industry-level emissions and assign emissions to each firm based on the fraction of their revenue in each industry.²³ Emissions include production, energy generation, waste disposal, and land industrialization. China’s State Intellectual Property Office collects the patent data. Following criteria established by the World Intellectual Property Organization, we classify a patent as “green” if it concerns products or designs that provide environmental benefits (e.g., waste technology, wind power, geothermal energy, solar energy, tidal energy, or biomass). This data has broader coverage than that of the ES ratings. For this analysis, we include all firms on the SSE and SZSE for which we have data, since we aim to see if the Connect program affects these primary, underlying outcomes.

4 Estimation Approach

4.1 Identification

We first confirm that the Connect programs affect trading volume. In Figure 1, the blue solid line shows the year-end market value share held by HKF investors through the Shanghai Connect as a fraction of total SSE market capitalization. In the first three years, the market value share increased slowly but steadily, then accelerated in 2018 and 2019, reaching 1.6% by the end of 2021. The dashed red line shows the fraction of SZSE market capitalization held by HKF investors through the Shenzhen Connect. It reached 2.6% by 2021. Although these represent small fractions of total shareholding, HKF investors may play an out-sized role relative to domestic investors because foreign investors are more

²²Given that some characteristics of Connect and non-Connect firms are statistically different before the commencement of the program, we also employ the estimation method proposed by Callaway and Sant’Anna (2021) which utilizes stabilized inverse-probability weighting. As demonstrated in Figure B.3 of Appendix B.3, the results are robust.

²³Data from *China Energy Statistical Yearbook*.

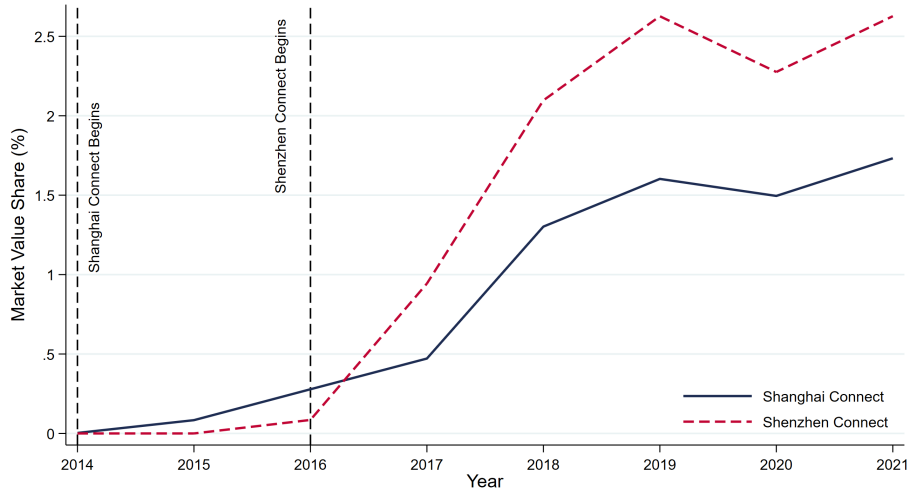
Table 1
SUMMARY STATISTICS PRIOR TO CONNECT PROGRAMS

	Connect Firms			Non-Connect Firms			Difference	
	obs	mean	sd	obs	mean	sd	diff	t
ES	1083	5.71	4.76	731	6.97	5.61	-1.26***	(-4.99)
ENV	1083	3.23	5.82	731	3.55	4.89	-0.32	(-1.26)
SOC	1083	8.39	5.17	731	10.68	7.72	-2.28***	(-7.00)
Log(assets)	1083	23.05	1.18	731	22.07	1.11	0.99***	(18.10)
Log(revenue)	1083	22.49	1.28	731	21.47	1.32	1.02***	(16.38)
Log(market cap)	1076	16.22	0.87	725	15.34	0.77	0.88***	(22.38)
Log(cap expenditure)	1083	19.73	1.68	731	18.83	1.58	0.90***	(11.61)
ROA	1083	0.06	0.05	731	0.04	0.04	0.02***	(8.81)
Growth rate of sales	1071	0.52	4.05	726	0.38	3.21	0.13	(0.78)
Age	1083	15.44	4.26	731	15.27	4.84	0.17	(0.75)
Tobin's Q	1076	1.91	1.31	724	1.76	0.93	0.15**	(2.83)
Profit to assets ratio	1083	0.08	0.05	731	0.06	0.05	0.02***	(8.87)
Cash flow to assets ratio	1083	0.17	0.12	731	0.17	0.14	-0.01	(-1.06)
Leverage ratio	1083	0.50	0.18	731	0.46	0.21	0.05***	(4.80)
SOE	1083	0.60	0.49	731	0.61	0.49	-0.01	(-0.34)
POE	1083	0.36	0.43	730	0.36	0.48	0.01	(0.11)
FOE	1083	0.03	0.26	731	0.03	0.23	0.01	(0.09)
QFII share	1083	0.30	0.74	731	0.23	0.64	0.06*	(2.54)
Insider trade	1083	0.01	0.06	731	0.07	0.16	-0.06***	(-9.49)
Turnover rate	1076	1.22	0.89	725	1.53	1.03	-0.31***	(-6.59)
Average daily return	1076	0.00	0.01	725	0.00	0.01	0.00	(0.16)
SD of daily return	1076	0.03	0.02	725	0.03	0.01	-0.00	(-1.67)
Log(total emissions)	1289	13.33	1.24	2528	11.90	1.12	1.42***	(34.52)
Log(production emissions)	1289	11.94	1.25	2528	10.52	1.12	1.42***	(34.41)
"Green" patents	998	7.69	19.18	2431	2.31	6.53	5.38***	(8.65)

Data on firms in sample from 2009 to 2013 (before the Connect programs begin). Sample contains 238 Connect and 192 non-Connect firms. ES ratings (ES) and environmental (ENV), and social (SOC) sub-ratings from Bloomberg and financial variables following [Allen, Qian, Tu and Yu \(2019b\)](#) and [Ma, Rogers and Zhou \(2021\)](#) based on CSMAR data. Connect firms include the initial cohort of firms in the Shanghai Connect that remain in the program for at least two years, while non-Connect firms join for less than two years or not at all.

influential – strongly predicting future stock returns ([Jones, Shi, Zhang and Zhang, 2020](#); [Lundblad, Shi, Zhang and Zhang, 2022](#); [He, Wang and Zhu, 2023b](#)) and their trading volume being negatively correlated with stock volatility ([Bian, Chan, Han and Shi, 2023](#)).

We apply DD estimation to identify the causal effect of the Shanghai Connect program on ES ratings. Firms joining the Shanghai Connect on its first day and remaining in the program for at least two years comprise the treatment group. All other firms, except those joining the Shanghai Connect program after its start and Shenzhen Connect firms, comprise the control group. There are two key identifying assumptions. First, no omitted fac-



Note: Market value share is the year-end market value of stocks held by HKF investors through the Shanghai and Shenzhen Connect programs divided by the market capital capitalization of the SSE and SZSE respectively.

Figure 1
MARKET VALUE SHARE OF HKF SHAREHOLDINGS THROUGH CONNECT PROGRAMS

tors affect both a firm’s ES rating and its inclusion in the Connect program. As discussed in Section 3.1, the criteria for inclusion depend only on a firm’s market capitalization and trading volume, not characteristics directly related to ES. Moreover, Bloomberg launched their ESG ratings in 2020 and constructed the ESG ratings retroactively. This eliminates the possibility that the ESG ratings influenced inclusion in the Connect program. It also eliminates distortions in ratings resulting from conflicts of interest for the rating agency during the sample period. Such conflicts have occurred in other settings: [Bolton, Freixas and Shapiro \(2012\)](#) argue that bond rating agencies inflated ratings to compete in rating-shopping prior to the subprime mortgage crisis.

Identification also requires that Bloomberg’s selection criteria for rating a firm are orthogonal to inclusion in the Connect program. Since we do not observe Bloomberg’s criteria, Appendix A.3 shows the results of estimating

$$\mathbf{D}_{it}^{ES} = \beta_1 \mathbf{SC}_i + \beta_2 \mathbf{SC}_i \times \mathbf{D}_t + \gamma X_{it} + \nu_t + \epsilon_{it}, \quad (1)$$

where \mathbf{D}_{it}^{ES} is a dummy variable set to one if firm i received an ESG rating in year t and zero otherwise. \mathbf{D}_t is an indicator variable set to one beginning in 2015, right after the Shanghai Connect program had commenced, and zero before. \mathbf{SC}_i equals one if firm i is in the initial cohort of the Shanghai Connect program, and zero otherwise. X_{it} includes time-varying controls that may affect receiving an ESG rating. These include firm finan-

cial characteristics described in Section 3.3 and various firm-characteristic-by-year fixed effects (industry-by-year, province-by-year, SOE-by-year, FOE-by-year, and “sin”-stock-by-year) to capture time-varying industry, province, SOE, FOE, and “sin”-stock unobservables that affect inclusion. The last is included because Hong and Kacperczyk (2009) show that institutional investors strategically avoid investing in “sin” (alcohol, tobacco, and gambling) stocks, and this may influence whether Bloomberg rates them. A substantial portion of northbound capital in the Connect programs flowed into these “sin” stocks, particularly alcohol, so we include the “sin”-stock-year interaction to control for this.

X_{it} also includes controls for two other channels through which listed firms are exposed to foreign investors. The first is the share of firm i in year t held by QFII investors. The second is an indicator to account for the effects of inclusion in the MSCI China Index, launched in 2018 by Morgan Stanley Capital International. Many institutional fund managers benchmark their returns against this index, so it is an additional channel for firms listed on the SSE and SZSE to attract foreign institutional investors’ attention, even though it does not provide a new trading venue. At its initiation, the index included 136 (82) firms out of the 538 (831) firms in the Shanghai (Shenzhen) Connect programs. We include year fixed effects (ν_t) in the specification to indicate that this is a two-way fixed effects estimator, even though these are absorbed by the fixed effects interactions included in X_{it} . ϵ_{it} captures firm-specific, time-varying unobservables that affect receiving a rating. We cluster errors by firm to allow for correlation of unobservables across years within a firm.

Column 1 of Table A.1 employs a probit model and uses contemporaneous values for the programs (Connect, QFII, and MSCI) and control variables and finds no significant effect from Connect status on receiving an ESG rating. Column 2 repeats the estimation using lagged control variables. Columns 3 and 4 repeat the same two specifications using a logit rather than probit. All the results are insignificant, consistent with Bloomberg choosing firms to rate independent of their inclusion in the Connect program.

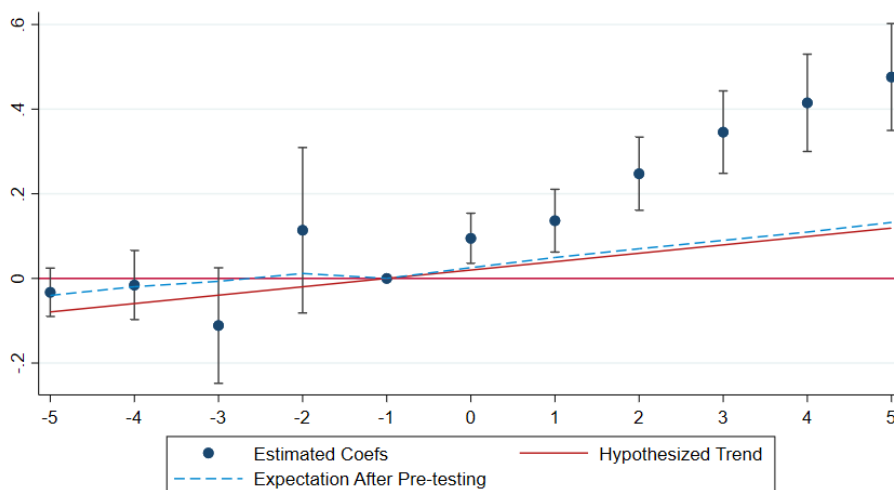
The second identifying assumption is that the treatment and control groups’ pre-existing time trends are parallel. To check this, we estimate an event study, normalizing the effect in year 2014 to zero

$$y_{it} = \exp \left[\sum_{-4 \leq r \leq 4, r \neq -1} \beta_r \mathbf{SC}_i \times \mathbf{1}_{irt} + \beta_{-5} \mathbf{SC}_i \times \mathbf{D}_{it}^{pre,5} + \beta_5 \mathbf{SC}_i \times \mathbf{D}_{it}^{post,5} + \omega_i + \nu_t \right] + \epsilon_{it}, \quad (2)$$

where we use the ES rating and the two sub-ratings as the dependent variables. r counts the number of years since 2014. $\mathbf{1}_{irt}$ is a dummy variable set equal to one if firm i in year t is r years relative to the beginning of the program and zero otherwise. $\mathbf{D}_{it}^{pre,5}$ ($\mathbf{D}_{it}^{post,5}$) are

dummy variables set equal to one if firm i in year t is five or more years before (after) the beginning of the program and zero otherwise. These capture the average effects before and after the nine-year window, respectively. \mathbf{SC}_i is set to one if firm i is in the Connect program, and zero otherwise. ω_i and ν_t are firm and year fixed effects.

