

UNIVERSITÉ D'ORLÉANS
ÉCOLE DOCTORALE SCIENCE DE LA SOCIÉTÉ
TERRITOIRE, ÉCONOMIE ET DROIT (SSTED)
LABORATOIRE D'ÉCONOMIE D'ORLÉANS
THÈSE
présentée par :

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soutenue le : **20 décembre 2024**
pour obtenir le grade de : **Docteur de l'Université d'Orléans**
Discipline/ Spécialité : **Sciences économiques**

**Natural Resources, Institutions, and Sustainable
Development: A Regional Analysis in Latin America**

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Acknowledgements

This thesis represents both the beginning and the culmination of an intense journey. It marks the completion of one of the most important phases of my life, and achieving this personal and professional goal would not have been possible without the support and encouragement of several people, to whom I express my deepest gratitude in these lines.

First and foremost, I would like to thank my supervisors, Camélia, Grégory and Sabine, for their invaluable guidance, support, encouragement and letting me take selfish decisions along the way. Their insights and expertise greatly shaped this work. In particular, I am grateful to Grégory for consistently pushing me to pursue clear, well-structured ideas and frameworks in my research projects. To Sabine, I extend my thanks for always reminding me of the broader implications of my research and how it can be translated into tangible outcomes. Finally, to Camélia, thank you for trusting and encouraging me to begin this journey; I would not have done it otherwise. I deeply appreciate and enjoy the long discussions and your challenges to my ideas—these conversations significantly enhanced the quality of this thesis.

I express my gratitude to ISC Paris and the region Centre-Val de Loire for the three years of doctoral funding, providing the necessary computer equipment for my work, and for funding my travel to present my research at various conferences.

I am deeply grateful to Josep-Maria Arauzo-Carod, Christa Brunnschweiler, Mathieu Couttenier, Steven Poelhekke, Wessel Vermeulen, and Marcel Voia for being part of the thesis jury. Your insightful questions, comments, and suggestions will be carefully considered and will greatly enhanced the quality of this work.

I would also like to thank all the administrative staff, Mélie, Isabelle and Emilie, for making everything run so smoothly. All Professors at the lab particularly Daniel, Thais, Marcel, Chair, Yohan, and Paris thanks for your comments and discussions on different topics.

To all my colleagues and friends —Mamadou, Nicko, Indigo, Yannick, Aynur, Julie, Lucien, Asbath, Wiem, Lihn, Bienvenu, Arnaud, Marie, Martin, Capota, and Cristina—thank you for making the lab an amazing place. Notably, senpais Wassim, Dylan, and Hugo, thank you for your comments and suggestions along the way. Pauline, thank you for not really answering my questions. Inessa, *voilà*. To those from my corner (and former residents), Flavien, Seb, Mehdi, Matilda, Sarah, and Sahar (the sweetest of the lab), first, sorry for the bad Spanish lessons and thank you for all the laughs and 'productive' breaks. West, it's been an honor to start this journey with you—see you on the other side. And to all the other PhD students in the lab, thank you!

To the members of the OECD Trento Centre, thank you for having me. It was truly an enriching experience. In particular, thanks to Wessel and Carlo for pushing me toward new research horizons.

To my friends from afar, members of the Office, Social Tuesday and Yumbo, thank you for the support and laughs over the years. Notably, thanks to Diana for your unwavering support throughout this adventure, I wouldn't pull it off without you.

I am eternally grateful to my family, the cornerstone of my life. To my father, sister, brothers, cousins, nephews, aunty, uncles, and grandparent thank you for your unwavering support and love—I am who I am because of you. To Marti, there are no words to describe how much you mean to me, and to Anita, thank you for always pushing me and being there to pick (me) up. To all of you, I love you.

Finally, I extend my gratitude to everyone who, directly or indirectly, played a role in helping me reach this milestone. I am deeply grateful for all the support I have received.

To all, I've never been great with words, and it shows here. Thank you.

José Ríascos

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General Introduction

General Introduction

This thesis on sustainable development and political economy in Latin America focuses on the interactions between natural resources, institutions, climate change, and sustainable development within a regional context. Climate change represents one of the most pressing challenges the world faces today, not only due to its profound impacts but also because it is largely driven by human activity. Addressing this issue requires a transformation of the global economy, particularly the energy matrix: on one hand, a reduction in fossil fuel consumption is necessary; on the other hand, a significant expansion in the deployment of renewable energy is essential. As the world confronts the consequences of climate change, a growing body of literature seeks to tackle this challenge from various perspectives.

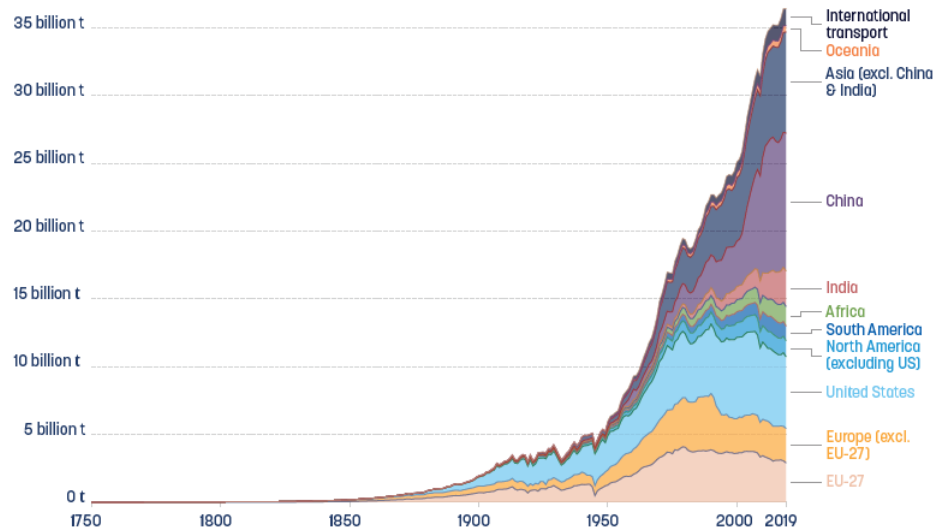
We explore the journey of Latin American regions in addressing climate change and advancing sustainable development, with a specific focus on natural resources. While a large body of literature addresses the role of fossil fuels in various aspects of development, including their implications for climate change (IEA, 2023*b*; Llop and Arauzo Carod, 2024), the effects of energy transition metals (ETMs) discovery and production, on sustainable development remain largely unexplored. This thesis, therefore, shifts the focus to mining in general and these critical minerals and metals needed for the green transition, in particular. We will further set up the broader context of the thesis, highlighting the interconnections between these topics and outlining how they are addressed throughout the study.

Climate change

It is unequivocal that human influence has warmed the atmosphere, ocean, and land (Calvin et al., 2023). Indeed, it is estimated that human activities have caused approximately 1.0°C of global warming above pre-industrial levels, and this rise is projected to increase to 1.5°C between 2030 and 2052 if current trends continue (IPCC, 2022).

While Earth's climate has naturally fluctuated throughout history, with cycles of ice ages and warmer periods occurring over the past 800,000 years, the current warming trend is fundamentally different. The rapid warming since the mid-1800s can be directly attributed to human activities, such as the burning of

Figure 1: Evolution of GHGs



Annual Total CO₂ Emissions by World Region. Source: World Bank (2021)

fossil fuels and deforestation. Unlike natural climate cycles, this anthropogenic warming is happening at an unprecedented rate and poses a significant challenge to human civilization and the planet's ecosystems (NASA, 2024b).

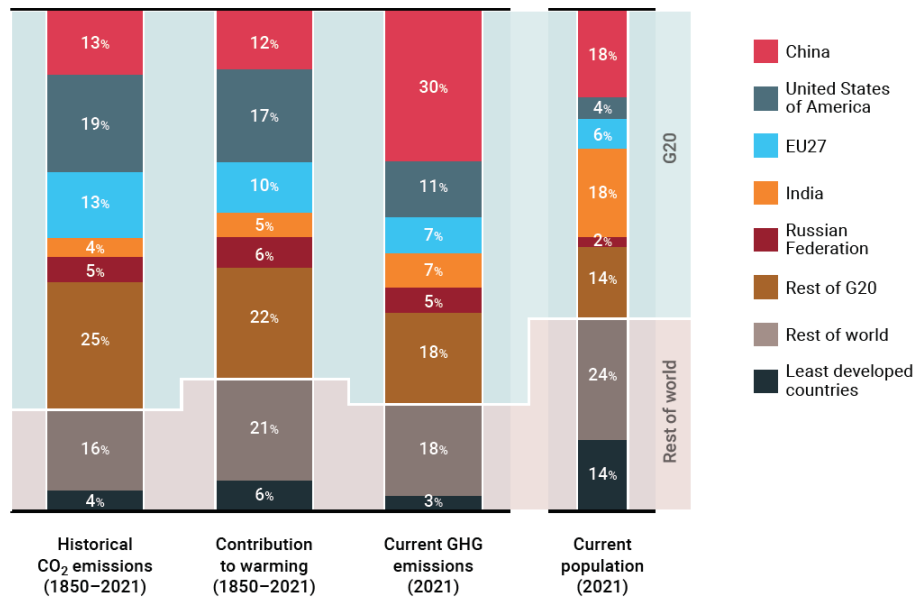
The rapid warming observed is driven by the greenhouse effect due to global greenhouse gas (GHG) emissions. GHG emissions continued to rise, increasing by 1.2 percent from 2021 to 2022, reaching a record 57.4 gigatons of CO₂ equivalent (Figure 1). CO₂ from fossil fuel combustion and industrial processes remains the main contributor, accounting for roughly two-thirds of all GHG emissions (United Nations Environment Programme, 2023). While renewable energy, particularly solar, has seen significant growth, global investment in fossil fuel extraction and use continues. Alarming, many governments still plan to produce more than double the fossil fuels by 2030, inconsistent with the long-term temperature goals of the Paris Agreement.

Inequality in consumption-based emissions is evident both among and within countries. Globally, the top 10% of the population, in terms of income, accounted for nearly half (48%) of total emissions, with two-thirds of this group residing in developed countries. In contrast, the bottom 50% of the world's population contributed only 12% of total emissions.

Historical emissions and contributions to global warming similarly vary significantly across countries and groups of countries. Nearly 80% of historical cumulative fossil fuel and LULUCF (land use, land-use change, and forestry) CO₂ emissions have come from G20 countries, with the largest contributions from China, the United States, and the European Union. In contrast, the least developed countries have contributed just 4% to these historical emissions (Figure 2).

Climate change has already triggered multiple observable changes in the Earth's climate system. One

Figure 2: Current and historic contributions to climate change



Source: United Nations Environment Programme (2023)

of the most prominent impacts has been the rise in global temperatures, which has led to more frequent and intense heatwaves across many regions. Alongside these temperature increases, global warming has also intensified the hydrological cycle, resulting in more frequent and severe heavy precipitation events on a global scale. In contrast, some regions are experiencing heightened risks of drought, as shifts in weather patterns disrupt traditional precipitation levels (Calvin et al., 2023).

Climate change has led to widespread adverse impacts and related losses and damages to both nature and people. Vulnerable communities, particularly those who have historically contributed the least to current climate change, are disproportionately affected (IPCC, 2022). Approximately 3.3 to 3.6 billion people live in highly vulnerable contexts. Increasing extreme weather and climate events have exposed millions to acute food insecurity and reduced water security. Indigenous Peoples, small-scale food producers, and low-income households are particularly at risk. From 2010 to 2020, mortality from floods, droughts, and storms was 15 times higher in highly vulnerable regions compared to those with low vulnerability (FAO, 2021). Economic damages from climate change have been detected in key sectors such as agriculture, forestry, fisheries, energy, and tourism. These impacts exacerbate existing inequalities, with the poorest communities bearing the greatest burden.

Global climate agreements

Over the past few decades, the international community has made significant progress in addressing climate change through a series of landmark agreements and initiatives. These frameworks have sought

to mitigate GHG emissions, protect vulnerable ecosystems, and promote global cooperation in the fight against climate change. Table 1 provides an overview of some of the most important agreements and initiatives that have shaped global climate policy. These efforts, underscore the growing recognition of the need for urgent and coordinated action on climate change.

Table 1: Main agreements and initiatives

Agreement or initiative	Year	Purpose
Montreal Protocol	1987	To stop the production of substances that damage the ozone layer
IPCC	1988	Provides scientific assessments of climate change, informing policy-makers and the public.
UNFCCC	1992	Established an annual forum (COP) for international discussions aimed at stabilizing the concentration of greenhouse gases in the atmosphere.
Kyoto Protocol	2005	First legally binding climate treaty. It required developed countries to reduce emissions by an average of 5 percent below 1990 levels, and established a system to monitor countries' progress.
Paris Agreement	2015	Governments set targets, with the goals of preventing the global average temperature from rising 2°C above preindustrial levels and pursuing efforts to keep it below 1.5°C
Glasgow Pact (COP26)	2021	Strengthened the Paris Agreement by urging countries to accelerate efforts to phase out coal, reduce methane emissions, and increase finance for developing countries.
Sharm el-Sheikh Plan (COP27)	2022	Established a loss and damage fund to help vulnerable countries cope with climate change impacts

Source : Maizland (2023)

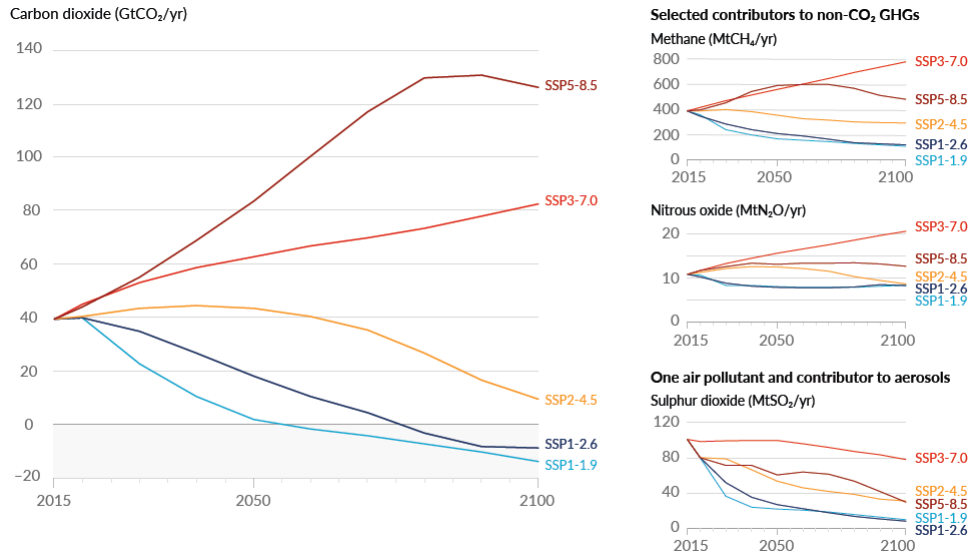
Among these agreements, the Paris Agreement stands out as a pivotal milestone in climate policy, marking a collective effort by governments to limit global warming to well below 2°C and pursue efforts to keep it below 1.5°C. The Paris Agreement not only set ambitious targets but also laid the groundwork for the transition toward decarbonization, a critical step in meeting energy demand while reducing reliance on fossil fuels. The subsequent section will explore the implications of decarbonization and the increasing demand for renewable energy, which are essential to achieving the goals set forth in the Paris Agreement.

Decarbonization and energy demand

The Paris Agreement aims to limit global warming to well below 2°C, ideally keeping it to 1.5°C. To achieve this, a significant transformation of the global energy matrix is required. Figure 3 presents various scenarios to meet different global warming targets, ranging from 1.5°C to 4.4°C. These scenarios are characterized by low greenhouse gas (GHG) emissions, with CO₂ emissions projected to decline to net zero around or after 2050, followed by varying levels of net negative CO₂ emissions (IPCC, 2022).

Meeting this ambitious target demands a low-carbon energy system. This will require the rapid deployment of clean energy technologies, both this decade and beyond. Global electricity use is expected

Figure 3: Future annual GHGs emissions



to increase dramatically, rising from 28,000 TWh in 2022 to as much as 110,000 TWh by 2050, with over 75% of this being supplied by wind and solar. Achieving this will also require a major expansion of electricity grids and the near-total decarbonization of the global vehicle fleet by 2050 (ETC, 2023).

However, the deployment of green energy is highly dependent on energy transition metals and minerals (ETMs). Table 2 shows key materials for wind and solar power, as well as electric batteries. Clean energy technologies will significantly drive the demand for some of these critical materials (ETC, 2023). For example, World Bank (2017) suggests that, depending on the scenario, the demand for certain elements could increase by as much as 150% to over 1,000%, particularly for metals needed in electric battery production.

Table 2: Key materials for selected green technologies

	Wind	Solar	Batteries
Aluminum	X	X	X
Chromium	X		
Cobalt			X
Copper	X	X	
Rare earth		X	
Iron	X	X	
Lead	X	X	X
Lithium			X
Manganese	X		X
Nickel	X	X	X
Silver		X	
Steel	X		X
Zinc	X	X	

This surge in demand underscores the critical role that metals such as lithium, cobalt, and nickel will play in the global energy transition. The energy transition between 2022 and 2050 could require an estimated 6.5 billion tonnes of materials, with steel, copper, and aluminum accounting for 95% of this total. While the bulk of these materials are needed in large quantities, others, such as lithium, will require around 20 million tonnes over this period. Despite the significant material requirements, there are sufficient known mineral resources available on land to meet future demand through 2050 (ETC, 2023).

However, certain materials, such as copper, nickel, and silver, may face potential shortages if demand accelerates rapidly without advancements in technology, material efficiency, or recycling. In such a scenario, reserves might need to expand by 30% for copper, 70% for nickel, and 90% for silver to meet total expected demand across all sectors by 2050 (ETC, 2023). In fact, considering current mines and those under construction, the installed capacity is expected to meet only half of the projected lithium and cobalt demand, and 80% of the copper needed to meet climate change goals by 2030 (IEA, 2021).

Overcoming this supply stress will require investment in exploration and the construction of new mines to diversify supply chains and meet demand. In this regard, developing and emerging countries face opportunities to play key roles in the supply chains needed to meet climate goals. World Bank (2017) highlights a gap in current and robust data mapping relevant mineral and metal resources in developing countries. Moreover, there are opportunities related to metal production versus estimated reserves. While relatively developed countries play larger roles in the production of certain resources, key reserves for some critical elements are largely concentrated in developing and emerging countries.

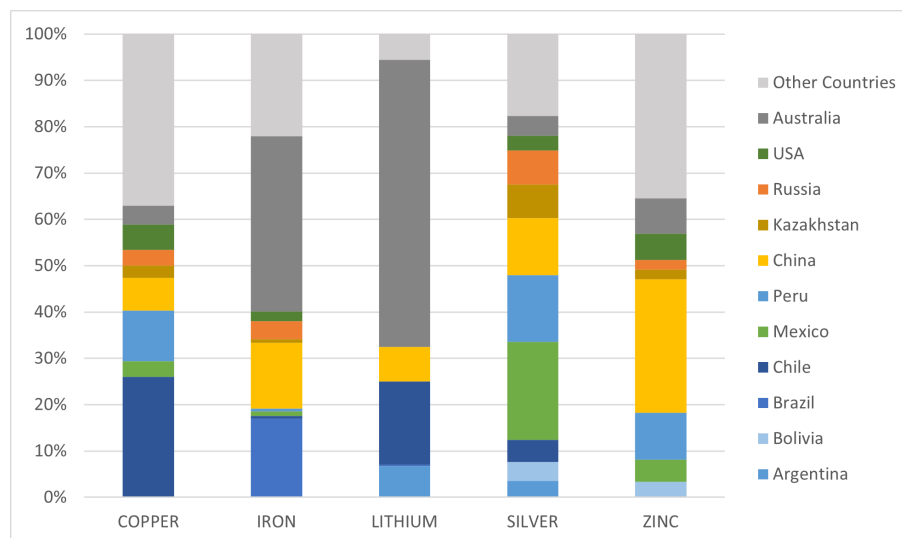
Latin America, climate change and ETM

Latin America and the Caribbean (LAC) contribute to approximately 7% of global GHG emissions. This contribution is relatively low compared to the emissions of China (30%), the United States (11%), and India (7%). Within the region, Argentina, Brazil, Mexico, and Venezuela are the largest emitters, responsible for 70% of LAC's total emissions (Cárdenas and Orozco, 2023).

The composition of LAC's emissions is notable, with CO₂ accounting for 43% of total CO₂-equivalent emissions, well below the global average of 74%. In contrast, the Agriculture, Forestry, and Other Land Use (AFOLU) sectors make up 40% of the region's total emissions—almost double the global average. This trend is driven by two factors: first, LAC has a higher share of land-intensive industries; and second, LAC has a cleaner energy matrix compared to the rest of the world, with nearly 60% of electricity generation coming from renewable sources (Cárdenas and Orozco, 2023).

Like other regions, LAC is experiencing the consequences of climate change. In 2023, the region recorded its highest average temperatures on record, along with more frequent precipitation anomalies and retreating glaciers. Southeastern South America is seeing increases in the intensity and frequency of

Figure 4: Global Supply of ETM



Global supply of selected ETM by country in 2018.
Source: U.S. Geological Survey (2020). Own elaboration

hot extremes, a likely decrease in cold extremes, and an increase in both mean and heavy precipitation. Extreme weather events such as tropical storms, heavy rains, floods, and landslides are also becoming more common. For example, climate-related events in 2023 alone caused 909 deaths and affected 11 million people (World Meteorological Organization, 2023).

The agricultural sector has been particularly vulnerable, with Latin America suffering the highest loss in crop and livestock production, which translates into the most significant reduction in calorie intake compared to other regions (FAO, 2021).

However, addressing climate change presents an opportunity for several countries in the region. Latin America is in a relatively strong position to become a key supplier for the global transition to climate-friendly energy. Brazil, Chile, Argentina, and Peru are among the best-positioned countries, with Bolivia potentially set to benefit, provided it can translate its vast lithium resources into recognized reserves. Latin America holds strategic advantages in the production of copper, iron ore, silver, and lithium. The region also plays an active role in the aluminum, nickel, manganese, and zinc sectors (World Bank, 2017). LAC currently accounts for over 40% of global silver and copper production and over 20% of the global lithium supply. The supply of lithium could increase significantly if Bolivia were to develop its extensive lithium reserves (See figure 4). While these countries profit from an advantageous position in the face of climate change, several other countries have operating mines and likely reserves in key materials (Figure 5).

As global demand for ETMs grows, Latin America's role in the energy transition will be crucial, but this opportunity is not without challenges. Multilateral organizations emphasize the potential benefits of

Figure 5: ETM mining activity



Author's elaboration. Source: U.S. Geological Survey (2020)

the sector, and there is increasing awareness of its role in addressing environmental and social issues (IEA, 2021). However, we can't overlook the possible negative effects on local territories. Indeed, a vast body of literature highlights the adverse consequences of natural resource extraction, including poor economic performance. These issues will be explored in more detail in the following section.

The resource curse and development

In 1993, Auty and Warhurst coined the term "natural resource curse" to describe the negative correlation between natural resource dependency and poor economic performance. Sachs and Warner (2001) later expanded on this concept, demonstrating how, between the 1970s and early 2000s, many resource-rich countries experienced stagnating economic growth. This puzzling behavior has led to a vast body of literature on the topic. For instance, countries like Hong Kong, Japan, South Korea, and Singapore, which have minimal natural resources, have achieved Western-level standards of living. In contrast, many resource-rich countries in Africa, the Middle East, and Latin America, despite their abundance of oil, minerals, and other resources, have experienced much less satisfactory economic outcomes. The literature attributes these unsettling patterns to various channels, which will be explored in the following sections.

Resource curse's channels

Characteristics of natural resources

First, it is important to highlight the unique characteristics of natural resources. Unlike other sectors, natural resources are not produced but rather extracted, meaning there is typically no complex production process involved. As a result, the relative use of inputs is lower compared to industries like manufacturing, where various inputs are needed to transform raw materials and increase their value added. As a result, natural resource wealth can emerge independently of other economic activities within a country (Humphreys et al., 2007). This is particularly true for the extraction of hydrocarbons, where specialized machinery and human capital are required—resources that are often unavailable in the extraction locations themselves.

Moreover, most products derived from natural resource extraction are commodities with little to no qualitative differentiation across markets. This lack of differentiation is linked to the idea that the natural resource sector generates few, if any, positive spillovers in the broader economy. However, there is no compelling evidence to suggest that resource-based production is inherently inferior to other forms of production in terms of linkages and spillovers. In fact, both forward and backward linkages in the resource sector can stimulate economic growth (Sinnot et al., 2011; Watkins, 1963; Vahabi, 2017).

Additionally, many natural resources are non-renewable, meaning their extraction leads to the depletion of a country's assets. For sustainable growth, countries must invest the income from resource extraction in the formation of other types of capital to ensure that both current and future generations benefit from its exploitation.

High rents

Commodity sectors, particularly hydrocarbons and minerals/metals, tend to generate high rents. This presents a potential risk, as overdependence on natural resources can lead to "Dutch disease" (Gylfason, 2001).¹ Sachs and Warner (2001) demonstrated that resource abundance leads to higher-than-normal domestic prices, making it difficult for manufacturers to compete in international markets, ultimately rendering the exporting sector uncompetitive.

Recent literature also exhibits the effects of natural resources in Canada (Beine et al., 2015; Moshiri et al., 2020), Indonesia (Pelzl and Poelhekke, 2021), and, more generally, in developing countries De Haas and Poelhekke (2019). Interestingly, these studies show mixed results. For example, Moshiri et al. (2020) states that highly productive firms are not affected, while De Haas and Poelhekke (2019) finds that the effect is localized, benefiting industries farther from the mining site.

Latin American countries have experienced similar effects from their agricultural sectors, which also

¹Dutch disease occurs when an increase in commodity exports appreciates the real exchange rate, which in turn shifts resources away from other sectors of the economy. Specifically, the appreciation of the exchange rate can adversely affect the manufacturing sector.

produce significant rents. For instance, coffee generates considerable rents in Brazil, Colombia, and Central America, while oilseeds and grains contribute significantly in Brazil, Argentina, and Chile Sinnot et al. (2011).

Price volatility

At a theoretical level, commodity prices may either trend downward or upward, particularly for non-renewables. A branch of the literature suggests that the negative effects of price trends may be attributed to the fact that global demand for primary products is inelastic with respect to world income. Therefore, specializing in primary products can be economically disadvantageous (Arezki et al., 2012). Nevertheless, empirical studies may support one trend or the other depending on the years of observation (Frankel, 2010). Rather than focusing solely on these trends, it is essential to note that commodities, particularly fossil fuels, experience high price volatility.

Commodity markets tend to be more volatile due to the low elasticity of both supply and demand. As a result, it takes time for markets to adjust to shocks on either side. In the oil sector, for instance, demand elasticity is low in the short run because capital stock is typically designed to operate with a specific energy-to-output ratio. Similarly, supply elasticity is often low because adjusting output takes time, especially when production capacities are already operating at full capacity (Frankel, 2010).

These low elasticities create significant price fluctuations, which can hinder development. When countries are heavily dependent on commodities, volatility increases uncertainty and risk, discouraging investment. Additionally, procyclical government policies during boom cycles can have damaging long-term effects. Governments may increase expenditures during periods of high commodity prices, leading to difficulties when prices fall. A failure to adjust government spending in response to falling international prices can significantly reduce government revenue, exacerbating the cyclical nature of the economy.

Institutions

High rents from natural resources can undermine the development of institutions.

“This pool of easy money (referring to rents from natural resources), especially when combined with government ownership, creates conditions conducive to rent-seeking and poor governance, and can undermine the development of good institutions and, consequently, of long-term growth” Sinnot et al. (2011).

The intrinsic relationship between natural resources and institutions has been widely discussed in the literature. These discussions can generally be divided into two key effects: the anti-democratic effect and the rise of corruption.

Ross (2001) argues that oil and minerals can undermine democracy, particularly in poorer countries. He identifies three channels through which this anti-democratic effect is transmitted: (i) the rentier effect, in which high resource rents allow governments to reduce taxes, thus diminishing accountability; (ii) the repression effect, where governments use resource rents to invest heavily in national security, enabling the

state to suppress democratic movements; and (iii) the modernization effect, which suggests that a highly educated and specialized working class tends to demand greater accountability and democracy. However, due to the characteristics of oil and mineral extraction, either governments do not prioritize investments in education, or citizens become engaged in rent-seeking activities, delaying democratization.

The underlying idea is that democracy is strongly linked with accountability and transparency, both of which deter the discretionary power of public officials. This, in turn, leads to better-quality institutions (Holmberg et al., 2009), fostering long-term development. Similarly, high rents from natural resources have been associated with increased corruption (Knutsen et al., 2016; Sala-i Martin and Subramanian, 2013; Sinnot et al., 2011; Leite and Weidmann, 1999).

Quality of institutions and governance

While the literature on the resource curse explains how natural resources can lead to poor economic performance and weak institutions, it does not fully account for cases where resource-rich countries have managed to perform well. Several attempts to reconcile these divergent outcomes have emerged, focusing on the importance of linkages and institutional quality in determining the economic impact of natural resources.

One early attempt to explain positive outcomes is the Staple Theory, which emphasizes the role of commodities ("staples") in driving economic development through linkage effects (Watkins, 1963). According to this theory, resource-based industries generate three key types of linkages:

1. Backward linkages stimulate investments in input-supplying industries.
2. Forward linkages lead to the development of industries that use the staple commodity as an input.
3. Final demand linkages capture the consumer demand generated by income from the resource sector.

These linkages can foster economic diversification and development. However, without these linkages, a country may fall into what is known as a staple trap, where economic diversification fails to materialize (Vahabi, 2017). Whether a country successfully develops linkages or not often depends on the characteristics of the resource itself and whether its extraction and processing can stimulate broader economic activities.

A more contemporary and widely accepted view in the literature is that natural resources can be either a blessing or a curse depending on the quality of institutions. As argued by Boschini et al. (2007), the impact of resources is not determined by resource endowments alone but rather by the interaction between the type of resources a country possesses and the quality of its institutions. A similar outcome is proposed by Couttenier (2008) in a theoretical model.

This conditional view, suggests that natural resources can either spur or hinder economic growth based on the institutional environment. If a country has high-quality, “producer-friendly” institutions, natural resources will contribute positively to economic growth by ensuring that resource rents are invested effectively in long-term development. Conversely, in the presence of weak or “grabber-friendly” institutions—where rent-seeking and corruption dominate—natural resources can exacerbate poor governance and hinder development.

A variety of studies support this perspective. For example, Mehlum et al. (2006) and Bhattacharyya and Hodler (2010) show that the quality of institutions plays a critical role in determining whether natural resources are a curse or a blessing. They argue that institutions shape how resource rents are managed: strong institutions promote transparency, accountability, and productive investment, while weak institutions foster rent-seeking, corruption, and mismanagement of resources. Similarly, Cust and Harding (2019) and Couttenier et al. (2017) reinforce this view, providing evidence that good governance helps mitigate the adverse effects of resource dependence.

This institutional approach is increasingly recognized as a way to reconcile the mixed results in the resource curse literature. Scholars such as Acemoglu and Robinson (2012), North (1990), and Rodrik et al. (2004) argue that institutional quality is the most critical factor for sustainable development. According to these scholars, well-functioning institutions create a framework in which resource wealth can be harnessed for productive purposes, including investment in infrastructure, education, and diversification of the economy.

In summary, the literature increasingly highlights that the economic outcomes of natural resource wealth are not predetermined by the resource itself but by the quality of institutions in place. Good institutions help ensure that resource rents are channeled into productive investments that foster long-term growth, while poor institutions create fertile ground for rent-seeking, corruption, and economic stagnation.

While the resource curse literature traditionally focuses on national-level outcomes, there is a growing recognition of the importance of analyzing resource dependency and its effects at the subnational level. In resource-rich countries, the concentration of extractive activities often varies significantly across regions, leading to divergent economic, social, and institutional outcomes. Subnational regions that are heavily reliant on natural resources may experience dynamics similar to the broader national trends, such as economic stagnation or institutional weakening.

Moreover, institutional quality can differ within countries, with some regions showing better quality of governance than others. A typical example is the case of Italy where the quality of institutions is higher in the northern regions. The local quality of institutions may play a significant role in the context of the resource curse. However, the literature is relatively scarce and even smaller if the institutions are

taken into account. Nevertheless, more attention should be given to this issue, indeed, Knutsen et al. (2016) show that mining regions present higher levels of corruption.

Given the complexity of the resource curse, it is essential to analyze these issues not only at the national level but also at subnational levels to fully understand how natural resource wealth impacts development and institutional quality in specific regions. This subnational approach allows for a more granular analysis of the channels through which resources may lead to positive or negative outcomes.

