COMISIÓN PARA EL MERCADO FINANCIERO

Regulador y Supervisor Financiero de Chile

Documento de Trabajo **N° 02/25**

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Julio 2025

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Documentos de Trabajo de la Comisión para el Mercado Financiero (CMF) Financial Market Commission (CMF)
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Banking on Renewables: How Finance Powers the Green Energy Boom*

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July 2025

*We thank Mark Garmaise and Gabriel Natividad for discussion and analysis of an earlier version of this paper. We thank Felipe Aldunate, Andres Barrios, Federico Huneeus, an anonymous referee from the CMF, and seminar participants at the Financial Market Commission and Universidad de los Andes, Chile for useful comments. We also thank Maximiliano Villalobos for excellent research assistance. Larrain acknowledges funding from FONDECYT Regular N° 1240442. The findings, interpretations, and conclusions are those of the authors and do not necessarily represent those of the Financial Market Commission of Chile. Larrain: mauriciolarraine@gmail.com; Rojas: carojas@cmfchile.cl.

Abstract

This paper examines the role of private bank financing in driving the expansion of non-conventional renewable energy, with a focus on solar and wind power. Using granular banking data of an emerging market, we find that bank credit has a greater impact on energy production for green energy firms, especially smaller ones, compared to conventional producers. This implies a higher return per dollar of credit for clean energy. While green energy firms face higher initial financing costs, these converge with conventional producers over time. Lower default rates among green energy firms suggest that banks improve credit assessments over time. We also find positive spillovers to other sectors: after a green plant is installed in a county, non-energy firms located in that county experience reduced financing costs and default rates.

Resumen

Este estudio analiza el rol del financiamiento bancario privado en la expansión de las energías renovables no convencionales, con énfasis en la solar y eólica. Usando datos bancarios granulares de una economía emergente, encontramos que el crédito tiene mayor impacto en la producción de empresas de energía verde, especialmente las más pequeñas, en comparación con las convencionales. Esto implica un mayor retorno por dólar prestado. Aunque estas firmas enfrentan costos de financiamiento iniciales más altos que las convencionales, estos convergen con el tiempo. Las menores tasas de morosidad sugieren que los bancos mejoran sus evaluaciones de riesgo crediticio en el tiempo. Además, tras la instalación de una planta verde en una comuna, las empresas no energéticas locales enfrentan menores costos de financiamiento y tasas de mora.

1 Introduction

To call solar power's rise exponential is not hyperbole, but a statement of fact. Installed solar capacity doubles roughly every three years, and so grows ten-fold each decade.

— *The Economist*, Special Edition, June 2024

Energy is at the heart of the climate challenge and a crucial part of the solution. Fossil fuels, such as coal, oil, and gas, are the largest contributors to global climate change. To mitigate the impacts of climate change, emissions must be significantly reduced. The world needs to decrease its dependence on fossil fuels and invest in alternative energy sources that are clean, affordable, and reliable. Renewable sources such as solar, wind, hydro, and geothermal emit little to no greenhouse gases, making them essential to the energy transition.

Global annual renewable capacity additions surged by nearly 50% in 2023, marking the fastest growth rate in the past two decades (International Energy Agency (2023)). Solar energy alone represented three-quarters of these renewable capacity additions worldwide. According to the IEA report, the foremost challenge for the international community is the rapid scaling up of financing and deployment of renewables in many emerging economies, which are at risk of being left behind in the new energy landscape.

In this paper, we explore the relationship between private bank financing and Chile's green energy boom. Chile presents an interesting case study, as it has rapidly become one of the most attractive destinations for investment in clean energy among emerging markets (Bloomberg NEF). By 2019, the country reached a record level of cumulative investment in renewable energy, totaling approximately USD 14 billion. Electricity generation capacity from unconventional green sources has surged from 4% of total generation in 2010 to 44% in 2023.

To conduct our analysis, we use unique granular banking data that captures month-level details on the full spectrum of energy producers, from large publicly traded firms to small unlisted companies, for the period 2014-2023. This data is merged with detailed information on each firm's energy production type. We categorize energy producers as "green" if over 50% of their production comes from non-conventional renewable sources (solar, wind, biomass, small hydro) or as conventional, if reliant on fossil fuels or large hydroelectric plants. Although large hydro is renewable, we group it with fossil fuels to reflects the large-scale, established nature of hydroelectric projects in Chile, which differs from the smaller, more innovative nature of non-conventional renewable sources.

We begin by examining the relationship between energy production and bank credit across for energy producers. Our firm-level panel regression shows an elasticity of 0.17, meaning a 100% increase in credit corresponds to a 17% rise in production. This effect remains highly significant after accounting for producer- and month-year fixed effects. The elasticity for green producers is nearly four times higher than for conventional ones, suggesting clean technologies yield much greater output per dollar borrowed. Additionally, we find that the elasticity of energy production to debt is significantly higher for small and medium-sized green producers compared to large ones, suggesting that financially constrained producers tend to exhibit higher marginal productivity of capital.

We next compare the cost of financing for green and conventional energy producers. Our transaction-level regressions show that, over the full sample period, green firms face loan rates that are 30 basis points higher than those of conventional firms, a result that remains robust to a Heckman correction for potential self-selection. However, when we split the sample into two periods (2013–2018 and 2019–2023), we find that financing costs converge in the latter period. This suggests that banks initially saw green energy as riskier but reassessed this view as they gained experience; ex-post, green producers appear no riskier than conventional ones.

We test this hypothesis by analyzing loan default rates among energy producers to assess ex-post credit risk. Our results show that green energy firms have a delinquency rate that is 0.8 percentage points lower than conventional producers across the entire sample period. This supports the hypothesis that banks improve their credit risk assessments of green firms as they become more familiar with low-carbon technologies. The borrowing spread for green producers is smaller at large banks, reflecting their stronger infrastructure and specialized analysts. While some small banks may develop niche expertise in green energy, our results suggest this is not the norm. On average, large banks offer more favorable terms. Although spreads at small banks were initially much higher, they declined markedly in the second half of the sample as banks gained experience and credit risk became easier to assess.

Green energy offers the advantage of being cheaper and more stable than conventional energy, with the marginal cost of solar and wind power near zero. In the final section, we investigate whether the energy boom benefits non-energy firms through lower energy prices. Specifically, we analyze the impact of green plant installations on non-energy firms within the same county, leveraging the staggered introduction of green plants across counties and time. From 2012 to 2023, the number of green plants nearly quadrupled, with most installations occurring in the central-northern region, where solar radiation is highest. Our findings show that after a green plant is introduced, non-energy firms in the county experience a reduction in financing costs by 23 basis points. Because the placement of green plants may not be entirely exogenous, we perform an instrumental-variable analysis for solar plants. We construct a Bartik-type instrument by interacting the national increase in solar production over time with the share of solar radiation in each county, generating plausibly exogenous variation. Our results remain robust.

We hypothesize that non-energy firms benefit from lower energy costs, which boosts their cash flows and reduces credit risk. We present two pieces of evidence to support this. First, if the energy boom lowers energy costs for firms, its impact should be greater on those with energy-intensive production processes. This is exactly what we find – the effect on the cost of credit is more than four times stronger for industrial (manufacturing) firms than for non-industrial firms. Second, if lower energy costs reduce credit risk, we should observe a decline in loan default rates. Indeed, after the introduction of a green plant in a county, default rates for non-energy firms in industrial sectors decrease by 0.4 percentage points. We show that a key channel through which the green energy boom impacts the broader economy is through firms utilizing Power Purchase Agreements with energy producers.

Our paper contributes to the literature on clean technology and finance. Lanteri and Rampini (2023) link financial constraints to firms' adoption of clean technologies, while Accetturo et al. (2022) and De Haas et al. (2023) empirically assess the role of bank credit in green technology investments. Kacperczyk and Peydro (2022), Reghezza et al. (2022), and Degryse et al. (2023) examine how banks shift credit from conventional to green firms.[1] Unlike these studies, which focus on firms as energy consumers, we analyze energy producers. By linking firm-level credit data with energy production, we estimate the returns on capital borrowed for clean energy technologies under varying financial conditions.

Our research also contributes to the literature on pricing climate risk in bank loans. Kempa et al. (2021) and Zhou et al. (2024) use syndicated loan data to compare the debt costs of renewable versus conventional energy firms across countries. Delis et al. (2024) also compare the debt costs of fossil fuel firms with other sectors. We extend this research in two ways: first, while syndicated loans focus on large firms, we study the entire private banking market in a country, using unique, confidential micro-data that cover firms of all sizes. More importantly, in addition to analyzing interest rates as an ex-ante credit risk measure, we examine loan delinquency as an ex-post credit risk

[1] For more on the role of banks in the low-carbon transition, see Degryse et al. (2020), Beyene et al. (2021), Laeven and Popov (2021), De Haas and Popov (2022), Mueller and Sfrappini (2022), Benincasa et al. (2022), and Green and Vallee (2024).

indicator.