The ES score contains zeros in the early years.²⁴ Silva and Tenreyro (2006), Cohn, Liu and Wardlaw (2022), and Chen and Roth (2023) show that average treatment effects using transformations, such as log-plus-one and inverse hyperbolic functions, can be biased and thus should not be interpreted as approximating a percentage effect. Instead, we apply Poisson pseudo maximum likelihood (PPML) as proposed in these studies.²⁵ Figure 2 plots the β_r coefficients estimated with ES as the dependent variable along with 95% confidence intervals. The pre-treatment coefficients display no obvious pattern and are not significantly different from zero, while the post-treatment coefficients are positive, increasing, and statistically significant. In Appendix A.5, we perform the same test on the ENV and SOC sub-ratings and find similar results.



Note: Dots are point estimates and bars are 95% confidence intervals from the event study in Equation (2) estimated using PPML. Red-solid line is hypothetical trend estimated according to Roth (2022). Blue-dashed line represents the average point estimates conditional on not finding a significant pre-trend if the red-solid was the true line. Generated using the Stata “pretends” package.

Figure 2
EVENT-STUDY ESTIMATES – ES RATINGS FOR SHANGHAI CONNECT FIRMS

A pre-trend test, the null hypothesis of which is $\beta_{-5} = \beta_{-4} = \beta_{-3} = \beta_{-2} = 0$, has an χ^2 statistic of 4.21 with a p value of 0.39. Roth (2022) argues that such a test may suffer from low power, so that the DD estimate based on it may be biased even if the test is passed.

²⁴From 2009 to 2014, out of 430 firms, 83, 92, 58, 5, 2, and 2 zeros are observed in each year.

²⁵In Table B.1 of Appendix B.1, we employ a linear regression. The results are robust.

Thus, we adopt the method in that paper and calculate a trend (red-solid line in Figure 2 with a slope of 0.0198), which results in an 80% probability of rejecting the pre-trends as insignificant. The blue-dashed line represents the point estimates conditional on not finding a significant pre-trend if the true trend was the hypothesized red line.²⁶ Thus, the hypothesized trend is unlikely in our case. Following [Rambachan and Roth \(2023\)](#), we also conduct a sensitivity analysis and find that the effect of the Connect program on ES ratings is robust even if we allow for a violation of parallel trends up to 0.3 as big as the maximal violation in the pre-treatment period (0.225), which is 3.4 times larger than the slope of the hypothesized trend.

4.2 Econometric specification

We employ a DD approach to estimate the Connect program’s causal effect on various outcomes. Since inclusion in the Connect program is orthogonal to factors influencing ES, the effect on the treatment relative to the control group is the causal effect of the Connect program on the outcome. Our benchmark specification is given by

$$y_{it} = \exp\left[\left(\beta_1 + \beta_2 \mathcal{T}_t\right) \times \mathbf{SC}_i \times \mathbf{D}_t + \left(\beta_3 + \beta_4 \mathcal{T}_{it}^E\right) \mathbf{E}_{it} + \gamma' X_{it} + \omega_i + \nu_t\right] + \epsilon_{it}, \quad (3)$$

where y_{it} is the outcome of interest, including the annual ES rating and sub-ratings for firm i in year t . \mathbf{SC}_i is as defined earlier – an indicator set to one if firm i is a Connect firm and zero otherwise. \mathbf{D}_t is an indicator variable set to one beginning in the year 2015 (after the Connect program begins) and zero before. \mathbf{E}_{it} is an indicator variable set to one in all years t after firm i exits the Connect program after having previously entered, if it does so, and zero otherwise. β_1 captures any level shift with the commencement of the program, while β_3 captures any level shift for firms leaving the program relative to being in the program.

As in [Dobkin, Finkelstein, Kluender and Notowidigdo \(2018\)](#), we allow for a linear trend in event time, \mathcal{T}_t , equal to the number of years since 2015 and zero before. \mathcal{T}_{it}^E is equal to the number of years since a Connect firm exited the program, if it does so, and zero otherwise. β_2 captures the relative change in trend for Connect relative to non-Connect firms once the policy begins, and β_4 captures any change in trend for firms leaving the program relative to the trend under the program. This specification allows for the pattern observed in Figure 2 — an approximately linear trend in response to the

²⁶The likelihood ratio of the observed pre-treatment coefficients under the hypothesized trend relative to under parallel trends is 1.07. Thus, the realization of the pre-trends is about as likely under the hypothesized as under parallel trends.

policy.

X_{it} includes controls that may affect ES ratings including firm financial characteristics described in Section 3.3 as well as firm-characteristic-by-year fixed effects (industry-by-year, province-by-year, SOE-by-year, FOE-by-year, and “sin”-stock-by-year fixed effects) that capture time-varying industry, province, SOE, FOE, and “sin”-stock effects. Firm fixed effects (ω_i) capture time-invariant, firm-specific unobservables that affect ES ratings. We display a year fixed effect (ν_t) to indicate that this is a two-way fixed effect estimator, even though the firm-characteristic-by-year fixed effects absorb these. We again use PPML to accommodate zero values for the ES rating.

5 Results

5.1 Benchmark results

We first estimate the average policy effect across the post-policy years, allowing only a level shift in ES ratings (Column 1 of Table 2). Joining the Connect program increases a firm’s ES rating by 14.1% on average post-policy.²⁷ When firms exit, their ES ratings do not experience a significant drop in the first year but begin declining at 7.1% per year thereafter. Column 2 is the benchmark regression. ES ratings increase 16.3% in the first year and increase by 11.5% annually thereafter. When evaluated at the mean ES rating (6.22) in 2013, the last full year without the Connect program, this equals a jump of 1.01 and an annual increase of 0.72. This compares to an average annual increase in ES ratings of 0.74 across all firms before 2013. Although the significant uptake in HKF shareholdings did not occur until a couple of years after the Connect programs began (Figure 1), the immediate increase in ES performance may have resulted from firms’ desire to immediately begin signalling to build foreign investors’ confidence. The effect upon exiting (-9.2%) equals 0.57, evaluated at the mean in 2013. These results indicate that the Connect program led to increased ES ratings for firms, and that these increases began reversing if a firm left the program.

Since inclusion in the Connect program is associated with financial characteristics, Column 3 checks robustness to controlling for changes in these characteristics around the policy by adding interactions of the financial covariates in X_{it} with D_t to the benchmark regression. This allows the covariates to have differential effects on ES ratings after the Connect program begins. The results are similar to those in the benchmark specification. Columns 4 and 5 repeat the benchmark regressions for the ENV and SOC sub-ratings.

²⁷We transform all PPML results to marginal effects throughout the paper.

Although the estimates are statistically significant for both, the magnitudes are much larger for the ENV than the SOC sub-rating. The ENV sub-rating experiences an increase of 41.8% in the first year or 1.40 evaluated at the mean in 2013 (3.36). It then increases at 20.0% (0.67) per year. The SOC sub-rating increases by 10.0% (0.93) in the first year evaluated at the mean in 2013 (9.31) and it increases by 7.5% (0.70) per year thereafter. These compare to average annual increases of 0.51 for ENV and 0.99 for SOC prior to the Connect program.²⁸

Table 2
EFFECT OF SHANGHAI CONNECT PROGRAM ON ES RATINGS AND SUB-RATINGS

	ES			ENV	SOC
	(1)	(2)	(3)	(4)	(5)
$SC_i \times D_t$	0.132*** (0.048)	0.151*** (0.057)	0.141** (0.070)	0.349** (0.136)	0.095** (0.046)
$SC_i \times D_t \times T_t$		0.109*** (0.027)	0.118*** (0.027)	0.182*** (0.060)	0.072*** (0.023)
E_{it}	0.067 (0.046)	0.007 (0.047)	0.003 (0.047)	0.001 (0.095)	0.001 (0.034)
$E_{it} \times T_{it}^E$	-0.074*** (0.024)	-0.096*** (0.025)	-0.100*** (0.024)	-0.197*** (0.060)	-0.027 (0.020)
Observations	5,083	5,083	5,066	5,083	5,083
Pseudo R^2	0.451	0.453	0.455	0.634	0.397
Province \times Year FE	Y	Y	Y	Y	Y
Industry \times Year FE	Y	Y	Y	Y	Y
SOE \times Year FE	Y	Y	Y	Y	Y
FOE \times Year FE	Y	Y	Y	Y	Y
"Sin"-Stock \times Year FE	Y	Y	Y	Y	Y
Firm Characteristics	Y	Y	Y	Y	Y
Firm Characteristics $\times D_t$	N	N	Y	N	N

Note: Selected coefficients from estimating Equation (3) with different dependent variables. SC_i is an indicator set to one if firm i is the first cohort of firms in Shanghai Connect program and stays in the program at least two years and zero otherwise. D_t is an indicator variable set to one beginning in 2015 and zero before. E_{it} is an indicator variable set to one beginning in year t if firm i exits the Connect program in year t after having previously entered, and zero otherwise. T_t measures the number of years since 2015. T_{it}^E equals the number of years since a treatment firm exits either program, if it did so, and zero otherwise. Columns 1 through 3 estimate with ES rating as the dependent variable, Column 4 with the ENV sub-rating, and Column 5 with the SOC sub-rating. All columns use PPML estimation. Standard errors clustered by firm are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

²⁸In unreported regressions, we re-estimate the baseline results, allowing for differential effects for “sin” versus non-“sin” stocks. The effects for non-“sin” stocks were slightly larger, and the effects for “sin” stocks insignificant. The latter could be because the northbound investments in “sin” stocks are primarily by individuals rather than institutions (we cannot separately quantify them) and individuals exert less influence, or it may result from self-selection. Investors that choose to hold “sin” stocks may care less about ES issues and thus choose to exert little influence on firms’ ES activities (Dyck, Lins, Roth and Wagner, 2019).

5.2 Heterogeneity, robustness, and validation checks

Column 1 of Table 3 distinguishes the effects of the Connect program on firms of different ownership types. The Connect program significantly affects ES ratings for SOEs and POEs, but not FOEs. This is consistent with FOEs experiencing influence from foreign investors before the Connect program began. For POEs, ES ratings increase by 15.5%, or 0.05 applying the 2013 mean rating for POEs (0.33), in the first year and then increase by 12.3% (0.041) annually. SOEs do not experience a change in the first year but do increase 6.9% per year thereafter. This equals 0.04, applying the mean rating for SOEs in 2013 (0.62). These compare to an average annual increase in ES ratings of 12.7% for POEs and 10.9% for SOEs prior to the Connect program. Our results are consistent with [Hsu, Liang and Matos \(2021\)](#), which finds that SOEs are responsive to environmental issues. Since inclusion in the SSE 180 or SSE 380 Indexes is necessary for being in the Connect program, the increase in ES ratings could be due to entry into the indexes themselves. To test for this, Column 2 re-estimates the benchmark regression, excluding the thirty firms that joined the two indexes in 2013 and 2014, just before the Connect program began. The results are very similar to the benchmark results.

The fraction of market value held by HKF investors increased considerably in 2018 (Figure 1) raising the question whether the main effects of the Connect program occurred then rather than at its initiation. To assess this, we carried out a placebo test with 2018 as the event threshold (i.e., setting D_t equal to one beginning in 2018 and adjusting T_t appropriately) in our benchmark sample. Column 3 shows no significant change in effects around the 2018 placebo threshold.

Bloomberg's ES ratings are based on objective measures. However, to the extent that these measures involve some subjectivity, Connect firms may exert more effort than non-Connect firms to influence the rating agency without any actual change in objective performance. To test for this, we examine whether the Connect program affected two important environmental outcomes not included in Bloomberg's criteria (described in Section 3.4). The first independent outcome is carbon emissions. We estimate a linear version of the benchmark model (Equation 3) with the log of annual firm-level emissions as the dependent variable. Column 4 of Table 3 reports the results for total emissions, and Column 5 for production emissions. Neither declines in the first year, but emissions decline more over time (by 1.4% per year for total and 1.3% for production emissions) for Connect relative to non-Connect firms. Column 6 reports estimates with "green" patent applications in a firm-year as the dependent variable. In the year the Connect program commences, treatment firms increase "green" invention patents by 3.5 (0.34 standard deviations) relative to non-Connect firms. In subsequent years, Connect firms increase the number of

patents by 2.7 (0.26 standard deviations) per year more than non-Connect firms.