LAC and the resource curse

Latin America and the Caribbean (LAC) is a key region in terms of both reserves and exploitation of non-renewable natural resources. As previously mentioned, LAC possesses significant reserves of critical resources essential for the deployment of green energy. Countries like Chile, Mexico, and Peru are home to important reserves of energy transition metals (ETMs), vital for the transition to renewable energy. Additionally, LAC holds nearly 15% of the world's oil and gas reserves, while accounting for less than 1% of global coal resources. Brazil, Venezuela, Mexico, Argentina, and Colombia are among the region's leading oil exporters, with Colombia being the primary coal supplier (IEA, 2023*a*).

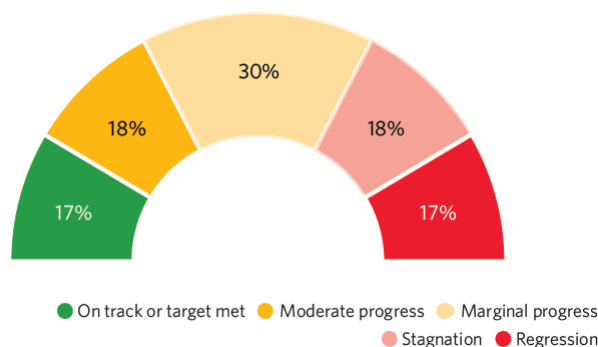
In terms of precious metals, countries like Peru and Mexico rank among the top ten global exporters, with Brazil, Colombia, and Bolivia also serving as important suppliers (World Gold Council, 2024). Given the region's resource abundance, it becomes crucial to analyze the potential positive and negative effects of mining activities.

The literature on the resource curse in Latin America paints a mixed picture, highlighting that the resource curse is not a deterministic phenomenon. Rather than mere resource abundance, it is the dependence on natural resources that appears to be associated with developmental challenges. Dunning (2008) argue that resources have been a blessing to LAC, while other scholars, such as Sinnott et al. (2011); Papyrakis and Pellegrini (2019), suggest that resources are neither a curse nor a blessing. Haber and Menaldo (2012) indicates that resources do not directly impact democracy in the region, in contrast to broader global findings (Frankel, 2010; Ross, 2015).

Cases like Venezuela and Chile demonstrate the complexity of the resource curse hypothesis in LAC. One explanation, as suggested by Ross (2015), is that the resource curse might be particularly linked to the oil industry, though this theory still lacks a comprehensive explanation for its broader effects. Furthermore, the literature emphasizes the importance of analyzing resource extraction at a regional level. Populations near extractive activities may either experience socio-environmental challenges (Papyrakis and Pellegrini, 2019) or benefit from sector booms (Ishiyama et al., 2018), while institutional quality may suffer from the mismanagement of royalties (Sinnott et al., 2011).

Given these dynamics, it is essential to examine the resource curse phenomenon at the subnational

Figure 6: Overall progress across SDG's targets based on 2015–2024



Source: United Nations (2024)

level. This approach is particularly relevant in the context of the emerging and under-explored mining of critical materials for the energy transition. Analyzing local-level outcomes may provide a more nuanced understanding of the resource curse's impact in Latin America, especially in relation to green energy development.

Sustainable development and extractive industry

The UN defines sustainable development as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. This broad definition encompasses economic growth, social inclusion, and environmental protection.

An important milestone in sustainability was the 2015 summit, where members adopted the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs), representing a commitment to end poverty, tackle inequalities, and preserve the planet.

However, “the achievement of the SDGs is in peril” (United Nations, 2024). Progress has stagnated or reversed due to several factors, such as the COVID-19 pandemic, ongoing wars, and increasing climate shocks, jeopardizing the efforts of member countries. Figure 6 presents the overall progress on the 135² targets. Only 17% are on track to meet the objectives, and 18% show moderate progress.

The status of the goals underscores the urgency of adopting measures to achieve sustainable development objectives. In this context, contributions from governments, communities, and industries are essential. Governments, in particular, recognize the importance of tailored, local solutions, providing support to departments and municipalities. As a result, within the OECD area, local governments account for nearly 60% of the total public investment dedicated to achieving the SDGs (OECD, 2020*b*).

The extractive industry also plays a key role in this framework. Not only does it provide critical inputs

²There are 169 targets, and 135 can be assessed using available data (UN General Assembly, 2023)

for both the economy and the green transition, but it is often located in remote and underdeveloped areas, bringing much-needed investment that can be crucial for long-term development. Additionally, the sector significantly contributes to foreign direct investment, exports, and government revenues.

The mining industry has the potential to positively impact all SDGs. While it directly influences climate change and economic development, with an inclusive approach and the adoption of best practices, the sector can also help reduce poverty, address inequalities, and promote environmental sustainability (World Economic Forum et al., 2016).

However, the literature on the resource curse suggests otherwise. While there is some evidence of positive effects regarding income (Aragón and Rud, 2013; Bazillier and Girard, 2020; Mamo et al., 2019). Most of the literature recognized that the extractive sector is also a major contributor to carbon emissions, environmental degradation, and the displacement of communities.

Therefore, a deeper understanding of the effects of the mining sector is necessary, particularly in the case of LAC, where the impacts are mixed. Specifically, there is a notable gap in the literature addressing these effects at the subnational level, where communities may experience either positive or negative outcomes.

Connecting the dots: Sustainability, climate change and mining

"Climate change, poverty, and inequality are defining challenges of our time—and it is crucial that we tackle them together, acknowledging the interconnections between people, the planet, and the economy" (World Bank, 2022).

Governments face the key task of addressing climate change while ensuring that resources are available for future generations. Tackling climate change presents both an opportunity and an obligation for this generation to secure sustainability. The effects of climate change significantly hinder efforts to achieve the SDGs and more broadly impact well-being, exacerbating various forms of deprivation, including food insecurity, lack of access to clean water, and threats to cultural heritage.

The relationship between sustainable development and climate change becomes even more pressing when we consider that low-income and high-poverty countries are particularly vulnerable to its effects. While climate change affects the entire population, projections show that it will disproportionately increase monetary poverty, widen gender gaps, reduce economic performance, and escalate food insecurity, especially in poor countries (World Bank, 2022). This dynamic threatens to undermine sustainable development in the long term.

This global challenge is particularly relevant for the mining industry, which occupies a pivotal role in both contributing to and mitigating these issues. On one hand, mining provides critical raw materials

essential for economic growth and the green energy transition. On the other hand, the sector is a major source of environmental degradation, carbon emissions, and social disruption, particularly in developing regions such as LAC.

The extractive industry is thus a double-edged sword: while it offers opportunities for development and the raw materials needed for climate solutions, it also presents risks to sustainable development if not managed carefully. In resource-rich regions, the pursuit of mining activities can conflict with climate action and sustainable development, particularly when operations result in biodiversity loss, pollution or displacement of people that exacerbates local vulnerabilities to climate impacts.

For LAC countries, where natural resources play a significant role in the economy, mining intersects directly with efforts to combat poverty and inequality. The challenge lies in harnessing the benefits of mining while minimizing its adverse effects, ensuring that the industry contributes positively to both sustainability and climate goals.

Addressing climate change is expected to increase the demand for ETMs, and LAC is well-positioned to meet this demand. The expansion of the mining industry represents a significant opportunity for the region. However, the acceptance of these projects and the management of the resulting windfalls depend heavily on the preferences and priorities of local communities.

Research contributions

This thesis is situated at the intersection of climate change, sustainable development, and natural resource extraction, with a particular focus on mining in Latin America. Addressing climate change is expected to increase the demand for energy transition metals (ETMs), benefiting several resource-rich countries. However, the effects of mining at the sub-national level remain largely unclear in the literature, especially for resources other than fossil fuels. This thesis focuses on the LAC region, for which existing research is scarce, and presents mixed findings.

The first chapter explores the resource curse at the subnational level, specifically examining the impact of the start of the mining sector on the quality of institutions in LAC regions. The second chapter investigates whether the initiation of mining activities in Mexican municipalities affects sustainable development. Finally, the third chapter analyzes whether, in the face of competing priorities such as security concerns, communities prioritize sustainable development. This is assessed by evaluating voter behavior in response to different investment allocations.

Chapter 1: Mining and Institutional Quality in Latin America: The Dark Side of the Green Transition

Meeting the climate change objective of limiting the global temperature increase to within 2°C requires a drastic decarbonization of the economy, which will drive a significant rise in the demand for energy transition minerals (ETMs). However, the potential effects of ETM mining, particularly at the subnational level, remain largely unexplored, especially regarding its impact on local institutional quality. This chapter investigates the effect of ETM mining on the quality of institutions within countries in Latin America and the Caribbean (LAC), a region with high potential to meet global ETM demand. We argue that the mining sector may negatively impact institutional quality, thereby impeding long-term development, as research suggests that institutional quality is a key determinant of development outcomes.

To address this issue, we constructed a novel dataset covering departments (or equivalent administrative units such as states) in 18 Latin American countries. We developed, at the department level, an institutional quality index using Latinobarometer data. This index captures three key dimensions of institutional quality: trust, corruption, and government effectiveness. To our knowledge, this represents the first attempt to create an institutional quality index at the subnational level in Latin America. Additionally, we incorporated other data sources, such as satellite imagery, geolocated mining data, and various datasets from national statistical offices, to construct key development indicators. We employ a Synthetic Difference-in-Differences approach. The treatment group consists of regions in LAC where an ETM mine begins operations for the first time, while the control group comprises regions with no ETM activity.

Our results suggest that there is no overall decline in institutional quality, however we observe a consistent negative effect on control of corruption, indicating increased perceived corruption. Additionally, in specific cases, trust in institutions is also negatively affected. Importantly, these effects are driven by regions where mining operations are relatively large compared to the population, highlighting the role of scale in shaping institutional outcomes. Further analysis reveals that in specific contexts mining can improve quality of institutions, although we cannot generalize this result.

We conclude that mining may pose a threat to long-term development by undermining institutional quality. Therefore, careful consideration of governance and institutional frameworks is crucial in new mining regions.

Chapter 2: Sustainable development and the extractive industry.

An assessment of the Mexican case

Addressing climate change is an urgent matter that requires the decarbonization of the global economy. Achieving climate goals involves reducing the consumption of fossil fuels and increasing the use of energy transition minerals (ETMs). Many countries in Latin America and the Caribbean (LAC) stand to benefit from the growing demand for these minerals. Among them, Mexico is a key player, with abundant resources in silver, zinc, copper, and other minerals. However, while the extractive sector is recognized for its potential to generate significant revenue for governments and provide vital inputs to the economy, there is a lack of awareness regarding its role in sustainable development, particularly in LAC regions.

We address this issue by analyzing the impact of the extractive industry on sustainable development in Mexican municipalities, adopting a holistic approach that covers various dimensions of sustainability. Mexico was selected for this analysis due to the significant transformation of its mining sector following the enactment of the new mining law and the liberalization brought about by the NAFTA agreement, which greatly increased investment in the sector.

To assess the effects of the mining industry, we examine the sector's impact on household income, economic inequality, education, and environmental degradation. For this purpose, we construct a database comprising Mexican municipality data sourced from Census records, NASA, and geolocated mine information. To measure environmental damage, we use the Normalized Difference Vegetation Index (NDVI), arguing that land degradation due to mining activity should be reflected in reduced vegetation quality, as indicated by a decrease in NDVI. We use a Staggered Difference-in-Differences approach. Our treatment group consists of municipalities where a mine began operations, while the control group includes municipalities without mining activity.

The results suggest that the mining sector does not have a significant effect on education or economic inequality. However, we observe a positive impact on household income, although robustness checks indicate that this effect is temporary. Additionally, there is clear evidence of environmental degradation. These findings are robust to alternative estimators, spillover effects, and different measures of environmental damage (e.g. vegetation quality, water contamination, air pollution).

We conclude that the extractive industry poses a threat to local sustainability. While mining activities boost household incomes, these benefits can be short-lived, and the associated environmental damage is significant. This supports the unrest and conflicts that often arise in communities when new mining projects are proposed nearby, as local concerns about sustainability and environmental degradation are justified.

Chapter 3: Voting Priorities: Security, Sustainability, and Strategic Investments in Colombian Municipalities

The local summit held within the framework of COP28 marked a significant milestone, emphasizing the critical role of regional administrations in achieving climate change objectives and, more broadly, the sustainable development goals set by nations. While national discourse frequently underscores the importance of sustainable development, local priorities do not always align with this trajectory. For instance, some sustainable development goals may conflict with each other. Furthermore, local leaders may prioritize policies that cater to voter preferences rather than sustainable development to secure their political careers.

This chapter addresses voter behavior in relation to sustainable development and security concerns in Colombia. I focus on Colombia due to its decentralized government, which allows for independence in resource allocation based on local needs, and its long-term internal conflict, providing a context for analyzing voters' priorities such as sustainable development, security, and more. I argue that, despite the absence of inherent conflicts between policy objectives, sustainable development may not be prioritized when more immediate concerns dominate.

To explore voting behavior in Colombian municipalities, I constructed a new database with data from 1,120 municipalities covering the period 2011-2019. I rely on investment allocation data from the *Contaduría Nacional* of each municipality to identify investments directly aimed at sustainable development by matching investment categories with the Sustainable Development Goals. Additionally, data from various sources such as the National Statistical Office, ministerial agencies, and oversight organizations are used to account for municipal characteristics. The analysis evaluates the likelihood of incumbent parties being re-elected, their electoral performance, and voter participation in response to sustainable development investments. I argue that voters react to the strategic allocation of resources, either punishing or rewarding incumbents. This behavior is analyzed using fixed effects estimation to account for unobserved voter characteristics across different municipalities.

The results suggest that voters in Colombian municipalities tend to prioritize security concerns and visible investments over those focused on sustainable development. A key finding from the heterogeneity analysis is that municipalities with higher levels of education are more responsive to the strategic allocation of resources. Similarly, municipalities with lower security concerns exhibit the same behavior. These results are robust to the inclusion of covariates and alternative investment measures that address potential endogeneity concerns.

I conclude that sustainable development investment is not the primary concern in Colombian municipalities. Voters respond more strongly to security concerns and visible investments. Additionally, there

are concerns regarding the short-term nature of projects due to the political cycle, which may undermine sustainability. However, addressing immediate issues and improving education, which fosters a better understanding of executive actions, could encourage voters to reassess how they evaluate their leaders.

In summary, this thesis contributes to the literature on resource curse analysis at the sub-national level, with a focus on non-fossil fuel mining in Latin America, while also exploring public attitudes toward sustainable development when confronted with competing priorities.

Chapter 1

Chapter 1

Mining and Institutional Quality in Latin America: The Dark Side of the Green Transition

Co-written with Sabine Bacouël-Jentjens & Grégory Levieuge & Camélia Turcu

1.1 Introduction

Limiting global warming and achieving the climate objectives set by the United Nations Climate Change Conference (COP) Agreements will require a profound restructuring of global economic activity. This transition involves shifting to a less energy-intensive economy and a low or zero-carbon future. As part of this energy transition, the demand for fossil fuels will decline, affecting producers, but it will also spur a significant increase in the demand for Energy Transition Metals (ETMs)¹. These metals are critical for the transmission, storage, and expansion of green energy technologies. The World Bank (2017) estimates that by 2050, the demand for ETMs needed to achieve various temperature targets (e.g., 2°C, 4°C, and 6°C warming) could increase substantially. For example, depending on the scenario, the demand for metals used in electric batteries could surge by as much as 1000%.

Decarbonization implies a dramatic increase in the consumption of certain mineral resources, such as copper, iron, and lithium. This shift in demand for natural resources² represents a significant opportunity for resource-rich developing countries. Latin American countries, for instance, have large reserves of copper, iron ore, silver, lithium, aluminum, nickel, manganese, and zinc. Similarly, Africa has abundant

¹For the rest of the text, ETM will refer to minerals and metals essential for the deployment of technologies required to meet a carbon-constrained scenario.

²We use the terms natural resources and commodities interchangeably to refer to traded, unbranded, bulk goods with little to no processing.

supplies of platinum, manganese, bauxite, and chromium, while Asia is rich in rare earths, iron, steel, and titanium, among other metals (World Bank, 2017).

The World Bank (2017) highlights the potential benefits of rising ETM demand for developing countries and stresses the lack of awareness among resource-rich nations about these opportunities. It provides a comprehensive mapping of known ETM to highlight the potential benefits from the sector. However, it is equally important to consider both the potential benefits and the challenges associated with ETM extraction. The resource curse literature suggests that countries abundant in natural resources may experience slower economic growth (Sachs and Warner, 2001; Frankel, 2010; Humphreys et al., 2007; Ross, 2001). In Latin America, however, empirical findings are mixed (Papyrakis and Pellegrini, 2019; Toscani, 2017).

The role of natural resources in development has been widely studied, and this paper focuses specifically on their effect on institutional quality. Several scholars have pointed out that natural resource exploitation can negatively impact institutional quality (Frankel, 2010; Sachs and Warner, 2001).

The importance of the quality of institutions is related to the idea that the institutional environment shapes economic outcomes. This approach has gained increased recognition in recent years. Scholars such as Acemoglu and Robinson (2012); North (1990); Rodrik et al. (2004), among others, argue that institutional quality is a critical factor for sustainable development. This presents a unique challenge for Latin America and the Caribbean (LAC), as the World Governance Indicators (WGI) suggest that the region lags behind high-income countries in institutional quality (see Figure 1.A.2), with little evidence of improvement over time.

This paper focuses on the impact of Energy Transition Metals (ETMs) on the quality of institutions at the subnational level in Latin America (LA). We focus on LA because the region has significant ETM endowments and accounts for a substantial portion of global supply. For example, LA countries produce nearly 50% of the world's silver and 40% of its copper (see Figure 1.A.1).

Moreover, Latin American economies are heavily dependent on natural resources. Net commodity-exporting countries account for 93% of the region's GDP (Sinnot et al., 2011). While this dependency—measured as the share of primary goods over total exports—has decreased over time to around 50%, it remains significantly higher than in developed countries (around 18%) and other developing regions, such as East Asia and the Pacific (29.9%) (ECLAC, 2021).

Given LAC's high dependency on natural resources, it is crucial to explore how the growing ETM sector might influence regional institutional quality. There is an increasing recognition of the importance of local institutions for sustainable development (Loveridge and Jackson, 1999; Rodríguez-Pose, 2013), yet empirical evidence on the impact of mining on institutional quality remains limited. To fill this gap, we aim to construct an index of institutional quality at the regional level for Latin American countries.

To the best of our knowledge, this is the first attempt to develop such an index for the region.

We analyze the effect of ETM mining on institutional quality across 336 subnational units in 18 LAC countries. Using the Synthetic Difference-in-Differences method, we find that while ETM mining does not lead to an overall decline in institutional quality, it consistently increases perceived corruption. Furthermore, individual analyses reveal that although mining generally has a negative effect on institutional quality, in specific cases, it can positively contribute to government effectiveness, driven by improvements in the provision of public goods.

The rest of the paper is divided as follows: Section 2 is dedicated to the literature review. Section 3 presents the data. Section 4 reports the results followed by robustness checks. The last section concludes.

1.2 Literature Review

The relationship between natural resources (NR) and development has been a central topic in the literature, with much of the focus on the resource curse—a concept that suggests resource abundance negatively impacts economic growth. Scholars such as Sachs and Warner (2001), Frankel (2010), Humphreys et al. (2007), and Ross (2001) have documented this negative relationship. However, in the case of Latin America (LAC), the findings are more nuanced: while Sinnot et al. (2011) argues that some Latin American countries have escaped the curse, Papyrakis and Pellegrini (2019) presents mixed results.

The literature identifies several mechanisms through which natural resources can hinder economic performance. First, the resource sector often generates limited spillover effects on the broader economy (Humphreys et al., 2007). Second, the high revenues from resource exports can cause Dutch disease (Gylfason, 2001), where an increase in commodity exports leads to an appreciation of the real exchange rate, drawing resources away from other sectors. Third, the volatility of resource prices can create fiscal challenges, especially when governments engage in pro-cyclical spending. In such cases, a sudden drop in prices during recessions can cripple both the economy and the government’s ability to respond. Further, high resource rents can erode institutional development, which is the central focus of this paper.

As Sinnot et al. (2011) put it: *“This pool of easy money (referring to rents from natural resources), especially when combined with government ownership, creates conditions conducive to rent-seeking and poor governance, and can undermine the development of good institutions and, consequently, of long-term growth.”*

The relationship between natural resources and institutions has been explored in the literature, often focusing on two key effects: the anti-democratic impact of resource dependence and the rise of corruption.

Ross (2001) argues that oil and minerals can undermine democracy, particularly in poorer countries. He identifies three channels through which this anti-democratic effect is transmitted: (i) the rentier

effect, where high resource rents allow governments to reduce taxes, diminishing accountability; (ii) the repression effect, where governments use resource rents to invest heavily in national security, enabling the state to suppress democratic movements; and (iii) the modernization effect, which suggests that a highly educated and specialized workforce tends to demand greater accountability and democracy. However, due to the nature of oil and mineral extraction, governments often deprioritize investments in education, or citizens become engaged in rent-seeking activities, delaying democratization.

The underlying premise is that democracy is strongly linked to accountability and transparency, both of which constrain the discretionary power of public officials. This, in turn, leads to better-quality institutions (Holmberg et al., 2009), fostering long-term development.

Similarly, high resource rents have been associated with increased corruption (Knutsen et al., 2016; Sala-i Martin and Subramanian, 2013; Sinnot et al., 2011; Leite and Weidmann, 1999).

However, while early efforts highlight the potential negative effect that mining has on the quality of institutions, scholars often condition this effect on the pre-existing institutional quality, thereby neglecting the role that mining itself can play in shaping institutions. The conditional relationship between natural resources and institutions has been widely studied at country level, focusing on how natural resources—typically in terms of economic growth—impact a country depending on its institutional quality. In this perspective, natural resources can either be a curse or a blessing. If institutional quality is high (producer-friendly), natural resources tend to spur growth. Conversely, if institutional quality is low (grabber-friendly), characterized by rent-seeking behavior, natural resources are likely to hinder development (Mehlum et al., 2006; Bhattacharyya and Hodler, 2010; Couttenier et al., 2017; Epo and Nochi Faha, 2019; Cust and Harding, 2019).

While the literature on the resource curse is extensive, empirical evidence regarding its implications at the subnational level, especially in developing countries, is less abundant and even scarce when addressing the quality of institutions.

In Africa, mining has been shown to increase corruption (Knutsen et al., 2016) and decrease the perceived provision of public goods (Konte and Vincent, 2021). In the American context, Couttenier et al. (2017) suggest that the institutional environment shapes the effect of mining on violence in the U.S. Regarding Latin America, Caselli and Michaels (2013) argue that the provision of goods and revenues neither improves nor declines in the presence of oil activity, raising questions about whether public officials benefit from these revenues. However, this study does not focus specifically on the quality of institutions.

This paper seeks to fill that gap by contributing to the literature on the effects of mining—particularly energy transition metals (ETMs)—on the quality of institutions in Latin America. To the best of our knowledge, no prior study has explored this issue within the LAC context. Moreover, this research adds to the broader literature on institutional quality at the subnational level, emphasizing its importance for

regional development.

1.3 Data and Specification

1.3.1 Data

To analyze the effect of ETM mining on the quality of institutions in LAC, we employ three types of datasets: first, a survey to construct the index of institutional quality, second, three sources to account for natural resource extraction in LAC, and finally, several sources to account for possible covariates.

Natural resources extraction

We employ three datasets to construct variables related to energy transition metals (ETMs), fossil fuels, and precious metals mining, providing a comprehensive view of the mining sector in LAC regions.

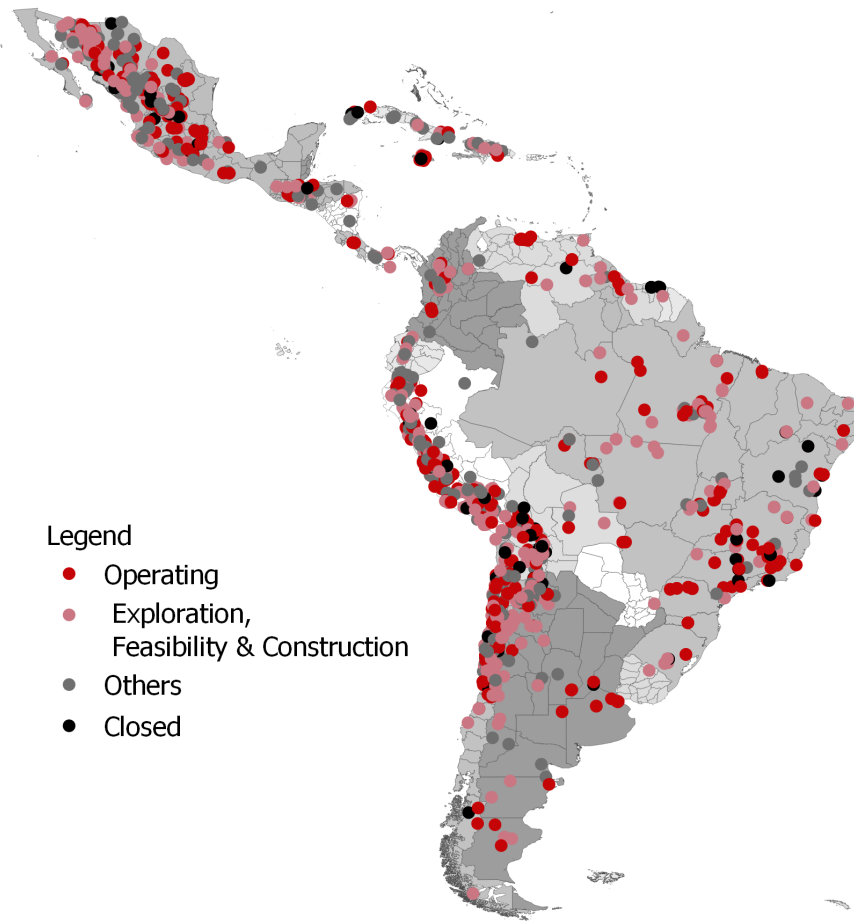
We use the S&P Global dataset to map ETM mining regions across Latin America. This dataset contains information on medium to large mining projects, including project phase, location, and resource type. Specifically, we use the data on mine start dates and locations. The location data is used to match mining operations to different regions in LAC, and the start year is used to construct the treatment group. Figure 1.1 presents the distribution of ETM operations across the continent. The data reveals a high concentration of mining activity, which is not surprising, as exploration is considered a high-risk phase. As a result, new discoveries tend to occur in areas with existing mining operations. Further, two additional sources are used to construct covariates to account for the rest of the mining sector.

For fossil fuel-related covariates, we construct a variable of the value of the capacity of oil and gas activity in the regions. We rely on the U.S. Geological Survey (USGS) database, which provides comprehensive information on major known mineral commodities, including their characteristics and geographical locations (Cunningham et al., 2005). Since the USGS survey is time-invariant and does not include the start or closure dates of mines, we account for the size of operations over time using mine capacity and international prices to construct a time-varying measure in our panel dataset.

Lastly, data from Minex is used to account for precious metal operations. Like the S&P Global dataset, Minex tracks medium to large-scale projects, but it offers less detailed granularity. Hence, due to data limitations, we use S&P to account for ETMs, and Minex to account for precious metals.

Importantly, we observe that the spatial concentration and distribution of ETMs in LAC is similar across the datasets (see Figures 1.A.3 and 1.A.4).

Figure 1.1: Mines location (S&P)



Source: Authors' elaboration based on S&P data

Regional quality of institutions index

We construct, to the best of our knowledge the first index of the institutions' quality, at the regional level, for Latin American countries. We followed the procedure presented by Charron et al. (2019) for the construction of the European Quality of Governance Index (EQI), a data related to regional governance in EU countries.

We use information from Latino barometer to perform the analysis. Latino barometro is a public opinion survey conducted on a regular basis analyzing the evolution of democracy, economy and society in selected LAC countries. We use 8 rounds (2009-2018) using in particular the questions related to confidence and trust in institutions and perceived corruption. Table 1.A.1 shows the countries included. Table 1.A.2 presents the number of questions and regions included in each of the waves used for this study.

On average, we employ 27 questions related to the quality of institutions in our study. To standardize

the variables, we rescale them using Z-scores, wherein lower values indicate poor institutional quality and higher values indicate better quality.

Subsequently, we conduct a factor analysis to determine the latent variables associated with the survey. Table 1.A.7 presents the results of the factor analysis conduct for the reference year 2018, the most recent in our sample. We follow Kaiser's rule, retaining factors with an eigenvalue greater than one in each round.

We use factor loadings to identify the component related to institutional quality based on the distribution of the questions. For instance, in the 2018 wave, table 1.A.8 presents the factor loadings, wherein questions related to corruption were loaded in factor 1, questions related to trust in factor 2, and questions related to government effectiveness in factor 3.

We use the factors and prioritize World Governance Indicators (WGI) from the World Bank to construct the index. We use *control of corruption*, for factors related to corruption, *regulatory quality* for factors related to trust and *government effectiveness* for factors related to the provision of public goods.

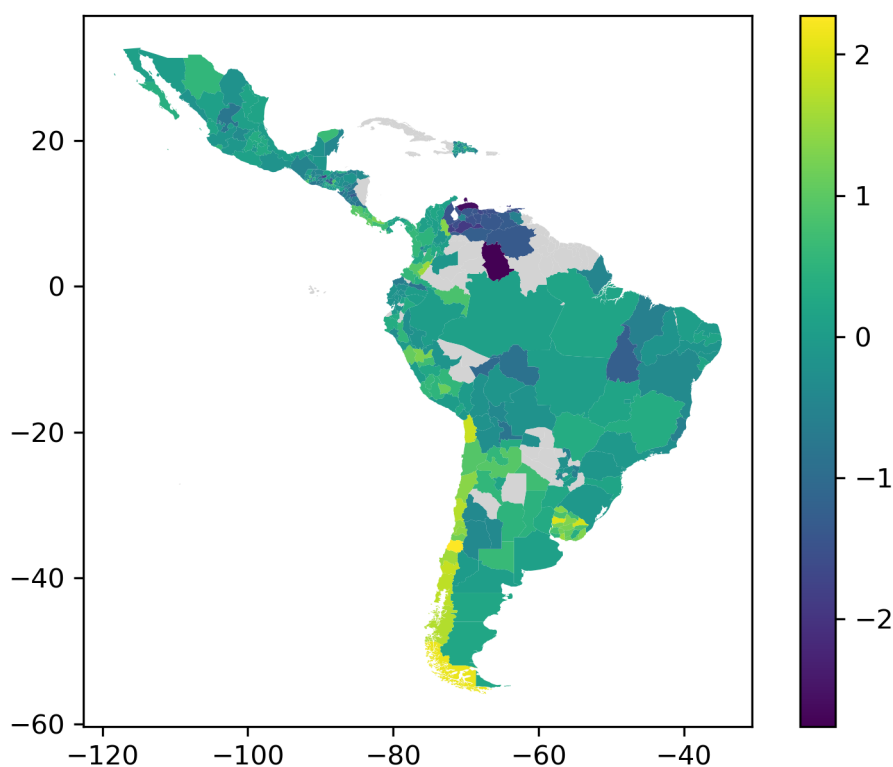
$$I_i = WGI_c + (R_i - \bar{R}_c) \quad (1.1)$$

Equation 1.1 is used for the construction of the index. Where i and c represent region and country respectively. I_i represents the index of quality of institutions, WGI_c represents the country quality of institution score given in the WGI, R_i represent the factor of the region and $\bar{R}_c$ represent the weighted average of regions' factors using population in line with the procedure of Charron et al. (2019). Note that the index of quality of institution of each region will be a deviation from the mean depending on the WGI of each country.

The scores of the index of quality of institutions are shown in Table 1.A.9 and Figure 1.2 map the index for LAC. For the year 2018, the region with the lowest score in terms of quality of institutions is the Amazonas region from Venezuela followed by the Falcon region from the same country (-2.75 and -2.57 respectively). The highest scores are from the regions of Magallanes & Antarctic (2.06) in Chile and Paysandú (1.91) in Uruguay. Further, the closest to the mean (which should be zero) are the region of Buenos Aires in Argentina (-0.004) and Itapúa in Paraguay (0.0022).

For statistical purposes, some regions are added to the sample to balance the panel. For those regions absent, the average score of the higher order aggregation was used (constructed with the available regions). We also fill the gaps in the survey (2012 and 2014) using the average score of $t+1$ and $t-1$.

Figure 1.2: Quality of institutions in Latin America



Note: High values imply high quality of institutions

Other variables

We further use several sources to account for population, used in the construction of the quality of institutions index, as well as potential covariates. The information of population comes from the institute of national statistics (or the equivalent) of each country ³. This information is used to construct the quality of institutions index and per capita variables.

The construction of the regional GDP is made in two steps. First we construct a measure of the percentage participation on the GDP of each region in the country. We calculate the region's GDP using World Bank's country GDP at constant US dollars (year 2010). Table 1.A.3 shows the source of the participation percentage of the regions and its source. In general, when available the regional GDP from OECD was used, otherwise from the national statistic office or equivalent for each country. If not available, we use a proxy for the GDP participation either from ONG's or other government institutes. When no information was found in all previously mentioned sources, we proxy the GDP using population.