Finally, we contribute to the growing literature on the local economic impacts of green energy expansion. Mauritzen (2020) and Brunner and Schwegman (2022) examine the effects of wind energy on local economies in the United States, while Fabra et al. (2024) and Serra (2024) explore the local economic impacts of solar and wind energy in Spain. Complementing this work, Cornaggia and Iliev (2024) shows that U.S. counties with abundant renewable wind energy resources benefit from lower municipal bond yields and higher credit ratings. We extend this line of research by analyzing how a green energy boom influences the local cost of bank debt and loan delinquency rates.

2 Green Energy Boom

Since 2012, Chile's energy production matrix has seen a substantial rise in non-conventional green energy.[2] As shown in Figure 1, the contribution of green energy to the matrix increased from 4% in 2010 to 44% by 2023. This significant growth, totaling 13.891 MW in green generation, is primarily due to an increase in solar plant capacity (8,629 MWh) and an increase in wind plant capacity (4,364 MWh) (see Figure 2). Regionally, this growth has been particularly pronounced in the northern part of the country. The northern zone's capacity expanded from 200 MWh in 2010 to nearly 9,000 MWh by 2023.

Investments in green energy in Chile have been substantial. As of March 31, 2022, there were 116 energy projects under construction nationwide, encompassing generation plants, transmission works, and green hydrogen projects. These projects collectively represent an investment of USD 7,363 billion. Companies have utilized a mix of financing methods for these investments, including bank credit, project finance, bond issuance, and

[2] See Nasirov et al. (2021) and Gonzales et al. (2023) for recent detailed descriptions of the energy market in Chile.

equity issuance.

This development is driven by several factors. Geographically, Chile is exceptionally well-suited for solar and wind energy. The country's diverse latitude and altitude variations result in a wide range of solar climates. The Atacama Desert in northern Chile, for example, receives some of the highest levels of solar radiation in the world. Additionally, Chile boasts exceptional wind resources, with strong winds blowing from the Pacific coast and the Andes Mountains, making it an ideal location for harvesting wind energy. Furthermore, Chile's high dependence on foreign fuel imports has motivated the country to explore and invest in green energy options.

Chile boasts a favorable business climate and an effective policy and regulatory framework. On April 1, 2008, Law 20.257 established a mandate for electric companies serving end customers to source a percentage of their energy from renewable sources. In January 2015, Law 20.805 was enacted to improve the electricity supply bidding system. This law extended the start times for supply contracts, thereby reducing risks for bidders, and introduced partial hourly blocks, facilitating greater participation in solar projects. Additionally, infrastructure developments, such as the integration of the SIC and SING grids, have further supported this progress.[3]

3 Data and Statistics

Our primary dataset consists of monthly granular bank-to-firm data covering the period 2012-2023 from the Financial Market Commission of Chile, the country's bank regulator. This confidential dataset spans firms across all sectors, including energy and non-energy. For credit stocks, we have monthly records of each firm's outstanding debt to each bank

[3]Until 2017, Chile's two main electricity systems—the Northern Interconnected System (SING) and the Central Interconnected System (SIC)—were entirely separate, posing a barrier to renewable energy expansion as generation areas in the north were far from demand centers. To address this, the government completed an interconnection between the two systems.

of the system. For credit flows, we analyze transaction-level data on loan disbursements, including loan amounts, interest rates, maturities, loan type, and interest rate type. Additionally, we track delinquency, identifying firms with loans over 90 days past due.

We also use data from the National Energy Commission of Chile to identify all energy producers from 2014-2023. For each energy firm, we have plant-level data on production capacity (MW) and energy type—conventional (diesel, coal, natural gas, large hydroelectric) or non-conventional (solar, wind, biomass, small hydro). A firm is classified as a green energy producer if more than 50% of its production comes from non-conventional renewable sources. If a green energy firm uses multiple technologies (e.g., solar and wind), we classify it by the technology that accounts for the majority of its production.

Lastly, we use publicly available data from Chile's Internal Revenue Service, which includes self-reported firm locations by county[4] and categorizes firms into 12 revenue-based size bins.[5] We merge the credit, energy, and size/location datasets using a unique firm identifier. For the spillover analysis, we combine the credit dataset with the size/location data for all non-energy firms.

Table 1 summarizes monthly energy production per firm (in MWh) from 2014 to 2023, disaggregated by technology and energy type. The green segment comprises 241 firms, mainly solar (56%), followed by wind, biomass, and mini-hydro. On average, wind producers generate the most (10,131 MWh), exceeding the solar average of 8,022 MWh. The conventional segment includes 36 firms, coal, diesel, natural gas, and large hydro, with coal producers leading in output (315,788 MWh monthly). While green firms are more numerous, conventional producers generate significantly more energy per firm.

[4]In Chile, the "comuna" – which we refer to as a county – is the smallest administrative unit in the country. Each county is part of a province, and each province, in turn, is part of a region. Currently, Chile has 346 counties.

[5]Firms are classified into 12 size bins based on annual revenue in USD. Micro 1 firms earn up to 8,326 USD, Micro 2 up to 24,979 USD, and Micro 3 up to 99,917 USD. Small firms range from 99,917 to 1,040,801 USD, split into Small 1, 2, and 3. Medium 1 and 2 cover 1,040,801 to 4,163,203 USD. Big firms span from 4,163,203 to over 41 million USD, divided into Big 1, 2, 3, and 4.

Table 2 summarizes the financial and real characteristics of all producers from 2012 to 2023, distinguishing between green and conventional energy producers. Several key differences emerge from the data. Green energy producers, on average, pay significantly higher interest rates on both local currency and dollar-denominated loans. Additionally, they secure substantially smaller loans than conventional producers. The loan term for green producers is shorter for local currency loans but longer for dollar loans. Outstanding debt is notably smaller for green producers, while the average delinquency rate is the same for both groups (1%). In terms of revenue size, green producers are significantly smaller than their conventional counterparts.

4 Bank Credit and Energy Production

To analyze the relationship between bank credit and green energy production, we plot the outstanding bank debt of green energy producers by year-month alongside their energy generation (MWh). Since financing precedes production, we account for this by considering the commissioning period, which includes arranging financing, constructing the project, and preparing for operations. According to Gumber et al. (2024), this period in Chile typically ranges from 12 to 24 months. Our baseline analysis assumes a 12-month lag, though results remain robust when using a 24-month lag. Figure 3 shows a strong positive correlation between bank debt and energy output 12 months later.

To formalize this relationship, we estimate a panel regression at the firm-month level for energy producers:[6]

$$\ln(\text{Energy Production})_{i,t+12} = \beta_1 \ln(\text{Debt})_{i,t} + \gamma_i + \gamma_t + \epsilon_{i,t}, \tag{1}$$

where Energy $\text{Production}_{i,t}$ is the amount of energy (in MWh) supplied by producer

[6]While this specification assumes a common elasticity, we later explore heterogeneity by interacting bank debt with firm size, an observable and policy, relevant firm characteristic.

i in the month-year t, and $\text{Debt}_{i,t}$ is the bank credit outstanding of producer i in the month-year t. The regression includes producer (γ_i) and month-year (γ_t) fixed effects.[7] We estimate this regression separately for green and conventional producers.

Table 3 presents the results for green energy producers under various fixed effects. The coefficient of debt is positive and significant in all specifications. Column 1 indicates an energy production elasticity to bank credit of 0.17, meaning a 100% increase in credit is associated with a 17% increase in production. With full fixed effects (column 3), this elasticity drops to 0.1. In contrast, conventional producers show an elasticity of 0.026 under the full-fixed-effects model, making the elasticity for green producers nearly four times greater (=0.1/0.026), a substantially greater amount.

To assess whether elasticity varies by green technology type, Appendix Table A1 distinguishes between solar, wind, and other green energy producers. The elasticity of solar production to debt is identical to that of wind production. To account for longer commissioning periods, Appendix Table A2 applies a 24-month, 36-month, and 48-month lag between financing and production, rather than 12 months, with unchanged results.

To address concerns about spurious correlation driven by firm-specific trends, we also estimate the model in first differences. This approach focuses on within-firm changes over time, helping to isolate short-run responses in energy output to changes in credit. Appendix Table A3 presents regression results in growth rates instead of levels, reinforcing the same conclusion: clean energy technologies generate a substantially higher return per dollar borrowed than conventional technologies.