Table 3
HETEROGENEITY, ROBUSTNESS, AND VALIDATION CHECKS: EFFECT OF SHANGHAI CONNECT PROGRAM ON ES RATINGS AND INDEPENDENT CSR MEASURES

	ES			log (Carbon Emissions)		"Green"
	Ownership (1)	Index (2)	2018 (3)	Total (4)	Production (5)	Patents (6)
$SOE \times SC_i \times D_t$	0.081 (0.063)					
$POE \times SC_i \times D_t$	0.144* (0.085)					
$FOE \times SC_i \times D_t$	-0.142 (0.205)					
$SOE \times SC_i \times D_t \times T_t$	0.067** (0.030)					
$POE \times SC_i \times D_t \times T_t$	0.116*** (0.039)					
$FOE \times SC_i \times D_t \times T_t$	0.060 (0.066)					
$SC_i \times D_t$		0.154*** (0.058)	-0.027 (0.083)	-0.014 (0.011)	-0.010 (0.012)	3.479** (1.458)
$SC_i \times D_t \times T_t$		0.112*** (0.028)	0.026 (0.024)	-0.014*** (0.004)	-0.013*** (0.004)	2.742** (1.280)
E_{it}	0.013 (0.046)	0.025 (0.050)	0.031 (0.041)	0.012 (0.017)	-0.003 (0.018)	-4.749 (4.321)
$E_{it} \times T_{it}^E$	-0.097*** (0.025)	-0.100*** (0.026)	-0.054** (0.022)	0.001 (0.007)	0.005 (0.008)	-3.105 (1.975)
Methodology	PPML	PPML	PPML	Linear	Linear	Linear
Observations	5,083	4,798	5,083	11,943	11,943	12,298
R^2 /Psuedo R^2	0.453	0.447	0.450	0.990	0.989	0.729
Province \times Year FE	Y	Y	Y	Y	Y	Y
Industry \times Year FE	Y	Y	Y	Y	Y	Y
SOE \times Year FE	Y	Y	Y	Y	Y	Y
FOE \times Year FE	Y	Y	Y	Y	Y	Y
"Sin"-Stock \times Year FE	Y	Y	Y	Y	Y	Y
Firm Characteristics	Y	Y	Y	Y	Y	Y

Note: Selected coefficients from estimating Equation (3). SC_i is an indicator set to one if firm i is the first cohort of firms in Shanghai Connect program and stays in the program at least two years and zero otherwise. D_t is an indicator variable set to one when the Connect program begins in 2015 and zero before. E_{it} is an indicator variable set to one beginning in year t if firm i exits the Connect program in year t after having previously entered, and zero otherwise. T_t measures the number of years since 2015 and T_{it}^E equals the number of years since a treatment firm exits either program, if it did so, and zero otherwise. Column 1 distinguishes effects by firm ownership type (some observations are omitted because ownership type cannot be determined). Column 2 excludes firms joining SSE 180 and SSE 380 in 2013 and 2014. Column 3 estimates a placebo test with D_t set to one beginning in 2018 and zero before and T_{it}^E appropriately adjusted. Columns 4 through 6 show results with log total carbon emissions, log production carbon emissions, and number of "green"-patent applications, respectively as dependent variables. These columns include all firms with data not just those with ES ratings. Standard errors clustered by firm are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5.3 Including the Shenzhen Connect program

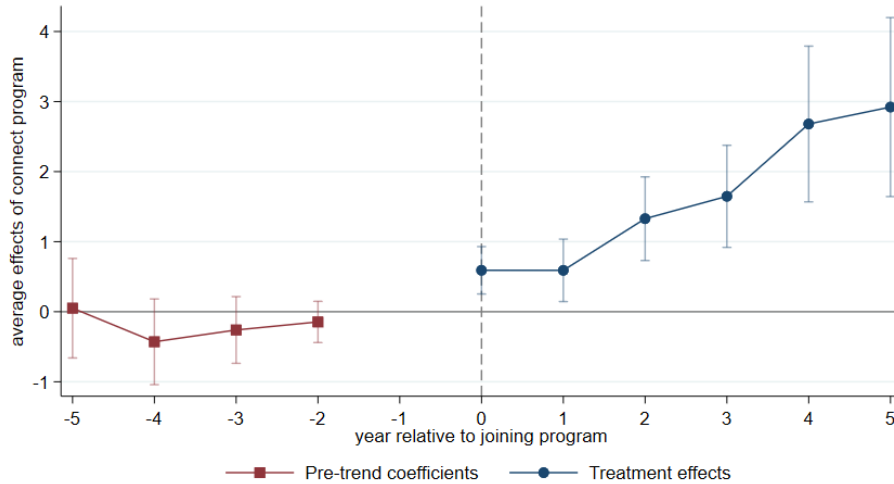
Examining the mechanisms behind the Connect program’s effect on ES performance in the next section requires that we include data on the Shenzhen Connect program to provide sufficient time-series variation. We perform a check here to see whether the combined Shanghai and Shenzhen Connect programs affect ES ratings. To do so, we add data for the initial cohort (firms joining the first day) of the Shenzhen Connect to the initial cohort of the Shanghai Connect. This changes the estimation to a staggered DD. [de Chaisemartin and d’Haultfoeuille \(2020\)](#), [Goodman-Bacon \(2021\)](#) and [Baker, Larcker and Wang \(2022\)](#) show that staggered DD estimation may bias estimates because later-treated units are compared to a combination of earlier-treated units and the control group.²⁹ [Sun and Abraham \(2021\)](#) further demonstrate that point estimates of dynamic effects under such conditions cannot be interpreted as reliable measures of "dynamic treatment effects". The recent literature ([Sun and Abraham, 2021](#); [Callaway and Sant’Anna, 2021](#); [de Chaisemartin and d’Haultfoeuille, 2023](#)) propose approaches to circumvent these problems. Figure 3 displays the results of applying the method in [Sun and Abraham \(2021\)](#) as recommended by [Baker, Larcker and Wang \(2022\)](#) to ES ratings. There is no discernible trend before firms join a Connect program but a significant upward trend after. In Appendix B.3, we report another method for checking the appropriateness of the staggered DD estimation, as well as checks for the ENV and SOC sub-ratings.

6 Mechanisms

In this section, we investigate why firms changed their ES activities after increased exposure to foreign investors through the Connect program. We examine the two main theories - signaling and influence - and then employ an approach to isolate their individual contributions.

[Lins, Servaes and Tamayo \(2017\)](#) argues that firms signal trustworthiness by investing in CSR. The investment acts like insurance that pays off when investors face a crisis of confidence and the reward for being trustworthy increases markedly. These arguments can be applied to domestic firms in China, that may signal their trustworthiness to foreign investors who face an information asymmetry. Characteristics of China’s stock market provide room for such signaling. [Firth, Wang and Wong \(2015\)](#) document that less-transparent firms are more affected by investor sentiment, and there is evidence that transparency is low for firms traded on China’s stock markets. [Allen, Qian, Shan and](#)

²⁹[Roth, Sant’Anna, Bilinski and Poe \(2023\)](#) and [de Chaisemartin and d’Haultfoeuille \(2022\)](#) provide surveys.



Note: Square and circular dots are point estimates from the generalized DD model of Sun and Abraham (2021) and bars are 95% confidence intervals based on 300 bootstrap iterations. Effect in period -1 is anchored at zero.

Figure 3

AVERAGE EFFECTS OF THE SHANGHAI AND SHENZHEN CONNECT PROGRAMS ON ES RATINGS

Zhu (2021) argues that institutional deficiencies in China's stock market, such as corporate governance, delisting procedures, and IPO process, can account for the poor performance of domestically-listed firms. Song and Xiong (2018) argue that even though China has adopted accounting regulations and standards for publicly-listed firms that are similar to most developed countries, enforcement has been lax and violation penalties low. Due to these, foreign investors might face greater information asymmetries about firms in China. Investments in ES activities by firms could raise their ES ratings and signal trustworthiness to foreign investors, reducing this information gap.

Alternatively, or in addition, foreign investors may directly influence domestic firms' ES activities. Dyck, Lins, Roth and Wagner (2019) provide evidence that investors, proportional to their concern with ESG performance, influence firms to improve their ESG ratings. Chen, Dong and Lin (2020) utilize the Russell Index reconstitution and find that an increase in institutional ownership improves subsequent CSR performance. Relatedly, Aggarwal, Erel, Ferreira and Matos (2011) find that a rise in institutional ownership is positively associated with better subsequent governance. Jia, Wang and Xiong (2017) show that local investors react more strongly to local analysts and foreign investors to foreign analysts. Given this, the commencement of the Connect programs opens domestic firms to the influence of foreign investors (and analysts) that may care more about ES performance than domestic.

For either of these mechanisms to be at play, it must be that foreign investors at the

time of the Connect program’s initiation care more about ES than China’s domestic investors. This appears to be the case. At the Shanghai Connect’s initiation in November 2014, only two investment management funds headquartered in Mainland China had joined the Principles for Responsible Investment (PRI), an international network of financial institutions supported by the United Nations and working to promote ESG factors and incorporate them into investment practices. In contrast, foreign PRI signatories increased from 734 in 2010 to 1,384 in 2015. By 2020, there were 3,038 signatories, only 49 of which were Mainland-China-based.³⁰ HKF investors also emphasize ES initiatives. About 76% of Hong Kong’s institutional investors plan to allocate similar or more resources to climate risk measurement than in the previous twelve months (HKIMR, 2022).

6.1 Combining the two theories

Under the signaling theory, ES ratings should causally increase northbound shares since foreign investors will reward higher ratings with increased ownership. Under the influence theory, northbound shareholdings should causally increase ES activities since greater foreign ownership leads to greater pressure on firms to increase them. These two theories can be summarized as a system of two simultaneous equations. Since the subsample used here is from 2013 to 2021, there are very few zero values for ES ratings (which we exclude) allowing a linear specification³¹

$$NBshare_{itq} = \beta_1 \log(y_{i,t-1}) + \beta_2 \mathbf{N}_{itq}^2 + (\beta_3 + \beta_4 \mathcal{T}_{i,t-1,q}^E) \mathbf{E}_{i,t-1,q} + \gamma' X_{i,t-1,q} + \omega_i + \nu_{tq} + \epsilon_{itq}, \quad (4a)$$

$$\log(y_{it}) = \beta_5 NBshare_{i,t-1} + \beta_6 C_i \times \mathbf{P}_{it} + (\beta_7 + \beta_8 \mathcal{T}_{i,t-1}^E) \mathbf{E}_{i,t-1} + \gamma' X_{i,t-1} + \omega_i + \nu_t + \epsilon_{it}, \quad (4b)$$

where t and q stand for year and quarter and other variables will be discussed shortly. If the signaling theory is at play, the direction of causality is from ES ratings to northbound shares (Equation 4a). If the influence theory is at play, the direction of causality is from northbound shares to ES ratings (Equation 4b). We lag values since we assume that signaling through northbound shares takes one year and ES ratings (published annually) are reported with a year lag.

The frequency of data differs in the two equations (yearly for ES ratings and quarterly for northbound shares). We discuss below how we deal with this. y_{it} is the ES rating of firm i in year t and y_{itq} is the quarterly value (the annual value replicated across the four quarters). $NBshare_{itq}$ is the northbound share of holdings for firm i in year t

³⁰As further evidence, in unreported results we find that the effects of the Connect program on the ChiNext firms’ ES performance are more significant than other Shenzhen Connect firms. Notably, the ChiNext firms are exclusively traded by HKF institutional investors.

³¹Most zero values occur prior to 2013. In this subsample there are only 5 firms (10 firm-year observations) out of 501 firms (4577 firm-year observations) with zero values.

and quarter q while $NBshare_{it}$ is the average annual value. X_{itq} are control variables, including year-quarter-firm financial characteristics described in Section 3.3 and province-, industry-, SOE-, FOE-, and "sin"-stock-by-year-by-quarter fixed effects. X_{it} contains the yearly averages of the firm financial characteristics and province-, industry-, SOE-, FOE-, and "sin"-stock-by-year fixed effects. The firm fixed effect (ω_i) captures time-invariant, firm-specific factors affecting the two endogenous variables. We show year (ν_t) and year-by-quarter (ν_{tq}) fixed effects, even though these are absorbed by other fixed effects to illustrate that this is a two-way fixed effects estimator. ϵ_{it} and ϵ_{itq} are firm-year and firm-year-quarter unobservables affecting ES ratings and northbound shares respectively.