We draw on life expectancy and average years of schooling from Global Data Lab Smits and Permanyer (2019) to control for human capital accumulation. We rely on average temperature at 2m of the surface

³Sources: (INDEC-Argentina, 2015; INE-Bolivia, 2021; IBGE-Brazil, 2018; INE-Chile, 2019; DANE, 2018; INEC-Costa Rica, 2021; ONE-Dominic Republic, 2016; INEC-Ecuador, 2012; DISGESTYC - El Salvador, 2021; INE-Guatemala, 2020; INE-Honduras, 2021; CONAPO, 2018; INIDE-Nicaragua, 2021; INEC-Panama, 2013; INE-Paraguay, 2015; INEI-Peru, 2019; INE-Uruguay, 2014; INE-Venezuela, 2021)

from ERA5 Monthly Aggregates - Latest Climate Reanalysis Produced by ECMWF / Copernicus Climate Change Service dataset Copernicus Climate Change Service (2017) to control for geographical conditions.

1.3.2 Methodology to assess the impact of ETMs on institutional quality

To investigate the effect of ETMs on the regional quality of institutions, we adopt a project evaluation approach. The treatment group consists of municipalities with active mines, while the control group includes municipalities without mining activity. The treatment begins with the earliest mine opening in a region, and we assume the treatment status remains constant, meaning we do not account for mine closures. We choose this approach as the dataset only accounts for medium to large operations, hence smaller operations may remain in the regions.

To estimate the effect of mining on quality of institutions, we use the following equation:

$$Y_{it}^j = \mu + \alpha_i + \beta_t + \tau W_{it} + \varepsilon_{it} \quad (1.2)$$

Where Y_{it}^j represents the a vector of institutional quality. Namely composed by the index of institutional quality and its components. α_i and β_t are region and time fixed effects, respectively, and W_{it} represents the treatment (in our case, the presence of an operating mine in the region). The error term is denoted by ε_{it} .

We employ a Synthetic Difference-in-Differences (SDID) method proposed by Arkhangelsky et al. (2021) for our baseline results. The SDID method aims to consistently estimate the causal effect of treatment W_{it} (an average treatment effect on the treated, or ATT), even if the parallel trends assumption does not hold between all treated and control units (Clarke et al., 2023). The estimation of ATT follows this equation:

$$\left(\hat{\tau}^{sdid}, \hat{\mu}, \hat{\alpha}, \hat{\beta} \right) = \underset{\tau, \mu, \alpha, \beta}{agr \ min} \left\{ \sum_{i=1}^N \sum_{t=1}^T (Y_{it} - \mu - \alpha_i - \beta_t - W_{it}\tau)^2 \hat{\omega}_i^{sdid} \hat{\lambda}_t^{sdid} \right\} \quad (1.3)$$

Here, the ATT is estimated using a two-way fixed effects model with optimal weights⁴ $\hat{\omega}_i^{sdid}$ and $\hat{\lambda}_t^{sdid}$. This procedure provides more flexibility than the canonical Difference-in-Differences (DID) and Synthetic Control approaches, and is therefore our preferred estimation method. In the robustness section we employ other DID estimators methods such as Staggered DID.

A key limitation of our empirical strategy is the short time span of the panel data (2010-2018). Mining exploration is a high-risk investment, which often leads to sector concentration, as new discoveries tend to occur near existing mining zones. Consequently, the number of new mining regions emerging each year

⁴See Arkhangelsky et al. (2021) for details on how the weights are calculated.

is relatively low, despite the sector’s overall expansion. Figure 1.A.5 presents the number of regions that initiated mining activity by year, revealing that most regions are traditional mining areas that began operations before the 1990s. Overall 16 regions started mining operations during the study period, with varying start dates and half of them present balanced information. Given these constraints, we argue that the Synthetic Difference-in-Differences (SDID) method offers more flexibility than a TWFE estimator in capturing the effects of mining on institutional quality.

1.4 Results

1.4.1 Baseline

We analyze the effect of mining start on the index of quality of institutions, we also analyzed the effect of mining in each component of the index: control of corruption, trust in institutions, and government effectiveness. The existing literature highlights the vulnerability of institutional quality to the mining sector, particularly due to the substantial rents it generates. In this context, we expect a negative impact on the institutional quality index as a whole.

Regarding the components, a negative effect is anticipated for two of them. First, corruption may increase due to additional rents that incentivize extractive behaviors. Second, trust in institutions may decline if conditions in the region deteriorate or fail to improve following the introduction of mining activity.

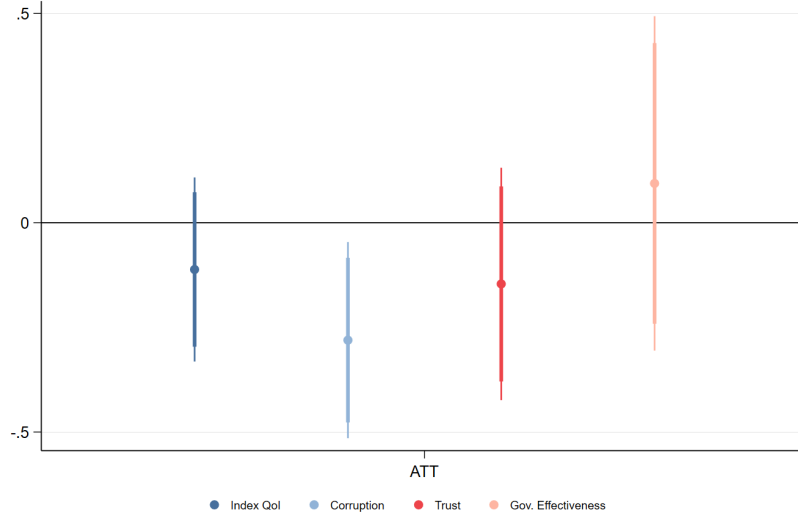
Regarding government effectiveness, the impact of the mining sector is less clear-cut and could be positive, negative, or neutral. A positive effect may arise if sector revenues—whether through windfalls or company initiatives—enhance the provision of public goods. A neutral effect would occur if these resources fail to materialize. A negative effect is possible if the government, constrained by limited resources, reallocates funds to favor mining operations at the expense of broader public service delivery, though we consider this scenario unlikely.

Figure 1.3 presents the baseline results for the ATT estimation of institutional quality and its components, with Table 1.A.4 in the appendix providing further details.

Our findings partially align with prior expectations: while mining does not appear to significantly affect the overall quality of institutions—represented by our index—the coefficient is negative but not statistically significant. A closer examination of the components suggests that mine openings do not impact government effectiveness or trust in institutions. However, control of corruption exhibits a significant negative effect of 0.2. To put this into perspective, this decline is comparable to a shift in the corruption index from Bogotá, the capital of Colombia (0.17), to César (-0.149), a peripheral region of the country.

This result is consistent with the resource curse literature, which links natural resource dependence

Figure 1.3: Estimated ATT of mining in Quality of Institutions



Note: Average treatment effects on the treated (ATT) of mining over quality of institutions Estimated using SDID. Confidence intervals plotted 5% and 10%.

to increased corruption in resource-rich regions. This poses a significant challenge, as strong institutions are widely recognized as essential for fostering long-term development.

Furthermore, the method allows to analyze the different cohorts include in the analysis, Figure 1.A.6 illustrates the annual average treatment effect on the treated (ATT) for the institutional quality index. While the average effect remains statistically insignificant, specific cohort trends emerge. For instance, in the cohort where mining began in 2014, a negative trend is observed following the mine's opening. Conversely, in the 2013 cohort, the institutional quality initially decreases but subsequently improves. For illustrative purposes, Figures 1.A.7, 1.A.8, 1.A.9 present the cohorts results for corruption, trust, and government effectiveness.

1.4.2 Robustness

We test the sensitivity of the results in three aspects. First we include covariates. Second, we consider the size of the mine. Third, we test alternative estimators such as stagger approach or a canonical TWFE.

Covariates

We employ a set of control variables to assess whether the results remain unchanged. To do so we modify the baseline equation as follows:

$$Y_{it}^j = \mu + \alpha_i + \beta_t + \tau W_{it} + \gamma X_{it} + \varepsilon_{it} \quad (1.4)$$

Where X_{it} is the vector of covariates. Specifically we use average years of schooling, a set of additional geographical controls such as temperature, latitude -to control for distance to equator-, area of department, area of tropical land and a dummy if it correspond to the capital, we use GDP per capita (log) to account for the size of the economy, further we control for the presence of other mining such as oil and gas activity and precious metals.

We are cautious in interpreting the results controlling for the GDP per capita for two reasons: first, the reduction in sample size, and second, the introduction of "bad" covariates, such as GDP, may decrease the performance of DID estimators rather than improving them (Callaway and Sant'Anna, 2020; Goodman-Bacon, 2021). Since GDP is closely correlated with the mining sector, its inclusion may not be ideal in this context.

The results are presented in Table 1.1 and are largely unchanged, the quality of institutions index is not significant, and the component of control of corruption still present a negative effect yet when GDP is included -columns 3 and 4- the effect is bigger. Further the effect remains significant when controls for fossil fuel and precious metals extraction are taken into account.

Table 1.1: Robustness: sensitivity to covariates

	(1)	(2)	(3)	(4)
Index QoI	-0.110 (0.125)	-0.112 (0.112)	-0.129 (0.123)	-0.148 (0.123)
Corruption	-0.285*** (0.116)	-0.289*** (0.111)	-0.370*** (0.108)	-0.391*** (0.109)
Trust	-0.149 (0.152)	-0.149 (0.140)	-0.0833 (0.154)	-0.118 (0.155)
Gov. Effectiveness	0.0951 (0.245)	0.0956 (0.216)	0.0793 (0.237)	0.0818 (0.242)
Avg years schooling	✓	✓	✓	✓
Temperature	✓	✓	✓	✓
Geographical		✓	✓	✓
GDP (log)			✓	✓
Oil & Gas				✓
Precious metals				✓

Note: Average treatment on the treated (ATT) using SDID estimator. Bootstrap standard errors in parentheses. Geographical refers to the inclusion of area of the region, latitude, area of tropical land and dummy for capital. Oil & gas refers to the presence of oil and gas activities in the region, Precious metals, controls for the presence of precious metals mining. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The Role of Mine Size

A potential concern is that variations in the size of regions and mining operations could either dilute or exaggerate the effect of mining on institutional quality. To address this issue, we divide the treatment

sample based on the relative size of the mining operation. The dataset includes information on the total tonnage of ore classified as reserves and resources. We use this measure, divided by the population, as a proxy for the mine’s relative size within the region. Mines with 300 or more tons of ore per capita are classified as large operations.

The results, presented in Table 1.2, indicate that regions with relatively small mining operations do not experience any significant effect on institutional quality. However, in regions where mining activity is relatively large, two effects emerge: a decline in control of corruption and a slight negative impact on trust in institutions, significant at the 10% level.

These findings align with the literature, which identifies high rents from the mining sector as a key mechanism driving institutional change. When mining operations are small, they may not exert enough influence to alter government or people behavior. However, when operations are relatively large, the inflow of windfalls can incentivize changes in stakeholder behavior, affecting institutional quality.

Table 1.2: Robustness: Relative size of mines

	Small mines	Large mines
Index QoI	-0.105 (0.0919)	-0.119 (0.320)
Corruption	-0.198 (0.122)	-0.469** (0.208)
Trust	-0.0381 (0.157)	-0.403* (0.207)
Gov. Effectiveness	-0.0621 (0.219)	0.461 (0.450)

Note: Average treatment on the treated (ATT) using SDID estimator. Bootstrap standard errors in parentheses. Small mines refers to those regions where mine started and the size of the mine is relatively small based on ore tonnage per capita (smaller than 300). Large mines refers to those regions where a mine started where the size of the mine was bigger than 300 ore tonnage per capita. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Alternative estimation methods

We use an alternative Difference-in-Differences (DID) approach to test the robustness of our results. Since the mining sector does not begin operations simultaneously across all regions, the treatment is considered staggered over time. To account for treatment heterogeneity, we apply the method proposed by Callaway and Sant’Anna (2020), as the literature suggests that in the presence of treatment heterogeneity, standard estimators such as Two-Way Fixed Effects (TWFE) may introduce bias due to the inclusion of already treated municipalities (Callaway and Sant’Anna, 2020; de Chaisemartin and D’Haultfoeuille, 2022; Goodman-Bacon, 2021).

We present two key results: the average treatment effect on the treated (ATT) in Table 1.A.5, and the event study in Figures 1.A.10 and 1.A.11. Our findings indicate a negative effect on trust in institutions following the start of mining operations, and this result remains robust after controlling for covariates. Additionally, a negative effect on control of corruption emerges only when covariates are included, with a magnitude similar to the baseline results.

The event study framework, which allows us to track the evolution of the effect over time, reveals that the decline in institutional quality does not occur immediately after mining operations start but rather takes a few years to materialize. In the case of trust, the effect becomes significant two years after operations begin, though it remains volatile. For corruption, the effect is significant in the fourth and fifth years.

1.4.3 Specific cases

The results suggest that mining negatively affects institutional quality; however, this effect is not uniform across all cases. The main impact is observed on control of corruption—indicating an increase in corruption—while trust in institutions may also be affected under specific conditions. Nevertheless, given the significant differences in political systems and regional conditions within Latin America, these effects may be more localized rather than broadly generalizable.

To address this issue, we propose conducting individual regressions for each treated region in our sample and analyzing the results collectively. Since the SDID method does not allow for the same setup as the baseline analysis, we present results for both SDID and staggered DID across different regions.

Table 1.A.6 reports the SDID and Staggered DID results for the eight regions analyzed. For the SDID, in one case in Peru, overall institutional quality declines, though none of the components appears to be driving this effect. Additionally, in one region in Dominican Republic -Sanchez Ramires- and one in Ecuador -Loja-, government effectiveness increases. This finding is particularly interesting, as it suggests that mining can provide benefits to host regions. In our data, government effectiveness is largely driven by the provision of public goods, meaning that an increase in this component implies improved public goods provision in mining regions. Moreover, unlike in the baseline analysis, this method does not reveal a significant negative effect on corruption.

We also present results using a staggered DID design using the Callaway-Sant'Anna estimator, which follows the robustness testing setup and is therefore more comparable to the baseline results than SDID. Consistent with the SDID findings, regions Loja and Sanchez Ramires exhibit a positive effect on government effectiveness, which translates into an overall improvement in institutional quality. However, there is also evidence of a decline in quality of institutions. Regions in Peru, present decrease in control of corruption and mixed effects in government effectiveness. The region Suroriental in Guatemala display

decreases in trust that translate in an overall decrease of quality of institutions and in Mexico mining also leads to negative effects, in one case in control of corruption and another in trust.

In summary, our analysis reveals an overall aligning with the more widely accepted view that mining negatively impacts institutional quality. However, in specific circumstances, mining activity can have a positive effect, primarily through improvements in government effectiveness and the provision of public goods.

1.5 Conclusion

This paper analyzes the impact of energy transition metals (ETMs) mining on the quality of institutions at the subnational level in Latin America. We employ a panel dataset covering 336 regions in Latin America from 2010 to 2018, constructing an institutional quality index based on three components: control of corruption, government effectiveness, and trust. To the best of our knowledge, this is the first index of institutional quality developed for the region.

Using a Synthetic Difference-in-Differences (SDID) approach to assess the effect of new mining regions on institutional quality, our findings suggest that mining has a localized but significant impact on institutional quality. While there is no overall decline in institutional quality, we observe a consistent negative effect on control of corruption, indicating increased perceived corruption. Additionally, in specific cases, trust in institutions is also negatively affected. Importantly, these effects are driven by regions where mining operations are relatively large compared to the population, highlighting the role of scale in shaping institutional outcomes.

The individual analysis reveals that while the overall effect of mining on institutional quality is largely negative, in specific cases, mining can contribute positively by enhancing government effectiveness through increased provision of public goods.

As the demand for ETMs rises in response to global efforts to address climate change, the mining sector is expected to expand. While multilateral organizations emphasize the opportunities this expansion presents for developing countries, they often overlook potential negative consequences. Our findings suggest that ETM mining may degrade the quality of institutions in mining regions, thereby undermining long-term sustainable development. Given the importance of strong institutions for regional development, these results indicate that careful consideration should be given to the governance and institutional frameworks surrounding resource extraction in Latin America to ensure positive spillovers.

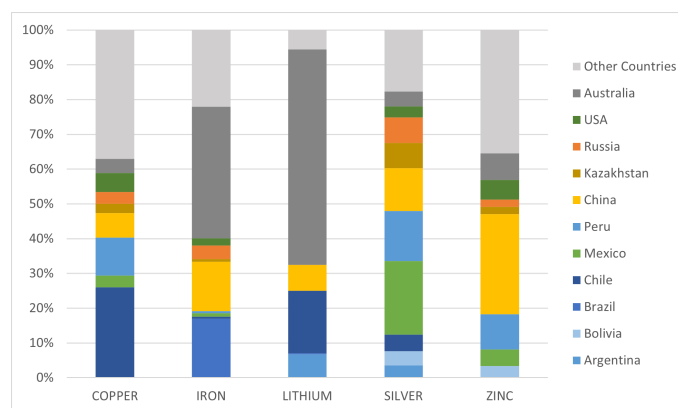
Several research avenues remain open for further exploration. One key area is the dual impact of mining on regions. On one hand, resource extraction can have positive effects through royalties and sector spillovers, while on the other hand, it may have negative impacts on institutional quality and various

aspects of sustainable development. Additionally, the effects of mine closures on sustainable development and institutions remain largely unexplored, particularly in developing countries. More generally, the role of institutional quality at the regional level in shaping long-term outcomes is not yet fully addressed in the literature, highlighting the need for more research in this area.

1.6 Appendix

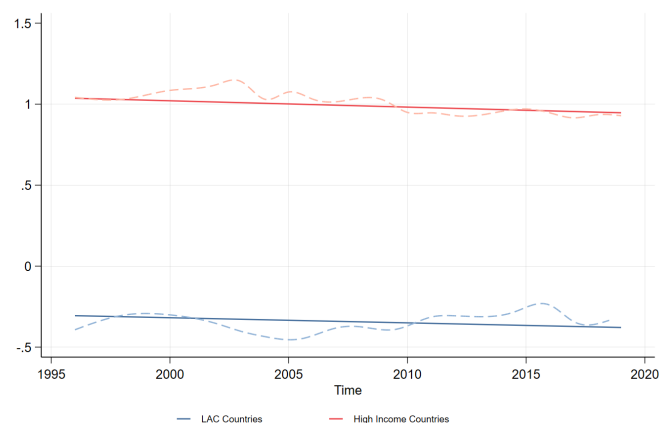
1.6.1 Figures

Figure 1.A.1: Global Supply of ETM



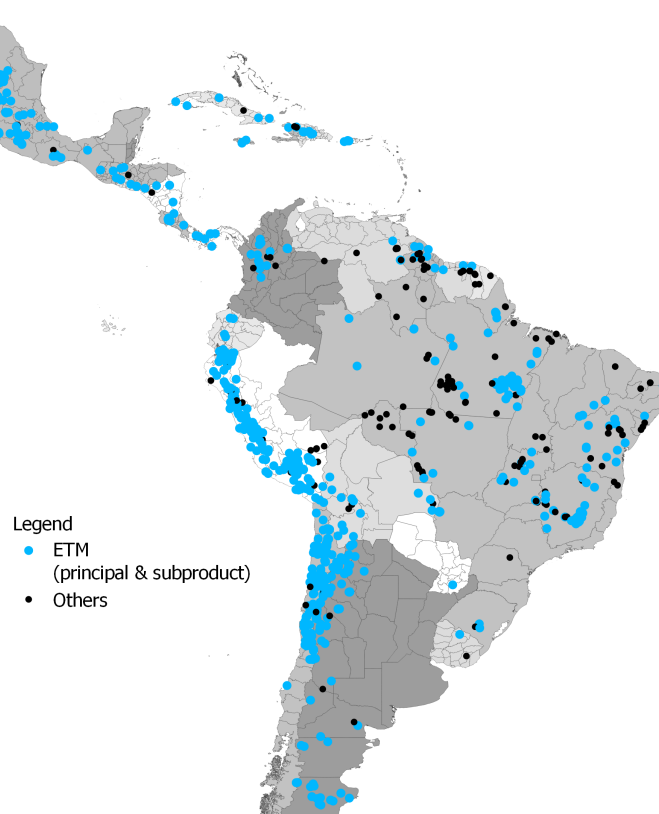
Global supply of selected ETM by country in 2018.
Source: U.S. Geological Survey (2020). Own elaboration

Figure 1.A.2: Global Supply of ETM



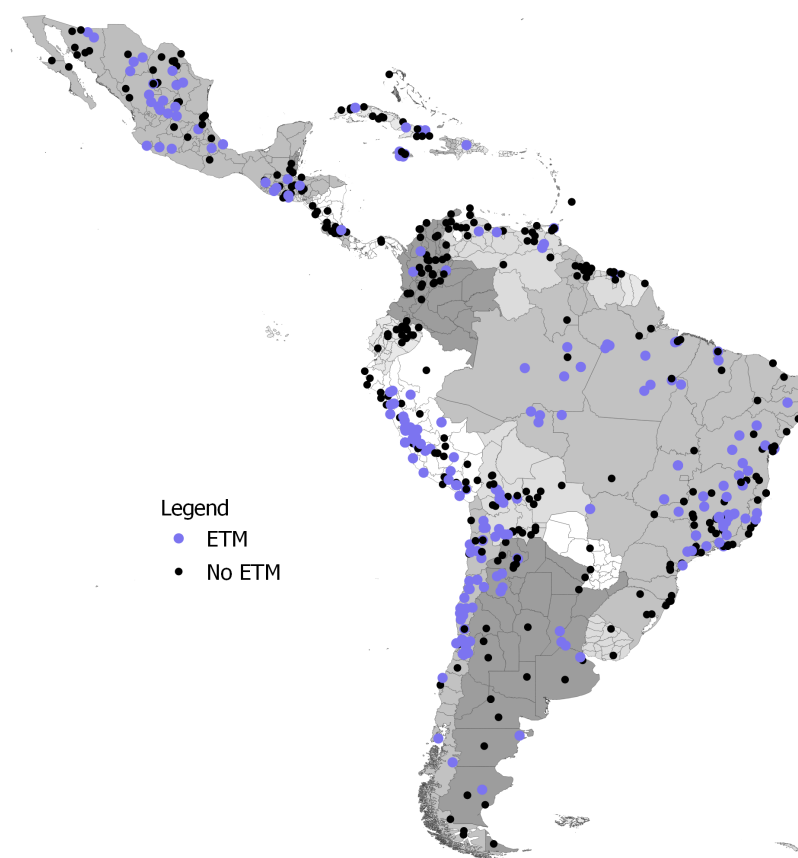
Evolution of quality of institutions based on the average value of 6 WGI indicators that goes from -2.5 to 2.5. The solid line represents the linear fitted value and the dashed line represents the median-spline. LAC excludes high-income countries (Chile and Uruguay). High-income countries are included based on World Bank classification. Source: Kraay et al. (2010). Own elaboration

Figure 1.A.3: Mines location (Minex)



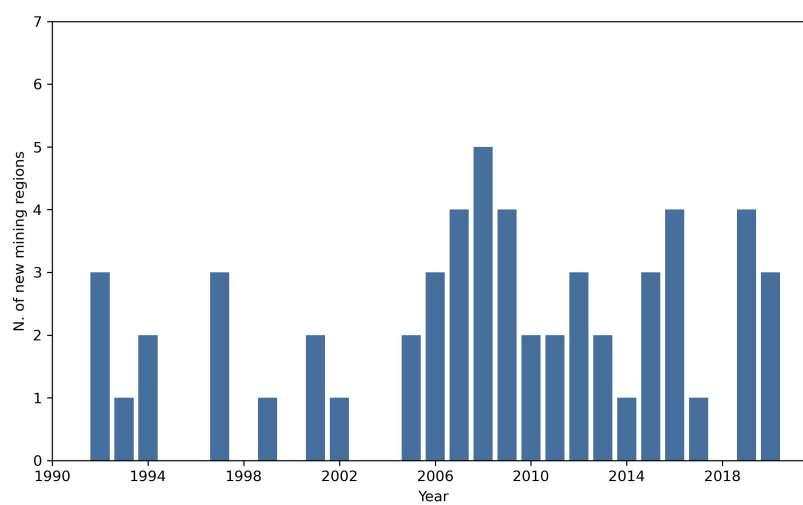
Source: Authors' elaboration based on Minex data

Figure 1.A.4: Mines location (USGV)



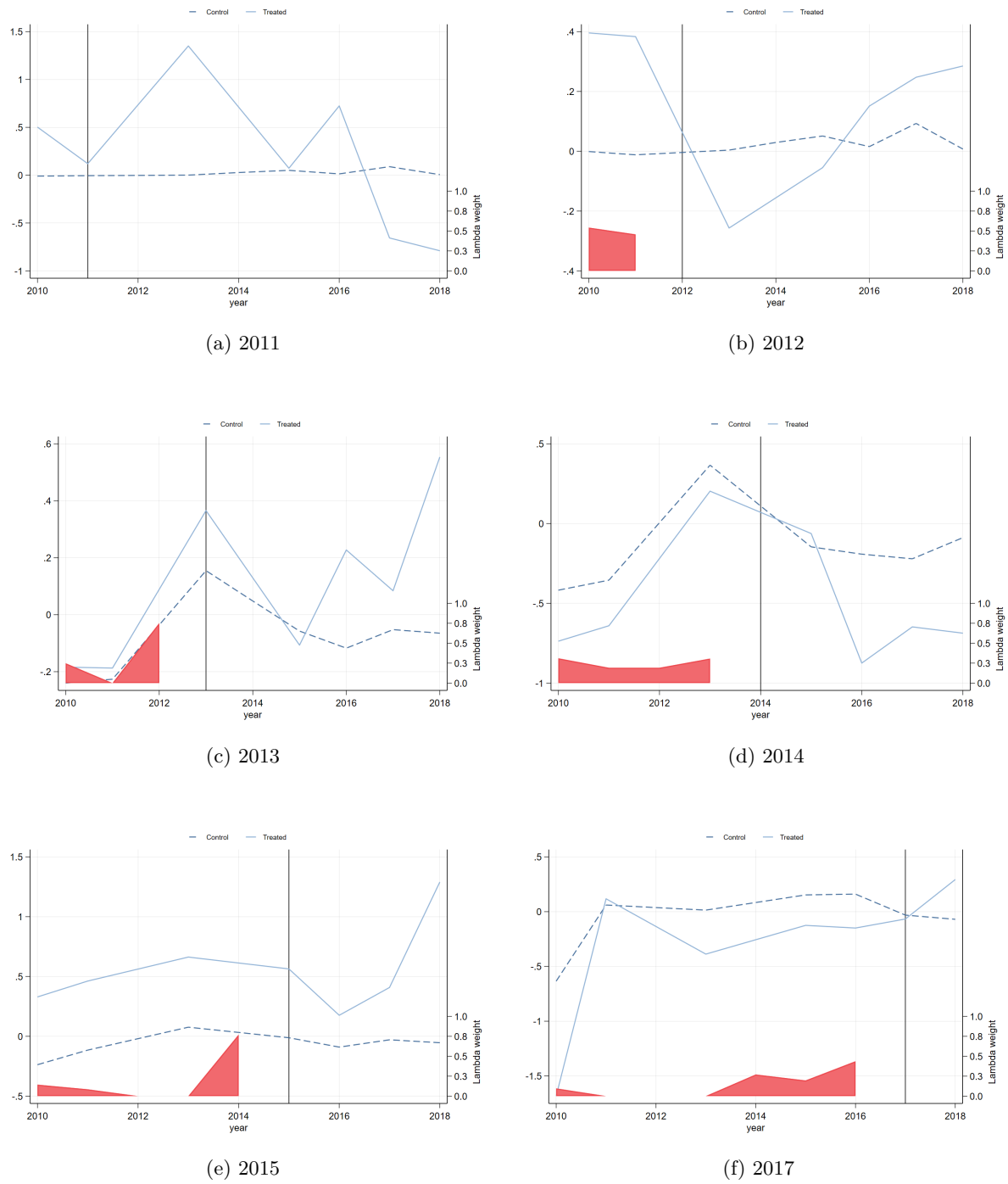
Source: Authors' elaboration based on USGV data

Figure 1.A.5: Evolution of mining regions



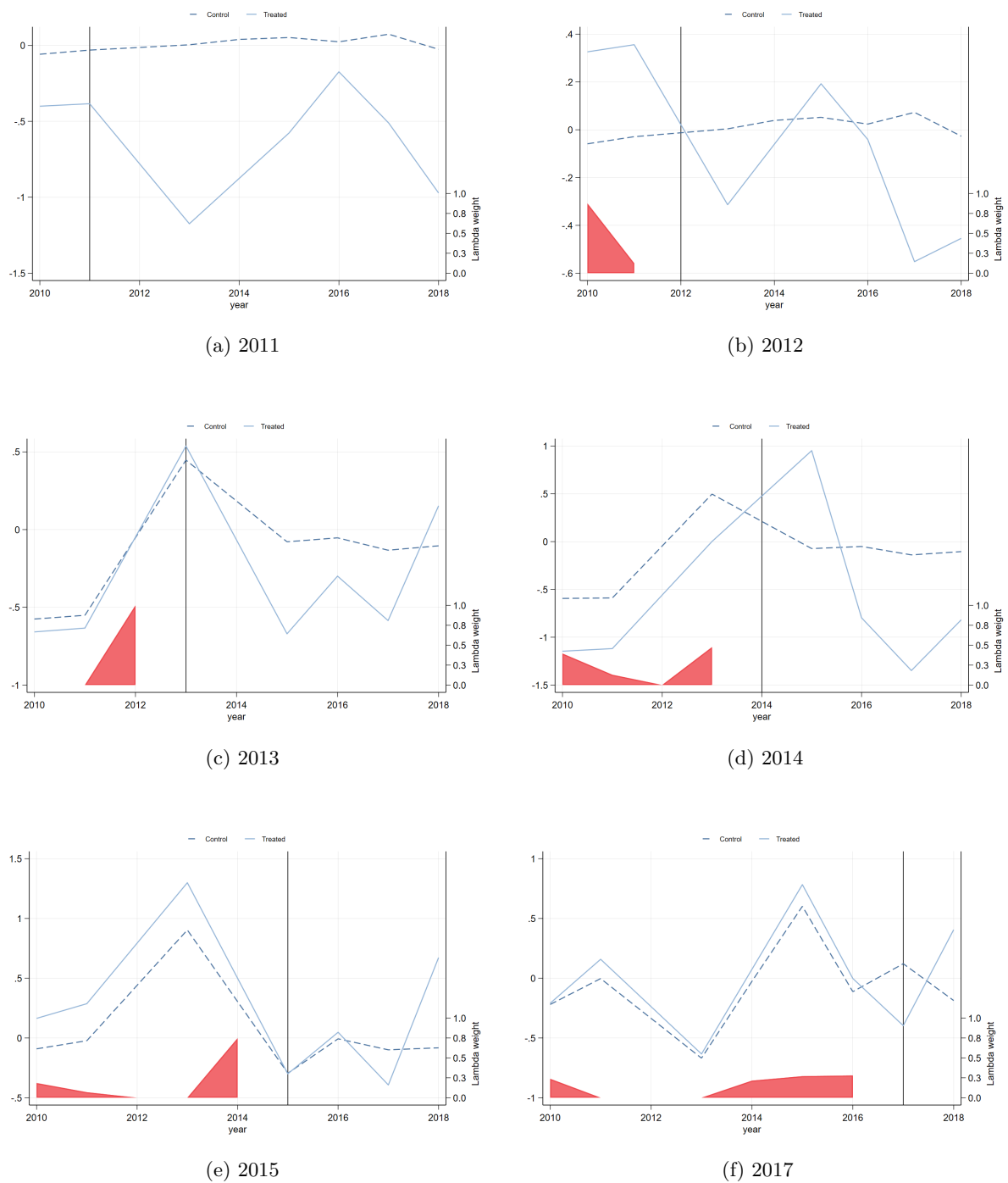
Number of new mining regions by year. Source: Own elaboration