Our sample includes both large and small energy producers. We extend Equation (1) by introducing an interaction term between bank debt and a dummy variable equal to one if the green energy producer is classified as small and medium enterprise at the begin-

[7] We include producer and month-year fixed effects to control for unobserved producer traits and time shocks. Random effects would assume no correlation between these unobservables and credit, an assumption that may not hold. Fixed effects provide more robust identification in our setting.

ning of our sample, based on the Internal Revenue Service's definition. Table 4 presents the results, which show a positive and significant interaction term across multiple specifications. The elasticity of energy production to debt for small and medium-sized green producers is 30% higher than for large green producers (=(0.134 + 0.039)/0.134). Since smaller firms are typically more financially constrained than larger firms, this finding aligns with Farre-Mensa and Ljungqvist (2016), who show that financially constrained firms tend to exhibit higher marginal productivity of capital.

5 Cost of Debt for Energy Producers

To investigate differences in loan interest rates, we use a sample of all energy firms, both green and conventional producers. In this case, the regression is conducted at the contract level, with the unit of observation being a loan originated in a given month-year. We estimate a loan-level regression, where the interest rate at loan origination is regressed on a dummy variable equal to one if the firm is a green energy producer:

$$\text{Interest Rate}_{l,t} = \beta_1 \text{Green}_i + \beta_2 \text{LoanCharact}_{l,t} + \gamma_t + \epsilon_{i,t} \tag{2}$$

where Interest $\text{Rate}_{l,t}$ is the annual interest rate of loan l in the month-year of origination t, Green_i is dummy equal to one if the firm is green and zero otherwise, $\text{LoanCharact}_{l,t}$ contains loan characteristics such as duration and loan size.[8]

The regression does not include firm fixed effects, as these would absorb the Green dummy (a time-invariant firm characteristic). γ_t is a fixed effect for the time the loan was originated. Since time fixed effects control for the economy's risk-free rate, this

[8]The regression also controls for several loan-level characteristics: a currency fixed effect, which captures differences in loans issued in various currencies; loan type and interest rate type, accounting for variations across loan structures and interest rate mechanisms; and a bank fixed effect to account for differences across financial institutions. Additionally, the model controls for firm characteristics, including firm size (measured in 12 annual sales bins) and geographic location at the county level.

specification is equivalent to using the interest rate spread over the risk-free rate as the dependent variable.

The results are presented in Table 5. The coefficient on Green is positive and highly significant, indicating that, on average, loans to green firms have an interest rate 30 basis points higher than those to conventional energy firms. The effect remains robust to controlling for loan characteristics such as maturity and amount.[9] However, caution is needed in attributing causality between green production and lower interest rates, as selection effects may partly influence these results.

To assess the stability of the financing cost disadvantage for green firms over time, we split the sample period in half and introduced a dummy variable equal to one for the second half (2018-2023) and zero otherwise (2013-2017). We then extended regression (2) by adding an interaction term between the green dummy and the post-2018 dummy. The coefficient for this interaction is negative, significant, and of similar magnitude to the green dummy, indicating that the financing cost disadvantage disappears in the second half of the sample, consistent with the findings of Kempa et al. (2021).

A potential source of bias arises because we only observe firms that obtained bank loans, while unobserved firms that did not secure financing may differ in key ways. To mitigate this problem, we apply a Heckman correction model to account for sample selection bias. In the first stage, we use a broader sample of energy firms from Chile's Internal Revenue Service, which includes all firms—some that obtained loans and others that did not. We estimate a probit model where the dependent variable equals one if the firm obtained a loan and zero otherwise, with independent variables capturing firm characteristics: revenue-based size, industry, employment, and geographic location (county). This stage generates the Inverse Mills Ratio, reflecting the likelihood that a firm obtains a loan.

[9] Though counterintuitive, higher debt levels are linked to lower delinquency, possibly because larger loans go to stronger firms with better cash flows or collateral. This may reflect selection, where banks lend more to safer firms rather than debt lowering risk.

In the second stage, we estimate the cost of debt using only firms that received loans, including the Inverse Mills Ratio to address potential selection bias. This corrects for differences between borrowers and non-borrowers, enabling an unbiased estimate of the effect of green energy status on interest rates. Column 5 of Table 5 presents the results. While the main credit effect remains stable, the interaction with the post-2018 dummy decreases in magnitude and significance, possibly reflecting shifts in lending standards after 2018. Nonetheless, the insignificant Inverse Mills Ratio suggests that selection bias does not systematically affect the interest rate estimates.[10]

The fact that initially green energy firms face higher financing costs than conventional producers but these costs converge over time suggests that banks improve their understanding of green technologies as they observe repayment outcomes. As shown in Figure 4, green energy plants tend to be significantly newer and younger than conventional ones. To test this hypothesis, we run a firm-level regression of loan delinquency on the green energy dummy:

$$\text{Delinquency}_{i,t} = \beta_1 \text{Green}_i + \beta_2 \ln(\text{Debt})_{i,t} + \gamma_t + \epsilon_{i,t}, \tag{3}$$

where $\text{Delinquency}_{i,t}$ is a dummy equal to one if firm i has any loan more than 90 days past due in period t. We control for the firm's outstanding debt in each period, an important determinant of delinquency, and include firm-size fixed effects to account for systematic differences by size. Table 6 reports the results. Green energy firms have a significantly lower delinquency rates than conventional firms throughout the whole sample. The probability that a green producer is in default is 0.6 percentage points lower than for conventional producers, which accounts for 60% of the average delinquency rate (=0.6%/1%). This supports the hypothesis that the initial cost disadvantage of green

[10] Although the Heckman correction addresses selection into borrowing, the negative relationship between delinquency and interest rates persists. This likely reflects residual selection within the borrower pool: banks offer lower rates to firms perceived as safer, which subsequently exhibit lower delinquency.

firms declines as banks learn more about green technologies and adjust credit assessments accordingly.

To further test this hypothesis, we re-estimate Equation (2) distinguishing between credit from large and small banks. We define large banks as the four largest banks in Chile, which together have a market share of two-thirds of bank credit in the country. We examine whether this difference in evaluation capacity affects the cost of debt. Large banks, with better infrastructure and specialized analysts (Stein, 2002), appear more capable of pricing clean energy risk. Table 7 shows that from 2014 to 2018, the spread between green and conventional producers was 86% higher at small banks than at large banks (48.2 vs. 25.9 basis points). While some small banks may develop niche expertise, this was not typical early on. After 2018, the spread stays flat at large banks but declines sharply at small banks, eliminating the green financing gap. This suggests small banks improved their ability to assess green credit risk as the sector matured.

6 Spillovers Effects of the Green Boom

Green energy provides a cost-effective and stable alternative to conventional energy sources. In this section, we explore whether the energy boom has benefited non-energy firms by reducing energy prices. To do so, we examine the impact of green energy plant installations on local borrowers, leveraging the staggered rollout of these plants across different counties over time. At the beginning of our sample period in 2012, Chile had 21 green energy plants; by 2023, this number had nearly quadrupled to 110 (Table 8). Figure 5 illustrates that the majority of these installations occurred in the central-northern region of the country, an area known for its high solar radiation.

We regress the cost of debt on a dummy variable that equals one after the introduction of a green plant in a county. The unit of observation is a loan originated in a specific county and month-year:

$$\text{Interest Rate}_{l,c,t} = \beta_1 \text{Green Plant in County}_{c,t} + \beta_2 \text{LoanCharact}_{l,c,t} + \gamma_c + \gamma_t + \epsilon_{l,c,t} \quad (4)$$

where Interest $\text{Rate}_{l,c,t}$ is the annual interest rate of loan l of a non-energy firm operating in county c in the month-year of origination t. Green Plant in $\text{County}_{c,t}$ is a dummy equal to one after a green plant is introduced in county c in time t. γ_c and γ_t are county and time fixed effects. The coefficient β_1 estimate the pre-post change in the interest rate paid by non-energy firms in a county that introduces a green plant, relative to a county that does not introduce a plant around the same time. We cluster standard errors at the county-time level, to account for within-county correlation across loans.

Table 9 presents the results, showing that the coefficient for the Green Plant in County dummy is negative and significant. Following the introduction of a green plant in a county, the cost of debt for non-energy firms decreases by 23 basis points compared to counties without green plant installations. However, these results should be interpreted with caution, as the location of green plants may not be entirely exogenous and could be influenced by underlying county-level economic factors.