In Equation (4a), the indicator variable for firm i exiting a Connect program (\mathbf{E}_{itq}) is included to control for the fact that foreign investors can only sell (not buy) the firm's stock once it exits. It is set equal to one beginning in the quarter the firm exits, if it does so, and zero otherwise. \mathcal{T}_{itq}^E is equal to the number of quarters since a Connect firm exited a program, if it does so, and zero otherwise. In Equation (4b), \mathbf{E}_{it} is included to control for changes in the ES rating due to a firm exiting a Connect program. It is set equal to one beginning in the year the firm exits a program, if it does so, and zero otherwise. \mathcal{T}_{it}^E is equal to the number of years since a Connect firm exited a program, if it does so, and zero otherwise.

The key coefficients of interest are β_1 , which captures the effect of ES ratings on northbound shares (the signaling effect), and β_5 , which captures the effect of northbound shares on ES ratings (the influence effect). Unless one or both of these is zero, an exogenous increase in either northbound share or ES ratings will create feedback between the two and amplify the effects. This simultaneity bias is the key challenge in estimation, which we address by using the excluded variable in each equation as an instrument. To examine the causal effect of ES ratings on northbound shares, we use a change in environmental regulation ($C_i \times \mathbf{P}_{it}$) as an instrument for ES ratings and test how foreign ownership responds to ES ratings. To examine the causal effect of northbound shares on ES ratings, we use squared duration in the Connect program (\mathbf{N}_{itq}^2) as an instrument for northbound shares and test how the ES ratings respond to a change in northbound shareholding. We use a single-equation method to address the simultaneity bias in estimating the system of equations. Therefore, we discuss these variables and identification in more detail when we discuss estimating each equation.

6.2 The signaling theory

To isolate the causal effect of ES ratings on northbound shareholdings, we employ an instrument that exogenously shifts ES ratings: an environmental regulatory change that centralized environmental monitoring and inspections (the variable $C_i \times \mathbf{P}_{it}$ excluded from Equation (4a)).³² After the policy change, provincial environmental protection departments began controlling the lower-level municipal and prefecture departments by appointing delegates to their offices and controlling their budgets. The change was implemented across all provinces except Shanxi and Xizang Autonomous Region in a staggered fashion from 2016 to 2019. Since firms' exposures to the policy are likely affected by the extent of their polluting activities, we weight firm responses by their pre-policy pollution production. \mathbf{P}_{it} is an indicator equal to one if firm i 's province is subject to the regulation in year t . We define regulatory exposure as

$$C_i = \frac{CE_i}{\overline{CE} + CE_i}, \quad (5)$$

where CE_i is firm i 's carbon emissions described in Section 3.4 averaged over the period 2009 to 2011 (pre-policy) and \overline{CE} is the average across all firms. C_i lies between zero and one and is an increasing function of firm i 's pre-policy pollution-emissions intensity. β_6 in Equation (4b) captures the differential effect on the ES ratings of more intensively-polluting firms from the regulatory change.

Identification requires that the regulation affects ES ratings but affects northbound shares only through its effect on ES ratings. The first condition is met as long as the policy sufficiently changes firms' environmental performance and, thereby, their ES ratings. We confirm the instrument's power below. The most likely challenge to the second condition is that the policy affected firms' financial performance and thereby their stock prices; and that foreign investors are more sensitive to these stock price changes than domestic investors. To check this, we run an event study regressing the stock price of all firms traded on the SSE and SZSE in the 24 months prior to and after the policy change, with the implementation month in the firm's province normalized to zero

$$sp_{itm} = \sum_{r \neq 0} \beta_r \mathbf{P}_{irtm} + \gamma' X_{itm} + \omega_i + \nu_{tm} + \epsilon_{itm}. \quad (6)$$

sp_{itm} is the average stock price, defined as monthly total trading value divided by monthly total trading volume, for firm i in month m of year t , and \mathbf{P}_{irtm} is equal to one if it is r

³²This is known as *Guiding Opinions on the Pilot Program of the Reform of the Vertical Management System of Monitoring, Supervision and Law Enforcement by Provincial-Level Environmental Protection Authority*. For details, see http://www.gov.cn/zhengce/2016-09/22/content_5110853.htm.

months relative to the regulatory change. Firm fixed effects (ω_i) capture firm-specific unobservables affecting the stock price, and X_{itm} includes province-, industry-, SOE-, FOE, and "sin"-stock-by-year-by-month fixed effects. We show a year-month fixed effect (ν_{tm}) in the specification, even though this is absorbed by the other fixed effects, to illustrate that this is a two-way fixed effects estimator. Appendix B.4 plots β_r along with 95% confidence intervals. There are no significant effects on stock prices around the staggered implementation dates. This suggests that the direct effects of the policy were not significant enough to affect stock prices and, therefore, differentially affect shares held by foreign and domestic investors. Since the instrument is orthogonal to stock returns, this also rules out that foreign investors are simply investing in financially successful firms and that ES improvements are a byproduct of their better financial conditions.

We estimate Equation (4a) using 2SLS. In the first stage, we include both Connect and non-Connect firms to increase the variation available for identification. We use data from 2013 onward because we use the previous years to compute the pre-policy emissions weightings for each firm. The data frequency in the first stage is annual (ES ratings), while the frequency in the second stage is quarterly (northbound shares) so we employ Mixed 2SLS (M2SLS), which allows for different aggregation levels in the two stages. M2SLS produces estimates that are consistent and asymptotically normal (Dhrymes and Lleras-Muney, 2006) provided that the groupings are independent of the structural error as they are when the grouping is a primitive (in our case, grouping quarterly observations into years). The first-stage equation is

$$\log y_{it} = \theta C_i \times \mathbf{P}_{it} + \sum_{k \in \{SH, SZ\}} [(\rho_1^k + \rho_2^k \mathcal{T}_{it}^k) \mathbf{SC}_i^k \times \mathbf{D}_t^k] + (\beta_1 + \beta_2 \mathcal{T}_{it}^E) \mathbf{E}_{it} + \gamma' X_{it} + \omega_i + \nu_t + \epsilon_{it}. \quad (7)$$

This includes the instrument, all the exogenous variables from the second-stage equation (Equation 4a) averaged at the annual level, plus an additional term in square brackets.³³ \mathbf{SC}_i^k is an indicator set to one if firm i is in program k (denoted by SH for Shanghai and SZ for Shenzhen) in any year. \mathbf{D}_t^k is an indicator variable set to one after Connect program k begins (2015 for Shanghai and 2017 for Shenzhen) and zero before. The terms inside the square brackets do not vary across firms within a year in the second stage and are therefore collinear with the time fixed effects in the second stage. ρ_1^k captures any level

³³To ensure the exclusion restriction is met, the first-stage equation must include the averaged values of all the exogenous variables in the second stage. The exit indicator and trend are the average values of the quarterly measures in the second stage. The firm-year characteristics and financial control variables in the first stage are the average values of the firm-year-quarter characteristics and financial control variables in the second. The firm fixed effect remains the same and the year fixed effect is the average of the year-quarter fixed effects in the second stage. Since the second stage includes only Connect firms, $\mathbf{SC}_i^k = 1$ for all observations and the term in square brackets is collinear with the time fixed effects in the second stage.

shift for the Connect relative to the non-Connect firms once the program begins.

Following [Dobkin, Finkelstein, Kluender and Notowidigdo \(2018\)](#), we allow different trends for the two programs by interacting \mathbf{SC}_i^k with \mathcal{T}_{it}^k , which equals the number of years since policy k is in effect for firm i . For firms that never join a program, it equals the number of years since the Connect program began (2015 for Shanghai and 2017 for Shenzhen) and zero before. ρ_2^k captures the change in trends for Connect firms relative to non-Connect once each policy begins. Importantly, since we include province-by-year fixed effects, the regulation's impact is identified by within-province variation over time.

In the second stage (Equation 4a), we replace $\log(y_{i,t-1})$ with the fitted values from the first stage ($\widehat{\log(y_{it})}$) lagged by one year. In doing so, we use the corresponding quarter in the previous year (e.g., the lagged fitted value for each of the four quarters in 2017 in the second stage would be the 2016 annual fitted values from the first stage). Also, since northbound shares are only available while a firm is in the Connect program, the second stage only uses year-quarters in which the firm is in the Connect program (but including exits after joining).

The top panel of Column (1) in Table 4 reports the estimates of Equation (7), where only the initial cohorts of both Connect programs are used as the treated group and those joining later are dropped from the sample. ES ratings are increasing in firms' carbon emission intensity with the advent of the regulation. Since the F -statistic for the first stage is slightly below the critical value of 10 in [Stock and Yogo \(2005\)](#), we apply the tF critical-value function developed in [Lee, McCrary, Moreira and Porter \(2022\)](#). The instrument is significant at the 7.5% level. After the regulatory change, a one standard deviation (0.22) increase in emissions intensity is associated with 4.0% higher ES ratings, or 0.23 evaluated at the mean ES rating in 2013 (5.71). In Appendix B.5, we estimate Equation (7) with the ENV and SOC sub-ratings as dependent variables as a validation test of the instrument and of Bloomberg's proper measurement of E versus S elements. As expected, the regulation has a strong effect on the ENV sub-rating both statistically and in magnitude but no significant effect on the SOC sub-rating.

The bottom panel of Column (1) reports the second-stage estimates. The effect is positive and significant. A one percent increase in ES rating leads to a 2.0 basis points increase in northbound shareholding, consistent with ES ratings acting as a positive signal for foreign investors. The average annual increase in ES ratings prior to the Connect programs (11.9%) would lead to an increase of 24 basis points in northbound shareholdings which is 18.1% of the average northbound shareholdings (1.31%).

Table 4
IV ESTIMATION OF MECHANISMS: SYSTEM OF EQUATIONS

	Signalling Theory (1)	Influence Theory (2)
<i>First-stage estimation</i>		
	ES_{it}	$NB\ share_{itq}$
$C_i \times P_{it}$	0.181*** (0.065)	
N_{itq}^2		-1.74e(-5)*** (5.51e(-6))
Obs	4,504	21,538
R^2	0.824	0.771
F statistic	9.75	9.94
tF significance	7.50%	0.75%
<i>Second-stage estimation</i>		
	$NB\ share_{itq}$	ES_{it}
$\log(\widehat{ES}_{i,t-1,q})$	0.020** (0.009)	
$\widehat{NB\ share}_{i,t-1}$		22.334** (10.269)
Obs	6,760	2,447
Province \times Year (Year-Quarter) FE	Y	Y
Industry \times Year (Year-Quarter) FE	Y	Y
SOE \times Year (Year-Quarter) FE	Y	Y
FOE \times Year (Year-Quarter) FE	Y	Y
"Sin"-Stock \times Year (Year-Quarter) FE	Y	Y
Firm Characteristics	Y	Y

Note: The first stage of Column (1) is estimated with Equation (7) and the second stage with Equation (4a). The data used in the first stage are annual and in the second stage quarterly. Lagged control variables are used in the second stage. The sample data in the first stage are from 2013 to 2021 and include both Connect and non-Connect firms in all periods. The data in the second stage are from 2017Q1 to 2021Q4 and are restricted to Connect firms in periods after they joined. The first stage of Column (2) is estimated with Equation (8) and the second stage with Equation (4b). The data used in the first stage are quarterly and those in the second stage are annual. Average annual fitted values are used in the second stage. The sample data are from 2017Q1 to 2021Q4 and includes only Connect firms in periods after they joined. Standard errors clustered by firm in both stages are in parentheses. Second stage errors based on a block bootstrap by firm (1,000 iterations). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

6.3 The influence theory

To isolate the effect of northbound shareholdings on ES ratings, we employ an instrument that exogenously shifts northbound shares but plausibly affects ES ratings only through northbound shareholdings. This is the variable (N_{itq}^2) excluded from Equation (4b) (the

linear term is absorbed by the year-quarter fixed effects). N_{itq} equals the number of quarters since firm i entered the Connect program as of year t and quarter q . The instrument is premised on the idea that northbound shareholdings exert nonlinear effects on ES ratings. For the exclusion restriction to be met, there must be no nonlinearity in ES ratings with respect to elapsed time independent of the Connect program. While this cannot be directly verified, Appendix B.6 provides suggestive evidence that this is the case. It shows that log ES ratings are nonlinear with respect to elapsed time for Connect firms but not for non-Connect firms.³⁴

Both stages of the 2SLS estimation include only data while firms belong to a Connect program, so that northbound shareholdings data are available. The first-stage equation is

$$NB\ share_{itq} = \beta_1 N_{itq}^2 + \theta C_i \times P_{itq} + (\beta_2 + \beta_3 \mathcal{T}_{itq}^E) E_{itq} + \gamma' X_{itq} + \omega_i + \nu_{tq} + \epsilon_{itq}. \quad (8)$$

This includes the instrument and all the exogenous variables from the second-stage equation (4b) measured at the quarterly level.³⁵ The latter include the effect of the environmental policy on northbound shareholdings and the level and trend change in holdings due to a firm exiting a connect program. X_{itq} includes firm-year-quarter financial characteristics described in Section 3.3 as well as province-, industry-, SOE-, FOE-, and "sin"-stock-by-year-quarter effects. Firm fixed effects (ω_i) capture time-persistent firm unobservables that affect northbound shares. We include year-by-quarter fixed effects (ν_{tq}) in the specification to indicate that this is a two-way fixed effect estimator, even though these are absorbed by the other fixed effects. In the second-stage equation (4b), we replace $NB\ share_{i,t-1}$ with the annual average of the fitted values from the first stage lagged by one year $\widehat{NB\ share}_{i,t-1}$. Since the second stage is at the annual level we again employ M2SLS.