Figure 1.A.6: Estimated ATT of mining in QoI



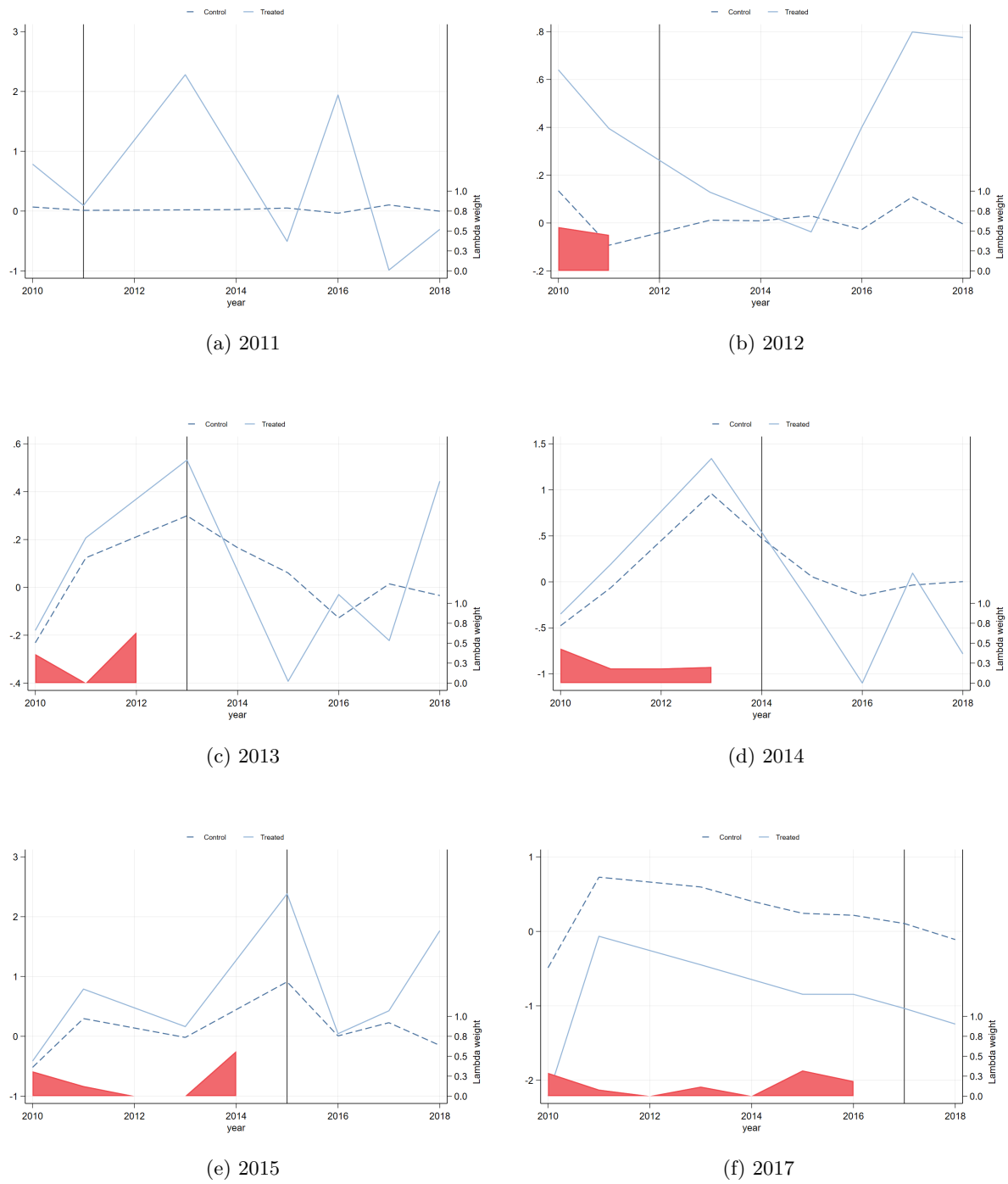
Coefficient plots of each year treatment group used to compute the ATT displayed in table 1.A.4 using a SDID estimator

Figure 1.A.7: Estimated ATT of mining in control of corruption



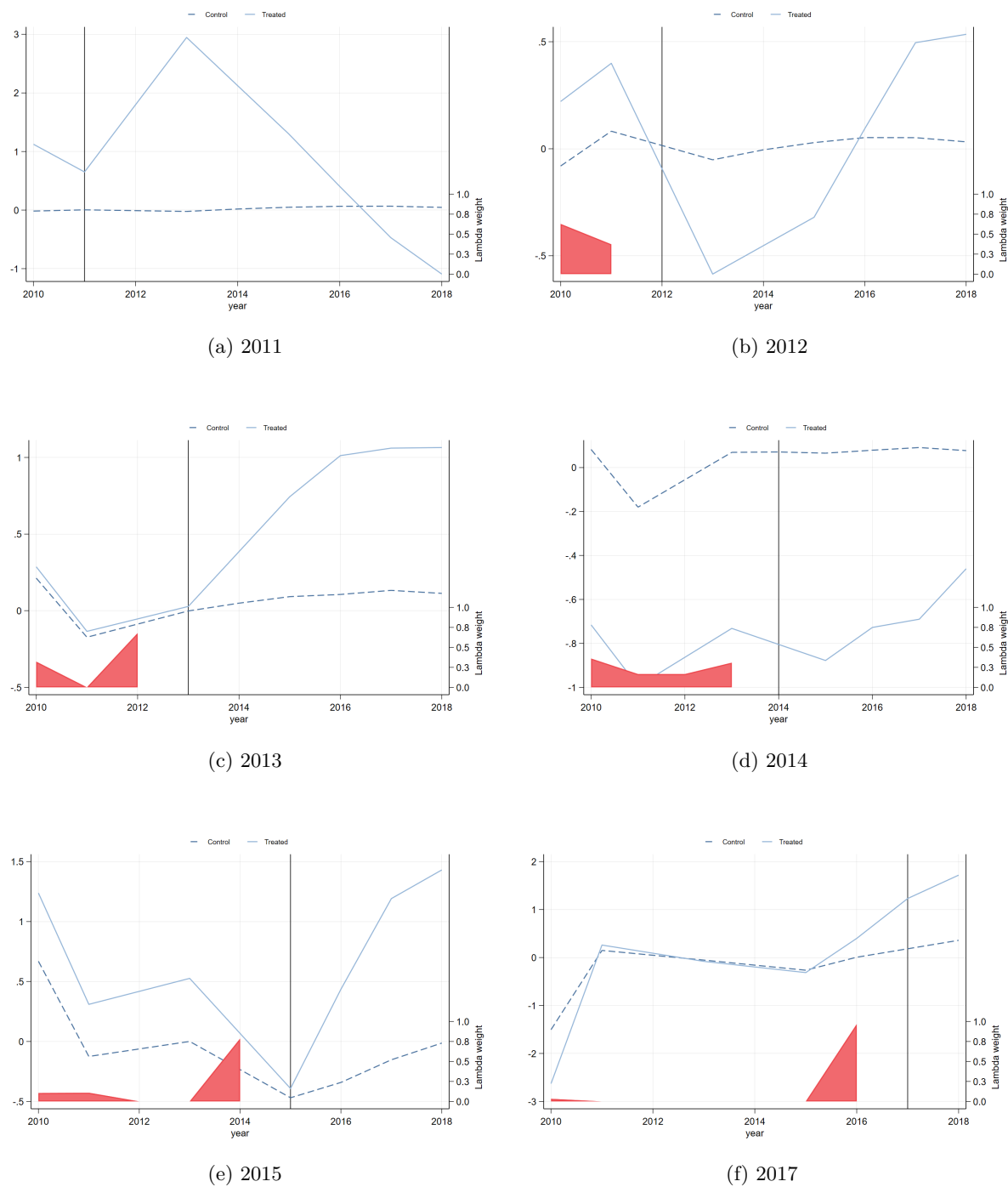
Coefficient plots of each year treatment group used to compute the ATT displayed in table 1.A.4 using a SDID estimator

Figure 1.A.8: Estimated ATT of mining in trust in institutions



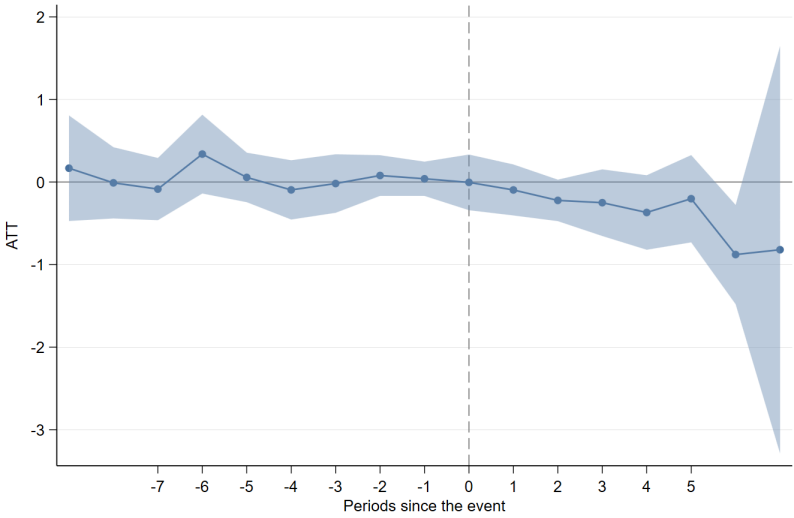
Coefficient plots of each year treatment group used to compute the ATT displayed in table 1.A.4 using a SDID estimator

Figure 1.A.9: Estimated ATT of mining in government effectiveness



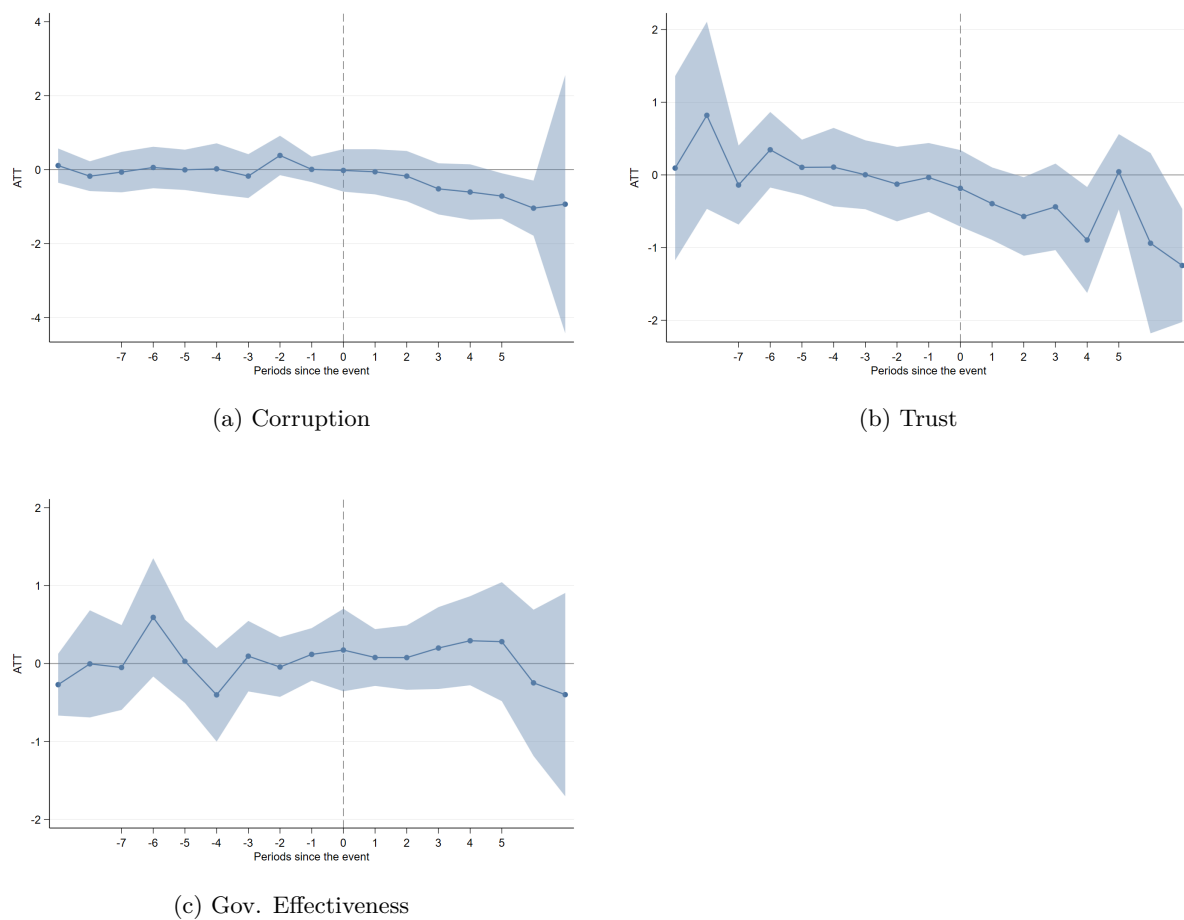
Coefficient plots of each year treatment group used to compute the ATT displayed in table 1.A.4 using a SDID estimator

Figure 1.A.10: Estimated ATT of mining in QoI based on stagger design



Event study of mine start on QoI based on Callaway and Sant'Anna (2020) estimator.

Figure 1.A.11: Estimated ATT of mining in components based on stagger design



Event study of mine start on different components of the index of quality of institution based on Callaway and Sant'Anna (2020) estimator.

1.6.2 Tables

Table 1.A.1: Countries in the Sample

Country Code	Country Name	N° of Regions★	On the index†
ARG	Argentina	22	13
BOL	Bolivia	9	9
BRA	Brasil	27	24
CHL	Chile	15	15
COL	Colombia	25	20
CRI	Costa Rica	7	7
DOM	Dominic Republic	31	30
ECU	Ecuador	23	18
GTM	Guatemala	22	22
HND	Honduras	17	17
MEX	Mexico	32	32
NIC	Nicaragua	17	16
PAN	Panama	10	10
PER	Peru	22	19
PRY	Paraguay	16	10
SLV	El Salvador	14	14
URY	Uruguay	19	18
VEN	Venezuela	24	23

★ includes overall sample

† includes regions with information available for the construction of the index

Table 1.A.2: Information used for the index of quality of institutions

Wave	N. Regions	N. Questions
2009	309	26
2010	310	30
2011	314	31
2013	308	22
2015	324	52
2016	295	17
2017	311	19
2018	319	24

Table 1.A.3: GDP Proxy per country

Country	Type of proxy	Source
Argentina	Energy consumption participation	Ministerio de Hacienda Argentina
Bolivia	Regional GDP	INE-Bolivia
Brasil	Regional GDP	OCDE
Colombia	Regional GDP	OCDE
Chile	Regional GDP	OCDE
Costa Rica	Energy consumption participation (per capita)	UNDP, University of Costa Rica
Dominic Republic	Population	
Ecuador	Regional GDP	Central Bank of Ecuador
El salvador	Population	
Guatemala	Regional GDP (per capita)	FUNDESA
Honduras	Population	
Nicaragua	Population	
Panama	Regional GDP	MINERPA
Paraguay	Proxy consumo energetico per capita (Population)	UNDP
Peru	Regional GDP	OCDE
Uruguay	Regional GDP	OTU, OPP
Venezuela	Population	

Table 1.A.4: Effect of starting of a mine in quality of institutions

	(1) Index QoI	(2) Corruption	(3) Trust	(4) Gov. Effectiveness
ATT	-0.112 (0.112)	-0.280** (0.120)	-0.146 (0.142)	0.0940 (0.204)
<i>N</i>	1449	1449	1449	1449

Note: Average treatment on the treated (ATT) using SDID estimator. Bootstrap standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 1.A.5: Robustness: Staggered DID estimator

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Index QoI	Corruption	Trust	Gov. Effectiveness	Index QoI	Corruption	Trust	Gov. Effectiveness
ATT	-0.235 (0.145)	-0.343 (0.258)	-0.472** (0.204)	0.118 (0.168)	-0.100 (0.091)	-0.357*** (0.115)	-0.243* (0.149)	0.356 (0.226)
Controls					✓	✓	✓	✓
N	2284	2309	2338	2378	2229	2241	2263	2316

Note: Stagger DID using Callaway and Sant'Anna (2020) estimator. The treatment is 1 if there's the start of mine in the region. Controls included are schooling, life expectancy, temperature and value of oil and gas mining. Bootstrap standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 1.A.6: Individual regs: Staggered DID estimator

	SDID estimator				Staggered DID estimator			
	Index QoI	Corruption	Trust	Gov. Effectiveness	Index QoI	Corruption	Trust	Gov. Effectiveness
Sanchez Ramires (DO)	0.336 (0.275)	-0.246 (0.411)	-0.112 (0.362)	1.101** (0.498)	0.274*** (0.0983)	-0.188 (0.169)	-0.384*** (0.134)	1.397*** (0.162)
Loja (EC)	0.547 (0.353)	-0.0661 (0.568)	0.101 (0.532)	0.861* (0.459)	0.224** (0.112)	0.0190 (0.174)	-0.409*** (0.103)	1.086*** (0.133)
Suroriental (GT)	-0.0860 (0.334)	0.247 (0.491)	-0.608 (0.431)	0.0146 (0.608)	-0.669*** (0.108)	-0.329 (0.210)	-1.644*** (0.152)	-0.0330 (0.0860)
Huánuco (PE)	0.0774 (0.279)	-0.0864 (0.410)	0.346 (0.356)	0.567 (0.473)	-0.00691 (0.120)	-0.476*** (0.131)	-0.117 (0.247)	0.575*** (0.189)
Loreto (PE)	-0.261 (0.292)	-0.498 (0.580)	0.331 (0.447)	-0.680 (0.528)	-0.192*** (0.0640)	-0.435*** (0.115)	0.101 (0.0958)	-0.240*** (0.0775)
Cusco (PE)	-0.509* (0.292)	-0.661 (0.580)	-0.653 (0.447)	-0.0873 (0.528)	-0.554*** (0.0956)	-0.727*** (0.0981)	-0.244* (0.124)	-0.690*** (0.170)
Zacatecas (MX)	-0.251 (0.355)	-0.354 (0.507)	-0.167 (0.574)	-0.209 (0.632)	-0.246* (0.135)	-0.354*** (0.0960)	-0.162 (0.213)	-0.207 (0.230)
México (MX)	-0.0813 (0.275)	-0.128 (0.411)	-0.124 (0.362)	0.0642 (0.498)	-0.0895 (0.0660)	-0.101 (0.0862)	-0.239*** (0.0919)	0.0740 (0.0737)

Note: Stagger DID using Callaway and Sant'Anna (2020) estimator. The treatment is 1 if there's the start of mine in the region. Controls included are schooling, life expectancy, temperature and value of oil and gas mining. Placebo standard errors in the case of SDID and Bootstrap standard error for Staggered DID in parentheses.
 * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

1.7 Online appendix

Table 1.A.7: Factor Analysis I (for 2018)

Factor analysis/correlation		Number of obs:	11,441	
Method: principal factors		Retained factors:	3	
Rotation: (unrotated)		Number of params:	69	
Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	6,77226	4,0396	0,67	0,67
Factor2	2,73266	1,56089	0,2704	0,9404
Factor3	1,17177	0,76902	0,1159	1,0563
Factor4	0,40275	0,21081	0,0398	1,0962
Factor5	0,19195	0,05662	0,019	1,1152
Factor6	0,13532	0,01833	0,0134	1,1285
Factor7	0,11699	0,06454	0,0116	1,1401
Factor8	0,05245	0,02731	0,0052	1,1453
Factor9	0,02514	0,0204	0,0025	1,1478
Factor10	0,00474	0,02355	0,0005	1,1483
Factor11	-0,01881	0,01917	-0,0019	1,1464
Factor12	-0,03798	0,00953	-0,0038	1,1426
Factor13	-0,0475	0,01958	-0,0047	1,1379
Factor14	-0,06708	0,01399	-0,0066	1,1313
Factor15	-0,08108	0,00593	-0,008	1,1233
Factor16	-0,087	0,00984	-0,0086	1,1147
Factor17	-0,09684	0,01444	-0,0096	1,1051
Factor18	-0,11128	0,01974	-0,011	1,0941
Factor19	-0,13101	0,00344	-0,013	1,0811
Factor20	-0,13445	0,00328	-0,0133	1,0678
Factor21	-0,13773	0,02163	-0,0136	1,0542
Factor22	-0,15936	0,02412	-0,0158	1,0384
Factor23	-0,18349	0,02149	-0,0182	1,0203
Factor24	-0,20498		-0,0203	1

Table 1.A.8: Factor Analysis II (loading's)

Variable	Factor1	Factor2	Factor3	Uniqueness
Q15-B Confidence in Police		0,4857		0,6685
Q15-C Confidence in Church				0,8797
Q15-D Confidence in National Congress		0,6451		0,524
Q15-E Confidence in Government		0,7093		0,4384
Q15-F Confidence in Judiciary		0,6861		0,4486
Q15-G Confidence in Political Parties		0,6388		0,5527
Q15-H Confidence in Electoral institution		0,6379		0,5002
Q16*-A NGO			0,5529	0,6424
Q16*-B National Companies			0,6202	0,555
Q16*-C Trade Unions		0,3096	0,4619	0,6791
Q16*-D Media			0,512	0,6731
Q16*-E International companies			0,679	0,5018
Q16*-F Banks			0,602	0,5675
Q16*-G Multilateral organizations			0,6593	0,5115
Q71-A Corruption of The president and officials	0,6604			0,4999
Q72-B Corruption of Members of parliament	0,7157			0,4333
Q73-C Corruption of Gov. officials	0,7052			0,4888
Q74-D Corruption of Local gov. councilors	0,7399			0,4257
Q75-E Corruption of Police	0,7091			0,4703
Q76-F Corruption of Ministry of finance	0,7586			0,404
Q77-G Corruption of Judges	0,7491			0,4121
Q78-H Corruption of Religion	0,6019			0,6048
Q79-I Corruption of Business executives	0,6666			0,531
Q80 Evolution of corruption				0,9108

Blanks <0.3. * Questions if the organization operate to improve the quality of life

Table 1.A.9: Index quality of institutions (2018)

Region	Corrup.	Trust	Effectiv.	Index
CO: Bogotá D.C.	0,173	0,105	0,076	0,118
CO: Amazonas	0,899	1,123	0,464	0,829
CO: Antioquia	0,725	0,175	0,555	0,485
CO: Atlántico	-0,258	0,453	0,212	0,136
CO: Bolívar	0,780	0,326	-1,004	0,034
CO: Boyacá	0,913	-0,553	-0,251	0,036
CO: Caldas	-0,135	-0,249	0,549	0,055
CO: Cauca	1,021	1,167	0,644	0,944
CO: César	-0,149	0,018	0,425	0,098
CO: Córdoba	0,055	0,066	0,080	0,067
CO: Cundinamarca	-1,062	0,881	0,991	0,270
CO: Huila	1,676	0,671	2,287	1,545

Region	Corrup.	Trust	Effectiv.	Index
CO: Magdalena	0,746	-0,097	0,005	0,218
CO: Meta	0,205	0,139	-0,685	-0,114
CO: Nariño	0,409	1,219	0,083	0,570
CO: Norte de Santander	0,824	2,286	0,976	1,362
CO: Risaralda	-1,437	0,606	-0,650	-0,494
CO: Santander	-0,372	-0,090	0,137	-0,108
CO: Tolima	-0,110	1,536	0,294	0,573
CO: Valle del cauca	0,207	0,542	0,056	0,268
CO: Sucre	0,107	0,216	-0,072	0,084
CO: La Guajira	0,107	0,216	-0,072	0,084
CO: Chocó	0,546	0,976	0,261	0,594
CO: Putumayo	0,552	0,631	-0,111	0,357
AR: Capital Federal	0,969	0,208	0,431	0,536
AR: Cuyo/Mendoza	0,002	-1,419	0,268	-0,383
AR: Noreste/Chaco	1,515	-0,013	0,631	0,711
AR: Noreste/Corrientes	0,568	-0,362	0,511	0,239
AR: Noreste/Entre Ríos	0,605	-0,271	0,549	0,294
AR: Noroeste/Salta	2,426	0,024	0,415	0,955
AR: Noroeste/Tucumán	-0,273	0,236	0,509	0,157
AR: Pampeana/Buenos Aires	0,141	-0,196	0,310	0,085
AR: Pampeana/Córdoba	0,781	0,350	0,345	0,492
AR: Pampeana/La Pampa	0,809	-1,810	2,873	0,624
AR: Pampeana/Santa Fé	0,516	0,626	0,220	0,454
AR: Patagónica/Neuquén	-0,215	0,044	0,142	-0,010
AR: Patagónica/Río Negro	0,254	-0,547	0,391	0,032
AR: Chubut	0,282	-0,771	1,135	0,216
AR: Jujuy	1,076	0,130	0,462	0,556
AR: San luis	0,002	-1,419	0,268	-0,383
AR: San Juan	0,002	-1,419	0,268	-0,383
AR: Santa Cruz	0,282	-0,771	1,135	0,216
AR: Catamarca	1,076	0,130	0,462	0,556

Region	Corrup.	Trust	Effectiv.	Index
AR: Tierra de Fuego	0,282	-0,771	1,135	0,216
BO: Beni	-0,105	-0,489	0,163	-0,144
BO: Chuquisaca	-0,642	-1,625	-0,198	-0,822
BO: Cochabamba	-0,595	-0,734	0,108	-0,407
BO: La Paz	-0,014	-0,524	-0,083	-0,207
BO: Oruro	0,296	-0,949	-0,015	-0,223
BO: Pando	1,359	-2,519	-1,978	-1,046
BO: Potosí	-0,142	-0,662	-0,097	-0,301
BO: Santa Cruz	-0,215	-0,358	-0,072	-0,215
BO: Tarija	1,316	-0,859	0,489	0,315
BR: Federal distric	-0,753	2,580	-1,978	-0,050
BR: Bahia	-0,408	-0,124	-0,587	-0,373
BR: Ceará	-0,013	-0,228	0,349	0,036
BR: Espírito Santo	-0,658	-0,028	-1,085	-0,591
BR: Goiás	0,412	0,402	-0,249	0,188
BR: Maranhão	0,341	-0,986	-1,104	-0,583
BR: Mato Grosso	0,251	0,129	-0,251	0,043
BR: Mato Grosso do Sul	0,552	0,393	0,053	0,333
BR: Minas Gerais	0,355	0,061	0,596	0,337
BR: Para	0,715	0,270	-0,447	0,179
BR: Paraíba	-0,473	0,271	0,683	0,160
BR: Paraná	-0,427	0,018	0,059	-0,117
BR: Pernambuco	0,874	0,000	-1,323	-0,150
BR: Piauí	0,046	0,015	-0,537	-0,159
BR: Río de Janeiro	-0,299	-0,311	-0,215	-0,275
BR: Rio Grande do Norte	-0,452	-0,868	1,187	-0,045
BR: Rio Grande do Sul	0,908	-1,059	-0,071	-0,074
BR: Rondônia	-1,515	-0,011	-1,067	-0,864
BR: Santa Catarina	0,529	0,045	-0,048	0,175
BR: Alagoas	0,067	-0,449	-0,029	-0,137
BR: Amazonas	0,364	0,042	-0,164	0,081

Region	Corrup.	Trust	Effectiv.	Index
BR: São Paulo	0,124	-0,245	-0,131	-0,084
BR: Sergipe	0,814	-0,172	-0,018	0,208
BR: Tocantins	-2,084	-0,714	-0,977	-1,258
BR: Amapá	-0,630	-0,103	-0,664	-0,466
CL: Metropolitana	1,879	1,097	1,275	1,417
CL: Tarapacá	1,557	2,394	1,585	1,845
CL: Antofagasta	0,697	1,672	0,392	0,920
CL: Atacama	1,870	0,685	1,577	1,377
CL: Coquimbo	2,502	1,542	1,120	1,721
CL: Valparaíso	0,937	1,095	2,386	1,473
CL: O'Higgins	1,138	0,817	1,582	1,179
CL: Maule	2,094	2,070	2,662	2,275
CL: Bío-Bío	1,652	0,910	2,104	1,556
CL: a Araucanía	0,630	2,775	2,073	1,826
CL: Los Lagos	1,637	1,096	2,578	1,770
CL: Aysén	1,292	1,949	1,872	1,704
CL: Magallanes y Antártica	1,633	2,781	1,896	2,103
CL: Los Ríos	0,771	1,518	2,939	1,743
CL: Arica y Parinacota	3,384	2,054	0,877	2,105
CR: San José	1,244	0,494	0,744	0,827
CR: Alajuela	1,493	0,537	0,703	0,911
CR: Cartago	1,521	1,051	-0,030	0,847
CR: Heredia	0,525	-0,121	1,193	0,532
CR: Guanacaste	0,510	0,088	2,214	0,937
CR: Puntarenas	1,746	0,276	1,092	1,038
CR: Limón	-0,290	1,920	0,483	0,704
DO: Distrito Nacional	0,137	0,605	-0,156	0,195
DO: Azua	-1,175	0,684	0,229	-0,088
DO: Baoruco	-1,861	0,618	0,720	-0,174

Region	Corrup.	Trust	Effectiv.	Index
DO: Barahona	-2,246	0,706	0,213	-0,443
DO: Dajabón	-0,909	-0,251	-0,029	-0,396
DO: Duarte	0,632	-0,007	-0,621	0,001
DO: El Seibo	-1,224	0,236	0,508	-0,160
DO: Espaillat	-1,000	0,037	-0,347	-0,437
DO: Hato Mayor	-0,567	0,134	0,265	-0,056
DO: Hermanas Mirabal / Salcedo	0,253	-0,099	-0,515	-0,120
DO: La Altagracia	-1,202	-0,145	-0,193	-0,513
DO: La Romana	0,741	1,421	-1,374	0,263
DO: La Vega	-0,722	-0,043	0,020	-0,248
DO: María Trinidad Sánchez	-0,759	-1,255	0,726	-0,429
DO: Monseñor Nouel	-0,443	0,183	-0,295	-0,185
DO: Montecristi	-0,334	-0,841	-1,010	-0,728
DO: Monte Plata	-0,705	0,440	0,080	-0,062
DO: Pedernales	-0,470	-1,269	-0,002	-0,580
DO: Peravía	0,282	-0,402	-1,931	-0,684
DO: Puerto Plata	0,316	0,604	0,024	0,315
DO: Samaná	-0,249	0,046	-0,169	-0,124
DO: Sánchez Ramírez	0,492	0,471	1,556	0,840
DO: San Cristóbal	-0,644	0,539	-0,089	-0,065
DO: San José de Ocoa	-0,736	1,405	-0,456	0,071
DO: San Juan	0,054	-0,348	0,438	0,048
DO: San Pedro de Macorís	-1,293	-1,408	1,133	-0,523
DO: Santiago	-0,293	-0,580	-0,721	-0,531
DO: Santiago Rodríguez	0,170	0,219	0,511	0,300
DO: Provincia Santo Domingo	0,000	0,137	-0,075	0,021
DO: Valverde	0,474	-0,523	0,575	0,175
EC: Azuay	0,427	-0,482	-0,602	-0,219
EC: Bolívar	-0,207	-0,983	0,804	-0,129
EC: Chimborazo	1,156	-1,150	0,293	0,100
EC: Cotopaxi	0,258	-0,569	-0,440	-0,250

Region	Corrup.	Trust	Effectiv.	Index
EC: El Oro	0,245	-0,819	0,446	-0,043
EC: Esmeraldas	-1,410	-1,401	0,888	-0,641
EC: Guayas	-0,188	-0,465	0,009	-0,214
EC: Imbabura	-0,506	-0,484	-0,505	-0,499
EC: Loja	0,405	-1,244	1,722	0,294
EC: Los Ríos	0,211	-0,871	0,092	-0,189
EC: Manabí	-0,038	-0,494	0,042	-0,163
EC: Morona Santiago	0,348	-0,745	1,336	0,313
EC: Orellana	0,544	1,482	-0,171	0,618
EC: Pichincha	-0,054	-0,508	-0,290	-0,284
EC: Santa Elena	-0,248	-1,308	0,690	-0,289
EC: Santo Domingo de los Sachilas	-0,157	-0,602	-0,203	-0,321
EC: Sucumbios	-2,152	0,615	-0,995	-0,844
EC: Tungurahua	-0,016	-0,796	0,032	-0,260
EC: Pastaza	-0,420	0,451	0,057	0,029
EC: Napo	-0,420	0,451	0,057	0,029
SV: Occidental/Ahuachapán	-0,533	-0,090	-0,926	-0,516
SV: Occidental/Santa Ana	0,350	0,110	-0,475	-0,005
SV: Occidental/Sonsonate	-0,421	0,219	-0,711	-0,304
SV: Central/La Libertad	0,288	0,350	0,227	0,288
SV: Central/Chalatenango	0,737	0,119	0,281	0,379
SV: Central/Cuscatlán	-1,130	-0,040	0,832	-0,113
SV: Central/San Salvador	-0,049	0,207	-0,363	-0,068
SV: Central/La Paz	-0,427	0,183	-0,740	-0,328
SV: Central/Cabañas	1,758	-1,670	1,134	0,408
SV: Central/San Vicente	-0,552	0,464	-0,169	-0,086
SV: Oriental/Usulután	0,064	-0,621	0,302	-0,085
SV: Oriental/San Miguel	-0,353	0,876	-0,751	-0,076
SV: Oriental/Morazán	-0,838	1,374	1,096	0,544
SV: Oriental/La Unión	-0,593	-0,003	0,365	-0,077