To mitigate potential endogeneity, we conduct an instrumental-variable analysis focused exclusively on solar plants. Our instrument follows a Bartik-type approach, interacting the participation of solar generation with respect to total generation over time with each county's share of total solar radiation.[11] The rationale is that counties with higher solar radiation are more likely to attract solar plants during the energy boom,

[11] In particular, we use the following instrument:

$$\text{Bartik Instrument}_{c,t} = \frac{\text{SolarRadiation}_c}{\sum_{c=1}^{n} \text{SolarRadiation}_c} \times \left(\frac{\text{SolarGeneration}}{\text{TotalGeneration}}\right)_{t-1} \quad (5)$$

Where SolarRadiation_c correspond to the total amount of radiation that the county c receives in a year. SolarGeneration corresponds to the twelve-month total cumulative generation of solar plants, and TotalGeneration corresponds to the country's twelve-month cumulative total energy generation. Data on solar radiation are sourced from Ministry of Energy.

and this cross-sectional variation is plausibly exogenous.

Table 10 presents the results. Column (1) reports the first-stage estimates: counties with higher solar radiation are significantly more likely to see green plant installations during periods of rapid national solar expansion. Column (2) shows the reduced-form results: the cost of debt declines in counties more exposed to the national solar boom. Column (3) presents the second-stage estimates: among counties where green plant installation was driven by national solar growth and local solar potential, the presence of a green plant is associated with a 122 basis point reduction in the cost of debt. However, this estimate is imprecise and should be interpreted with caution.

Since the previous instrument applies only to solar plants and may not capture the broader impact of green plant installations, we revert to the full-sample analysis using OLS. We hypothesize that lower energy costs benefit non-energy firms by boosting their cash flows and reducing credit risk. We present two pieces of evidence to support this. First, if the energy boom reduces energy costs for firms, the effect should be more pronounced for those with energy-heavy production processes. To test this, we re-estimate Equation (4) separately for firms in the industrial (manufacturing) and non-industrial sectors. The results show that the reduction in the cost of debt after the installation of a green plant is over four times greater (=0.52/0.12) for firms in the industrial sector, where energy consumption is more intensive.

Second, if lower energy costs boost the cash flows of non-energy firms and reduce their credit risk, this should lead to a decline in loan default rates. To test this, we estimate the effect of a green plant's introduction in a county on the ex-post default rates of firms located there. Our findings in Table 11 show that after the installation of a green plant, default rates for non-energy firms in industrial sectors decrease by 0.3 percentage points, representing 30% of the average delinquency rate (=0.3% /1%).

Finally, the price of energy in Chile consists of both national and local components.

Non-energy firms that benefit most from a reduction in energy prices following the introduction of a green plant in a particular county are likely those that experience a larger decrease in the local component of the price. We hypothesize that these firms are those with Power Purchase Agreements (PPAs) with energy producers. PPAs are private contracts through which firms purchase electricity directly from energy producers.[12] Firms without PPAs purchase electricity at regulated prices from energy distributors. PPA firms have greater flexibility to renegotiate and renew contracts with energy producers, enabling them to benefit from reduced energy costs after green energy is introduced.

To test this hypothesis, we follow a two-step approach. First, we examine whether the installation of a green plant increases the likelihood that a firm enters into a PPA. We estimate a regression where the dependent variable is a dummy indicating whether a firm has a PPA, and the key independent variable is a dummy indicating whether a green plant was installed in the county where the firm operates. We focus on medium and large firms, as small firms are legally restricted from entering into PPA contracts.[13] The results, shown in Table 12 , indicate that the probability of a firm entering a PPA increases by 1% following the installation of a green plant. This is a significant effect, representing roughly 20% of the average likelihood of having a PPA agreement (=1%/5.5%).

In the second step, we analyze whether firms experience a reduction in the cost of bank credit after entering into a PPA. We regress loan interest rates on a dummy variable indicating whether a firm has signed a PPA. The results show that medium and large firms experience a 50 basis point reduction in their financing costs after entering into a PPA (Table 13).

[12]For a discussion of PPAs in the international energy market, see Backstrom et al. (2023). For a discussion of PPAs in Chile, see Vial (2023).

[13]Under Chilean law, firms consuming less than 500 kW of energy cannot enter PPA contracts. Firms consuming between 500 kW and 5,000 kW have the option to enter into a PPA, while firms with consumption above 5,000 kW are required to do so. We obtain the data of PPAs from the National Energy Commission.

In sum, the decrease in credit costs following a PPA, combined with the increased probability of entering a PPA after the installation of a green plant, suggests that a key channel through which the green energy boom impacts the entire economy is through PPA contracts. PPAs give firms access to cheaper energy, particularly in energy-intensive sectors. This arrangement, combined with the installation of green plants, allows these firms to reduce their financing costs and default risk.

7 Conclusions

This paper highlights the critical role of private bank financing in driving the growth of renewable energy, particularly in solar and wind technologies. Using granular banking data, we demonstrate that green energy producers, especially smaller, financially constrained firms, gain significantly more from bank credit than their conventional counterparts. This results in a higher energy output per dollar borrowed, suggesting that clean energy technologies are not only environmentally sustainable but also represent a more efficient and productive allocation of capital.

Our findings suggest that private bank financing plays an increasingly important role in green energy development, especially for smaller and financially constrained firms. However, this effect emerges gradually. Green firms initially faced higher borrowing costs, reflecting banks' limited experience and perceived risk. As banks observed repayment behavior and improved project evaluation, financing costs declined, initially led by larger banks, but eventually narrowing most sharply at smaller banks as they gained experience. Yet some frictions persist, especially for newer technologies, early-stage firms, and smaller lenders. This points to potential value in efforts that support bank learning and reduce early-stage uncertainty, particularly in markets with less-developed financial infrastructure.

Beyond its direct impact on energy production, the green energy boom generates positive spillovers to non-energy sectors. Counties with green plant installations benefit from lower financing costs and reduced default rates, likely due to cheaper electricity, especially for energy-intensive industries. These spillovers highlight the broader economic benefits of green energy, reinforcing the case for continued investment in clean infrastructure. In this context, a more capable and better-informed banking sector becomes pivotal, not just for scaling renewables, but for amplifying their economy-wide gains.

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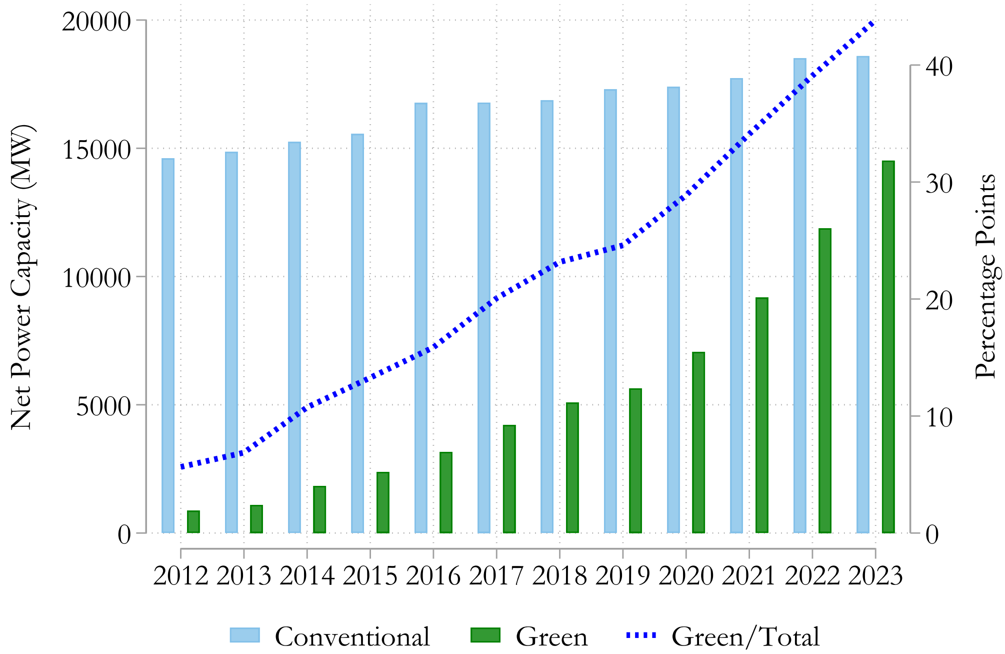
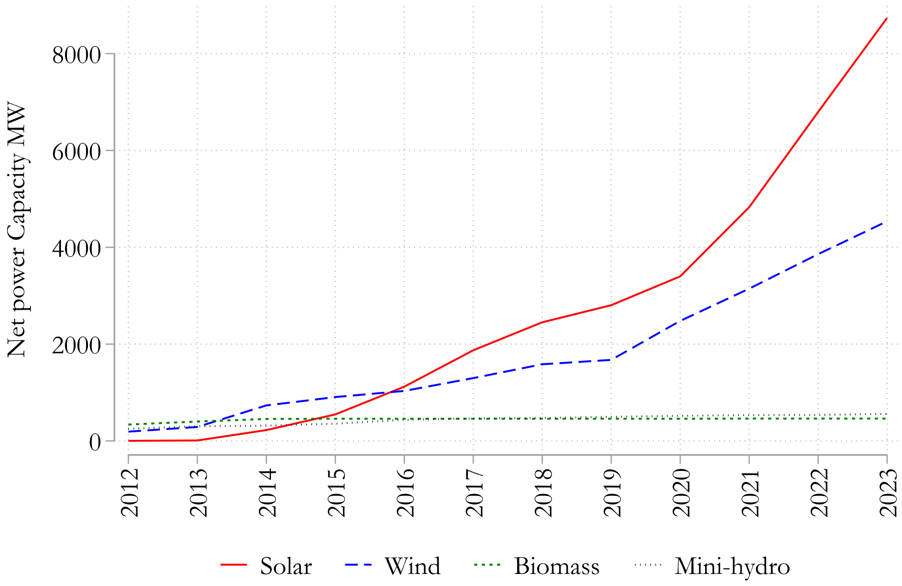
Figures