The top panel of Column (2) in Table 4 reports the estimates for the first-stage equation using quarterly data from 2017Q1, when HKEX began disclosing northbound shareholding for individual stocks, to 2021Q4. The coefficient of N_{itq}^2 is negative and statistically significant. Applying the tF critical-value function of Lee, McCrary, Moreira and Porter (2022), the first-stage coefficient is significant at the 0.75% level. The bottom

³⁴Since annual data must be used for this test, we use a more parsimonious specification (log of elapsed time in the program). Using the square of elapsed time also results in insignificant effects for the non-Connect firms. The first stage of the 2SLS estimation uses quarterly data since we employ M2SLS.

³⁵To ensure the exclusion restriction is met, the first-stage equation must include the non-averaged values of all the exogenous variables in the second stage. The exit indicator and trend in the second stage are the average values of the corresponding first-stage variables. The firm-year characteristics and the year fixed effects in the second stage are the average values of the firm-year-quarter characteristics and year-quarter fixed effects from the first stage respectively, and the firm fixed effects in the second stage remain the same as in the first stage.

panel of Table 4 reports estimates of the second-stage equation. The sample includes only Connect firms and uses data from 2017 to 2021. For every percentage point rise in northbound shareholding in a quarter, the ES rating in the following year increases by 22.3%. This is an increase of 1.39 evaluated at the mean ES rating in 2013 (6.22). This is consistent with foreign investors influencing firms' ES ratings.

Because we find evidence consistent with both the signaling and influence theory, an exogenous increase in either northbound shareholdings or ES ratings will have greater long- than short-run effects. An exogenous one percent increase in ES ratings increases northbound shareholding in the next year by 0.02%, while an exogenous one percent increase in northbound shareholding increases ES ratings in the next year by 22.3%. Accounting for feedback between the two, the long-run effect of an exogenous increase in either will be 76.6% higher than the first-year response.

7 Conclusion

We find that deregulating China's financial system to allow more foreign investors in its stock market leads to increased ES performance for firms receiving foreign investments. The evidence is consistent with both foreign investors exerting influence on domestic firms to improve their ES performance and firms improving their ES activities to signal their trustworthiness to foreign investors. Thus, exogenous increases in either ES performance or foreign investment holdings will reinforce each other and amplify the long-term effects. This identifies an important channel for cross-country convergence in ES performance either through a transmission of concern with ES from the source to the target country or through efforts by firms in the target country to signal their quality.

It would be useful to obtain direct evidence of these mechanisms. For example, are the increased ES ratings valuable as a signal to foreign investors in later times of crisis? Alternatively, do firms that are more opaque by some measure benefit more from the increased ES ratings that result from foreign investment? Does ES performance increase relatively more for firms that receive investments from foreign investors that value ES relatively more? This would require a measure of the value that foreign investors place on ES. Given the feedback between the two mechanisms, it is essential to disentangle the two in order to estimate the causal effects of these direct measures. The instrumenting approach developed in this paper could be used to do so by estimating sub-samples split by the direct measures.

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A Data

A.1 Construction of SSE and SZSE stock indexes

The SSE 180 Index is constructed as follows. After excluding stocks listed for less than one quarter or under ST, all remaining are assigned an aggregate rank which equals the sum of their ranks on market capitalization and trading volume during the past year. To make the index representative of industry composition in the entire market, a quota for the number of firms in each industry is calculated by multiplying 180 by the market value share of all stocks in the industry divided by the total market value of all stocks. Firms are then selected into the index by their aggregate rank within each industry and subject to the quota. The SSE 380 index is constructed similarly, except stocks paying no dividends in the previous five years or for more than five years cumulatively are excluded.

For the SZSE Component Index, stocks listed less than a half year, under ST, or with market capitalization in the top 1% are excluded. All remaining stocks are sorted based on their aggregate rank, which equals the sum of their ranks on market capitalization and trading volume during the previous half year. After filtering out those in the bottom 10% of this aggregate rank, the top 500 stocks are selected based on their market capitalization ranking but subject to the same industry representation as in the aggregate market. After removing the SZSE Component Index constituents from the SZSE 1000 Index, which adopts the same method of construction as the SZSE Component Index, the remaining 500 stocks are selected as the SZSE Small/Mid-Cap Innovation Index constituents, again subject to the same industry representation as in the aggregate market.

A.2 Bloomberg ESG data

Proprietary ESG ratings and three sub-ratings are provided by Bloomberg, which began publishing in 2020. The ratings are based on over 600 company-reported and derived key performance indicators. In particular

1. Environment

- **Air Quality:** Air Quality Disclosure Score, Nitrogen Oxide Emissions, VOC Emissions, Carbon Monoxide Emissions, Particulate Emissions, Sulphur Dioxide/Sulphur Oxide Emissions
- **Climate Change:** Climate Change Disclosure Score, Emissions Reduction Initiatives, Climate Change Policy, Climate Change Opportunities Discussed,

Risks of Climate Change Discussed, Direct CO2 Emissions, Indirect CO2 Emissions, ODS Emissions, GHG Scope 1/2/3, Scope 2 Market Based GHG Emissions, Scope of Disclosure, Carbon per Unit of Production

- Ecological & Biodiversity Impacts: Ecological & Biodiversity Impacts Disclosure Score, Biodiversity Policy, Number of Environmental Fines, Environmental Fines (Amount), Number of Significant Environmental Fines, Amount of Significant Environmental Fines
- Energy: Energy Disclosure Score, Energy Efficiency Policy, Total Energy Consumption, Renewable Energy Use, Electricity Used, Fuel Used - Coal/Lignite, Fuel Used - Natural Gas, Fuel Used - Crude Oil/Diesel, Self Generated Renewable Electricity, Energy Per Unit of Production
- Materials & Waste: Materials & Waste Disclosure Score, Waste Reduction Policy, Hazardous Waste, Total Waste, Waste Recycled, Raw Materials Used, % Recycled Materials, Waste Sent to Landfills, Percentage Raw Material from Sustainable Sources
- Supply Chain: Supply Chain Disclosure Score, Environmental Supply Chain Management
- Water: Water Disclosure Score, Water Policy, Total Water Discharged, Water per Unit of Production, Total Water Withdrawal, Water Consumption

2. Social

- Community & Customers: Community & Customers Disclosure Score, Human Rights Policy, Policy Against Child Labor, Quality Assurance and Recall Policy, Consumer Data Protection Policy, Community Spending, Number of Customer Complaints, Total Corporate Foundation and Other Giving
- Diversity: Diversity Disclosure Score, Equal Opportunity Policy, Gender Pay Gap Breakout, % Women in Management, % Women in Workforce, % Minorities in Management, % Minorities in Workforce, % Disabled in Workforce, Percentage Gender Pay Gap for Senior Management, Percentage Gender Pay Gap Mid & Other Management, Percentage Gender Pay Gap Employees Ex Management, % Gender Pay Gap Total Employment Including Management, % Women in Middle and or Other Management
- Ethics & Compliance: Ethics & Compliance Disclosure Score, Business Ethics Policy, Anti-Bribery Ethics Policy, Political Donations

- Health & Safety: Health & Safety Disclosure Score, Health and Safety Policy, Fatalities - Contractors, Fatalities - Employees, Fatalities - Total, Lost Time Incident Rate, Total Recordable Incident Rate, Lost Time Incident Rate - Contractors, Total Recordable Incident Rate - Contractors, Total Recordable Incident Rate - Workforce, Lost Time Incident Rate - Workforce
- Human Capital: Human Capital Disclosure Score, Training Policy, Fair Remuneration Policy, Number of Employees - CSR, Employee Turnover %, % Employees Unionized, Employee Training Cost, Total Hours Spent by Firm - Employee Training, Number of Contractors
- Supply Chain: Supply Chain Disclosure Score, Social Supply Chain Management, Number of Suppliers Audited, Number of Supplier Audits Conducted, Number Supplier Facilities Audited, Percentage of Suppliers in Non-Compliance, Percentage Suppliers Audited

3. Governance

- Audit Risk & Oversight: Audit Risk & Oversight Disclosure Score, Audit Committee Meetings, Years Auditor Employed, Size of Audit Committee, Number of Independent Directors on Audit Committee, Audit Committee Meeting Attendance Percentage
- Board Composition: Board Composition Disclosure Score, Company Conducts Board Evaluations, Size of the Board, Number of Board Meetings for the Year, Board Meeting Attendance %, Number of Executives / Company Managers, Number of Non-Executive Directors on Board
- Compensation: Compensation Disclosure Score, Company Has Executive Share Ownership Guidelines, Director Share Ownership Guidelines, Size of Compensation Committee, Number of Independent Directors on Compensation Committee, Number of Compensation Committee Meetings, Compensation Committee Meeting Attendance %
- Diversity: Diversity Disclosure Score, Board Age Limit, Number of Female Executives, Number of Women on Board, Age of the Youngest Director, Age of the Oldest Director
- Independence: Independence Disclosure Score, Number of Independent Directors
- Nominations & Governance Oversight: Nominations & Governance Oversight Disclosure Score, Size of Nomination Committee, Number of Independent Di-

rectors on Nomination Committee, Number of Nomination Committee Meetings, Nomination Committee Meeting Attendance Percentage

- Sustainability Governance: Sustainability Governance Disclosure Score, Verification Type, Employee CSR Training
- Tenure: Tenure Disclosure Score, Board Duration (Years)

A.3 Reporting probability by Bloomberg

To test whether the selection criteria for Bloomberg to produce an ESG rating for a firm are orthogonal to inclusion in the Stock Connect programs, we estimate Equation (1). Table A.1 reports the estimates.

Table A.1
REPORTING PROBABILITY BY BLOOMBERG

	(1)	(2)	(3)	(4)
SC_i	-0.32 (0.200)	-0.38* (0.209)	-0.52 (0.396)	-0.59 (0.421)
$SC_i \times D_t$	0.39 (0.311)		0.90 (0.762)	
$SC_i \times D_{i,t-1}$		0.42 (0.313)		1.05 (0.748)
Method	probit	probit	logit	logit
Obs	4,383	3,726	4,383	3,726
Control Variables	t	$t-1$	t	$t-1$
Province \times Year FE	Y	Y	Y	Y
Industry \times Year FE	Y	Y	Y	Y
SOE \times Year FE	Y	Y	Y	Y
FOE \times Year FE	Y	Y	Y	Y
"Sin"-Stock \times Year FE	Y	Y	Y	Y

Note: Selected coefficients from estimating Equation (1) using probit and logit models. An indicator variable for whether Bloomberg includes the firm in their ESG ratings is the dependent variable. The control variables are lagged or not as shown in the bottom panel. Standard errors clustered by firm are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

A.4 Bloomberg ES ratings and stock returns

Berg, Fabisik and Sautner (2020) shows that some vendors may revise ESG scores retrospectively, making them more predictive of future corporate performance. Following that

paper, we test the correlation between future stock returns and Bloomberg ES ratings:

$$\mathbf{SR}_{it} = \alpha \mathbf{ES}_{i,t-1} + \gamma' X_{it} + \omega_i + \nu_t + \epsilon_{it} \quad (\text{A1})$$

Here, \mathbf{SR}_{it} is the stock return and \mathbf{ES}_{it} is the annual ES rating of firm i in year t . X_{it} includes controls that may affect ES ratings including firm financial characteristics described in Section 3.3 as well as firm-characteristic-by-year fixed effects (industry-by-year, province-by-year, SOE-by-year, FOE-by-year, and “sin”-stock-by-year fixed effects) that capture time-varying industry, province, SOE, FOE, and “sin”-stock effects. Firm fixed effects (ω_i) capture time-invariant, firm-specific unobservables that affect stock returns. We display a year fixed effect (ν_t) to indicate that this is a two-way fixed effect estimator, even though the firm-characteristic-by-year fixed effects absorb these.