Region	Corrup.	Trust	Effectiv.	Index
GT: Metropolitana/Guatemala	-0,483	-0,124	-0,378	-0,328
GT: Norte/Alta Verapaz	-0,991	-0,140	-0,290	-0,474
GT: Norte/Baja Verapaz	-0,359	0,120	-0,806	-0,348
GT: Nororiental/Chiquimula	-0,195	1,144	-0,868	0,027
GT: Nororiental/El Progreso	-0,979	-0,681	-0,884	-0,848
GT: Nororiental/Izabal	-0,242	-0,267	0,911	0,134
GT: Nororiental/Zacapa	-1,881	-1,449	-2,295	-1,875
GT: Suroriental/Jalapa	-1,093	-0,233	-0,274	-0,533
GT: Suroriental/Jutiapa	-0,201	-0,694	-0,862	-0,586
GT: Suroriental/Santa Rosa	-0,819	-0,783	-0,458	-0,687
GT: Central/Chimaltenango	1,311	0,200	-0,577	0,312
GT: Central/Escuintla	0,049	-0,795	-1,593	-0,780
GT: Central/Sacatepequez	-0,074	0,287	-0,950	-0,245
GT: Suroccidental/Quetzaltenango	-0,385	-0,141	-0,433	-0,320
GT: Suroccidental/Retalhuleu	-0,131	1,592	0,990	0,817
GT: Suroccidental/San Marcos	-0,344	0,142	-0,427	-0,210
GT: Suroccidental/Solola	-1,266	-0,140	-0,812	-0,739
GT: Suroccidental/Suchitepéquez	-0,380	0,066	0,226	-0,030
GT: Suroccidental/Totonicapan	1,346	1,138	-0,381	0,701
GT: Noroccidental/Quiché	-0,836	0,250	-0,860	-0,482
GT: Noroccidental/Huehuetenango	0,215	-0,030	-0,167	0,006
GT: Nororiental/Petén	-0,108	0,342	-0,581	-0,116
HO: Atlántida	0,081	0,459	0,327	0,289
HO: Choluteca	-0,108	0,146	0,279	0,106
HO: Colón	-0,662	-1,416	0,390	-0,563
HO: Comayagua	-0,361	0,395	-0,456	-0,141
HO: Copán	-0,032	0,054	0,016	0,013
HO: Cortés	-0,261	-0,122	-0,572	-0,318
HO: El Paraíso	1,101	-0,715	-1,478	-0,364
HO: Francisco Morazán	0,132	-0,250	-0,655	-0,258
HO: Gracias a Dios	0,106	-0,328	-0,881	-0,368

Region	Corrup.	Trust	Effectiv.	Index
HO: Intibucá	1,175	0,236	1,165	0,859
HO: La Paz	-0,743	-0,007	0,477	-0,091
HO: Lempira	-1,973	-1,454	-0,334	-1,254
HO: Ocotepeque	-0,737	-1,438	-1,504	-1,226
HO: Olancho	0,515	-0,469	-0,538	-0,164
HO: Santa Bárbara	-0,330	-0,597	-0,247	-0,392
HO: Valle	-0,651	0,983	-0,093	0,079
HO: Yoro	-0,455	-0,293	-0,859	-0,536
MX: Baja California	-0,716	1,809	-0,869	0,075
MX: Baja California Sur	-0,273	1,168	0,306	0,400
MX: Coahuila	-0,009	-0,372	-0,265	-0,215
MX: Chihuahua	0,604	0,320	0,714	0,546
MX: Durango	0,213	0,338	-0,288	0,088
MX: Nuevo León	-0,634	0,329	0,833	0,176
MX: San Luis Potosí	-0,130	-0,033	0,334	0,057
MX: Sinaloa	-0,519	-0,504	0,515	-0,169
MX: Sonora	-1,172	0,641	0,549	0,006
MX: Tamaulipas	0,258	0,406	-0,211	0,151
MX: Zacatecas	-0,973	-0,305	-1,089	-0,789
MX: Aguascalientes	0,769	-0,578	-0,142	0,016
MX: Colima	-0,695	0,431	1,709	0,481
MX: Guanajuato	-0,739	-0,136	-0,264	-0,380
MX: Jalisco	-0,402	-0,236	0,205	-0,145
MX: Michoacán	-0,099	0,114	-0,280	-0,088
MX: Nayarit	-1,360	1,514	0,383	0,179
MX: Querétaro	-1,487	0,805	0,700	0,006
MX: Ciudad de México	-0,062	0,405	-0,314	0,010
MX: Hidalgo	-0,585	1,434	0,191	0,347
MX: México	-0,190	0,418	0,573	0,267
MX: Morelos	-0,101	0,898	-1,106	-0,103
MX: Puebla	-0,159	0,606	0,418	0,288

Region	Corrup.	Trust	Effectiv.	Index
MX: Tlaxcala	1,600	-1,531	0,450	0,173
MX: Campeche	-2,155	-0,078	1,574	-0,220
MX: Chiapas	-1,497	-0,118	0,152	-0,488
MX: Guerrero	0,196	0,389	-0,275	0,103
MX: Oaxaca	-0,727	0,389	-0,172	-0,170
MX: Quintana Roo	-0,690	-0,692	0,083	-0,433
MX: Tabasco	0,417	-0,423	0,078	0,024
MX: Veracruz	-0,621	0,518	0,100	-0,001
MX: Yucatán	-0,382	0,345	2,009	0,657
NI: Managua	-1,006	-0,719	-0,538	-0,754
NI: Chinandega	-1,377	-1,271	-0,061	-0,903
NI: León	-0,548	-0,365	-0,919	-0,611
NI: Masaya	-0,606	-0,497	-0,283	-0,462
NI: Granada	-0,709	-0,116	-0,483	-0,436
NI: Carazo	-1,018	-1,344	0,132	-0,743
NI: Rivas	-1,042	0,002	-1,130	-0,723
NI: Chontales	-0,648	-0,666	-0,697	-0,670
NI: Boaco	-2,100	-1,200	-0,743	-1,348
NI: Matagalpa	-1,045	-0,966	-0,862	-0,958
NI: Jinotega	0,203	-0,278	-2,076	-0,717
NI: Estelí	-0,177	-0,707	0,085	-0,266
NI: Nueva Segovia	-0,916	-0,602	-0,507	-0,675
NI: Río San Juan	-0,387	0,450	-2,475	-0,804
NI: R.A.A.S	-0,140	-0,111	-0,185	-0,145
NI: R.A.A.N	1,365	1,443	-0,176	0,877
NI: Madriz	-0,833	-0,924	-0,506	-0,755
PA: Panamá	-0,169	0,244	0,269	0,115
PA: Colón	-0,493	0,163	0,718	0,129
PA: Bocas del Toro	1,025	1,356	1,343	1,241
PA: Coclé	-0,592	0,926	0,334	0,223

Region	Corrup.	Trust	Effectiv.	Index
PA: Chiriquí	-0,044	1,422	0,808	0,729
PA: Herrera	-0,080	-0,642	-0,184	-0,302
PA: Los Santos	-1,144	0,981	0,885	0,241
PA: Veraguas	1,088	0,799	0,097	0,661
PA: Darién	-0,323	0,796	0,844	0,439
PA: Comarca Ngäbe Buglé	0,773	-0,317	-1,143	-0,229
PY: Asunción	-0,469	0,117	-0,470	-0,274
PY: San Pedro	-0,501	0,426	-0,629	-0,235
PY: Cordillera	1,623	-1,767	-0,241	-0,128
PY: Caaguazú	0,077	0,071	-0,842	-0,232
PY: Caazapá	-0,111	0,594	-0,235	0,083
PY: Itapúa	-0,143	0,641	-0,636	-0,046
PY: Paraguarí	0,530	-0,230	-2,058	-0,586
PY: Alto Paraná	-0,946	-0,061	-0,728	-0,578
PY: Central	-0,630	0,165	0,486	0,007
PY: Amambay	-0,528	0,332	-1,517	-0,571
PE: Lima	-0,027	0,373	-0,253	0,031
PE: Amazonas	-1,338	0,088	0,345	-0,301
PE: Áncash	0,827	1,477	0,981	1,095
PE: Apurímac	1,950	2,561	-1,134	1,126
PE: Arequipa	-0,040	0,612	-0,561	0,004
PE: Ayacucho	-0,175	0,824	0,874	0,508
PE: Cajamarca	0,306	0,418	0,861	0,528
PE: Cusco	-0,217	0,582	1,307	0,557
PE: Huancavelica	0,282	1,501	0,003	0,596
PE: Huánuco	0,672	1,767	1,430	1,289
PE: Ica	0,737	1,005	-0,053	0,563
PE: Junín	0,521	0,449	-0,282	0,229
PE: a libertad	-0,353	0,346	-0,074	-0,027
PE: Lambayeque	-0,605	0,103	-0,449	-0,317

Region	Corrup.	Trust	Effectiv.	Index
PE: Loreto	-0,694	0,970	-0,236	0,013
PE: Piura	-0,617	0,925	0,694	0,334
PE: Puno	-0,060	0,341	-0,318	-0,012
PE: San Martín	-0,118	-0,035	-0,350	-0,168
PE: Tacna	-0,767	-0,142	0,649	-0,087
PE: Pasco	0,492	1,239	0,384	0,705
PE: Moquegua	-0,061	0,575	0,227	0,247
PE: Ucayali	-0,716	0,341	-0,080	-0,152
UY: Montevideo	1,984	0,578	1,035	1,199
UY: Artigas	1,904	0,388	1,708	1,333
UY: Canelones	1,678	0,614	1,070	1,121
UY: Cerro Largo	2,278	1,500	2,032	1,937
UY: Colonia	0,208	0,406	0,946	0,520
UY: Durazno	1,421	1,452	0,842	1,238
UY: Flores	2,605	0,191	0,800	1,199
UY: Florida	1,636	1,358	0,285	1,093
UY: Lavalleja	1,087	-1,475	1,598	0,403
UY: Maldonado	1,595	0,921	0,939	1,152
UY: Paysandú	3,440	0,866	1,781	2,029
UY: Río Negro	0,607	0,521	2,592	1,240
UY: Rivera	2,414	-0,146	-0,145	0,708
UY: Rocha	1,743	1,015	1,224	1,328
UY: Salto	2,236	0,172	0,098	0,835
UY: San José	2,091	1,046	1,405	1,514
UY: Soriano	1,326	0,244	0,787	0,786
UY: Tacuarembó	2,346	0,677	0,944	1,322
UY: Treinta y Tres	1,603	0,588	0,351	0,847
Distrito Capital	-0,934	-1,862	-2,032	-1,609
VE: Amazonas	-3,458	-2,871	-1,957	-2,762
VE: Anzoátegui	-1,020	-1,864	-1,043	-1,309

Region	Corrup.	Trust	Effectiv.	Index
VE: Apure	-0,863	-1,927	-0,988	-1,259
VE: Aragua	-1,180	-1,948	-1,549	-1,559
VE: Barinas	-1,684	-2,294	-1,716	-1,898
VE: Bolívar	-0,969	-2,149	-0,967	-1,361
VE: Carabobo	-1,267	-2,221	-1,578	-1,688
VE: Cojedes	-2,157	-0,063	-2,204	-1,475
VE: Falcón	-0,851	-3,166	-3,694	-2,570
VE: Guárico	-0,785	-1,763	-1,607	-1,385
VE: Lara	-0,648	-1,793	-1,722	-1,388
VE: Mérida	-1,560	-2,267	-0,806	-1,544
VE: Miranda	-1,039	-1,887	-1,590	-1,505
VE: Monagas	-0,315	-0,259	-1,142	-0,572
VE: Nueva Esparta	-1,404	-2,268	-1,771	-1,814
VE: Portuguesa	-0,879	-1,625	-2,022	-1,509
VE: Sucre	-0,780	-1,379	-2,337	-1,498
VE: Táchira	-0,821	-2,448	-2,139	-1,803
VE: Trujillo	0,536	-1,886	-0,006	-0,452
VE: Vargas	-0,509	-2,583	-1,595	-1,562
VE: Yaracuy	-0,645	-1,604	-1,980	-1,410
VE: Zulia	-1,290	-1,847	-1,264	-1,467

Chapter 2

Chapter 2

Sustainable development and the extractive industry. An assessment of the Mexican case

Co-written with Sabine Bacouël-Jentjens & Grégory Levieuge & Camélia Turcu

2.1 Introduction

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, introduced 17 sustainable development goals (SDGs).¹ While these SDGs have played a crucial role in the political agenda so far, the 2023 SDG Progress report indicates that these objectives are still far from being accomplished. Some goals have regressed to their 2015 baseline due to recent events such as the COVID-19 pandemic, the war in Ukraine, and climate-related disasters (UN General Assembly, 2023).

An urgent need for action is evident, particularly in addressing climate change. Meeting the climate objectives outlined in the United Nations Climate Change Conference (COP) Agreement and limiting global warming require a significant transformation of our economic activities. This transition involves shifting towards a less energy-intensive economy and embracing a future that is low-carbon or carbon-free.

Notably, the energy transition will inevitably result in a reduction in the demand for fossil fuels, impacting the producers of these resources. However, at the same time, it will also create an unprecedented demand for Energy Transition Metals (ETM). Recognizing this potential, the World Bank emphasizes the

¹The UN defines sustainable development as a development process that meets the needs of the present without compromising the ability of future generations to meet their own needs. It puts particular attention on the eradication of poverty and the reduction of inequalities.

significant benefits notably in the form of windfalls, that increased demand for metals and in particular ETM can bring to emerging and developing countries. Latin American economies, in particular, hold substantial deposits of copper, iron ore, silver, lithium, aluminum, nickel, manganese, and zinc, making them well-positioned to play a pivotal role in meeting the emerging demand for ETM (World Bank, 2017). This will potentially trigger high economic benefits.

Nevertheless, it is crucial to highlight the potential adverse environmental impact of the mining sector. The mining industry is widely recognized as one of the most ecologically impactful sectors (Lei and Michaels, 2014).

As the world strives to meet the SDGs and combat climate change, the intricate interplay between sustainable development and the energy transition becomes increasingly evident. Many Latin American countries are striving to maintain this intricate balance. Economies work to reduce poverty and inequalities and, in general, to improve the social standards of the population while trying to address climate change challenges, notably by reducing their dependency on fossil fuels.

Several Latin American countries have introduced incentives to generate more investment in the mining sector and diversify their economies. Mexico is one such country that has made significant efforts to promote its mining sector. During the 1970s, Mexico was severely impacted by the oil crisis. In response, the government took measures to diversify its economy offering incentives to boost the manufacturing and mining sectors. An important step to promote mining was the implementation of the New Mining Law in 1993, which opened up mining, both exploration and exploitation, to foreign capital. Furthermore, with the entry into force of the North American Free Trade Agreement (NAFTA) with the United States and Canada in January 1994, the new Foreign Investment Law allowed greater liberalization of the mining industry in Mexico (Saade Hazin, 2013).

As a result, Mexico's economy has experienced significant growth in the extraction of natural resources, particularly in the mining sector, in recent decades. However, this growth has also been accompanied by an increase in socio-environmental conflicts (Tetreault, 2022). Although Mexico's economy has not undergone the same level of "reprimarization" as certain South American countries, it is essential to understand the impact of mining on sustainable development indicators. To this end, this study aims to investigate the contribution of the mining boom to sustainable development in Mexico.

What sets our study apart is its holistic approach to understanding the complex interplay between mining activities and sustainable development. Unlike previous research that has often focused on isolated dimensions, we comprehensively analyze three critical aspects: economic performance and income inequality, education, and environmental quality. We thus cover socio-economic and environmental-related perspectives.

Our study pioneers the use of staggered difference-in-differences (DID) to examine the impact of

mining, specifically metals and minerals, on sustainable development. We employ the estimator proposed by Callaway and Sant’Anna (2020) to address the biases associated with conventional two-way fixed-effect estimations (Goodman-Bacon, 2021; de Chaisemartin and D’Haultfoeuille, 2022; Sun and Abraham, 2021).

Additionally, we significantly contribute to the limited literature by leveraging the discoveries of mineral deposits as exogenous sources of variation, offering robust evidence of the mining sector’s effects. Our analysis at the municipal level in Mexico presents a novel case study, as Mexico, for most of the studied period, lacked both royalty mechanisms and redistribution systems for mining regions. This allows us to isolate the sector’s impact under conditions of minimal government intervention.

Finally, we introduce a proxy for environmental degradation that covers extensive areas or the entire territory, unlike other approaches that rely on localized sampling. This methodological advancement broadens the scope of analysis and offers a scalable framework for studying environmental impacts.

To understand the impact of mining on sustainable development, we construct a unique dataset covering 2403 municipalities from 1990 to 2020. Our study sheds light on the multifaceted impact of mining on these dimensions. The findings reveal the potential for mining to increase local income levels, but also highlight the adverse environmental consequences it can bring. We do not find significant effects on education or economic inequalities. Through this in-depth exploration of the Mexican case, we contribute to the global discourse on the effects of the mining sector on sustainable development in emerging countries, providing valuable insights for policymakers, researchers, and stakeholders who are addressing the challenges posed by the mining industry in their pursuit of a more sustainable future.

The rest of the paper is divided as follows. Section 2 is dedicated to the literature review. Section 3 offers a comprehensive overview of the development of the mining sector in Mexico and describes the data and methodology used in the paper. Section 4 presents the results of our analysis. In Section 5, we check the robustness of our findings. In Section 6, we discuss in more details the drivers of our results. Section 7 concludes.

2.2 Literature Review

An extensive body of literature examines the effects of natural resource extraction on sustainable development at the cross-country or country level. This paper proposes a different approach, focusing primarily on empirical analysis at the sub-national level, within a single country.

The mining industry plays a crucial role in the economic development of countries by providing essential inputs for production. However, it is often perceived as one of the sectors with the most significant effects on society and the environment. As a result, the industry actively participates in discussions on

sustainable development. Although mining companies acknowledge their role in contributing to the energy transition and sustainable development, they often overlook the negative impacts associated with the extraction process (Frederiksen and Banks, 2022). Taking into account the SDG as a map to measure the possible contributions of the mining sector, Merino-Saum et al. (2018) highlight that minerals are directly involved in achieving affordable and clean energy (SDG7), responsible consumption and production (SDG 12) and climate action (SDG 13). Additionally, mining companies can make direct or indirect contributions to reducing poverty (SDG 1), improving health (SDG 3), enhancing education (SDG 4), empowering women (SDG 5), and reducing inequalities (SDG 10) (Frederiksen and Banks, 2022; Hilson and Maconachie, 2019). However, it is crucial to note that the mining sector is also known for its negative environmental impacts, potentially affecting land (SDG 14) and bodies of water (SDG 6 and 15), among others.

The intrinsic relationship between sustainable development and the exploitation of natural resources has been extensively explored in the literature. One prevailing concept often discussed is the resource curse, which suggests that countries heavily reliant on natural resources tend to experience negative development outcomes. As a consequence, much of the literature has focused on examining the positive or negative effects of resource extraction and over-dependency on natural resources on various dimensions of sustainable development.

The literature developed at the national level gives mixed results and is not yet settled (Badeeb et al., 2017; Rosser, 2006). It does however suggest that the quality of institutions may shape the effect of natural resources on the economy. That is, once the quality of institutions is taken into account natural resources do not represent a curse (Aragon et al., 2015; Epo and Nochi Faha, 2019; Mehlum et al., 2006; Sala-i Martin and Subramanian, 2013).

A scarce yet growing body of literature examines the effects of non-renewable natural resource extraction at the sub-national level. Aragón and Rud (2013) is one of the earliest and key studies to investigate the effects of a mine on consumption in neighboring communities. They find that gold mining increases the level of consumption of the population in the neighboring area.

Similar setups have been used to analyze the impact of natural resource extraction around the globe on different aspects of sustainable development. In the case of Africa, positive effects are generally found in consumption Bazillier and Girard (2020), urbanization (Mamo et al., 2019) or other (Axbard et al., 2021; Benshaul-Tolonen, 2018). Negative spillover effects are found in terms of agricultural productivity (Aragón and Rud, 2015) and health (von der Goltz and Barnwal, 2018). This negative dimension can be seen also on the side of an increase of inequalities (Aragon et al., 2015) and corruption (Knutson et al., 2016).

In the case of Latin America and the Caribbean (LAC), the literature also shows mixed results. For

instance, gold mining in Peru has positive spillover effects on consumption in the vicinity of the mine (Aragón and Rud, 2013). Nevertheless, the oil activity in Brazil does not show a significant effect on consumption (Caselli and Michaels, 2013). Further Rau et al. (2015) find that waste from a mining site in Chile leads to a decrease in academic performance due to lead concentration in the blood of the population in the neighboring area.

Regarding the Mexican case, the literature related to the effects of the mining sector highlights the negative effects on the vicinity of the mines in Aguascalientes (Mitchell et al., 2016), Zacatecas (Salas-Muñoz et al., 2022) and San Luis Potosí (Monzalvo-Santos et al., 2016). The empirical studies are conducted by sampling and analyzing the composition of the flora and fauna affected. As a result, the studies only focus on specific locations.

On a more general note, Tetreault (2022) shows that the mining sector has been increasing since its liberalization. However, the increase has been accompanied by a spike in socio-environmental conflicts with neighboring communities.

In conclusion, the literature related to the extraction of natural resources at the sub-national level is growing and gives nuanced results. Most of the authors focus on particular aspects of sustainable development, revealing both positive and negative spillover effects. However, research on this topic remains limited, particularly in the context of LAC, and even more so in the case of Mexico. Therefore, our objective is to contribute to the existing literature by offering a comprehensive examination of the mining sector's effects on sustainable development in Mexico.

2.3 Data and Specification

2.3.1 Mexican Context

Mexico has acknowledged the importance of fostering the mining sector and has actively promoted its growth. This is not surprising considering the long mining tradition of the country. The mining sector has been part of the Mexican economy since pre-Hispanic civilizations.

Currently, Mexico holds a prominent position as the leading producer of silver worldwide and has considerable deposits of other minerals and metals, including gold, copper, and zinc (Figure 2.A.1). The mining sector in Mexico contributes significantly to the industrial GDP, accounting for 8.6% of its total. Mexico's vast territory encompasses an abundance of geological riches, with nearly 70% of the land exhibiting favorable geology for mining operations (Secretaría de Economía de Mexico, 2022).

The notable growth of the mining sector can be partly due to government efforts to promote it, beginning with the New Mining Law in 1993. This landmark legislation facilitated the entry of foreign capital into the mining sector, enabling both exploration and exploitation activities to thrive. The mining

situation in the country mirrors that of its counterparts in Latin America and the Caribbean (LAC), where the state owns the minerals, and mining companies are required to pay fees for exploration and resource extraction.

Following the implementation of the Mining Law, the government initially chose not to introduce a royalties system for the mining sector. Instead, payments for extraction rights were based on the size of the extraction site. However, due to the sector's growth and rising commodity prices during the 2000s, the Mexican government decided to implement additional taxes resembling a royalties scheme. In 2013, a new royalty-like tax of 5% on profits was introduced, which was later increased to 7.5%. This adjustment aligned the country's system with the more widely used royalty schemes employed in other LAC countries, such as Brazil, Colombia, and Peru (International Monetary Fund, 2012).

As part of Mexico's fiscal reform in January 2014 and subsequent amendments to the Federal Rights Law in 2016, the Fondo Minero (Fund for the Sustainable Regional Development of Mining States and Municipalities) was established. This fund is financed through a royalty scheme, which includes special, additional, and extraordinary mining rights, requiring mining companies to contribute toward social infrastructure projects aimed at improving the quality of life in mining communities.

The revenue from the Fondo Minero is distributed as follows:

- 2.5% is allocated to the Ministry of Agrarian, Territorial, and Urban Development (SEDATU) for social projects.
- 20% goes to the federal government for infrastructure programs approved in the federal budget.
- 77.5% is divided between municipalities and states, with 62.5% directed to municipalities where mineral extraction takes place, and the remaining 37.5% allocated to the corresponding state.

Further, the modifications of the mining law in 2022, declared lithium a mineral of national interest, consequently "The exploration, exploitation, benefit, and use of lithium are exclusively in charge of the State".² Hence making evident the interest of the country in active participation in the energy transition.

2.3.2 Data

Sustainable development measures

To assess in detail the impact of the mining sector on sustainable development in Mexico, we focus on two dimensions: a socio-economic one (i.e. income, inequalities, education) and an environmental one (i.e. environmental damages). The mining sector accounts for 8.6% of Mexico's industrial GDP;

²Text translated by the authors from Spanish. The original text says "La exploración, explotación, beneficio y aprovechamiento del litio quedan exclusivamente a cargo del Estado..."

therefore, we can anticipate that it contributes to the economic development of the municipalities where mines are located. Additionally, our analysis delves into the intricate relationship between mining and income inequalities, as these activities can either alleviate poverty or exacerbate disparities within local communities. We also explore the potential effects of the sector on education, considering both possible improvements in access to education and potential detrimental effects. It should be noted that empirical evidence at the national level suggests that the abundance of natural resources may be negatively correlated with education (Gylfason, 2001; Ross, 2001; Sachs and Warner, 2001). Furthermore, considering that the mining sector is often viewed for its substantial environmental impact; our research addresses the environmental sustainability aspects of mining, offering an examination of land degradation (proxied by NDVI as a measure of vegetation health) as well as water and air pollution.

To this end, we construct a novel dataset for Mexico covering 2,403 municipalities considering information on key sustainable development indicators and the mining sector. Table 2.A.1 presents descriptive statistics of the variables used. Further tables 2.A.16 and 2.A.17 in the online appendix provide correlation tables of the variables.

Our main data source for the characteristics of Mexican municipalities is the extended survey of the census. The main differences between the basic questionnaire and the extended version lie in their coverage and the number of questions they contain. We rely on the extended survey as it has information on the municipality of the households, their characteristics, and their income (other standardized surveys conducted in Mexico as the household survey do not specify the location at the municipality level). We consider data from four rounds of the Census covering 1990-2020.

We employ the information of the households and individuals for different variables of interest and the control variables. For household income, we use the question "Monthly income from work in the household" or equivalent. In total, our dataset has information on 10,931,947 households. Figure 2.1 maps the average income of municipalities for 2020 as a reference year. We observe that municipalities with higher levels of income are mostly located in the north of the country as well as the near area of the capital, highlighting the well-documented disparities between the northern and southern regions (Sánchez-Reaza and Rodríguez-Pose, 2002; Trejo Nieto, 2020).

We use household income to construct two measures of income inequalities, namely the Gini and Theil index.³ Figure 2.A.2 maps the Gini at the municipality level. We drop municipalities that present missing values in any of the four rounds of the census used. As a result, our dataset finally covers 2,403 municipalities. Income inequalities show an overall decrease (Figure 2.A.3).

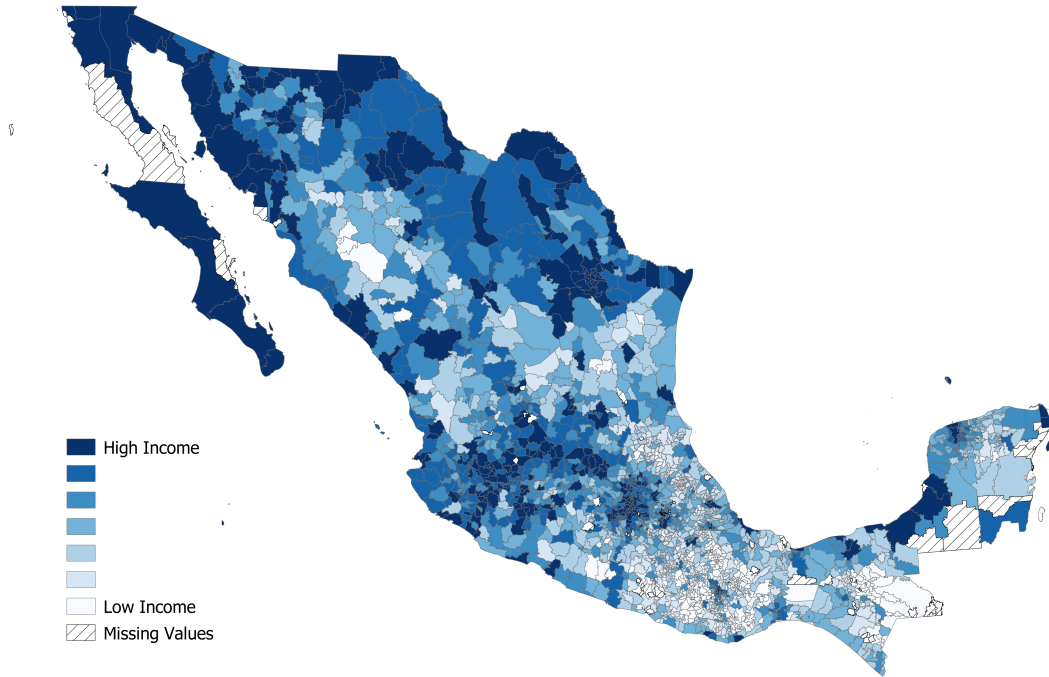
Using the education status data of individuals from the survey, we construct measures for the sec-

³We use the INEQDECO package in Stata for the construction of the Gini and Theil indices based on income data from the census

ondary schooling rate and the average years of schooling. Over time, there has been a noticeable improvement in these education indicators (Figure 2.A.4).

The Mexican education system is organized into three main levels: basic education, upper secondary education, and tertiary education. Basic education consists of three years of preschool (ages 3–5), six years of primary school (ages 6–11), and three years of lower secondary education (ages 12–14 or 15), forming the compulsory education until 2012. Upper secondary education, designed for students aged 15–18, offers both general and vocational pathways, while tertiary education includes universities and technical institutions. Since 2012, compulsory schooling in Mexico has covered 14 years, spanning from preschool to upper secondary education (OECD, 2019).

Figure 2.1: Income Distribution



To assess the environmental impact we use high-definition satellite data from NASA to construct a normalized difference vegetation index (NDVI) at the municipality level. The NDVI is a commonly used remote sensing index that indicates the amount and vigor of vegetation in an area by analyzing the difference in reflectance between near-infrared and red light. It is computed as:

$$NDVI = \frac{NIR - RED}{NIR + RED} \quad (2.1)$$

Where NIR and RED are the amounts of near-infrared and red light, respectively, reflected by the vegetation and captured by the sensor of the satellite. The formula is based on the fact that chlorophyll absorbs RED whereas the mesophyll leaf structure scatters NIR. NDVI values thus range from -1 to +1, where negative values correspond to an absence of vegetation (Pettorelli et al., 2005).

The literature highlights the potential and documented negative effects of the mining sector. In the case of Mexico, several studies have demonstrated a correlation between the mining industry and land degradation resulting from exposure to metal contamination (Mitchell et al., 2016; Salas-Muñoz et al., 2022; Monzalvo-Santos et al., 2016). We hypothesize that this land degradation will adversely affect the local flora, leading to a reduction in the quality and quantity of vegetation, which, in turn, would be reflected in decreased NDVI values.

The NDVI is high-frequency data. To harmonize our model we aggregate the data at the municipality-year level. For this reason, we use yearly data from 2000-2020 in our model (in that regard, the frequency of the environmental data is different than other sustainable development outcomes). Figure 2.A.5 shows the distribution of the NDVI in Mexico for 2020. As expected high values of the index are located in the south of the country. Further, in the sample, we observe that there is an overall decrease in the mean NDVI in the country with a slight recovery at the end of the studied period.

For robustness purposes, we also examine whether the environmental impact of the mining sector affects bodies of water and translates into air contamination. We use data from the Comisión Nacional del Agua (2023), which provides information on water quality from 2012 to the present for selected bodies of water (superficial water, as in rivers, and lakes). In the case of air quality, we rely on the ODIAC dataset which is a high-spatial-resolution global emission data product of CO₂ emissions from fossil fuel combustion (Oda and Maksyutov, 2015). As in the case of NDVI data, we aggregate the CO₂ emissions data at the municipality level for the period 2000-2020.