Figure 1: Power generation capacity in Chile



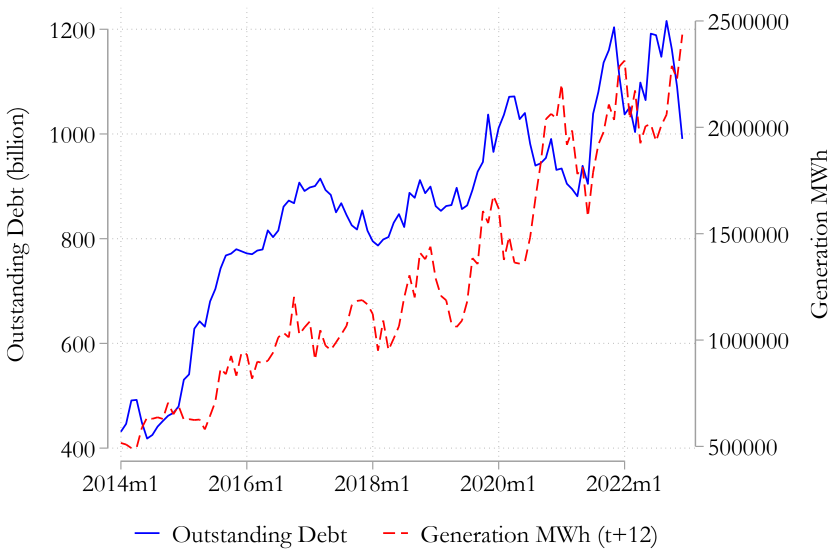
Note: This figure shows the evolution of green energy production capacity compared to conventional energy in Chile. The bars represent total capacity, while the line indicates the proportion of green capacity relative to the total system capacity. Producers are classified as green if over 50% of their output comes from non-conventional renewable sources, including solar, wind, biomass, or small hydro. Data source: http://energiaabierta.cl/

Figure 2: Effective green energy production capacity



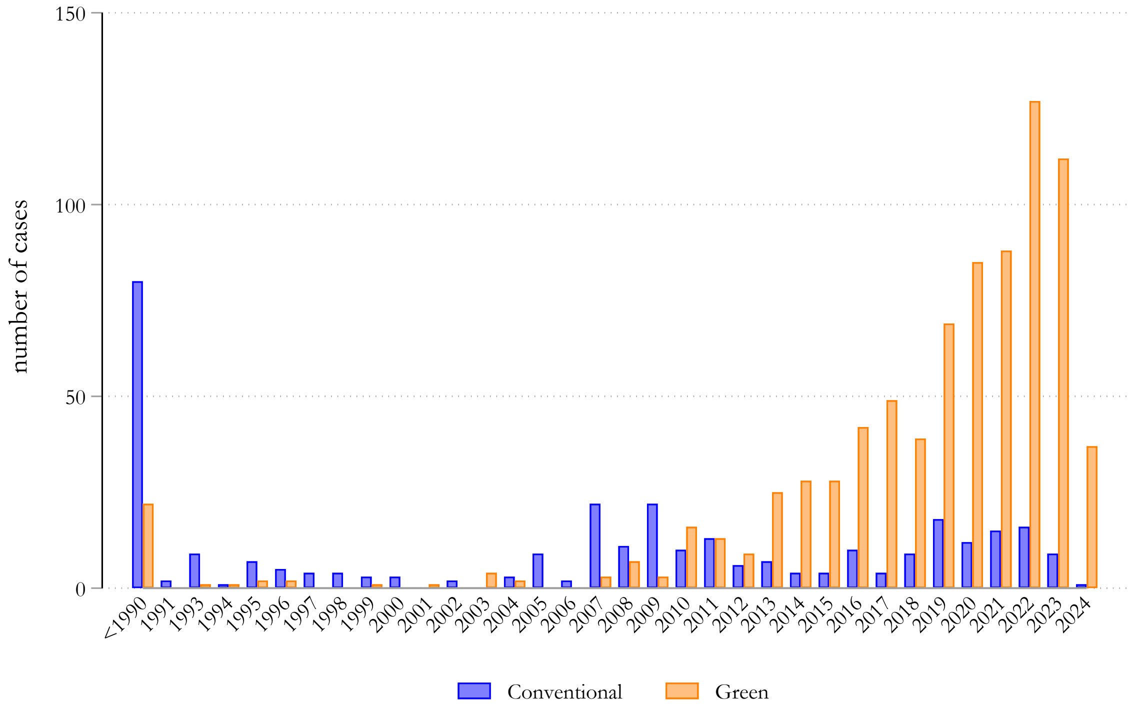
Note: This figure shows the evolution of the green energy production capacity on an annual basis. Each line represents a different type of green technology. Data source: http://energiaabierta.cl/

Figure 3: Green energy production and outstanding bank debt



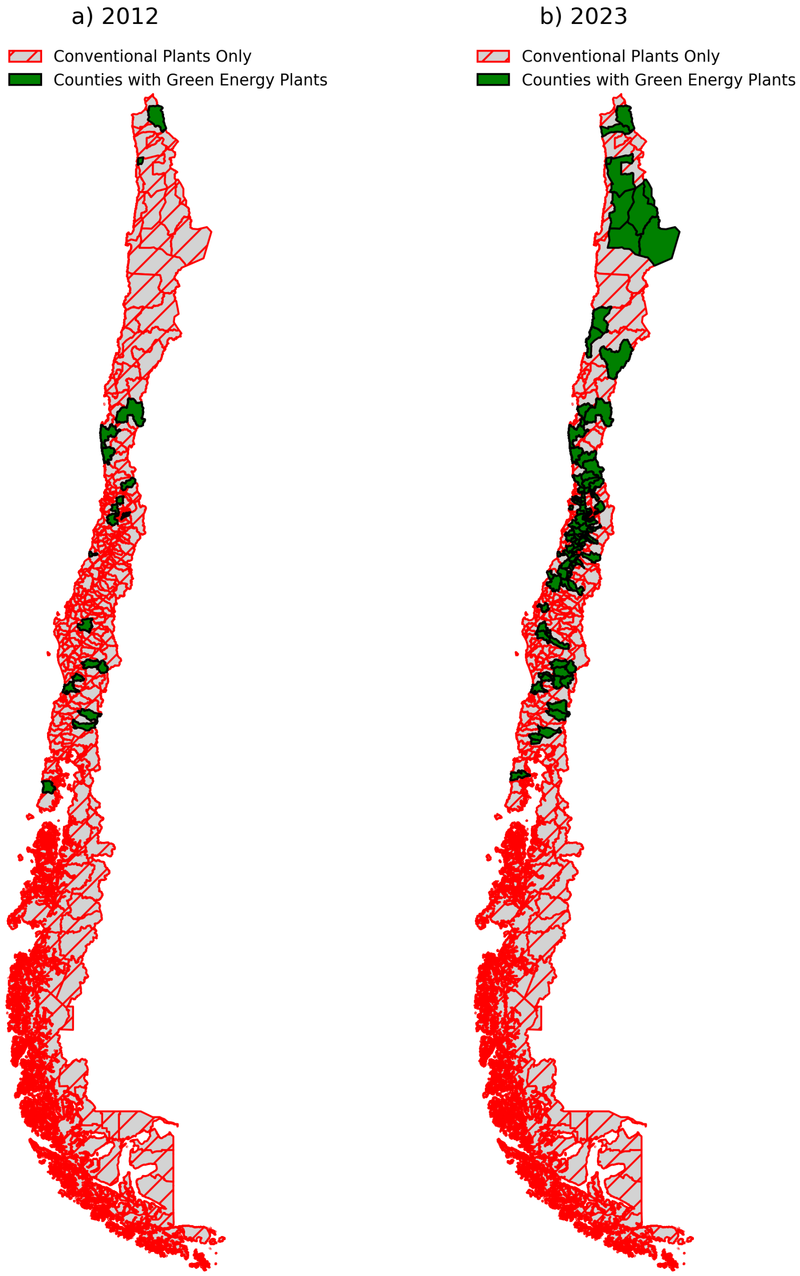
Note: This figure plots the outstanding bank debt (CLP billions) of green energy producers for each year-month, alongside their energy generation (MWh) 12 months later. Data source: Author's calculations based on debt data from the Financial Market Commission of Chile and energy data from the National Energy Commission of Chile.