Table A.2 presents the estimated results for Equation (A1). In Columns 1 and 2, the estimation is performed on the full sample. The analysis reveals that the coefficients for both the lagged and two-period lagged ES ratings are not significant. In Columns 3 and 4, the analysis is replicated using the same sample of firms as in our benchmark regression, confirming the robustness of the results. Finally, Columns 5 and 6 use the subsample employed in our mechanisms test (from 2017 to 2021). The findings remain consistent.

A.5 Pre-trend tests for sub-ratings

Using Equation (2), we test the pre-trend for the ENV and SOC sub-ratings. As shown in Figures A.1, the pre-trends for the Shanghai Connect firms are similar to those of the non-Connect firms for both sub-ratings.

A.6 Variable definitions

- ROA: Net income divided by book value of total assets at quarter end. Source: CSMAR.
- Growth rate of sales: The firm’s year-over-year change in sales. Source: CSMAR.
- Market capitalization: The firm’s closing price at month end multiplied by its month-end share outstanding divided by the aggregated market capitalization of the Chinese domestic stock market (SSE and SZSE as applicable). Source: CSMAR.
- Tobin’s Q: The book value of total assets minus the book value of equity plus the market value of equity scaled by the book value of total assets at each year end. Source: CSMAR.

Table A.2
CORRELATION BETWEEN BLOOMBERG ES RATINGS AND STOCK RETURNS

	(1)	(2)	(3)	(4)	(5)	(6)
$ES_{i,t-1}$	0.049 (0.061)		0.112 (0.077)		-0.069 (0.086)	
$ES_{i,t-2}$		-0.028 (0.073)		0.031 (0.091)		-0.142 (0.109)
Observations	9,271	8,159	5,083	4,616	4,881	4,624
R^2	0.734	0.740	0.790	0.797	0.795	0.791
Province \times Year FE	Y	Y	Y	Y	Y	Y
Industry \times Year FE	Y	Y	Y	Y	Y	Y
SOE \times Year FE	Y	Y	Y	Y	Y	Y
FOE \times Year FE	Y	Y	Y	Y	Y	Y
"Sin"-Stock \times Year FE	Y	Y	Y	Y	Y	Y
Firm Characteristics	Y	Y	Y	Y	Y	Y

Note: Selected coefficients from estimating Equation (A1). The dependent variable is stock returns, defined as the percent change in the year-end stock price. ES is the annual ES rating. X_{it} includes controls that may affect ES ratings including firm financial characteristics described in Section 3.3 as well as firm-characteristic-by-year fixed effects (industry-by-year, province-by-year, SOE-by-year, FOE-by-year, and "sin"-stock-by-year fixed effects) that capture time-varying industry, province, SOE, FOE, and "sin"-stock effects. Columns 1 and 2 estimate with the full sample, Columns 3 and 4 estimate with the subsample used in our benchmark regression, and Columns 5 and 6 estimate with the subsample between 2017 and 2021. Standard errors clustered by firm are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

- Cash flow to assets ratio: Cash and cash equivalents divided by the book value of total assets measured at year end. Source: CSMAR.
- Leverage ratio: book value of debt divided by the book value of total assets measured at year end. Source: CSMAR.
- SOE: A dummy variable equal to one if a firm's ultimate owner or blockholder is a government related entity, and zero otherwise. Source: CSMAR, WIND.
- POE: A dummy variable equals to one if a firm's ultimate owner or blockholder is an individual or other non-government related entity, and zero otherwise. Source: CSMAR, WIND.
- FOE: A dummy variable equal to one if a firm's ultimate owner or blockholder is a foreign/HMT related entity, and zero otherwise. Source: CSMAR, WIND.
- QFII share: QFII share (%) The fraction of shares hold by qualified investor institutional investors (QFII) at year end. Source: CSMAR.

- Insider trade: insider selling as a percentage of the firm’s market capitalization on day t . Source: CSMAR.
- Turnover rate: Average daily turnover over the past 12 months. Turnover is defined as trading volume (in shares) divided by total shares outstanding. Source: CSMAR
- Average daily return: Average daily return over the past 12 months. Source: CSMAR.
- SD of daily return: Standard deviation of daily stock return. Source: CSMAR.

B Additional Tests

B.1 Test with ES level using linear regression

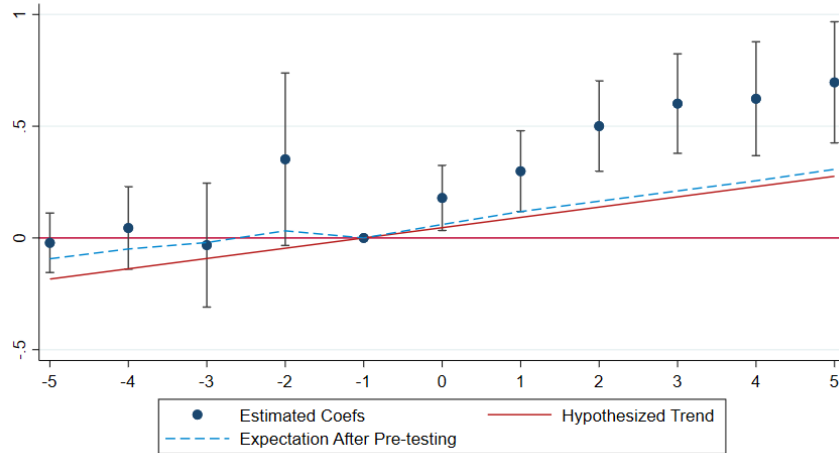
In Table B.1, we replicate the benchmark specification and robustness checks with the levels of ES rating and ENV and SOC sub-ratings, using a linear OLS regression.

B.2 Staggered and stacked estimation with all cohorts of the Shanghai and Shenzhen Connect programs

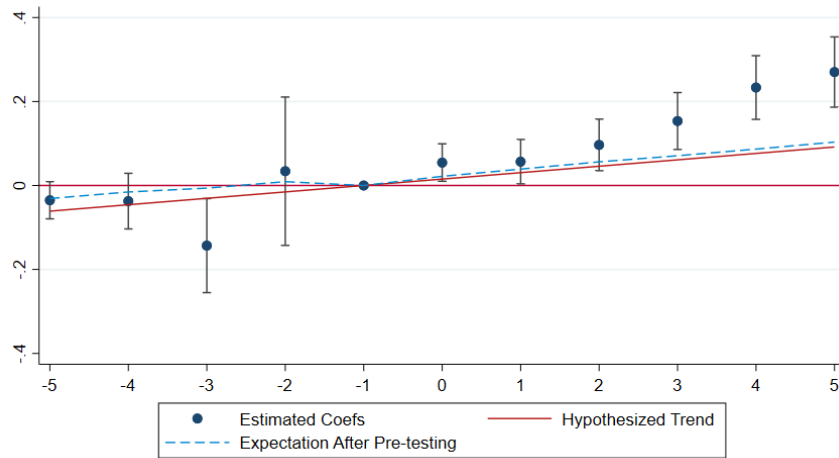
In this section, we pool all Connect firms of the Shanghai and Shenzhen programs together to estimate the causal effect of the Connect programs on various outcomes. We employ DD estimation with Connect firms as the treatment group and all other (non-Connect) firms traded on the exchange as the control group. Since inclusion in the Connect program is orthogonal to factors affecting ESG, the effect on the treatment relative to the control group is the causal effect of the Connect program on the outcome. We employ a parametric DD approach to allow for a differential time trend prior to the policy implementation relative to after

$$\begin{aligned}
y_{ijt} = & \sum_{k \in \{SH, SZ\}} \left[\beta_0^k \mathbf{SC}_i^k \mathcal{T}_t^{2009} + (\beta_1^k + \beta_2^k \mathcal{T}_{it}^k + (\beta_3^k + \beta_4^k \mathcal{T}_{it}^k) \mathbf{SC}_i^k) \mathbf{D}_{it}^k \right] \\
& + (\beta_5 + \beta_6 \mathcal{T}_{it}^E) \mathbf{E}_{it} + \gamma' X_{it} + \nu_{jt} + \alpha_i + \epsilon_{ijt}, \tag{A1}
\end{aligned}$$

where y_{ijt} is the outcome of interest including the annual ESG rating and sub-ratings for firm i in industry j in year t . \mathbf{SC}_i^k is as defined earlier – an indicator set to one if firm i is in program k in any year. \mathbf{D}_{it}^k is an indicator variable set to one if policy k is in effect for firm i in year t . For non-Connect firms, this is set to one after the Connect programs



(a) ENV sub-rating



(b) SOC sub-rating

Note: Dots are point estimates and bars are 95% confidence intervals from the event study in Equation (2) estimated using PPML. Red-solid line is hypothetical trend estimated according to Roth (2022). Blue-dashed line represents the average point estimates conditional on not finding a significant pre-trend if the red-solid was the true line. Generated using the Stata “pretends” package.

Figure A.1

EVENT-STUDY ESTIMATES FOR SUB-RATINGS FOR SHANGHAI CONNECT PROGRAM

begin (2015 for Shanghai and 2017 for Shenzhen) and zero before. For Connect firms this equals one beginning in the year they join the Connect program and zero before. E_i is an indicator variable set to one in all years t after firm i exits a Connect program after having previously entered. β_1^k captures any level shift with the commencement of program k while β_3^k captures any level shift for the Connect relative to the non-Connect firms. β_5 captures any level shift for firms leaving either program relative to being in the program.

Table B.1
EFFECT OF SHANGHAI CONNECT PROGRAM ON ES RATINGS AND SUB-RATINGS — LINEAR ESTIMATION

	ES					ENV	SOC
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$SC_i \times D_t$	1.061** (0.463)	0.792 (0.484)	0.087 (0.552)		0.652 (0.493)	0.849 (0.665)	0.731 (0.541)
$SC_i \times D_t \times T_t$		0.837*** (0.245)	0.892*** (0.244)		0.778*** (0.253)	0.953*** (0.353)	0.711*** (0.236)
$SC_i \times D_t \times SOE_i$				0.219 (0.544)			
$SC_i \times D_t \times POE_i$				1.097 (0.809)			
$SC_i \times D_t \times FOE_i$				-1.320 (2.605)			
$SC_i \times D_t \times T_t \times SOE_i$				0.507* (0.287)			
$SC_i \times D_t \times T_t \times POE_i$				1.189*** (0.409)			
$SC_i \times D_t \times T_t \times FOE_i$				1.213* (0.671)			
E_{it}	0.645 (0.547)	0.085 (0.569)	0.246 (0.568)	0.074 (0.562)	0.361 (0.602)	0.177 (0.889)	-0.013 (0.454)
$E_{it} \times T_{it}^E$	-0.563** (0.257)	-0.763*** (0.261)	-0.753*** (0.257)	-0.800*** (0.264)	-0.785*** (0.273)	-1.211*** (0.392)	-0.279 (0.272)
Observations	5,083	5,083	5,083	5,083	4,815	5,083	5,083
R^2	0.809	0.813	0.816	0.814	0.816	0.742	0.852
Province \times Year FE	Y	Y	Y	Y	Y	Y	Y
Industry \times Year FE	Y	Y	Y	Y	Y	Y	Y
SOE \times Year FE	Y	Y	Y	Y	Y	Y	Y
FOE \times Year FE	Y	Y	Y	Y	Y	Y	Y
"Sin"-Stock \times Year FE	Y	Y	Y	Y	Y	Y	Y
Firm Char	Y	Y	Y	Y	Y	Y	Y
Firm Char \times D_t	N	N	Y	N	N	N	N

Note: Selected coefficients from estimating a linear version of Equation (3) with different dependent variables. SC_i is an indicator set to one if firm i is the first cohort of firms in Shanghai Connect program and stays in the program at least two years and zero otherwise. D_t is an indicator variable set to one beginning in 2015 and zero before. E_{it} is an indicator variable set to one beginning in year t if firm i exits the Connect program in year t after having previously entered, and zero otherwise. T_t measures the number of years since 2015. T_{it}^E equals the number of years since a treatment firm exits either program, if it did so, and zero otherwise. Columns 1 through 5 estimate with ES rating as the dependent variable, Column 6 with the ENV sub-rating, and Column 7 with the SOC sub-rating. All columns use OLS regressions. Standard errors clustered by firm are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

T_{it}^{2009} is equal to the number of years since 2009. T_{it}^k is equal to the number of years since policy k is in effect for firm i . For firms that never join a program, it equals the number of years since the Connect program began (2015 for Shanghai and 2017 for Shenzhen) and zero before. For firms that join a program it equals the number of years since they joined and zero otherwise. T_{it}^E is equal to the number of years since a Connect firm exited program k , if it does so, and zero otherwise. β_0^k captures any differential time trend for Connect firms under program k over the entire sample period (the industry-by-year fixed effects capture the baseline trends). β_2^k captures any change in trend when policy k

begins while β_4^k captures the relative change in trend for Connect firms once the policy begins. β_6 captures any change in trend for firms leaving either program relative to the trend under the program.