Mining variables

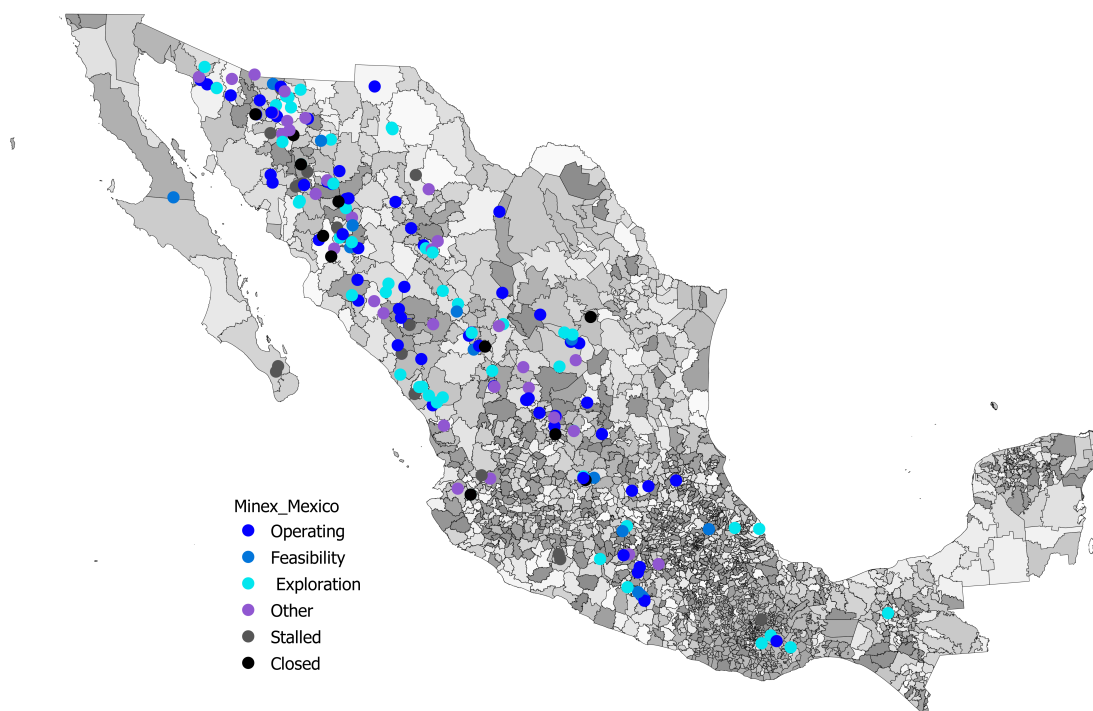
We combine the information from the census with data on mining, taken from Minex. The database provides information about medium-size or larger known mineral commodities, their characteristics, and the geographical location of mines with a global scope. In the case of Mexico, the dataset covers 193 observations. Figure 2.2 shows the location of the different activities in the territory. The data shows that 33% of the mines are operating, 25% are in exploration, 16% in feasibility and the rest present another status. Furthermore, most of the mining activity is concentrated in northern and central areas of the country.

In this study, we employ data on both the start of mining operations and the discovery of mineral

deposits. Our approach is based on the observation that there was a significant surge in the number of mining discoveries and the establishment of new mines after the early 1990s as shown in Figure 2.A.6. This growth of the sector corresponds to the liberalization of the mining industry, which occurred after the new mining law and the North American Free Trade Agreement (NAFTA) was implemented. The goal of these policy changes was to encourage foreign investment in the mining sector.

When considering the composition of the materials being extracted, we observe that a large proportion of the mining activities in our sample pertain to precious metals. Approximately 77% of the mining operations in our study involve gold or silver as the primary metal in the deposit. Copper ranks as the third most common metal, accounting for 12% of the sample, followed by Zinc at 4%. Other minerals present in the deposits included in our analysis comprise graphite, iron, lithium, and several others.

Figure 2.2: Mines location



Control variables

We use census data to control for the demographic characteristics of the population. In particular, we use information on age, sex, indigenous language, and accumulated education of the head of the family as controls. Further, we rely on information from INEGI and geocoded data to construct geographical controls. At the municipality level, we use a percentage of agricultural land, a dummy if the municipality

has a coastline and distance to DF.

2.3.3 Methodology

To evaluate the impact of the mining sector on sustainable development, we start by testing whether municipalities with active mines (the treated group) exhibit higher or lower levels of key development factors compared to non-mining municipalities. To achieve this, we adopt a staggered difference-in-differences (DID) model:

$$Y_{it} = \beta D_{it} + \lambda X_{it} + \alpha_i + \alpha_t + e_{it} \quad (2.2)$$

where Y_{it} represents the outcomes of interest. We use income to assess economic development; years of schooling and percentage of secondary enrollment for education; Gini index and Theil index for economic inequalities; and we use NDVI for environmental damages. D_{it} is a binary variable equal to 1 if there is a mine operating since year $\tau \leq t$. X_{it} is a vector of time-varying socio-demographic characteristics used as controls in the model. Finally α_i, α_t represent municipality and year fixed effects respectively. e_{it} is the error term.

We define the treatment and control group based on the characteristics of the mining sector. The treatment is composed of those municipalities that present the start of activities of a mine ($D_{it} = 1$). The control group is composed of those municipalities that do not have one. As a robustness check, we also test whether the discovery of a deposit has an impact on development. To do this, we generate a binary variable equal to 1 if there is a discovery in a given municipality.

Given the nature of the mining sector, our approach differs from the conventional difference-in-differences (DID) methodology as we have multiple time periods to consider. As shown in Figure 2.A.6, the start of mine operations in Mexico is staggered, and we assume that once a municipality begins mining operations, it does not change this status. However, the standard two-way fixed-effect estimation relies on the implicit assumption of a constant treatment effect over time, that is unlikely to hold in our case, therefore, this estimation method may be biased (Goodman-Bacon, 2021; de Chaisemartin and D’Haultfoeuille, 2022; Callaway and Sant’Anna, 2020; Sun and Abraham, 2021). To address this issue, we adopt the estimator proposed by Callaway and Sant’Anna (2020) for our analysis. In the sample, 54 municipalities experienced the discovery of a new deposit during the study period (1990-2020). Additionally, 40 municipalities started mining sector operations for the first time within the same period.

We use this estimator to compute the average treatment on the treated (ATT) using various approaches. Specifically, we take advantage of group-specific ATT and event study methodologies to analyze our results. The former enables us to examine the impact of mining on different groups of municipalities

based on the year of treatment. In other words, we assess the average treatment effect for municipalities that entered the treatment group in year t . The latter approach involves running Equation (2.3) to explore the dynamic effects of the treatment. This allows us to observe the treatment's impact and its evolution until time $t = L$, while also accounting for the anticipation of municipalities receiving the treatment.

$$y_{it} = \sum_{e=-K}^{-1} \beta_e^{anticip} D_{it}^e + \sum_{e=0}^L \beta_e D_{it}^e + \gamma X_{it} + \alpha_t + \alpha_i + v_{it} \quad (2.3)$$

Note that there are three versions of equations (2.2) and (2.3), depending on the outcome of interest.

For inequalities and education, the time dimension covers the period from 1990 to 2020, using four data points (1990, 2000, 2010, and 2020). In this case, our database is a panel where i represents municipalities. The treatment corresponds to municipalities where mining activities began. Due to the frequency of the census, the treatment is aggregated to the next available date. For example, if a mine starts operations in 2005 in a given municipality, the municipality is considered treated starting in 2010.

For income, we use data at the household level rather than the municipality level, making our dataset a series of repeated cross-sections. The treatment criteria are determined at the municipality level, meaning that treated households are those residing in municipalities where a mine is operational. The time dimension is dictated by the census and spans the period from 1990 to 2020, using four points. As with inequalities and education, treatment is assigned in the next available census period.

For NDVI (Normalized Difference Vegetation Index), we use a yearly panel dataset over the period from 2000 to 2020 at the municipality level, including only geographical controls. Our approach to assessing the environmental impact of the mining sector differs significantly from the existing literature. Unlike studies that directly measure water or soil quality (Mitchell et al., 2016; Salas-Muñoz et al., 2022; Monzalvo-Santos et al., 2016), our methodology does not allow for detailed contamination assessments based on sampling. However, it enables the analysis of larger geographical areas, offering a broader perspective on environmental impacts.

2.4 Baseline Results

Table 2.1 presents a summary of our main findings, with detailed result tables available in the appendix. We observe that the start of a mine in a municipality increases the level of income of households. Additionally, we observe a reduction in the NDVI, indicating a decline in vegetation quality. For the analysis of household income, we used a repeated cross-sectional regression approach from the Callaway and Sant'Anna (2020) estimator to take advantage of a more comprehensive dataset. Figure 2.A.7 presents

the event study set-up for the effect of mining on household income. Detailed results are displayed in Table 2.A.2. Our results reveal a significant impact of the mining sector on household income. The average treatment effect is positive and statistically significant, and it continues to remain positive even after the initial period of treatment. We also observe a positive effect one period before the start of the mine ($t - 1$); however, the average effect prior to the start of the mine is negative. This result can be explained by the various activities that surround the mining sector before the start of mining operations, such as the feasibility and construction of the mine site. Furthermore, due to data constraints we are unable to measure growth rates of household income. Consequently, we interpret our findings as indication a one-time increase in the level of income of those households located in the municipality where a mine starts operation. This increase happens even before the start of the mine.

Table 2.1: Dynamic effects of mining

Income		Environment (NDVI)	
Event - Study			
Average ($t < 0$)	-0.116*** (0.0228)	Average ($t < 0$)	78.84*** (20.51)
Average ($t \geq 0$)	0.137*** (0.0259)	Average ($t \geq 0$)	-377.3** (181.9)
Group Specific Effect			
G. Average	0.124*** (0.0134)	G. Average	-59.96*** (22.69)
N	8300793	N	51282

Note: The table shows staggered DID estimations. The dependent variable is the logarithm of income of the households and in the case of environment the NDVI at the municipality level. Average treatment effect on the treated (ATT) of the start of a mine for each specification. Event study results show the overall ATT across all groups overtime, while the group-specific results average the ATT of each group. ($t < 0$) Represent average anticipation of the treatment and ($t \geq 0$) and G. Average are the ATT of start of the mine depending of the specification. For income the sample unit is households and for NDVI municipalities. WildBootstrap (WB) standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The second part of table 2.1 shows the main findings of the results for environmental impacts using the NDVI. We observe the average effect of mining over the studied period (2000-2022). The results indicate that the mining sector has a significant environmental impact, as expected. The negative effects reflect a reduction of the NDVI, hence, a reduction in the health of the vegetation in the municipality. Table 2.A.3 presents short-listed results for the NDVI estimation, Table 2.A.18 in online appendix presented detailed results. The event study suggests that the effect of the opening of a mine is not significant in the years following the event but over the years it becomes visible and is captured by the health of the vegetation

as displayed in Figure 2.A.8. We interpret this lag in the impact as the time it takes for the sector to have significant negative environmental impacts that are observed with satellite imagery. Moreover, we observe that on average the post-treatment effect is negative and significant along different aggregation methods allowed by the Callaway and Sant’Anna (2020) estimator. In this regard, our results are in line with the literature that highlights the negative environmental spillovers of the sector.

Table 2.A.4 for the rest of the outcomes. We observe that the start of a mine does not significantly impact neither education, measured by secondary enrollment rate or average years of education, nor the distribution of income. We do not find any significance for the average effect post-treatment, neither the effect in ten nor 20 years is significant. We observe a modest reduction of the inequalities before the start of the mine measured by the Gini. However, the result is not fully consistent with the Theil index. In the case of the Theil index, the pre-treatment indicates a reduction of inequalities as the Gini. Nevertheless, the effect after 10 years of the start of the mine indicates an increase in inequalities, this effect of the start of the mine is not observed using the Gini. Consequently, we conclude that the effect of the mining sector on inequalities is not robust.

The baseline results suggest a dual effect of the start of operation of a mine in a municipality: on the one hand, household income levels increase. However, this increase is accompanied by stronger environmental contamination, as evidenced by the reduction of the NDVI. We highlight that the effect on income is perceived earlier than the environmental damage, according to the results. Furthermore, the extractive sector does not appear to have a significant influence on education or economic inequalities within the host municipalities. Therefore, in the following section, we will focus on the robustness of the impact of the mining sector on household income and environmental damage.

2.5 Robustness Checks

To ensure the robustness of our findings, we employ several approaches. Firstly, we modify the treatment and control group by selecting municipalities in closer proximity to the mining sites. Secondly, we account for the possibility that changes in the surrounding areas may occur before the actual start of mining activities due to differences in time between the discovery of deposits and the start of mining. To do this, we re-estimate our baseline equation using the year of discovery as the treatment. Further, we adopt an alternative estimation method to test the validity of our results. Finally we test the sensitivity of our results by changing the proxy variables used for the environmental dimension.

2.5.1 Distance Dynamics

To ensure the robustness of our findings regarding the effects on income and the environment, we conducted additional tests. Firstly, we examined whether the impact of mining sites spills over to neighboring municipalities. To do this, we created buffers around the mine sites and included municipalities located within these buffers as part of the treated group. We tested different buffer sizes ranging from 5km to 75km from the mines.

In the case of income, we found that the results remained consistent and qualitatively similar with the selected buffers (See Table 2.A.5, Figure 2.A.9). However, the magnitude of the results decreased beyond 10 kilometers. Additionally, while the average effect on the treated is positive, group-specific coefficients are less significant (and even negative in the 75km buffer).

The event study analysis revealed that there was an increase in income levels even before the start of the mine, and this level remained relatively stable in the periods following the mine's start for the closest municipalities (within 5km). However, for farther buffer distances, the income boost observed initially decays over time as shown in figure 2.A.11a.

We interpret these results as evidence of the enclave nature of the mining sector. The initial income boost may be attributed to the construction phase of the mine, but once the mine is operational, we observe a slight decline in income levels.

These findings support the idea that the mining sector has only local effects on income, and these effects tend to diminish as distance from the mine increases.

The extensive literature on the environmental effects of mining consistently highlights the negative impacts on nearby areas. Indeed, our findings suggest a similar picture. We observe that the significance of the effects diminishes in municipalities beyond a distance of 25km from a mine, and the results are no longer robust out with a 10 km buffer (Figure 2.A.10). Table 2.A.6 presents the average effects for different distances, revealing that in the event study setup, the average effect after the start of the mine is significant at 5km, 10km, and 25km. However, when examining group-specific average effects, we find that only the treatment at 5 km and 10 km distances is statistically significant. These results partially align with the literature, which emphasizes the enclave nature of the environmental impacts, suggesting that the effects are more concentrated in closer proximity to the mining sites.

2.5.2 Anticipation Effects: Impact of Mines Discovery

Our findings on income suggest that changes in income dynamics start to occur even before the actual start of mining operations. This observation can be attributed to preliminary phases such as exploration, feasibility studies, and construction, which require investments that can impact household incomes. Ad-

ditionally, once a mineral deposit is discovered in a municipality, expectations and anticipation may start to build up, potentially influencing income levels or the environment for that matter.

We could also argue that the anticipation results violate the pre-trend assumption of the Difference-in-Differences (DID) method. We address this issue in two ways. First, we use entropy balancing to create more comparable treatment groups, thereby reducing bias in the estimated treatment effects Hainmueller (2012). Second, we modify our approach by using the discovery year instead of the start of the mine's operation.

Entropy balancing requires a set of covariates to balance the treatment and control groups. Due to this requirement, we perform the preprocessing only on the income results, which allows us to use a rich group of covariates. We use characteristics of the head of the family and the year to perform the entropy balancing. In the second step, we run the baseline analysis without those controls. The results, presented in Table 2.A.7, show a similar pattern: an initial negative and subsequent positive effect prior to the start of the mine. However, the overall pre-trend is not statistically significant, and the Average Treatment Effect on the Treated (ATT) is positive.

Second, we modify our approach by using the year of discovery instead of the year the mine starts operation to define the treatment group. This adjustment allows us to capture the effects of different mining phases and their potential influence on income dynamics, providing a more accurate representation of the treatment effect. Additionally, households are less likely to experience anticipatory effects since exploration does not necessarily lead to the exploitation of resources. Consequently, by using this approach, we address pre-trend concerns and we contribute to the literature that uses the discovery of deposits as exogenous sources of variation (Brunnschweiler and Poelhekke, 2021; Cavalcanti et al., 2019; Cotet and Tsui, 2013; Smith, 2015).

We first test whether we find similar results using as a treated group all the municipalities that have a discovery in our sample, this method differs from the baseline as the treated group is bigger due to those locations in which there has been a discovery but a mine is not operating yet. As a result, we do not expect to have the same results with this methodology as the treated group may include municipalities with stalled projects or in feasibility that do not necessarily have a significant impact on the municipality. In the second step, we slice the treated group so that it only includes municipalities with operating mines.

The results obtained for income levels show weak effects in our analysis. We observe an increase in income levels in the period immediately following the discovery of a mineral deposit. However, the average effect over the post-discovery period is not statistically significant. When examining the group-specific setup, we find mixed results as well. While the average effect is positive, two specific groups (2000 and 2020) exhibit a negative effect on income levels. These findings remain consistent even when we exclude municipalities with deposit discoveries that are not currently operating.

We interpret the results as evidence of the limited capacity of the mining sector to permanently increase household wealth through income. Despite an initial boost in income levels following a deposit discovery, these effects are not sustained over time. This suggests that the mining sector may have limitations in its ability to generate long-term prosperity for households if we consider an income-level approach.

To address this issue, we use a wealth index based on household characteristics. It is a measure of cumulative living standards of the households, we argue that improvements in the living standards will closer relate to long-term income. The results are presented in table 2.A.8 and indicate that the discovery does not have a significant enough effect to move households to the next quintile in the index. Furthermore, while the Average Treatment Effect on the Treated (ATT) is positive, its value is not different from the value in $t-2$. These findings confirm our concerns about the limitations of the mining sector in generating long-term prosperity for households.

In the case of NDVI we find similar results as the baseline (see Figure 2.A.11), the average effect is negative in both set-ups. Further, we observe negative effects sooner compared with using the start of the mine as a source of variation (from two years after the discovery). The results are largely unchanged when we omit those municipalities without operating mines.

2.5.3 Alternative Estimator

In addition to our baseline estimator, we also employ an alternative estimation method for Equation (2.3). Specifically, we utilize the estimator proposed by de Chaisemartin and D'Haultfoeuille (2022). Unlike the approach presented by Callaway and Sant'Anna (2020), this estimator does not allow for group or cohort-specific Average Treatment Effects (ATT).

The results obtained using this alternative estimator exhibit a similar pattern to our baseline findings. However, the significance levels differ as shown in Table 2.A.11 and Figure 2.A.12. Specifically, in the case of income, we observe a significant effect only in the year of the start of the mine. On the other hand, for the Normalized Difference Vegetation Index (NDVI), we observe a significant effect only after $t+13$.

2.5.4 Environmental Concerns: Land, Water and Air Contamination

A concern using NDVI could be that our measure is not capturing an increase in land degradation but rather an expansion of the urban area in the municipalities. Indeed if the urban area expands it could lead to a decrease of green cover, therefore reducing the NDVI. To address this issue we use land cover yearly data from Friedl and Sulla-Menashe (2022) to exclude urban areas and reestimate the NDVI value. The

result show a negative effect on the NDVI similar in size to the baseline, albeit its significance is lower (Figure 2.A.13).

Further, we validate the results related to environmental damage by employing alternative measures, specifically we test for contamination in bodies of water and air contamination. For the former, we utilize data from Comisión Nacional del Agua (2023), which provides information on water quality from 2012 to the present for selected bodies of water (superficial water, as in rivers, and lakes).

We conduct tests to determine if the start of a mine increases the presence of heavy metals in the water.⁴ For this analysis, we define the treatment group as those observations (rivers, lakes, etc.) located within a 10-kilometer radius from a mine. The results indicate that mining does indeed lead to an increase in the levels of arsenic, mercury, and potentially chromium in the water.

Table 2.A.12 displays the results, and we observe that the average effect is both significant and positive in the event study setup. However, in the case of chromium, the group-specific setup no longer yields a positive effect. These findings provide additional evidence for the concerns regarding the environmental impact of mining activities.

We use data from ODIAC dataset, a high-spatial resolution global emission data product that tracks CO₂ emissions from fossil fuel combustion (Oda and Maksyutov, 2015). Similar to our approach with the NDVI data, we aggregated the CO₂ emissions data at the municipal level for the period from 2000 to 2020, and the results are presented in Table 2.A.13. Our analysis reveals that the average effect is not statistically significant, neither post the start of mining activities nor in the group specification. However, we do find weak evidence of an increase in CO₂ emissions; notably, the dynamic effect in the year of the start of mining is significant as well as other specific years. Furthermore, in the group specification, six cohorts show an increase in emissions, while only two exhibit a reduction.

In summary, the different proxies we employed provide evidence of the mining sector's adverse impact on the environment. In line with previous studies, our results suggest that the sector contributes to land degradation, as reflected in the reduced health of vegetation. Furthermore, we also observe evidence of heavy metals in bodies of water, but we do not find strong evidence of increased pollution at the municipal level, although such effect cannot be ruled out.

2.6 Discussion

In the previous section, we showed that the mining sector had a significant effect on household income, while also generating negative environmental spillovers. In this section, we aim to analyze whether these effects are driven by specific types of mines, such as those involved in the extraction of precious metals,

⁴We test for the presence or increase of arsenic, cadmium, chromium, mercury, nickel, lead, cyanide, copper, and zinc.

bulk commodities, particularly energy transition metals, or mining sites of a particular size. Additionally, we conduct further tests to examine whether the income shock resulting from mining activities affects different quantiles of the population.

We initially investigate whether the size of a mine influences the impact of the mining sector on a municipality. Our dataset categorizes mines into three sizes: medium, major, and giant deposits. To examine this, we modify the treatment group in our baseline analysis, including only municipalities with specific mine sizes, while excluding other mining municipalities from the sample.

Table 2.A.14 presents the ATT based on the characteristics of the mine. In terms of income, the results indicate that the effects are primarily driven by giant and major mining sites. Interestingly, we observe a slightly larger effect for giant operations. In municipalities where the mining sector starts with moderate-sized operations, the effect of the mine's start on income is not statistically significant. Additionally, major-sized mines tend to have negative spill-over effects on the environment of the host municipalities.

Furthermore, the behavior of the mining sector is primarily influenced by the extraction of precious metals. This finding aligns with our expectations, considering that nearly 80% of the sample consists of mines where the primary metals extracted are gold or silver. Consequently, we do not find any significant effects of Energy Transition Metals (excluding silver) on household income. The negative environmental effect do not seem to be exclusive to a particular type of commodity, although the effect in our sample is not robust among specifications.⁵

To analyze the distributional effects of the mining boom on households within the municipalities, we divide our sample into quantiles and estimate the outcomes for each cohort. Table 2.A.15 presents the results. The findings indicate that the lowest quantile, as well as the 3rd and 4th quantiles, benefit from the mining sector. Interestingly, although the lowest quantile experiences the largest effect, this impact is not persistent over time in the dynamic setting. On the other hand, higher quantiles continue to experience positive effects from the mining boom.

The results suggest that the discovery and further extraction of natural resources do not necessarily guarantee an increase in household income in the neighboring areas. Rather, the implications are similar to opening Pandora's box, as positive spillovers in terms of income if there are any, may be accompanied by negative environmental effects. This interaction explains the increase of unrest and conflicts in communities with mining projects, as the positive and negative effects of the mining sector will largely depend on the characteristics of the mine.

⁵The results of precious metals present qualitatively the same behavior of the baseline, although, in the case of event study specification, the average post treatment effect is not significant

2.7 Conclusion

In this study, we analyzed the impact of the mining sector on the sustainable development of Mexican municipalities. For this purpose, we used a novel dataset constructed using satellite data, mining information, and the Mexican Census data. We exploited the variability caused by the introduction of the new mining law and NAFTA, which liberalized the mining sector. Consequently, we examined whether the opening of a mine in a municipality impacts sustainable development.

This subject is important due to the international effort to address climate change. The energy transition and the deployment of green energy are intensive in the use of minerals and metals. Hence, there is an urgency to understand the economic and environmental impact of the mining sector development.

Our findings reveal that the discovery and initiation of mining activities contribute to an increase in the income levels of municipalities. However, the persistence of this effect over time varies depending on the characteristics of the mine. It is important to note that the benefits are not evenly distributed among households within the municipalities. Notably, the results suggest that middle-income households experience persistent increases in their revenue. Additionally, some spillover effects can be observed in neighboring areas, albeit to a lesser extent.

Simultaneously, the mining sector has negative environmental effects, particularly in the host municipality with spillovers to the closest neighbors. These effects may not be immediately evident in the short term. Nevertheless, we find negative impacts on water quality, manifested by the presence of heavy metals, and the degradation of the land. Our analysis does not uncover significant effects on education or income inequalities.

A potential avenue for future research, and a limitation of this study, is the role of artisanal and small-scale mining (ASM) in local development. ASM remains a critical economic activity for many rural communities, yet it is often underrepresented in official statistics, making it challenging to establish robust strategies to address its impact. Organizations such as the Servicio Geológico Mexicano (SGM) and the Fideicomiso de Fomento Minero play vital roles in promoting and supporting ASM by providing technical assistance, capacity-building programs, and financial resources to enhance the sustainability and development of these operations. Nevertheless, the lack of reliable data hinders comprehensive assessments of ASM's contributions and challenges. Advances in artificial intelligence and satellite imagery analysis offer promising opportunities to overcome this limitation by improving the identification and monitoring of ASM activities in Mexico, to address this issue.

Overall, our study sheds light on the complex dynamics of the mining sector, highlighting both the economic benefits and environmental challenges associated with it. The unequal distribution of benefits and potential negative consequences contribute to the increased unrest observed between communities

and mining projects.

An increase in extraction within the mining sector is expected to meet the demand for addressing climate change, especially when it comes to energy transition metals. Hence, mitigation policies aimed at achieving carbon neutrality may function as a double-edged sword. On one hand, they reduce carbon emissions, but on the other, they have mixed effects on sustainable development for the mining communities, with increased income levels accompanied by increased environmental damage due to extraction.

Our findings emphasize the need for a balanced approach that carefully considers both the economic and environmental impacts of mining. Sustainable development in mining communities requires policies that not only harness the economic benefits but also mitigate the environmental damage. Striving for this balance is essential for the long-term well-being of these communities, the decrease in conflicts between communities and mining projects, and the broader goal of sustainable development.