Figure 4: Number of Energy Plants Founded Each Year



Note: This figure shows the number of energy plants founded each year, categorized by type: green (orange) and conventional (blue). Data source: http://energiaabierta.cl/

Figure 5: Counties with Green Energy Plants: 2012 versus 2023



Note: This figure compares the distribution of counties with green energy plants in Chile between 2012 (panel a) and 2023 (panel b). Data source: http://energiaabierta.cl/

Tables

Table 1: Energy Production (Monthly MWh)

	Number of Firms	p25	p50	p75	Mean
Green Energy					
Solar	134	384	719	6,942	8,022
Wind	26	1,725	6,163	13,745	10,131
Biomass	19	1,296	5,415	19,388	13,630
Mini Hydro	62	369	1,234	2,367	2,218
Total	**241**				
Conventional Energy					
Diesel	41	16	105	952	2,045
Coal	12	66,129	170,815	347,345	315,788
Large Hydro (Run-of-River)	12	5,714	12,508	24,632	18,972
Natural Gas	8	198	6,710	218,335	247,640
Large Hydro (Storage)	4	9,175	177,803	1,085,304	475,347
Total	**36**				

Note: This table reports monthly energy production (in MWh) by technology, grouped into green and conventional categories. For each technology, it shows the number of firms, as well as the 25th percentile (p25), median (p50), 75th percentile (p75), and mean of monthly production from 2014 to 2023. These statistics are computed across all firms within each group. Green technologies include solar, wind, biomass, and mini-hydro; conventional sources include diesel, coal, large hydro (run-of-river and storage), and natural gas. Source: National Energy Commission of Chile.

Table 2: Summary Statistics for Energy Producers

	Number obs.			Mean		
	All	Green	Conventional	All	Green	Conventional
Interest Rate of CLP Loans (%)	2,551	1,922	629	6.21	6.34	5.82
Interest Rate of USD Loans (%)	2,792	1,517	1,275	3.99	4.33	3.59
Loan Amount of CLP Loans (CLP Th)	2,551	1,922	629	899,165	585,935	1,856,286
Loan Amount of USD Loans (USD Th)	2,792	1,517	1,275	3,110,000	1,600,000	4,900,000
Term of CLP Loans (#months)	2,551	1,922	629	18.68	17.14	23.38
Term of USD Loans (#months)	2,792	1,517	1,275	63.90	68.11	58.88
Outstanding Debt (in USD)	26,269	19,032	7,237	22,800,000	12,800,000	49,400,000
Delinquency (%)	26,629	19,032	7,237	1.00	1.00	1.00
Firm Size (1:Low/12:High)	5,591	3,620	1,971	10.21	9.70	11.17

Note: This table presents summary statistics for the financial and real variables of all energy producers from 2012 to 2023, reporting the number of observations and the mean for each variable across all producers, as well as separately for green and conventional producers. The variables include the interest rate on loans in local currency (CLP) and dollars (USD), loan amounts in local currency (thousand CLP) and dollars (thousand USD), loan terms (in months) for both currencies, firm size based on revenue size bins (1 for the smallest, 12 for the largest), the value of outstanding debt (in USD), and the loan delinquency rate, defined as a dummy variable equal to one if a producer has an outstanding loan over 90 days past due. Data sources: Financial Market Commission of Chile and the Internal Revenue Service of Chile (for the firm size variable).

Table 3: Bank Debt and Energy Production: Green and Conventional Producers

	Green Energy Production t+12			Conventional Energy Production t+12		
	(1)	(2)	(3)	(4)	(5)	(6)
ln(Debt)	0.169***	0.139***	0.102***	0.099***	0.086***	0.026***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)
Observations	49,235	49,235	49,235	11,220	11,220	11,220
R-squared	0.194	0.390	0.688	0.048	0.107	0.757
Time Fixed Effect	No	Yes	Yes	No	Yes	Yes
Firm Fixed Effect	No	No	Yes	No	No	Yes

Note: This table presents firm-level regression results examining the relationship between outstanding bank debt and energy production 12 months ahead for green and conventional energy producers. The dependent variable is the log of energy production at $t+12$, and the independent variable is the log of outstanding bank debt. Columns (1)–(3) cover green producers, while columns (4)–(6) focus on conventional producers. Columns (1) and (4) exclude fixed effects, columns (2) and (5) include year-month fixed effects, and columns (3) and (6) add firm fixed effects. Robust standard errors are in parentheses, with significance denoted by ***p<0.01, **p<0.05, *p<0.1.

Table 4: Bank Debt and Green Energy Production by Firm Size

	Green Energy Production t+12		
	(1)	(2)	(3)
ln(Debt)	0.134***	0.125***	0.008
	(0.005)	(0.005)	(0.014)
ln(Debt) × SME	0.039***	0.017***	0.096***
	(0.005)	(0.005)	(0.014)
Observations	49,235	49,235	49,235
R-squared	0.196	0.390	0.689
Time Fixed Effect	No	Yes	Yes
Firm Fixed Effect	No	No	Yes

Note: This table presents firm-level regression results examining the relationship between outstanding bank debt and energy production 12 months ahead for green energy producers. The dependent variable is the log of energy production at $t + 12$, and the independent variable is the log of outstanding bank debt and its interaction with a dummy variable indicating whether the firm is a small or medium enterprise (SME), as defined by sales size according to the Internal Revenue Service. Columns (1)–(3) cover green producers, while columns (4)–(6) focus on conventional producers. Columns (1) and (4) exclude fixed effects, columns (2) and (5) include year-month fixed effects, and columns (3) and (6) add firm fixed effects. Robust standard errors are in parentheses, with significance denoted by ***p<0.01, **p<0.05, *p<0.1.

Table 5: Cost of Debt of Green versus Conventional Energy Producers

	(1)	(2)	(3)	(4)	(5) Heckman Correction
Green	0.307***	0.299***	0.268***	0.528***	0.543***
	(0.0695)	(0.0698)	(0.0689)	(0.0714)	(0.0717)
Green X Post 2018				-0.618***	-0.231*
				(0.110)	(0.118)
Ln(Term)		0.0579*	0.0523	0.0552	0.0584*
		(0.0342)	(0.0345)	(0.0345)	(0.0345)
Ln(Amount)		-0.0397**	-0.0409**	-0.0457**	-0.0159
		(0.0186)	(0.0186)	(0.0185)	(0.0184)
12 Months Delinquency			-0.329**	-0.437***	-0.667***
			(0.145)	(0.143)	(0.152)
Inverse Mills Ratio					-0.332
					(0.252)
Observations	5,590	5,590	5,590	5,590	5,223
R-squared	0.943	0.943	0.943	0.944	0.949
Time Effect	Yes	Yes	Yes	Yes	Yes
Currency Effect	Yes	Yes	Yes	Yes	Yes
Loan type effect	Yes	Yes	Yes	Yes	Yes
Bank effect	Yes	Yes	Yes	Yes	Yes
Type interest rate effect	Yes	Yes	Yes	Yes	Yes
Firm sales level	Yes	Yes	Yes	Yes	Yes
Firm county effect	Yes	Yes	Yes	Yes	Yes

Note: This table presents loan-level regression results examining the relationship between the cost of bank debt and whether energy producers are classified as green. The dependent variable is the cost of debt in the originated loan, while the independent variable is Green, a time-invariant dummy that equals 1 if the energy producer is classified as green. All regressions control for loan term (in months), loan amount (in USD), and a delinquency dummy that equals 1 if the borrower experienced credit delinquency in the last 12 months. Additional controls include currency, loan type, interest rate type, bank fixed effects, firm size indicators, and county location. Column (4) introduces an interaction term between the Green dummy and a dummy for the second half of the sample period (Post-2018). Column (5) shows the results correcting using a Heckman Correction Model (in the first stage, we estimate a probit model of loan access as a function of firm size, industry, employment, and location. This yields the Inverse Mills Ratio, which captures the likelihood of obtaining a loan and is included as a control in the second stage). Robust standard errors are reported in parentheses, with significance levels denoted by ***p<0.01, **p<0.05, and *p<0.1.