X_{it} includes controls that may affect ESG ratings. This includes province fixed effects that capture unobservables common to a province and firm financial characteristics described in Section 3.3. Industry-by-year fixed effects (v_{jt}) capture industry-specific unobservables by year that influence ESG ratings. Firm fixed effects (α_i) capture time-invariant, firm-specific unobservables that affect ESG ratings.

This is a staggered DD estimation – effects are identified by both cross-sectional and time series variation. Cross-sectionally, some firms qualified for Connect while others did not for reasons unrelated to ESG ratings. Dynamically, the Shanghai and Shenzhen programs were implemented in different years. Additional time series variation is provided by firms entering and exiting the Connect programs at different times as they gained or lost qualification, again for reasons unrelated to their ESG ratings.

Table B.2 presents the point estimates of Equation (A1). In the staggered estimation, firms that joined the Connected program between 2015 and 2017 are selected as the treatment group, while firms that never joined or joined after 2020 serve as the control group. The sample period spans from 2009 to 2020. As shown in Columns (1) through (3), our main results from the estimation of the benchmark model are robust, with coefficients similar in scale to those in the benchmark case.

We then estimate Equation (A1) using the stacked method (Cengiz, Dube, Lindner and Zipperer, 2019). Specifically, we treat firms that joined the Connect program in a particular year as a cohort of the treatment group, while firms that never joined or joined after 2020 serve as the control group. Observations for each cohort are truncated five years before and after the event year, stacked together, and the cohort fixed effects are interacted with all other fixed effects to account for repeated observations. Columns (4) through (6) in Table B.2 report these point estimates, with standard errors clustered by firm and cohort. Our main results remain robust.

B.3 Robustness checks — staggered DD estimation of Connect programs' effects using initial cohorts of Shanghai and Shenzhen programs

Here we perform additional robustness checks of the appropriateness of the staggered DD estimation using initial cohorts of both the Shanghai and Shenzhen Connect programs. Figure B.1 displays the results of applying the method proposed by de Chaisemartin and

Table B.2
ROBUSTNESS CHECK WITH ALL COHORTS OF SHANGHAI AND SHENZHEN CONNECT FIRMS

	Staggered DD Estimation			Stacked DD Estimation		
	ES	ENV	SOC	ES	ENV	SOC
	(1)	(2)	(3)	(4)	(5)	(6)
$SC_i^{SH} \times D_{it}^{SH}$	0.077 (0.058)	0.317** (0.138)	0.003 (0.046)	0.044 (0.037)	0.225** (0.090)	-0.018 (0.030)
$SC_i^{SH} \times D_{it}^{SH} \times T_{it}^{SH}$	0.084*** (0.029)	0.160** (0.063)	0.050** (0.024)	0.063*** (0.020)	0.105** (0.045)	0.035** (0.016)
$SC_i^{SZ} \times D_{it}^{SZ}$	0.050 (0.047)	0.098 (0.123)	-0.002 (0.032)	0.022 (0.026)	0.064 (0.069)	-0.027 (0.016)
$SC_i^{SZ} \times D_{it}^{SZ} \times T_{it}^{SZ}$	0.032 (0.024)	0.009 (0.052)	0.026 (0.018)	0.020 (0.014)	-0.001 (0.030)	0.015 (0.010)
E_{it}	-0.063* (0.036)	-0.081 (0.074)	-0.043* (0.025)	-0.070*** (0.020)	-0.089** (0.042)	-0.048*** (0.014)
$E_{it} \times T_{it}^E$	-0.041* (0.024)	-0.102* (0.058)	-0.003 (0.017)	-0.040*** (0.013)	-0.092*** (0.033)	-0.002 (0.009)
Observations	9,048	9,048	9,048	24,561	24,561	24,561
Pseudo R^2	0.450	0.598	0.374	0.446	0.595	0.367
Province \times Year FE	Y	Y	Y	Y	Y	Y
Industry \times Year FE	Y	Y	Y	Y	Y	Y
SOE \times Year FE	Y	Y	Y	Y	Y	Y
FOE \times Year FE	Y	Y	Y	Y	Y	Y
"Sin"-Stock \times Year FE	Y	Y	Y	Y	Y	Y
Firm Characteristics	Y	Y	Y	Y	Y	Y

Note: Selected coefficients from estimating Equation (A1). SC_i^k is an indicator set to one if firm i is in program k in any year. D_{it}^k is an indicator variable set to one if the policy is in effect for firm i in year t for program k . For Shanghai (Shenzhen) control firms this equals one in 2015 (2017) and later and zero otherwise. For treatment firms this equals one in the years after they join the Connect program and zero before. E_i is an indicator variable set to one if firm i exits either of the Connect programs in year t after having previously entered. T_{it}^k measures the number of years firm i has been subject to policy k . For Shanghai (Shenzhen) control firms it equals the number of years since 2015 (2017) and zero before. For treatment firms it equals the number of years since joining program k and zero before. T_{it}^E equals the number of years since a treatment firm exits either program if it did so and zero otherwise. In Column (4) through (6), the stacked method is applied (Cengiz, Dube, Lindner and Zipperer, 2019). All columns use PPML estimation. Standard errors clustered by firm from Column (1) through (3) and by firm by cohort from Column (4) through (6) are in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

d’Haultfoeuille (2023) on the ES rating. There is no discernible trend prior to firms joining a Connect program, but a significant upward trend after the policy takes effect.

Figure B.2 applies the same method to the ENV and SOC sub-ratings. For both, there is no discernible trend prior to joining a Connect program, but a significant upward trend after the policy takes effect.

Since Table 1 shows that some characteristics of connect and unconnected firms are statistically different, we perform the estimation method as in Callaway and Sant’Anna (2021), who propose a doubly robust DD estimator based on stabilized inverse probability

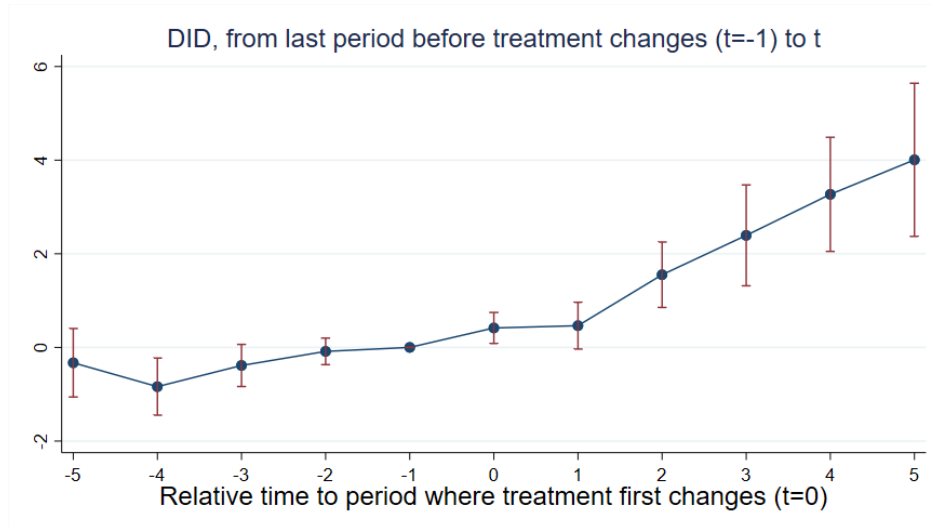


Figure B.1

AVERAGE EFFECTS FOR ES RATING USING METHOD IN [DE CHAISEMARTIN AND D’HAULTFOEUILLE \(2023\)](#)

weighting. As shown Figure B.3, our results are robust.

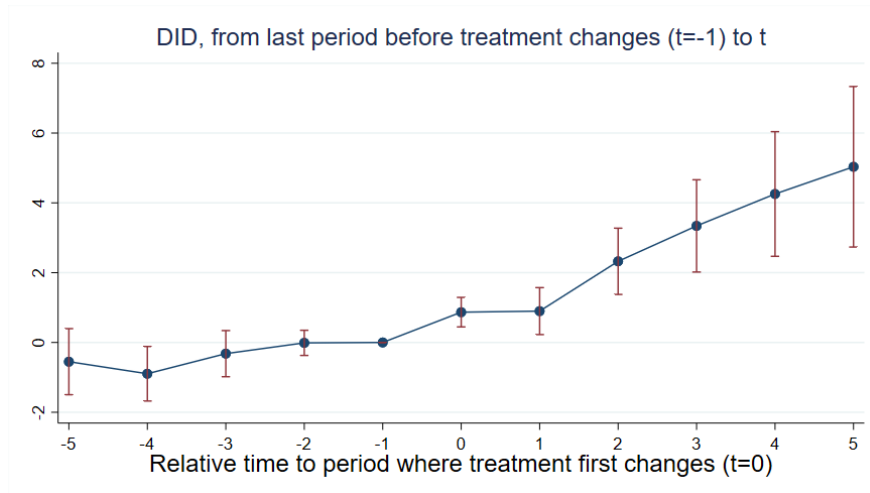
Figure B.4 displays results of applying the method proposed by [Sun and Abraham \(2021\)](#) to the ENV and SOC sub-ratings. There is no discernible trend prior to firms joining a Connect program, but a significant upward trend after the policy takes effect.

B.4 Event study for stock price reaction to environmental policy

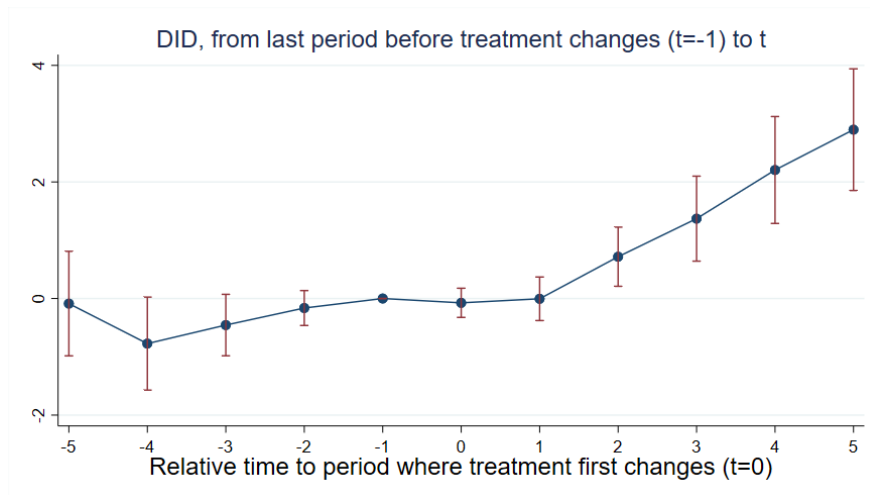
Figure B.5 shows the coefficients and 95% confidence intervals for the stock-price event study in Equation (6) of the main text. Estimation uses 24 months of data before and after the environmental policy change and includes all stocks on the SSE and SZSE.

B.5 Relevance of the environmental policy instrument

In order to examine the relevance of the environmental policy, we estimate Equation (7) with the ENV and SOC sub-ratings as dependent variables. Since 743 firm-year observations out of 4,577 are zero for the ENV sub-rating, we apply PPML. The results are shown in Table B.3. As expected, the environmental regulation has a strong effect on the ENV sub-rating both statistically and in magnitude (82.2%) but no significant effect on the SOC sub-rating.