2.8 Appendix

Figure 2.A.1: Global supply participation

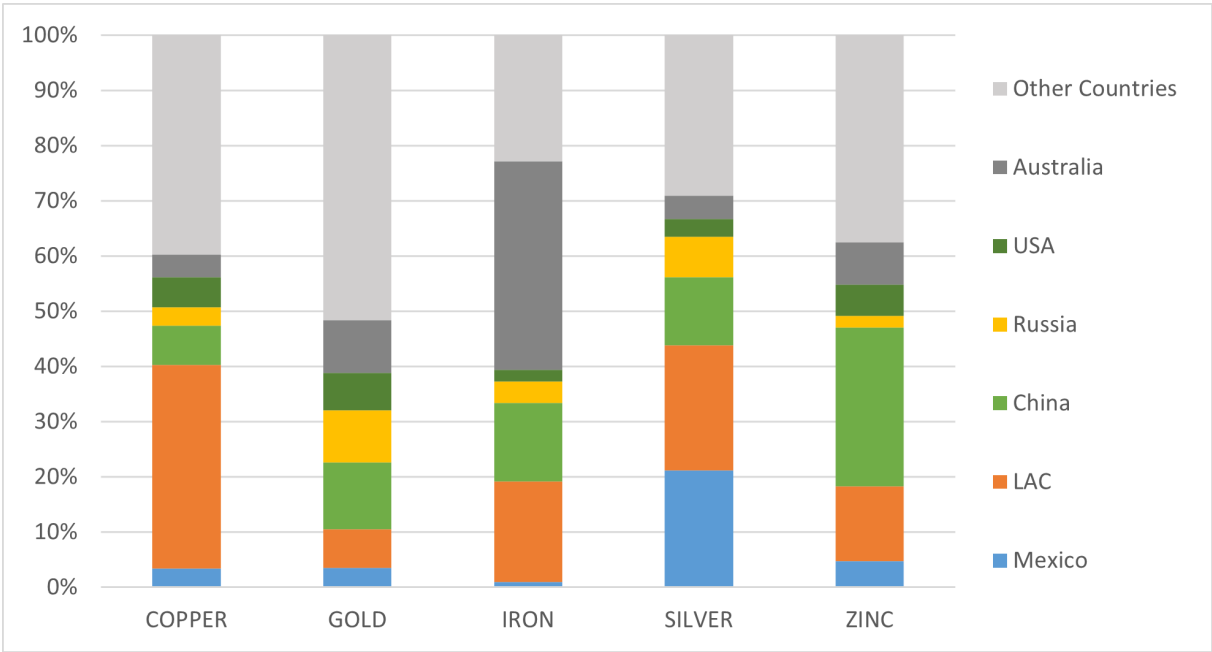


Figure 2.A.2: Gini Index

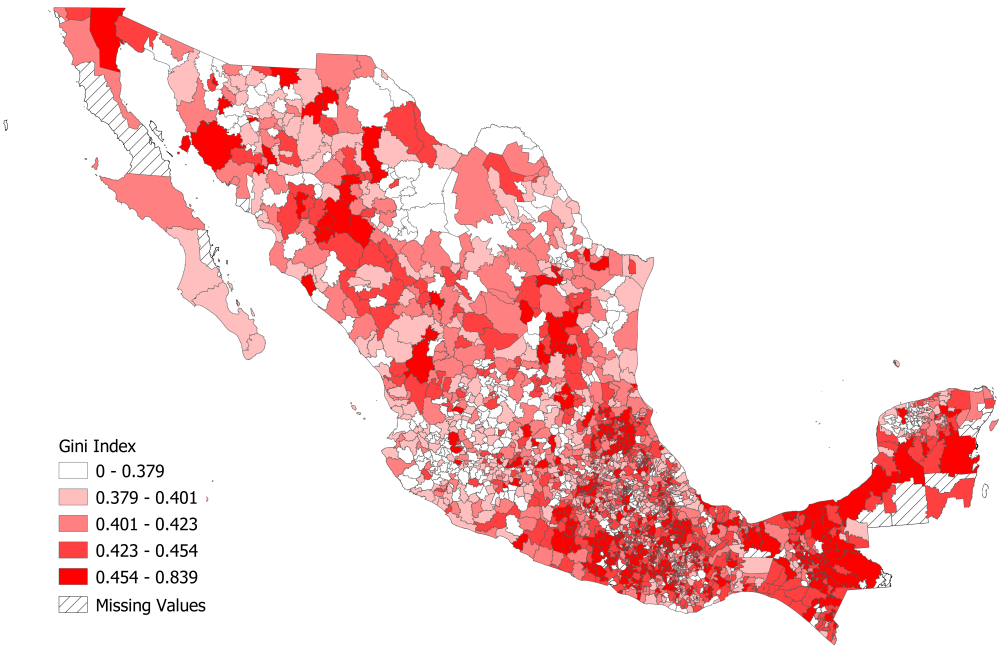


Figure 2.A.3: Evolution of inequalities indicators

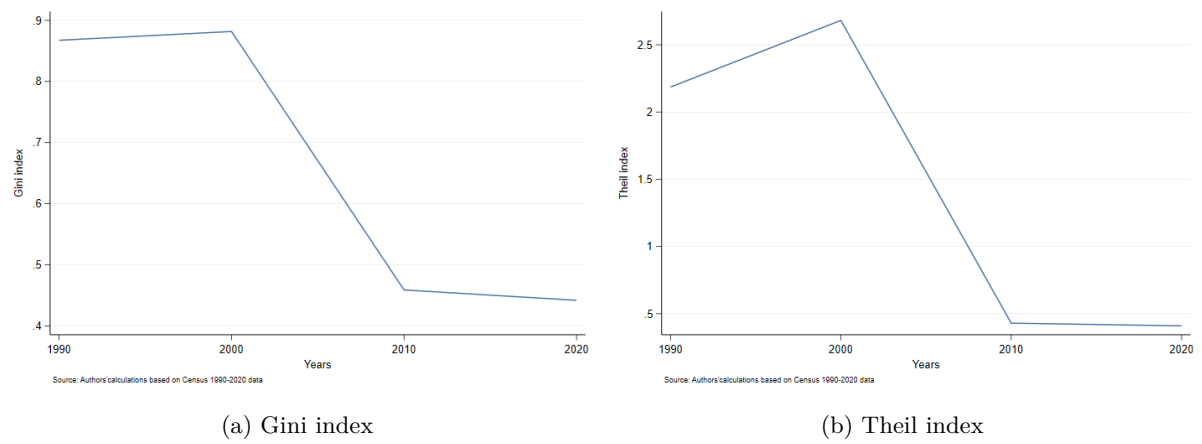


Figure 2.A.4: Evolution of education indicators

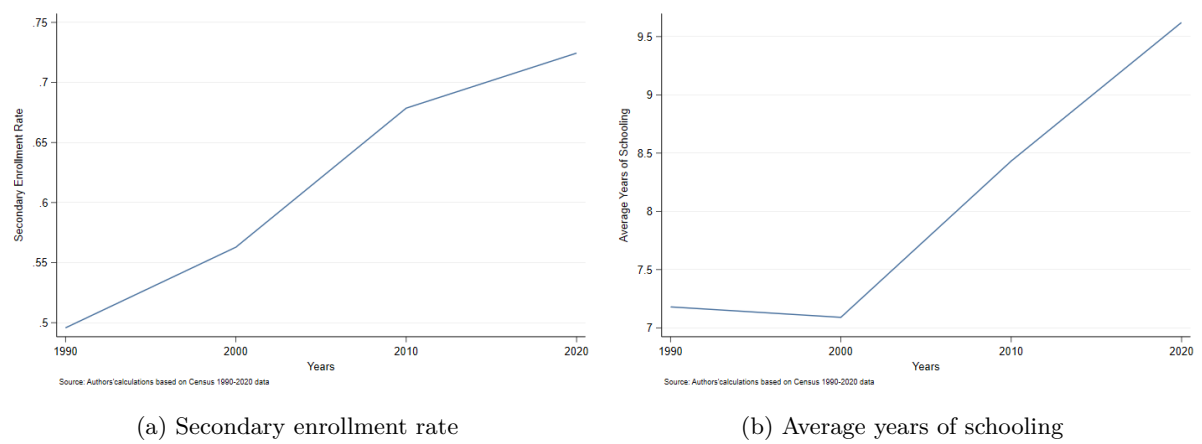


Figure 2.A.5: NDVI Maps

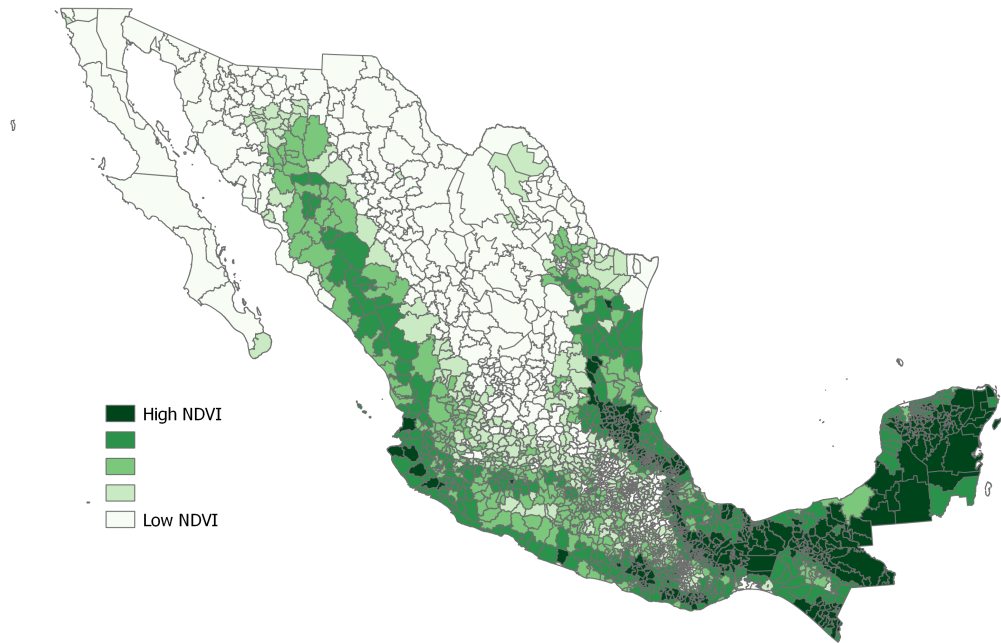


Figure 2.A.6: Evolution of the mining sector

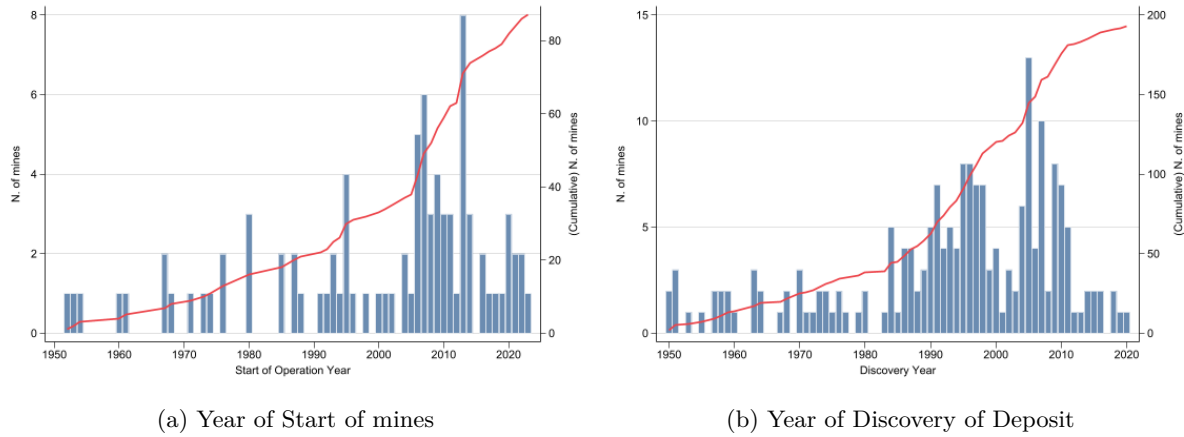
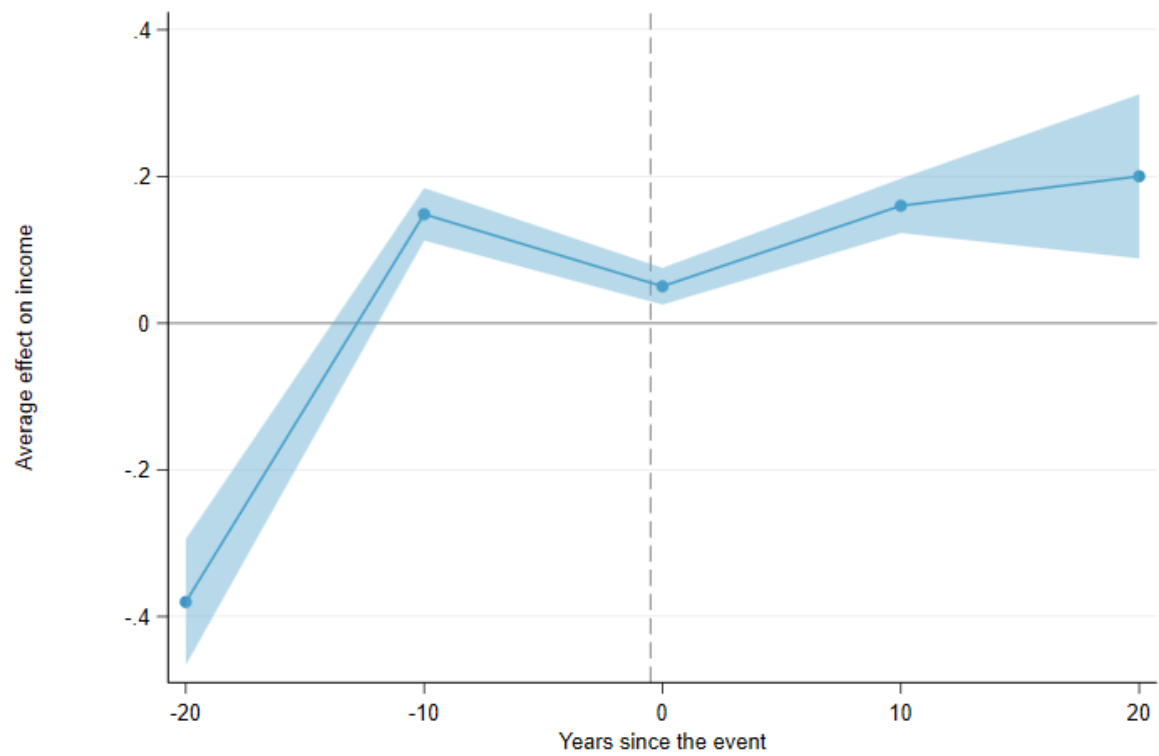
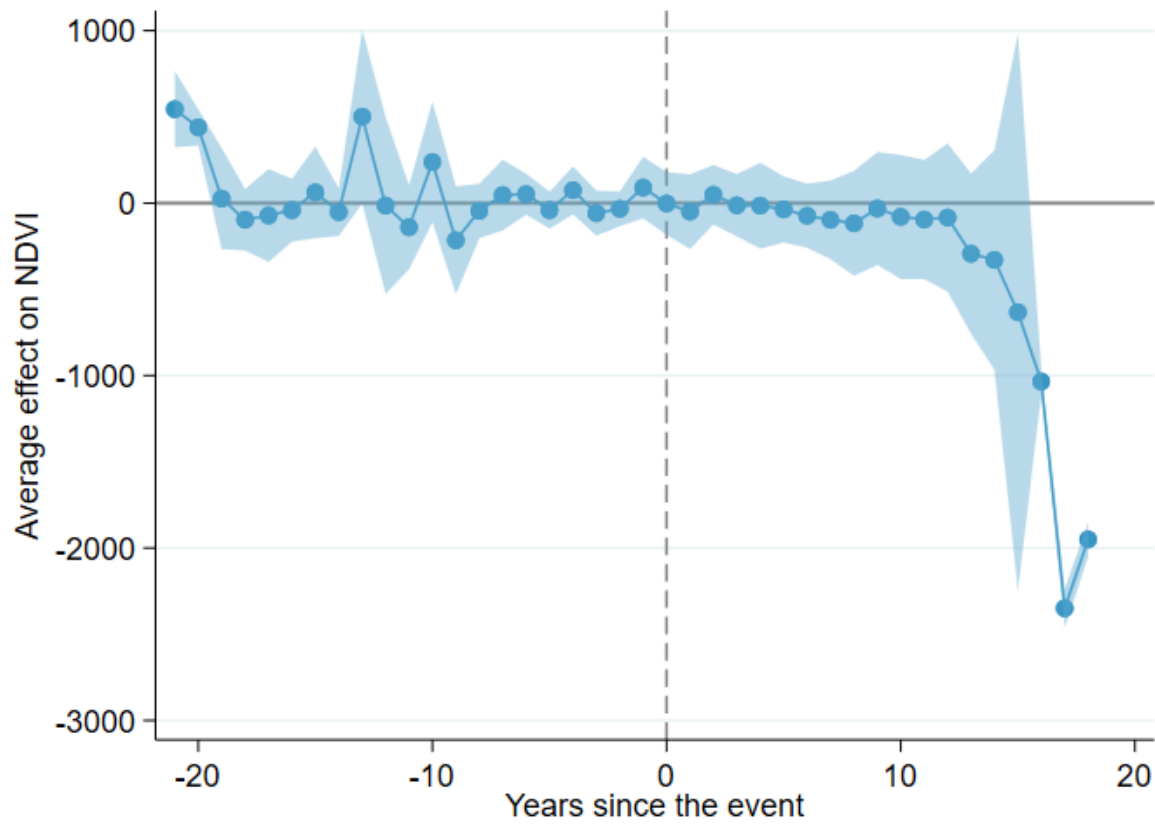


Figure 2.A.7: Effect of mining on Income



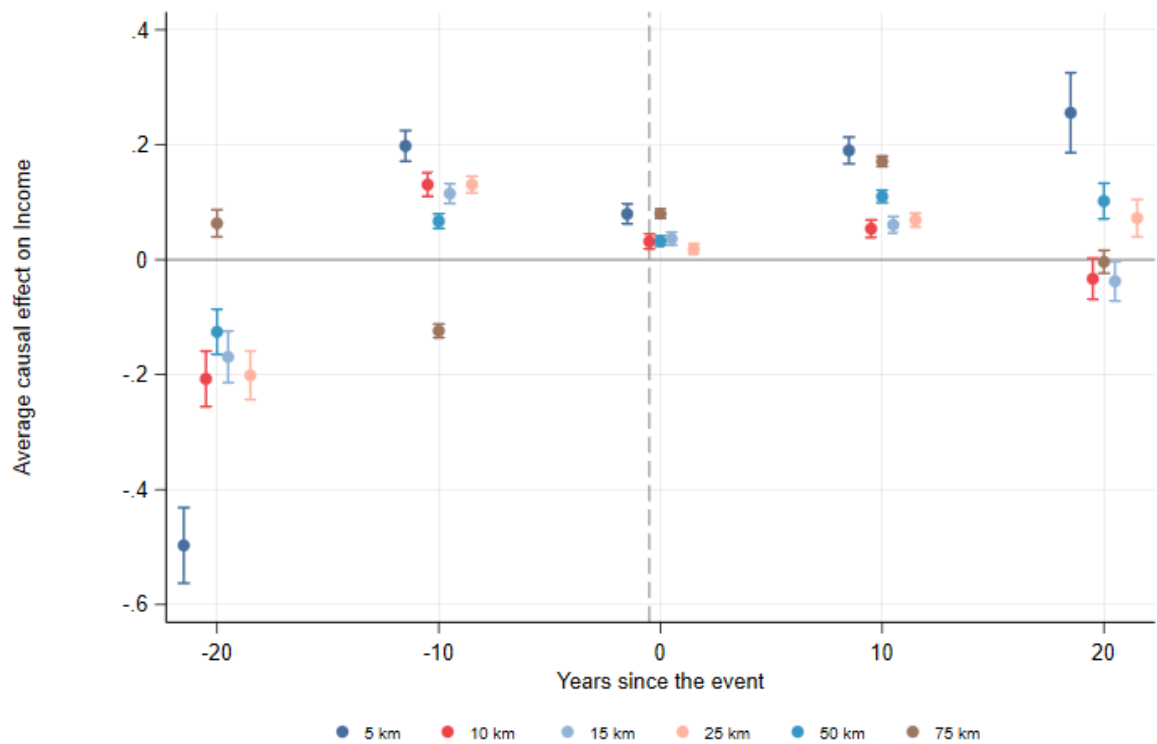
Event Study based on Callaway and Sant'Anna (2020) estimator. The treatment is defined by the start of the operation of a mine in the municipality. We use WB for the standard errors.

Figure 2.A.8: Effect of mining on Environment (NDVI)



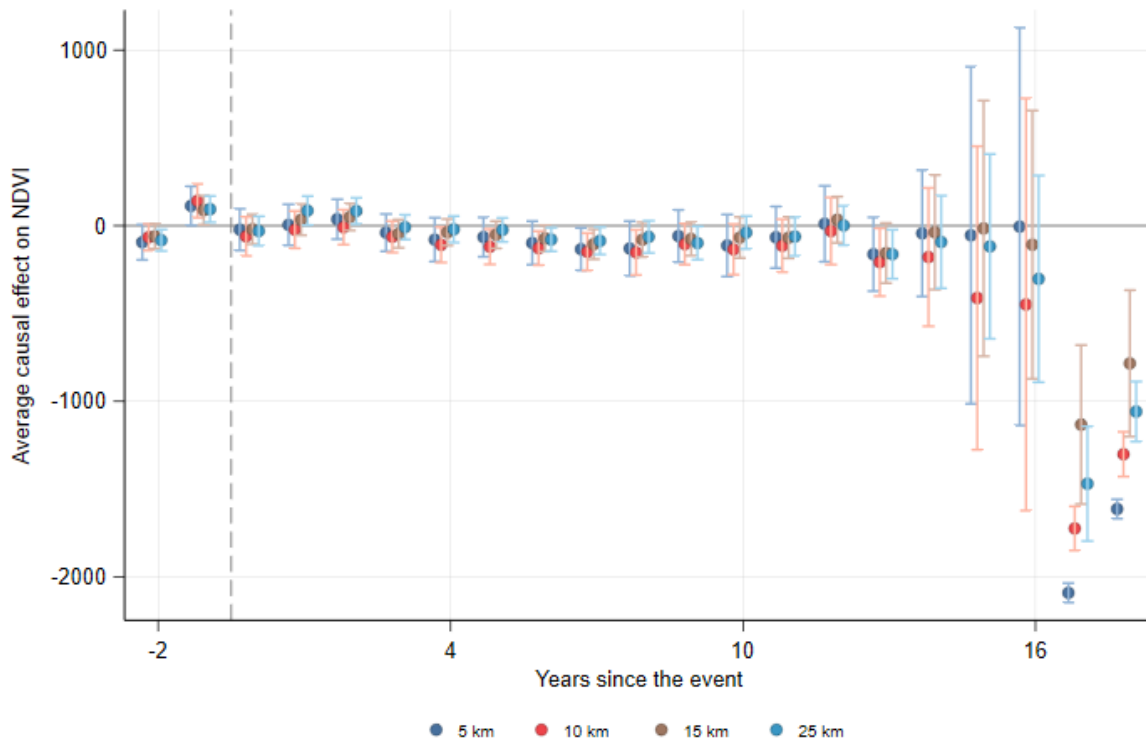
Event Study based on Callaway and Sant'Anna (2020) estimator. The treatment is defined by the start of operation of a mine in the municipality. We use WB for the standard errors.

Figure 2.A.9: Robustness test: Effect of mining on Income



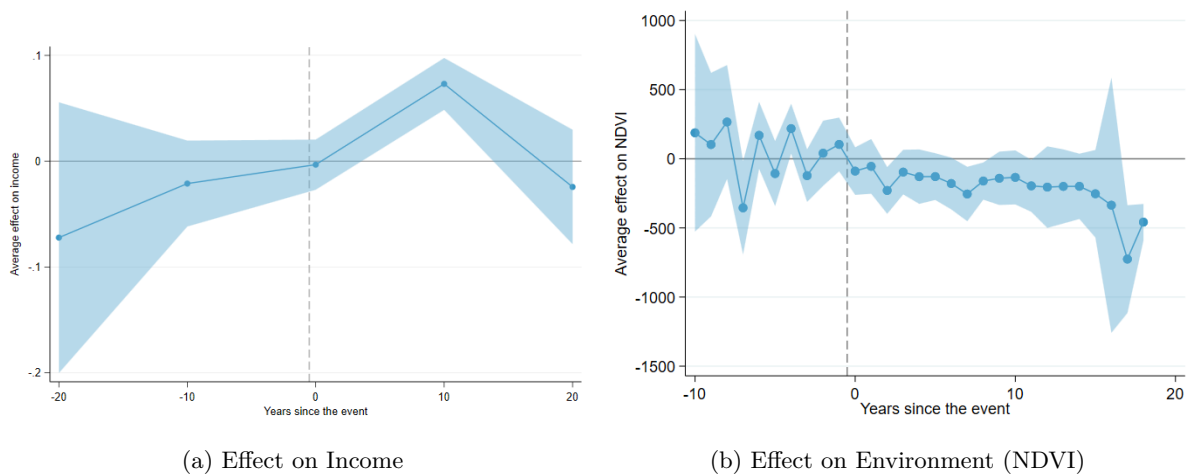
Event Study based on Callaway and Sant'Anna (2020) estimator. The treatment is defined by the start of operation of a mine, the treated municipalities are chosen based on distance from the mine. We use WB for the standard errors.

Figure 2.A.10: Robustness test: Effect of mining on Environment (NDVI)



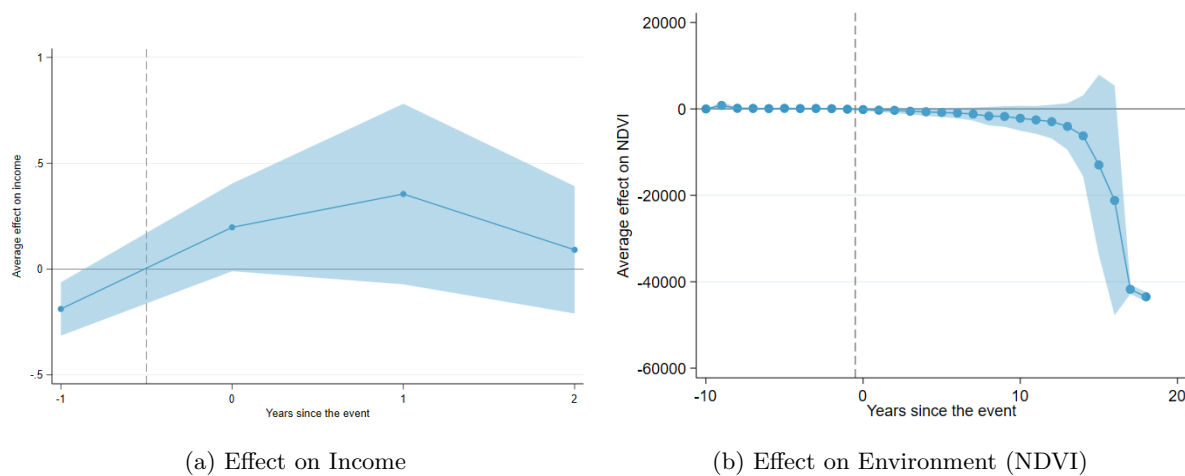
Event Study based on Callaway and Sant'Anna (2020) estimator. The treatment is defined by the start of operation of a mine, the treated municipalities are chosen based on distance from the mine. We use WB for the standard errors.

Figure 2.A.11: Robustness test: Discovery year



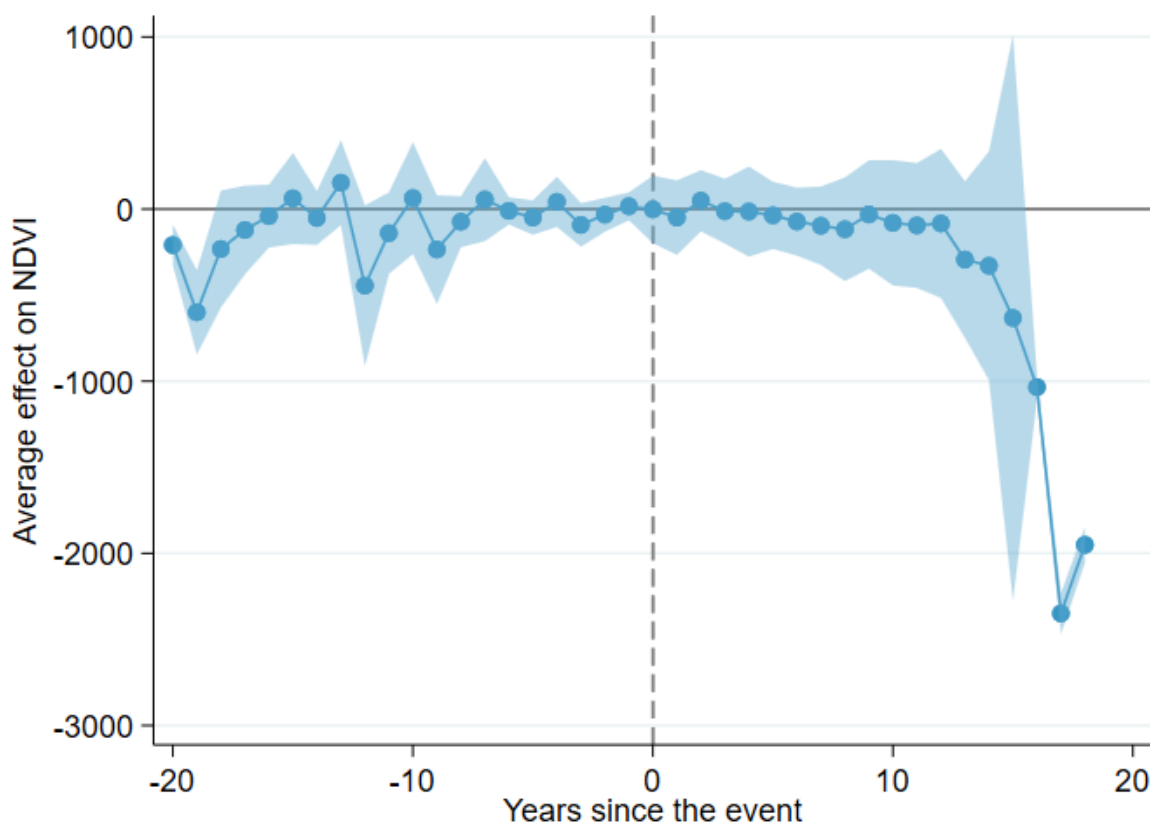
Event Study based on Callaway and Sant'Anna (2020) estimator. The treatment is defined by the year of discovery of the deposit. We use WB for the standard errors.

Figure 2.A.12: Robustness test: Alternative estimator



Event Study based on de Chaisemartin and D'Haultfoeuille (2022) estimator. The treatment is defined by the year of the start of the operation of the mine. We use WB for the standard errors.

Figure 2.A.13: Robustness test: Effect of mining on Environment (NDVI) excluding urban area



Event Study based on Callaway and Sant'Anna (2020) estimator. The treatment is defined by the start of operation of a mine, the treated municipalities are chosen based on distance from the mine. The calculation of NDVI for the municipalities excludes the urban areas. We use WB for the standard errors.

Table 2.A.1: Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Household level					
Income (log)	8,400,723	7.82	1.73	-6.87	14.10
wealth index	10,867,450	2.96	1.38	1.00	5.00
index core	10,867,450	-0.82	2.45	-11.63	10.98
Sex*	10,931,947	1.40	0.76	1.00	3.00
Age*	10,915,540	47.62	16.53	8.00	130.00
Indigeneous language*	10,931,947	0.15	0.36	0.00	1.00
Acummulated education*	10,891,245	7.58	10.91	0.00	111.00
Start treatment	10,931,947	43.02	290.21	0.00	2020.00
Year	10,931,947	2008.57	10.75	1990.00	2020.00
Municipality level (Census)					
Enrollment rate	9,606	0.52	0.20	0.00	1.00
Acummulated education*	9,606	5.93	2.09	0.41	13.98
Gini (Income)	9,602	0.65	0.24	0.00	0.98
Theil Index (Income)	9,602	1.42	1.19	0.00	4.80
Population	9,612	42939.32	127281.80	81.00	1922523.00
Sex*	9,612	1.34	0.19	1.00	2.01
Age*	9,611	48.70	4.36	33.54	73.00
Indigeneous language*	9,612	0.18	0.32	0.00	1.00
Acummulated education*	9,611	6.54	3.97	0.28	68.22
Agricultural land (%)	9,592	0.32	0.25	0.00	1.00
Start treatment	9,612	46.66	302.11	0.00	2020.00
Year	9,612	2005.00	11.18	1990.00	2020.00
Municipality level (Satellite data)					
NDVI	51,849	5458.81	1557.49	711.54	8752.05
Distance to DF	51,849	438891.20	376350.80	0.00	2265103.00
Coast	51,849	0.06	0.24	0.00	1.00
CO2 emissions	51,849	13.32	45.89	0.00	740.81
Start treatment	51,849	46.90	302.43	0.00	2022.00
Year	51,849	2010.00	6.06	2000.00	2020.00
Bodies of water					
Biochemical Oxygen Demand	24,452	20.64	93.16	2.00	5190.00
Dissolved oxygen	17,150	72.02	28.50	1.70	183.20
Total Arsenic	37,709	0.0093	0.0562	0.0003	6.8330
Total Cadmium	36,180	0.0017	0.0243	0.0000	4.3140
Total Chromium	35,999	0.0135	0.3720	0.0005	39.0233
Total Mercury	37,164	0.0003	0.0016	0.0000	0.1121
Total Nickel	28,447	0.0055	0.0921	0.0002	12.7400
Total Lead	36,171	0.0034	0.0114	0.0002	0.5968
Total Cyanides	15,259	0.0028	0.0067	0.0005	0.3037
Total Copper	2,899	0.0082	0.0549	0.0003	2.1530
Total Zinc	9,947	0.0357	0.2212	0.0004	12.6500
Temperature	39,896	27.44	4.68	1.30	46.00
Start treatment	41,195	20.58	201.54	0.00	2023.00
Year	41,194	2016.52	2.89	2012.00	2022.00

* Refers to characteristics of the head of the family

Table 2.A.2: Dynamic effects of mining on income

(Event Study)		(Group-Specific Effect)	
Average ($t < 0$)	-0.116*** (0.0228)	G. Average	0.124*** (0.0134)
Average ($t \geq 0$)	0.137*** (0.0259)	$g = 2000$	0.0987** (0.0465)
$t = -20$	-0.380*** (0.0432)	$g = 2010$	0.117*** (0.0177)
$t = -10$	0.149*** (0.0188)	$g = 2020$	0.159*** (0.0154)
$t = 0$	0.0503*** (0.0123)		
$t = 10$	0.160*** (0.0179)		
$t = 20$	0.200*** (0.0582)		
N	8300793	N	8300793

Note: The table shows staggered DID estimations. The dependent variable is the logarithm of income of the households. Average treatment effect on the treated (ATT) of start of a mine for each specification. Event study results show the overall ATT across all groups overtime, while the group-specific results average the ATT of each group. ($t < 0$) Represent average anticipation of the treatment and ($t \geq 0$) and G. Average are the ATT of start of the mine depending of the specification. ($t = n$) represents the ATT of n years since/before the event (being 0 the year of the start of the mine). $g = k$ represents the ATT across time of the group of municipalities that received the treatment in the year k . * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. WildBootstrap (WB) standard errors in parentheses.

Table 2.A.3: Dynamic effects of mining on NDVI

(Event Study)		(Group-Specific Effect)	
Average ($t < 0$)	78.84*** (20.51)	G. Average	-59.96*** (22.69)
Average ($t \geq 0$)	-377.3** (181.9)	$g = 2002$	-2092.9*** (26.74)
$t = 0$	-30.45 (97.02)	$g = 2005$	384.9*** (5.548)
$t = 8$	-227.3* (125.1)	$g = 2009$	-261.2*** (19.36)
$t = 13$	-341.4* (187.8)	$g = 2011$	-49.15*** (13.35)
$t = 16$	-901.0*** (32.09)	$g = 2014$	169.9*** (11.50)
$t = 17$	-2086.4*** (28.65)	$g = 2019$	-193.7*** (6.330)
$t = 18$	-1612.2*** (29.89)	$g = 2020$	181.4*** (6.477)
N	51282	N	51282

Note: the table shows staggered DID estimations. Complete table of results available in online appendix. The dependent variable for environment is the NDVI at municipality level. Average treatment effect on the treated (ATT) of start of a mine for each specification. Event study results show the overall ATT across all groups overtime, while the group-specific results average the ATT of each group. ($t < 0$) Represent average anticipation of the treatment and ($t \geq 0$) and G. Average are the ATT of start of the mine depending of the specification. ($t = n$) represents the ATT of n years since/before the event (being 0 the year of the start of the mine). $g = k$ represents the ATT across time of the group of municipalities that received the treatment in the year k . * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. WildBootstrap (WB) standard errors in parentheses.

Table 2.A.4: Dynamic effects of mining on Education and Economic Inequalities

(Event Study)					(Group-Specific Effect)				
	Enrollrate	Esco	Gini	Theil		Enrollrate	Esco	Gini	Theil
Average ($t < 0$)	-0.0329* (0.0193)	0.00894 (0.0986)	-0.0551*** (0.0141)	-0.206*** (0.0786)	G. Average	-0.00125 (0.0153)	-0.0595 (0.0851)	-0.0105 (0.00971)	0.109* (0.0617)
Average ($t \geq 0$)	-0.0177 (0.0207)	-0.0461 (0.125)	-0.0188 (0.0150)	0.101 (0.0962)	$g = 2000$	-0.0439 (0.0346)	0.0132 (0.217)	-0.0238 (0.0255)	0.0828 (0.163)
$t = -20$	-0.0195 (0.0386)	0.0225 (0.214)	-0.0740*** (0.0206)	-0.293* (0.172)	$g = 2010$	0.00750 (0.0223)	-0.0778 (0.125)	-0.0127 (0.00982)	0.150** (0.0755)
$t = -10$	-0.0463** (0.0229)	-0.00457 (0.107)	-0.0361*** (0.0115)	-0.119 (0.0829)	$g = 2020$	0.0255 (0.0180)	-0.100 (0.106)	0.00503 (0.0113)	0.0743 (0.0618)
$t = 0$	0.00777 (0.0177)	0.00729 (0.0903)	-0.00955 (0.0117)	0.105 (0.0716)					
$t = 10$	-0.0313 (0.0214)	-0.124 (0.113)	-0.0154 (0.0114)	0.137* (0.0772)					
$t = 20$	-0.0294 (0.0357)	-0.0220 (0.234)	-0.0314 (0.0263)	0.0604 (0.148)					
N	9522	9522	9519	9519		9522	9522	9519	9519

Note: the table shows staggered DID estimations. The dependent variable 'Enrollrate' represents the secondary school enrollment rate, while 'Esco' denotes average years of schooling. 'Gini' and 'Theil' correspond to respective economic inequality indexes. The table displays the Average Treatment Effect on the Treated (ATT) for each specification. Event study results show the overall ATT across all groups overtime, while the group-specific results average the ATT of each group. ($t < 0$) Represent average anticipation of the treatment and ($t \geq 0$) and G. Average are the ATT of start of the mine depending of the specification. ($t = n$) represents the ATT of n years since/before the event (being 0 the year of the start of the mine). $g = k$ represents the ATT across time of the group of municipalities that received the treatment in the year k . WildBootstrap (WB) standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2.A.5: Robustness Test: Treatment Groups by Distance on Income

	(Event Study)	(Group-Specific Effect)
5 km	0.175*** (0.0163)	0.145*** (0.00919)
10 km	0.0174* (0.00910)	0.0444*** (0.00619)
15 km	0.0199** (0.00882)	0.0511*** (0.00552)
25 km	0.0533*** (0.00771)	0.0532*** (0.00464)
50 km	0.0815*** (0.00773)	0.0750*** (0.00459)
75 km	0.0825*** (0.00534)	0.110*** (0.00372)

Note: the table shows staggered DID estimations. The dependent variable is logarithm of income of the households. Average treatment effect on the treated (ATT) of start of a mine for each specification. Event study results show the overall ATT across all groups overtime, while the group-specific results average the ATT of each group. First column refers to the criteria to choose treated municipalities based on distance to the mine. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. WB standard errors in parentheses.