Table 6: Loan Delinquency of Green versus Conventional Energy Producers

	(1)	(2)	(3)
Green	-0.006***	-0.007***	-0.008***
	(0.002)	(0.002)	(0.002)
ln(Debt)	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)
Observations	23,112	23,112	23,109
R-squared	0.015	0.019	0.140
Time Fixed Effect	No	Yes	Yes
County Fixed Effect	No	No	Yes
Firm Size Fixed Effect	No	No	Yes

Note: This table presents firm-level regression results examining the relationship between loan delinquency and whether energy producers are classified as green. The dependent variable is a dummy that equal to 1 if the energy producer has an outstanding loan that is delinquent (more than 90 days past due), while the independent variable is Green, a time-invariant dummy that equals 1 if the energy producer is classified as green. All regressions control for the bank loan outstanding (in USD). Column (1) excludes fixed effects, column (2) includes year-month fixed effects, and column (3) adds firm fixed effects. Robust standard errors are reported in parentheses, and significance levels are denoted by ***p<0.01, **p<0.05, *p<0.1.

Table 7: Cost of Debt of Energy Producers: Large versus Small Banks

	(1) All banks	(2) Large Banks	(3) Small Banks
Green	0.528***	0.259*	0.482***
	(0.071)	(0.140)	(0.081)
Green × Post 2018	-0.618***	-0.200	-0.757***
	(0.110)	(0.226)	(0.134)
ln(Term)	0.055	-0.047	0.153***
	(0.035)	(0.064)	(0.041)
ln(Amount)	-0.046**	-0.130***	-0.061***
	(0.019)	(0.036)	(0.020)
Delinquency	-0.437***	0.018	-0.569***
	(0.143)	(0.343)	(0.167)
Observations	5,590	1,888	3,702
R-squared	0.944	0.941	0.961
Time Fixed Effect	Yes	Yes	Yes
Currency Fixed Effect	Yes	Yes	Yes
Loan-type Fixed Effect	Yes	Yes	Yes
Rate-type Fixed Effect	Yes	Yes	Yes
Bank Fixed Effect	Yes	Yes	Yes
Firm Size Fixed Effect	Yes	Yes	Yes
Firm County Fixed Effect	Yes	Yes	Yes

Note: This table presents loan-level regression results examining the relationship between the cost of bank debt and whether energy producers are classified as green. The dependent variable is the cost of debt in the originated loan, while the independent variable is Green, a time-invariant dummy that equals 1 if the energy producer is classified as green. Column (1) includes all banks, column (2) focuses on large banks (Chile's four largest), and column (3) examines smaller banks. All regressions control for loan term (in months), loan amount (in USD), and a delinquency dummy that equals 1 if the borrower experienced credit delinquency in the last 12 months. Additional controls include currency, loan type, interest rate type, bank fixed effects, firm size indicators, and county location. Robust standard errors are reported in parentheses, and significance levels are denoted by ***p<0.01, **p<0.05, *p<0.1.

Table 8: Counties and Energy Production Plants

	2012 jan	2023 dec	Change
Total Counties	**346**	**346**	**-**
North	44	44	-
Centre	207	207	-
South	95	95	-
Counties with energy plants	**99**	**225**	**126**
North	19	36	17
Centre	47	135	88
South	33	54	21
Counties with green energy plants	**44**	**190**	**146**
North	8	36	28
Centre	19	121	102
South	17	33	16
Counties with only green energy plants	**21**	**110**	**89**
North	5	18	13
Centre	9	75	66
South	7	17	10

Note: This table presents the distribution of energy production plants across Chilean counties from January 2012 to December 2023, along with changes over this period. The first row shows the total number of counties in Chile's three main regions: North, Centre, and South. The table then provides a breakdown of the number of counties with energy plants, the number of counties hosting at least one energy plant, and the number of counties exclusively hosting green energy plants.

Table 9: Green Energy Plant Installation and Cost of Debt of Non-Energy Firms

	(1) All Firms	(2) Industrial Firms	(3) Non-industrial Firms
Green Plant in County$_{ct}$	-0.228***	-0.522***	-0.120***
	(0.037)	(0.080)	(0.029)
ln(Term)	-1.945***	-1.838***	-1.992***
	(0.031)	(0.044)	(0.034)
ln(Amount)	-0.484***	-0.512***	-0.475***
	(0.006)	(0.010)	(0.007)
Delinquency	2.131***	1.984***	2.192***
	(0.066)	(0.096)	(0.078)
Observations	2,042,990	493,669	1,549,268
R-squared	0.795	0.800	0.794
Time Fixed Effect	Yes	Yes	Yes
Currency Fixed Effect	Yes	Yes	Yes
Loan-type Fixed Effect	Yes	Yes	Yes
Rate-type Fixed Effect	Yes	Yes	Yes
Bank Fixed Effect	Yes	Yes	Yes
Firm Size Fixed Effect	Yes	Yes	Yes
Firm County Fixed Effect	Yes	Yes	Yes

Note: This table presents loan-level regression results analyzing the relationship between the installation of green energy plants in a county and the cost of debt for non-energy firms. The dependent variable is the cost of debt for loans to non-energy firms, while the independent variable (County$_{ct}$) is a dummy equal to 1 after a green energy plant is installed in the firm's county. Column (1) shows results for all firms, column (2) focuses on industrial firms, and column (3) on non-industrial firms. All regressions control for loan term (in months), loan amount (in USD), and a delinquency dummy indicating whether the borrower experienced credit delinquency in the past 12 months. Additional controls include currency, loan type, interest rate type, bank fixed effects, firm size, and county location. Standard errors are clustered at the county-time level and reported in parentheses. Significance levels are denoted as ***p<0.01, **p<0.05, and *p<0.1.

Table 10: Solar Energy Plant Installation and Cost of Debt of Non-Energy Firms

	(1) First stage	(2) Reduced form	(3) Second stage
Bartik Instrument$_{c,t}$	0.0355***	-0.0433*	
	(0.00773)	(0.0257)	
$\widehat{\text{Solar Plant in County}}_{c,t}$			-1.220*
			(0.717)
Ln(Term)	0.00265***	-2.199***	-2.196***
	(0.000860)	(0.0400)	(0.0399)
Ln(Amount)	-0.000415	-0.528***	-0.528***
	(0.000321)	(0.00690)	(0.00690)
12 Months Delinquency	-0.00369	2.344***	2.340***
	(0.00290)	(0.0776)	(0.0773)
Observations	1,554,437	1,554,437	1,554,437
R-squared	0.715	0.779	0.421
Time Fixed Effect	Yes	Yes	Yes
Currency Fixed Effect	Yes	Yes	Yes
Loan-type Fixed Effect	Yes	Yes	Yes
Rate-type Fixed Effect	Yes	Yes	Yes
Bank Fixed Effect	Yes	Yes	Yes
Firm Size Fixed Effect	Yes	Yes	Yes
Firm County Fixed Effect	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: This table presents loan-level regression results analyzing the relationship between the installation of solar energy plants in a county and the cost of debt for non-energy firms. The dependent variable is the cost of debt for loans to non-energy firms. The independent variable Solar Plant in County$_{ct}$ is a dummy equal to 1 after a solar energy plant is installed in the firm's county, which we instrument with Bartik Instrument$_{c,t}$ = $\frac{\text{SolarRadiation}_c}{\sum_{c=1}^{n}\text{SolarRadiation}_c} \times \left(\frac{\text{SolarGeneration}}{\text{TotalGeneration}}\right)_{t-1}$. Column (1) shows the first-stage results, column (2) shows the reduced-form results, and column (3) shows the second-stage results. All regressions control for loan term (in months), loan amount (in USD), and a delinquency dummy indicating whether the borrower experienced credit delinquency in the past 12 months. Additional controls include currency, loan type, interest rate type, bank fixed effects, firm size, and county location. Standard errors are clustered at the county-time level and reported in parentheses. Significance levels are denoted as ***p<0.01, **p<0.05, and *p<0.1.