(a) ENV sub-rating



(b) SOC sub-rating

Figure B.2

AVERAGE EFFECTS FOR SUB-RATINGS USING METHOD IN [DE CHAISEMARTIN AND D'HAULTFOEUILLE \(2023\)](#)

B.6 Suggestive evidence for exclusion restriction of N_{itq}^2

This section provides suggestive evidence that the instrument N_{itq}^2 in Section 6.3 affects ES ratings only through northbound shareholdings. Since this analysis relates elapsed time in the program to ES ratings, annual data must be used. As a result, we employ a more parsimonious nonlinear function (log of elapsed years) than the square of elapsed quarters used in our 2SLS estimation (the linear trend in ES ratings is absorbed by the

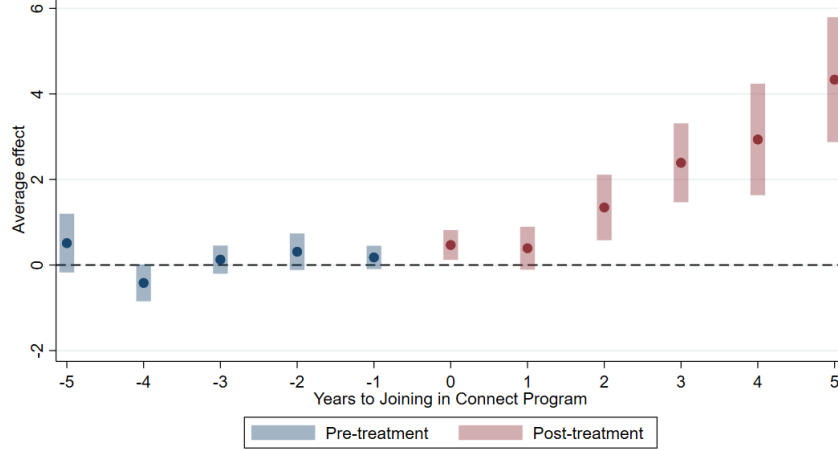


Figure B.3

AVERAGE EFFECTS FOR ES USING METHOD IN [CALLAWAY AND SANT'ANNA \(2021\)](#)

Table B.3

RESPONSE OF ENV AND SOC SUB-RATINGS TO ENVIRONMENTAL POLICY CHANGE

	ENV	SOC
$C_i \times \mathbf{P}_{it}$	0.600*** (0.156)	0.050 (0.046)
Obs	4,577	4,577
Pseudo R^2	0.781	0.831
F Statistic	14.76	1.18
Province \times Year-Quarter FE	Y	Y
Industry \times Year-Quarter FE	Y	Y
SOE \times Year-Quarter FE	Y	Y
FOE \times Year-Quarter FE	Y	Y
"Sin"-Stock \times Year-Quarter FE	Y	Y
Firm Characteristics	Y	Y

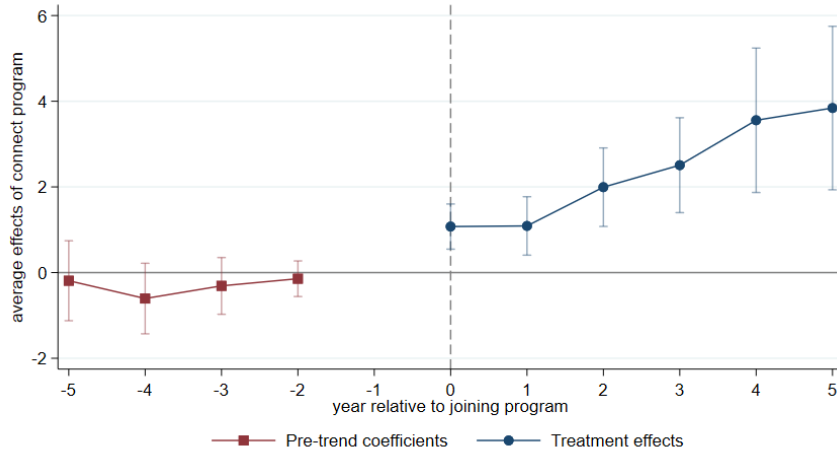
Note: Equation (7) estimated with PPML. The sample data are from 2013 to 2021 and include both Connect and non-Connect firms in all periods. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

year fixed effects).³⁶ We estimate:

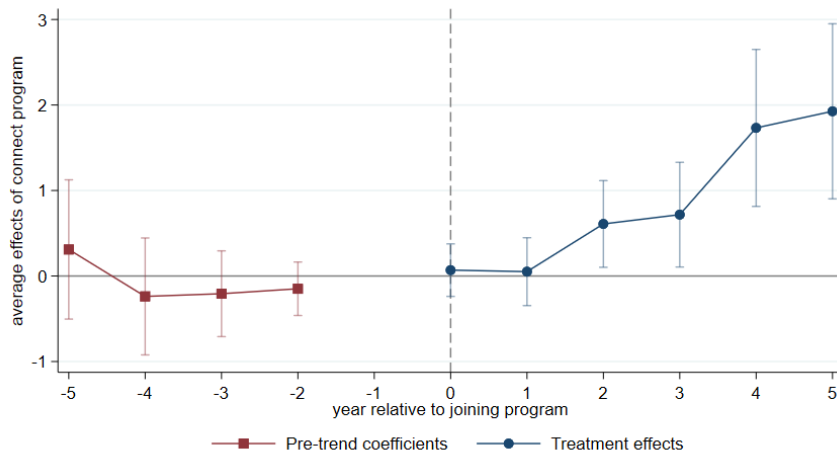
$$\log \mathbf{ES}_{it} = \beta_1 \log \mathbf{N}_{it} + (\beta_2 + \beta_3 \mathcal{T}_{it}^E) \mathbf{E}_{it} + \gamma' X_{it} + \omega_i + \nu_t + \epsilon_{it}, \quad (\text{A2})$$

where $\log \mathbf{ES}_{it}$ is the logarithm of annual ES rating for firm i in year t . \mathbf{N}_{it} is the number of years since the Connect program began. For the Shanghai program this is the number of years since 2015 and for the Shenzhen program the number of years since

³⁶The square of elapsed years also has an insignificant effect on log ES ratings for non-Connect firms.



(a) ENV sub-rating

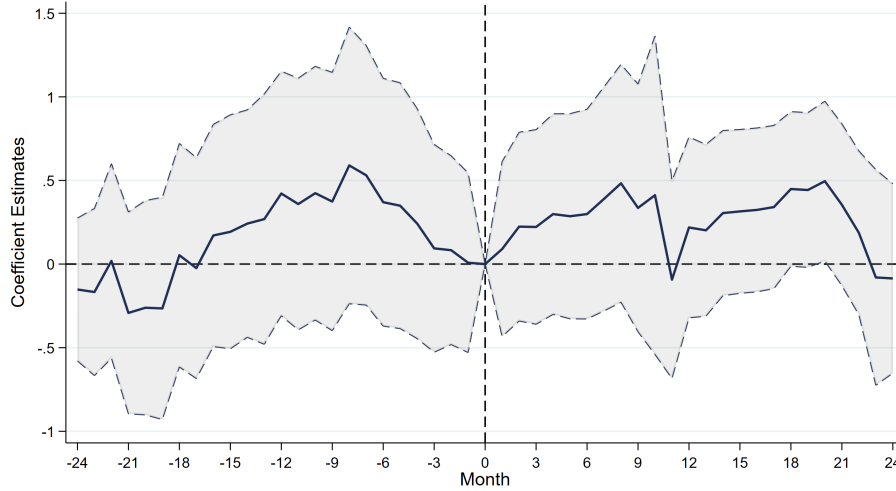


(b) SOC sub-rating

Figure B.4

AVERAGE EFFECTS FOR SUB-RATINGS USING METHOD IN [SUN AND ABRAHAM \(2021\)](#)

2017. E_i is an indicator set to one in all years t after firm i exits a Connect program, if it does so, after having previously entered and zero otherwise. T_{it}^E is equal to the number of years since a Connect firm exited a program, if it does so, and zero otherwise. X_{it} includes controls that may affect ES ratings including firm financial characteristics described in Section 3.3 as well as firm-characteristic-by-year fixed effects (industry-by-year, province-by-year, SOE-by-year, FOE-by-year, and “sin”-stock-by-year fixed effects) that capture time-varying industry, province, SOE, FOE, and “sin”-stock effects. Firm fixed effects (ω_i) capture time-invariant, firm-specific unobservables that affect ES rat-



Note: Solid lines are point estimates and shaded area 95% confidence intervals from the event study in Equation (6).

Figure B.5

EVENT STUDY FOR STOCK PRICE EFFECTS FROM ENVIRONMENTAL POLICY

ings. We display a year fixed effect (ν_t) to indicate that this is a two-way fixed effect estimator, even though the firm-characteristic-by-year fixed effects absorb these. This analysis utilizes data from 2017 to 2021, consistent with the time frame used in Section 6.3.

The first two columns of Table B.4 estimate Equation (A2) for the first cohort of firms in the Shanghai Connect program. Column (1) uses the contemporaneous elapsed time, while Column (2) uses the lagged value (the 2SLS estimates employ lagged values of northbound shareholdings). Both specifications show that log ES ratings are increasing and concave in the elapsed time since firms entered the Connect program. Columns (3) and (4) repeat these estimates for the first cohort of firms in the Shenzhen Connect program. The results are similar, again showing an increasing and concave effect of elapsed time on annual ES ratings.

Columns (5) and (6) of Table B.4 estimate the following equation for non-Connect firms on the Shanghai and Shenzhen stock exchanges:

$$\log \mathbf{ES}_{it} = (\beta_{1a} \mathbf{SSE}_i + \beta_{1b} \mathbf{SZSE}_i) \times \log \mathbf{N}_{it} + (\beta_2 + \beta_3 \mathcal{T}_{it}^E) \mathbf{E}_{it} + \gamma' X_{it} + \omega_i + \nu_t + \epsilon_{it}, \quad (\text{A3})$$

where \mathbf{SSE}_i and \mathbf{SZSE}_i are indicators distinguishing firms on the Shanghai and Shenzhen stock exchanges. Column (5) of Table B.4 estimates this equation using contemporaneous values for elapsed time (\mathbf{N}_{it} is set to the number of years since 2015 for Shanghai exchange firms and since 2017 for Shenzhen exchange firms). β_{1a} and β_{1b} are both insignificant.

Column (6) repeats this estimation using lagged elapsed time. Both coefficients are again insignificant for firms on both exchanges.

Overall, these results are consistent with log ES ratings being increasing and concave with respect to elapsed time in the program for Connect firms. In contrast, log ES ratings for non-Connect firms display no nonlinear effects with respect to elapsed time in the program. This provides suggestive evidence that elapsed time exerts nonlinear effects on log ES ratings via northbound shareholdings but not directly.

Table B.4
SUGGESTIVE EVIDENCE FOR EXCLUSION RESTRICTION OF N_{itq}^2

	SSE-Connect Firms		SZSE-Connect Firms		Non-Connect firms	
	(1)	(2)	(3)	(4)	(5)	(6)
$\log N_{it}$	0.149*** (0.055)		0.105*** (0.036)			
$\log N_{i,t-1}$		0.167*** (0.057)		0.133*** (0.046)		
$SSE_i \times \log N_{it}$					-0.386 (0.609)	
$SZSE_i \times \log N_{it}$					-0.361 (0.308)	
$SSE_i \times \log N_{i,t-1}$						0.488 (0.935)
$SZSE_i \times \log N_{i,t-1}$						0.131 (0.445)
Obs	2,439	1,949	2,522	1,940	1,056	843
R^2	0.920	0.950	0.925	0.957	0.938	0.957
Province \times Year FE	Y	Y	Y	Y	Y	Y
Industry \times Year FE	Y	Y	Y	Y	Y	Y
SOE \times Year FE	Y	Y	Y	Y	Y	Y
FOE \times Year FE	Y	Y	Y	Y	Y	Y
"Sin"-Stock \times Year FE	Y	Y	Y	Y	Y	Y
Firm Characteristics	Y	Y	Y	Y	Y	Y

Note: Columns (1) through (4) estimate Equation (A2). Columns (1) and (2) include the initial cohort of Shanghai Connect firms while Columns (3) and (4) include the initial cohort of Shenzhen Connect firms. Columns (5) and (6) estimate Equation (A3) and include non-Connect firms on both the Shanghai and Shenzhen stock exchanges. All columns employ OLS estimation and use data from 2017 to 2021. Standard errors clustered at the firm level are shown in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.