Table 11: Green Energy Plant Installation and Loan Delinquency of Industrial Firms

	(1)	(2)	(3)
Green Plant in County$_{ct}$	-0.009***	-0.004***	-0.003**
	(0.001)	(0.001)	(0.001)
ln(Debt)	-0.002***	-0.001***	-0.004***
	(0.000)	(0.000)	(0.000)
Observations	6,452,426	6,452,426	6,448,578
R-squared	0.000	0.004	0.605
Time Effect	No	Yes	Yes
Firms Effect	No	No	Yes

Note: This table presents firm-level regression results analyzing the relationship between the installation of green energy plants in a county and loan delinquency for non-energy industrial firms located in that county. The dependent variable is the cost of debt for loans to non-energy industrial firms, while the independent variable (Green Plant in County$_{ct}$) is a dummy equal to 1 after a green energy plant is installed in the firm's county. All regressions control for the bank loan outstanding (in USD). Column (1) excludes fixed effects, column (2) includes year-month fixed effects, and column (3) adds firm fixed effects. Standard errors are clustered at the county-time level and reported in parentheses. Significance levels are denoted as ***p<0.01, **p<0.05, and *p<0.1.

Table 12: Green Energy Plant Installation and Likelihood of Securing a Power Purchase Agreement

	(1)	(2)	(3)
Green Plant in County$_{ct}$	0.017***	0.008***	0.010***
	(0.001)	(0.001)	(0.001)
Observations	3,269,040	3,269,040	3,269,040
R-squared	0.002	0.019	0.495
% of Firms with PPA	5.5%	5.5%	5.5%
Time Effect	No	Yes	Yes
Firm Effect	No	No	Yes

Note: This table presents firm-level regression results analyzing the relationship between the installation of green energy plants in that county and the likelihood of securing a Power Purchase Agreement (PPA), in which a non-energy firm contracts directly with the energy producer. The dependent variable is a dummy that equal one if a firm the firm has an outstanding PPA, while the independent variable (Green Plant in County$_{ct}$) is a dummy equal to 1 after a green energy plant is installed in the firm's county. The sample of firms is restricted to middle and large non-energy firms, as small firms are legally restricted from entering into PPA contracts. % of Firms with PPA denotes the fraction of medium and large firms that have PPA contracts. Column (1) excludes fixed effects, column (2) includes year-month fixed effects, and column (3) adds firm fixed effects. Standard errors are clustered at the county-time level and reported in parentheses. Significance levels are denoted as ***p<0.01, **p<0.05, and *p<0.1.

Table 13: Securing a Power Purchase Agreement and the Cost of Debt

	(1)	(2)
Power Purchase Agreement$_{it}$	-0.522***	-0.505***
	(0.086)	(0.090)
ln(Term)		-1.067***
		(0.028)
ln(Amount)		-0.274***
		(0.006)
Delinquency		1.725***
		(0.082)
Observations	1,025,590	1,025,590
R-squared	0.715	0.733
Time Effect	Yes	Yes
Currency Effect	Yes	Yes
Loan type effect	Yes	Yes
Bank effect	Yes	Yes
Type interest rate effect	Yes	Yes
Firm effect	Yes	Yes

Note: This table presents loan-level regression results examining the relationship between the cost of bank debt of non-energy firms and securing a Power Purchase Agreement (PPA). The dependent variable is the cost of debt in the originated loan, while the independent variable is a dummy equal to one after the firm secures a PPA. The sample of firms is restricted to middle and large non-energy firms, as small firms are legally restricted from entering into PPA contracts. All regressions control include currency, loan type, interest rate type, bank fixed effects, firm size indicators, and county location. Column (2) controls in addition for loan term (in months), loan amount (in USD), and a delinquency dummy that equals 1 if the borrower experienced credit delinquency in the last 12 months. Robust standard errors are reported in parentheses, with significance levels denoted by ***p<0.01, **p<0.05, and *p<0.1.

Appendix

Table A1: Bank Debt and Energy Production: Different Types of Green Producers

	(1) Solar t+12	(2) Wind t+12	(3) Other Green t+12
ln(Debt)	0.109***	0.108***	0.051***
	(0.002)	(0.005)	(0.004)
Observations	34,452	4,224	11,087
R-squared	0.689	0.707	0.687
Time Fixed Effect	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes

Note: This table presents firm-level regression results examining the relationship between outstanding bank debt and energy production 12 months ahead for different types of green energy producers. The dependent variable is the log of energy production at $t + 12$, and the independent variable is the log of outstanding bank debt. Column (1) reports the results for solar producers, column (2) for wind producers, and column (3) for all other green energy producers. All regressions include year-month and firm fixed effects. Robust standard errors are in parentheses, with significance denoted by ***p<0.01, **p<0.05, *p<0.1.

Table A2: Bank Debt and Energy Production using a 24, 36 and 48-month Horizon

	Green Energy Production t+h			Conventional Energy Production t+h		
	(1)	(2)	(3)	(4)	(5)	(6)
			h=24 months			
ln(Debt)	0.181***	0.153***	0.101***	0.104***	0.010***	0.026***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.003)
Observations	44,759	44,759	44,759	10,200	10,200	10,200
R-squared	0.212	0.360	0.707	0.051	0.058	0.814
Time Fixed Effect	No	Yes	Yes	No	Yes	Yes
Firm Fixed Effect	No	No	Yes	No	No	Yes
			h=36 months			
ln(Debt)	0.171***	0.143***	0.0588***	0.105***	0.102***	0.0170***
	(0.00170)	(0.00181)	(0.00219)	(0.00457)	(0.00468)	(0.00369)
Observations	40,283	40,283	40,283	9,180	9,180	9,180
R-squared	0.181	0.322	0.697	0.054	0.061	0.820
Time Fixed Effect	No	Yes	Yes	No	Yes	Yes
Firm Fixed Effect	No	No	Yes	No	No	Yes
			h=48 months			
ln(Debt)	0.159***	0.132***	0.0187***	0.107***	0.106***	0.0101***
	(0.00184)	(0.00194)	(0.00241)	(0.00482)	(0.00489)	(0.00380)
Observations	35,807	35,807	35,807	8,160	8,160	8,160
R-squared	0.148	0.287	0.689	0.056	0.065	0.834
Time Fixed Effect	No	Yes	Yes	No	Yes	Yes
Firm Fixed Effect	No	No	Yes	No	No	Yes

Note: This table presents firm-level regression results examining the relationship between outstanding bank debt and energy production 24, 36, 48 months ahead for green and conventional energy producers. The dependent variable is the log of energy production at $t + h$, where h takes the values 24, 36, and 48, and the independent variable is the log of outstanding bank debt. Columns (1)–(3) cover green producers, while columns (4)–(6) focus on conventional producers. Columns (1) and (4) exclude fixed effects, columns (2) and (5) include year-month fixed effects, and columns (3) and (6) add firm fixed effects. Robust standard errors are in parentheses, with significance denoted by ***p<0.01, **p<0.05, *p<0.1.

Table A3: Bank Debt and Energy Production: Regression in Growth Rates

	Δ Green Energy Production t+12			Δ Conventional Energy Production t+12		
	(1)	(2)	(3)	(4)	(5)	(6)
$\ln(\text{Debt}_t)$ - $\ln(\text{Debt}_{t-12})$	0.061***	0.062***	0.064***	0.032***	0.026***	0.029***
	(0.003)	(0.003)	(0.003)	(0.006)	(0.005)	(0.005)
Observations	44,758	44,758	44,758	10,200	10,200	10,200
R-squared	0.021	0.050	0.061	0.004	0.144	0.165
Time Fixed Effect	No	Yes	Yes	No	Yes	Yes
Firm Fixed Effect	No	No	Yes	No	No	Yes

Note: This table presents firm-level regression results examining the relationship between the percentage change in outstanding bank debt and the percentage change energy production 12 months ahead for green and conventional energy producers. The dependent variable is the 12-month change in the log of energy production at $t+12$, and the independent variable is the 12-month change in the log of outstanding bank debt. Columns (1)–(3) cover green producers, while columns (4)–(6) focus on conventional producers. Columns (1) and (4) exclude fixed effects, columns (2) and (5) include year-month fixed effects, and columns (3) and (6) add firm fixed effects. Robust standard errors are in parentheses, with significance denoted by ***p<0.01, **p<0.05, *p<0.1.

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