Table 2.A.6: Robustness Test: Treatment Groups by Distance on Environment

	(Event Study)	(Group-Specific Effect)
5 km	-248.5** (116.0)	-39.40* (21.17)
10 km	-287.8*** (103.8)	-66.12*** (19.33)
15 km	-111.7 (102.9)	-20.31 (16.53)
25 km	-186.5** (76.04)	6.157 (14.98)
50 km	-109.9 (101.7)	-31.70 (21.15)
75 km	-38.11 (88.29)	-50.02*** (16.89)

Note: the table shows staggered DID estimations. The dependent variable is the NDVI at municipality level. Average treatment effect on the treated (ATT) of start of a mine for each specification. Event study results show the overall ATT across all groups overtime, while the group-specific results average the ATT of each group. First column refers to the criteria to choose treated municipalities based on distance to the mine. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. WB standard errors in parentheses.

Table 2.A.7: Robustness Test: Sample based on entropy balancing for Income

(Event Study)		(Group-Specific Effect)	
Average ($t < 0$)	0.0185 (0.0352)	G. Average	0.284*** (0.0315)
Average ($t \geq 0$)	0.292*** (0.0435)	$g = 2000$	0.285** (0.0529)
$t = -20$	-0.2955*** (0.0855)	$g = 2020$	0.282*** (0.0330)
$t = -10$	0.332*** (0.0701)		
$t = 0$	0.241*** (0.0329)		
$t = 10$	0.247*** (0.0553)		
$t = 20$	0.387*** (0.0540)		
N	944404	N	944404

Note: The table shows staggered DID estimations using weights computed with entropy balancing. The dependent variable for income is the logarithm of income of the households. Average treatment effect on the treated (ATT) of start of a mine for each specification. Event study results show the overall ATT across all groups overtime, while the group-specific results average the ATT of each group. ($t < 0$) Represent average anticipation of the treatment and ($t \geq 0$) and G. Average are the ATT of start of a mine depending of the specification. ($t = n$) represents the ATT of n years since/before the event (being 0 the year of the start of the mine). $g = k$ represents the ATT across time of the group of municipalities that received the treatment in the year k . * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Wild-Bootstrap (WB) standard errors in parentheses.

Table 2.A.8: Robustness Test: Treatment based on Discovery date for Wealth index

	(1)
Average ($t < 0$)	0.0823*** (0.0170)
Average ($t \geq 0$)	0.232*** (0.00755)
$t = -20$	0.138*** (0.0322)
$t = -10$	0.0262* (0.0131)
$t = 0$	0.180*** (0.00676)
$t = 10$	0.251*** (0.00739)
$t = 20$	0.265*** (0.0138)
N	10394186

Note: The table shows staggered DID estimations. The dependent variable is wealth index. Average treatment effect on the treated (ATT) of discovery of a deposit for each specification. Event study results show the overall ATT across all groups overtime, while the group-specific results average the ATT of each group. ($t < 0$) Represent average anticipation of the treatment and ($t \geq 0$) and G. Average are the ATT of discovery of a deposit depending of the specification. ($t = n$) represents the ATT of n years since/before the event (being 0 the year of the start of the mine). $g = k$ represents the ATT across time of the group of municipalities that received the treatment in the year k . * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. WildBootstrap (WB) standard errors in parentheses.

Table 2.A.9: Robustness Test: Treatment based on Discovery date for Income

(Event Study)		(Group-Specific Effect)	
Average ($t < 0$)	-0.0467 (0.0332)	G. Average	0.0315*** (0.0116)
Average ($t \geq 0$)	0.0152 (0.0140)	$g = 2000$	-0.0474** (0.0237)
$t = -20$	-0.0722 (0.0653)	$g = 2010$	0.105*** (0.0151)
$t = -10$	-0.0211 (0.0207)	$g = 2020$	-0.0851*** (0.0227)
$t = 0$	-0.00325 (0.0121)		
$t = 10$	0.0731*** (0.0125)		
$t = 20$	-0.0243 (0.0276)		
N	8175666	N	8175666

Note: The table shows staggered DID estimations. The dependent variable for income is the logarithm of income of the households. Average treatment effect on the treated (ATT) of discovery of a deposit for each specification. Event study results show the overall ATT across all groups over-time, while the group-specific results average the ATT of each group. ($t < 0$) Represent average anticipation of the treatment and ($t \geq 0$) and G. Average are the ATT of discovery of a deposit depending of the specification. ($t = n$) represents the ATT of n years since/before the event (being 0 the year of the start of the mine). $g = k$ represents the ATT across time of the group of municipalities that received the treatment in the year k . * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. WildBootstrap (WB) standard errors in parentheses.

Table 2.A.10: Robustness Test: Treatment based on Discovery date for Environment

(Event Study)		(Group-Specific Effect)	
Average ($t < 0$)	47.69 (38.07)	G. Average	-147.0*** (52.76)
Average ($t \geq 0$)	-219.4* (132.7)	$g = 2002$	-413.9*** (63.09)
$t = 0$	-88.96 (87.78)	$g = 2003$	-1482.2*** (13.93)
$t = 6$	-178.6* (95.42)	$g = 2004$	-5.229 (13.08)
$t = 7$	-254.7** (100.4)	$g = 2006$	-154.5*** (12.43)
$t = 8$	-160.9** (68.55)	$g = 2008$	133.1*** (6.102)
$t = 11$	-195.9** (95.78)	$g = 2011$	-208.8*** (59.00)
$t = 17$	-725.5*** (198.7)	$g = 2016$	-16.49 (14.91)
$t = 18$	-458.3*** (67.05)		
N	50316		50316

Note: the table shows staggered DID estimations. Complete table of results in online appendix. The dependent variable for environment is the NDVI at municipality level. Average treatment effect on the treated (ATT) of discovery of a deposit for each specification. Event study results show the overall ATT across all groups overtime, while the group-specific results average the ATT of each group. ($t < 0$) Represent average anticipation of the treatment and ($t \geq 0$) and G. Average are the ATT of discovery of a deposit depending of the specification. ($t = n$) represents the ATT of n years since/before the event (being 0 the year of the start of the mine). $g = k$ represents the ATT across time of the group of municipalities that received the treatment in the year k . * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. WildBootstrap (WB) standard errors in parentheses.

Table 2.A.11: Robustness Test: Alternative estimator (de Chaisemartin and D'Haultfoeuille (2022))

NDVI		Income	
Average ($t \geq 0$)	-130.7 (133.5)	Average ($t \geq 0$)	0.2599* (0.1426)
$t = 0$	-30.1 (126.5)	$t = 0$	0.1972* (0.1056)
$t = 13$	-341.4* (203.2)	$t = 1$	0.3546 (0.2175)
$t = 17$	-2085.9*** (27.7)	$t = 2$	0.0911 (0.1533)
$t = 18$	-1612.2*** (27.6)	$t = -1$	-0.1883*** (0.0642)

Note: The table shows staggered DID estimations. The complete table of results is available in the online appendix. The dependent variable is the logarithm of income of the households and in the case of environment the NDVI at the municipality level. Average treatment effect on the treated (ATT) of start of a mine. ($t \geq 0$) is the ATT of start of a mine. ($t = n$) represents the ATT of n years since/before the event (being 0 the year of the start of the mine operation). WildBootstrap (WB) standard errors in parentheses. Complete table in 2.A.12
 * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.A.12: Robustness Test: Effect of mining on bodies of water

	(Event Study)	(Group-Specific Effect)
Arsenic	0.00320*** (0.000605)	0.00413*** (0.000406)
Mercury	0.000187*** (0.0000538)	0.000150*** (0.0000184)
Chromium	0.00661** (0.00325)	0.00171 (0.00442)

Note: the table shows staggered DID estimations. The dependent variable measures of concentration of heavy metals in bodies of water. Average treatment effect on the treated (ATT) of start of a mine for each specification. Event study results show the overall ATT across all groups overtime, while the group-specific results average the ATT of each group. All measures of heavy metals are coded in mg/L. WB standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 2.A.13: Robustness Test: Effect of mining on CO2 emissions

Event Study		Group Specific	
Average ($t < 0$)	0.00801 (0.00864)	G. Average	-0.0422 (0.0486)
Average ($t \geq 0$)	-0.0209 (0.0834)	$g = 2004$	0.133*** (0.0160)
$t = 0$	0.0321** (0.0147)	$g = 2010$	0.251*** (0.0422)
$t = 15$	0.137* (0.0775)	$g = 2013$	0.103*** (0.0303)
$t = 18$	0.530*** (0.134)	$g = 2020$	-0.0549*** (0.00965)
N	51177		51177

Note: the table shows staggered DID estimations. The dependent variable is average CO2 emissions at municipality level. Average treatment effect on the treated (ATT) of start of a mine for each specification. Event study results show the overall ATT across all groups overtime, while the group-specific results average the ATT of each group. ($t < 0$) Represent average anticipation of the treatment and ($t \geq 0$) and G. Average are the ATT of start of the mine depending of the specification. ($t = n$) represents the ATT of n years since/before the event (being 0 the year of the start of the mine). $g = k$ represents the ATT across time of the group of municipalities that received the treatment in the year k . * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Wild-Bootstrap (WB) standard errors in parentheses.

Table 2.A.14: Discussion: Treatment based on characteristics of the mine

	Income		NDVI	
	(Event Study)	(Group-Specific)	(Event Study)	(Group-Specific)
	By Size			
Giant	0.296*** (0.0451)	0.293*** (0.0424)	170.4*** (13.60)	144.2*** (3.316)
Major	0.236*** (0.0469)	0.232*** (0.0225)	-498.9*** (216.1)	-128.3*** (22.16)
Moderate	-0.000 (0.0528)	-0.006 (0.020)	-100.0 (0.0451)	-23.16 (47.01)
	By Type			
Precious	0.218*** (0.0311)	0.213*** (0.0177)	-378.9 (246.2)	-50.05* (27.26)
ETM	0.021 (0.0738)	-0.045 (0.0316)	-168.7* (101.4)	-92.12 (57.90)

Note: the table shows staggered DID estimations. The dependent variable is logarithm of income of the households in the case of Income and in the case of environment the NDVI at municipality level. Average treatment effect on the treated (ATT) of start of a mine for each specification. Event study results show the overall ATT across all groups overtime, while the group-specific results average the ATT of each group. First column refers to the criteria to choose treated municipalities based on the characteristics of the mine, treated municipalities that do not meet the criteria are excluded from the sample. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. WB standard errors in parentheses.

Table 2.A.15: Discussion: Treatment based on income distribution of the population

	(Event Study)	(Group-Specific Effect)
Bottom 20%	0.565*** (0.185)	0.511*** (0.0897)
20% - 40%	0.218*** (0.034)	0.148*** (0.0191)
40% - 60%	0.356 (0.0088)	0.229*** (0.017)
60% - 80%	0.235*** (0.013)	0.208*** (0.011)
Top 20%	0.0514 (0.042)	0.0686*** (0.0263)

Note: the table shows staggered DID estimations. The dependent variable is logarithm of income of the households. Average treatment effect on the treated (ATT) of start of a mine for each specification. Event study results show the overall ATT across all groups overtime, while the group-specific results average the ATT of each group. First column refers to the quantile of the population used. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. WB standard errors in parentheses.

2.9 Online Appendix

Table 2.A.16: Correlation tables

(a) Correlation Household level									
	Income	wealth index	index core	Sex*	Age*	Indigenous*	Acu Edu*	Treatment	
Income (log)	1.00								
wealth index	0.31	1.00							
index core	0.22	0.91	1.00						
Sex*	0.11	0.04	0.01	1.00					
Age*	0.04	0.07	0.04	0.14	1.00				
Indigenous language*	0.02	-0.28	-0.33	0.01	0.04	1.00			
Accumulated education*	0.05	0.16	0.14	-0.03	-0.11	-0.10	1.00		
Start treatment	0.01	0.01	0.01	-0.01	0.00	-0.04	0.00	1.00	

(b) Correlation Municipality level (Inequalities and education)										
	Enrollment	Acu Edu	Gini	Theil	Population	Sex*	Age*	Indigenous*	Acu Edu*	Treatment
Enrollment rate	1.00									
Accumulated education	0.72	1.00								
Gini (Income)	-0.55	-0.48	1.00							
Theil Index (Income)	-0.50	-0.46	0.96	1.00						
Population	0.19	0.37	-0.02	-0.03	1.00					
Sex*	0.62	0.57	-0.77	-0.75	0.11	1.00				
Age*	0.34	0.13	-0.44	-0.42	-0.15	0.54	1.00			
Indigenous language*	-0.03	-0.26	-0.18	-0.22	-0.12	0.07	0.01	1.00		
Accumulated education*	0.17	0.23	0.15	0.21	0.18	0.01	-0.11	-0.32	1.00	
Agricultural land (%)	0.01	0.08	0.02	0.02	-0.05	0.02	-0.09	-0.12	0.01	1.00
Start treatment	-0.02	0.04	0.00	0.00	0.00	-0.02	0.00	-0.07	0.01	-0.10

Table 2.A.17: Correlation tables

(a) Correlation municipality level												
	NDVI	Distance to DF	Coast	Start treatment	NDVI	Dist to DF	Coast	Treatment				
	1.00				1.00							
	-0.13	1.00			-0.13	1.00						
	0.03	0.24	1.00		0.03	0.24	1.00					
	-0.13	0.21	-0.02		-0.13	0.21	-0.02	1.00				
(b) Correlation bodies of water level												
	BOD	DO	As	Cd	Cr	Hg	Ni	Pb	Cu	Cn	Temp	Treatment
Biochemical OD	1.00											
Dissolved oxygen	-0.39	1.00										
Total Arsenic	0.00	0.00	1.00									
Total Cadmium	-0.04	0.09	-0.08	1.00								
Total Chromium	-0.08	-0.24	0.07	-0.06	1.00							
Total Mercury	-0.03	0.05	-0.09	-0.03	-0.03	1.00						
Total Nickel	0.06	-0.28	0.00	0.10	0.34	-0.07	1.00					
Total Lead	-0.05	-0.03	0.35	0.24	0.11	-0.04	0.10	1.00				
Total Cyanides	0.10	-0.09	-0.09	0.58	-0.09	-0.04	-0.04	0.02	1.00			
Total Copper	0.05	0.09	-0.05	0.49	-0.02	-0.03	0.24	0.07	1.00	-0.01		
Total Zinc	0.00	0.02	-0.05	0.86	0.01	-0.05	0.22	0.31	0.72	0.28	1.00	
Temperature	-0.18	0.26	0.02	-0.02	-0.21	-0.06	-0.10	-0.27	-0.04	-0.06	1	
Start treatment	-0.05	0.07	0.20	0.39	0.13	-0.05	0.17	0.45	0.44	0.19	-0.3916	1

Table 2.A.18: Dynamic effects of mining on NDVI

(Event Study)		(Group-Specific Effect)	
Average	78.84***	G. Average	-59.96***
($t < 0$)	(20.51)		(22.69)
Average	-377.3**	$g = 2002$	-2092.9***
($t \geq 0$)	(181.9)		(26.74)
$t = -21$	571.5***	$g = 2004$	42.05***
	(26.16)		(6.115)
$t = -20$	220.6***	$g = 2005$	384.9***
	(12.17)		(5.548)
$t = -19$	177.8	$g = 2006$	-284.4***
	(482.7)		(94.96)
$t = -18$	-113.1	$g = 2007$	53.15
	(347.6)		(43.89)
$t = -17$	120.1	$g = 2008$	64.21
	(241.5)		(51.07)
$t = -16$	-55.63	$g = 2009$	-261.2***
	(362.8)		(19.36)
$t = -15$	140.0	$g = 2010$	-54.60***
	(276.0)		(5.234)
$t = -14$	-6.584	$g = 2011$	-49.15***
	(204.1)		(13.35)
$t = -13$	458.1**	$g = 2013$	197.6**
	(219.2)		(81.17)
$t = -12$	-51.24	$g = 2014$	169.9***

	(Event Study)	(Group-Specific Effect)	
	(288.6)	(11.50)	
$t = -11$	-68.34 (161.2)	$g = 2018$ (5.587)	19.59***
$t = -10$	257.2 (169.5)	$g = 2019$ (6.330)	-193.7***
$t = -9$	-210.6 (166.6)	$g = 2020$ (6.477)	181.4***
$t = -8$	-44.62 (109.6)		
$t = -7$	20.97 (112.1)		
$t = -6$	69.24 (61.02)		
$t = -5$	8.615 (67.88)		
$t = -4$	20.76 (83.39)		
$t = -3$	26.60 (81.21)		
$t = -2$	-66.35 (68.82)		
$t = -1$	180.4** (89.20)		
$t = 0$	-30.45 (97.02)		

	(Event Study)	(Group-Specific Effect)
$t = 1$	-58.71 (95.05)	
$t = 2$	33.78 (88.36)	
$t = 3$	-53.42 (84.30)	
$t = 4$	-68.06 (111.0)	
$t = 5$	-97.20 (84.16)	
$t = 6$	-110.3 (80.46)	
$t = 7$	-148.7 (99.28)	
$t = 8$	-227.3* (125.1)	
$t = 9$	-132.8 (129.3)	
$t = 10$	-198.8 (151.1)	
$t = 11$	-183.8 (146.2)	
$t = 12$	-164.2 (177.1)	
$t = 13$	-341.4*	

	(Event Study)		(Group-Specific Effect)
			(187.8)
$t = 14$	-345.0		(284.3)
$t = 15$	-442.3		(629.8)
$t = 16$	-901.0***		(32.09)
$t = 17$	-2086.4***		(28.65)
$t = 18$	-1612.2***		(29.89)
N	51282	N	51282

Note: the table shows staggered DID estimations.

The dependent variable for environment is the NDVI at municipality level. Average treatment effect on the treated (ATT) of start of a mine for each specification. Event study results show the overall ATT across all groups overtime, while the group-specific results average the ATT of each group. ($t < 0$) Represent average anticipation of the treatment and ($t \geq 0$) and G. Average are the ATT of start of the mine depending of the specification. ($t = n$) represents the ATT of n years since/before the event (being 0 the year of the start of the mine). $g = k$ represents the ATT across time of the group of municipalities that received the treatment in the year k . * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

WildBootstrap (WB) standard errors in parentheses.

Table 2.A.19: Robustness Test: Treatment based on Discovery date for Environment

(Event Study)		(Group-Specific Effect)	
Average	47.69	G. Average	-147.0***
($t < 0$)	(38.07)		(52.76)
Average	-219.4*	$g = 2002$	-413.9***
($t \geq 0$)	(132.7)		(63.09)
$t = -5$	-106.9	G2003	-1482.2***
	(119.8)		(13.93)
$t = -4$	218.3**	$g = 2004$	-5.229
	(91.74)		(13.08)
$t = -3$	-121.8	$g = 2005$	6.809
	(96.86)		(61.63)
$t = -2$	40.33	$g = 2006$	-154.5***
	(120.0)		(12.43)
$t = -1$	103.9	$g = 2007$	-47.23
	(99.07)		(33.53)
$t = 0$	-88.96	$g = 2008$	133.1***
	(87.78)		(6.102)
$t = 1$	-54.87	$g = 2009$	-201.5**
	(100.9)		(82.03)
$t = 2$	-229.1***	$g = 2010$	-62.35
	(86.15)		(74.09)
$t = 3$	-96.17	$g = 2011$	-208.8***
	(82.26)		(59.00)
$t = 4$	-129.2	$g = 2016$	-16.49

	(Event Study)	(Group-Specific Effect)
	(100.3)	(14.91)
$t = 5$	-128.6 (86.25)	
$t = 6$	-178.6* (95.42)	
$t = 7$	-254.7** (100.4)	
$t = 8$	-160.9** (68.55)	
$t = 9$	-141.0 (98.46)	
$t = 10$	-134.5 (99.66)	
$t = 11$	-195.9** (95.78)	
$t = 12$	-204.8 (150.4)	
$t = 13$	-199.8 (136.7)	
$t = 14$	-199.3* (120.4)	
$t = 15$	-253.0 (161.5)	
$t = 16$	-335.5 (470.8)	

	(Event Study)	(Group-Specific Effect)
$t = 17$	-725.5***	
	(198.7)	
$t = 18$	-458.3***	
	(67.05)	
N	50316	

Note: the table shows staggered DID estimations.

The dependent variable for environment is the NDVI at municipality level. Average treatment effect on the treated (ATT) of discovery of a deposit for each specification. Event study results show the overall ATT across all groups over time, while the group-specific results average the ATT of each group. ($t < 0$) Represent average anticipation of the treatment and ($t \geq 0$) and G. Average are the ATT of discovery of a deposit depending of the specification. ($t = n$) represents the ATT of n years since/before the event (being 0 the year of the start of the mine). $g = k$ represents the ATT across time of the group of municipalities that received the treatment in the year k . * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. WildBootstrap (WB) standard errors in parentheses.

Table 2.A.20: Robustness Test: de Chaisemartin and D'Haultfoeuille (2022) estimator

	(NDVI)		(Income)
Average	-130.7	Average	0.2599*
$(t \geq 0)$	(133.5)	$(t \geq 0)$	(0.1426)
$t = 0$	-30.1	$t = 0$	0.1972*
	(126.5)		(0.1056)
$t = 1$	-58.6	$t = 1$	0.3546
	(123.8)		(0.2175)
$t = 2$	33.9	$t = 2$	0.0911
	(99.8)		(0.1533)
$t = 3$	-53.2	$t = -1$	-0.1883***
	(100.3)		(0.0642)
$t = 4$	-67.6		
	(124.2)		
$t = 5$	-96.6		
	(105.8)		
$t = 6$	-109.9		
	(98.9)		
$t = 7$	-148.2		
	(117.8)		
$t = 8$	-226.7		
	(149.3)		
$t = 9$	-132.4		
	(149.2)		
$t = 10$	-198.3		

	(NDVI)	(Income)
	(175.6)	
$t = 11$	-183.5	(169.4)
$t = 12$	-164.0	(184.2)
$t = 13$	-341.4*	(203.2)
$t = 14$	-344.4	(203.2)
$t = 15$	-442.3	(900.7)
$t = 16$	-900.6	(1016.6)
$t = 17$	-2085.9***	(27.7)
$t = 18$	-1612.2***	(27.6)
$t = -1$	-172.8	(110.2)
$t = -2$	4.9	(55.9)
$t = -3$	5.4	(82.2)
$t = -4$	-22.1	(84.8)

	(NDVI)	(Income)
$t = -5$	-33.3	
	(104.4)	

Note: the table shows staggered DID estimations. The dependent variable is the logarithm of income of the households and in the case of environment the NDVI at the municipality level. Average treatment effect on the treated (ATT) of the start of a mine. $t \geq 0$) is the ATT of the start of a mine. $(t = n)$ represents the ATT of n years since/before the event (being 0 the year of the start of the mine operation). WildBootstrap (WB) standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Chapter 3

Chapter 3

Voting Priorities: Security, Sustainability, and Strategic Investments in Colombian Municipalities

3.1 Introduction

COP28 marked a significant milestone by featuring a local climate action summit, underscoring the pivotal role played by local leaders in reducing emissions, mitigating climate risks, and propelling national efforts towards accelerated progress on climate action (Bloomberg, 2023). As national governments are increasingly recognizing the urgency to address climate change, and achieve the Sustainable Development Goals (SDGs), it is noteworthy that local governments play a pivotal role, for example, within the OECD area local governments account for almost 60% of the total public investment dedicated to SDGs (OECD, 2020*b*).

However, there could be a potential divergence between the national discourse and the needs of local populations. Consequently, local representatives may find themselves torn between pursuing political agendas that resonate with the national discourse or the majority of voters, thereby ensuring the continuity of their political movement at the local level. This could result in policies that do not fully align with the SDGs or broader sustainable development objectives.

Developing nations with decentralized governance systems, such as Colombia, Brazil, and Argentina,

provide a particularly compelling context to examine this divergence. As municipalities can offer a more tailored basket of goods to meet local needs (Peterson, 1997). In such contexts, the interaction between national priorities and local politics becomes even more significant, as local governments, with their substantial decision-making autonomy, face both opportunities and challenges in aligning sustainable development investments with local goals.

The topic holds significant interest, especially given the potential conflicts among certain Sustainable Development Goals (SDGs) (Kroll and Zipperer, 2020). As such, policy choices made by decision-makers often hinge on the preferences of voters, their respective political ideologies and their political careers. This aspect underscores the complexity of navigating sustainable development priorities within the constraints of political realities. Moreover, the finite nature of government budgets further amplifies the challenge, as policymakers must carefully allocate resources among competing development projects within their jurisdictions. This dynamic interplay between conflicting SDGs, political preferences, political careers and budgetary limitations adds layers of complexity to the pursuit of sustainable development agendas at local levels.

This study focuses on the motivations behind local administrations' emphasis on sustainable development investments, and the consequences in voting behavior. Specifically, how incumbents use SDGs investment to secure their political tenure. In general, Incumbents' decisions are influenced by three primary factors: their level of competence in office, their ideological preferences and the preferences on the voters. Consequently, voters may either reward or penalize incumbents based on their observed performance throughout their tenure and the allocation of resources in their preferred development topics. This analysis aligns with the 'reward-punishment' hypothesis within the valence economic voting literature, wherein voters assess incumbents based on their prioritization of issues deemed important to the electorate (Kukolowicz and Górecki, 2017).

In this research, I specifically investigate the case of Colombia, a developing country with a well-established democracy. Colombia is chosen for its unique political landscape, which, despite maintaining a strong presidential system, underwent significant constitutional changes in 1991. These reforms granted municipalities greater autonomy in decision-making, particularly in allocating investments that align with elected officials' development plans, provided they broadly adhere to national priorities, a requirement easy to fulfill. Additionally, Colombia's territorial characteristics, especially concerning security issues, present a valuable opportunity to explore whether voters prioritize security concerns over Sustainable Development Goals (SDGs) in their electoral decisions.

The study uses a panel of 1,120 Colombian municipalities, covering four elections during the period from 2011 to 2019, to evaluate whether prioritizing investment in projects that directly contribute to SDGs influences voting behavior. The findings suggest that voters tend to reward or punish incumbents

more based on security-related issues than on sustainable development initiatives. Additionally, voters respond positively to visible infrastructure investments, such as those in the transportation sector that typically deliver visible infrastructure in the country, regardless of their direct contribution to sustainable development. This raises concerns about the sustainability of these choices, as policymakers may prioritize short-term investments that align with electoral cycles, potentially undermining long-term sustainability goals.

The rest of the paper is structured as follows. The next section presents the political context of Colombia and a literature review. The third section discusses the data and methodology. The fourth section presents the results, followed by a heterogeneity analysis in the fifth section. The sixth section examines the robustness of the results. Finally, I conclude with a discussion of the findings, and provide policy recommendations.

3.2 Context

3.2.1 Colombian political landscape

Colombia is one of the oldest democracies in Latin America, with a long tradition of electoral participation. Since 1819, Colombians have engaged in elections, and the introduction of direct voting for the president and most legislative positions in 1916 further reinforced democratic practices. Over time, political and institutional reforms have shaped the country's governance model, influencing electoral competition and local administration. A key transformation occurred in the 1980s with the decentralization process, which granted greater autonomy to local governments. This shift culminated in the first mayoral elections by popular vote in 1988, (Registraduría Nacional del Estado Civil, 2024). While the literature suggests that voting is a habit that must be built over time (Franklin, 2004), Colombia's long-standing democratic tradition implies that its voters have well-established electoral behaviors, minimizing the need for a prolonged learning curve.

The 1991 Constitution further reshaped Colombia's political landscape by simplifying the requirements for establishing political parties. Currently, a political movement can gain legal recognition by collecting at least 50,000 signatures, a relatively low threshold in Colombia's political environment. While this reform led to a proliferation of political organizations, electoral competition remains concentrated among a few dominant parties, particularly in the legislature. Given this political structure, incumbents seeking to extend their careers often align with established parties to maximize their electoral prospects. The electoral system is structured around four-year terms for both executive and legislative positions. While mayors and other executive officials cannot be re-elected immediately, they may run again after sitting out one term, whereas legislative officials can seek indefinite re-election. As a result, analyses of electoral

continuity focus on party re-election rather than individual incumbents. Additionally, national and regional elections are held in alternating cycles, requiring voters to participate in two separate elections every four years.

At the municipal level, the mayor serves as the highest administrative authority, responsible for implementing policies within the framework established by the Constitution, national laws, and local regulations. Mayors oversee a broad range of responsibilities, including public services, territorial planning, social and economic development, environmental protection, and citizen participation. Additionally, they manage areas such as housing, agriculture, culture, justice, security, employment, and disaster prevention. An important feature of Colombia's governance model is that municipalities are legally required to fill service gaps when higher levels of government fail to meet their obligations. This places significant demands on local governments, requiring continuous coordination with regional and national entities.

To fulfill their responsibilities, municipalities rely on various funding mechanisms. Intergovernmental transfers, such as those from the General System of Participations (SGP), provide essential resources for public services. Additionally, local governments can generate revenue through taxes, fees, and municipal bonds. However, the allocation of resources is often subject to restrictions, particularly in key sectors like education and health. This financial structure limits a mayor's ability to implement discretionary projects, which can, in turn, influence voter perceptions of government performance.

3.2.2 Literature Review

A significant body of literature explores how politicians strategically adjust their actions to maximize electoral success (Ferejohn, 1986; List and Sturm, 2006; Dodlova and Zudenkova, 2021; Fiva and Natvik, 2013). At the core of this research is the idea that politicians, as rational actors, prioritize winning over their personal policy preferences. The principal-agent relationship between voters and politicians creates an incentive structure where incumbents who align their decisions with voter expectations are rewarded with reelection, while those who fail to do so face electoral consequences (Kukołowicz and Górecki, 2017; Klačnja and Titiunik, 2017). However, this mechanism may be constrained in situations where reelection is not permitted, thus diminishing the accountability of the incumbent.

Voters, in turn, evaluate incumbents based on a range of priorities, which can include economic performance, security, public services, and broader political concerns. Politicians, aware of these electoral incentives, strategically adapt their policies to align with voter preferences. For instance, List and Sturm (2006), using environmental expenditure as a measure of the environmental policy stance of governors, find that politicians are willing to override their preferences when reelection is at stake. Consequently, in the US environmental investment systematically fluctuates between periods when incumbents can seek reelection and those bound by term limits. The behavior is extended to others stakeholders in the

American context. Bonnet and Olper (2024) find that governors are influenced by lobbying, their results shows an heterogeneous effect in the renewable and climate policies. Similarly, research in Nordic countries by Fiva and Natvik (2013) highlight how public investments are influenced by strategic considerations of elected parties. It suggests that incumbents tend to increase investments in their preferred areas when the perceived probability of winning is higher.

This strategic behavior extends beyond budget allocations to electoral messaging and targeted investments. In Colombia, Drazen and Eslava (2010) shows that voters penalize poor fiscal performance, with budget deficits reducing the likelihood of reelection. At the same time, incumbents tend to concentrate spending on infrastructure projects, such as roads and water plants, in the years leading up to elections, signaling a deliberate effort to influence voter sentiment. These findings align with broader research on Latin America, where fiscal policy and investment patterns are often tied to electoral considerations. For instance, Sakurai and Menezes-Filho (2008) demonstrates that in Brazil, capital investment—rather than current expenditure—has a significant effect on reelection probabilities, underscoring the importance of visible, long-term projects as electoral tools. In Chile, Morales and Belmar (2022) finds that incumbents strategically engage with local communities through campaign spending and personal interactions, particularly in rural areas where direct engagement with voters can enhance electoral outcomes.

Despite the broad literature on political strategy, a key element remains underexplored: the role of sustainable development concerns in shaping voter preferences. While research has extensively analyzed the impact of fiscal performance, security Holmes and Gutiérrez de Piñeres (2013); Gallego (2018a), and clientelism on electoral outcomes, little attention has been given to whether voters prioritize sustainability-related issues, such as environmental protection, climate resilience, or investments aligned with the Sustainable Development Goals (SDGs). In Colombia, for example, Galindo-Silva (2015) finds that new parties—despite often exhibiting higher investment levels—face lower chances of reelection, yet the nature of these investments remains largely unexplored. The existing literature offers valuable insights into voter behavior in the region but has yet to systematically assess whether sustainability plays a role in electoral dynamics.

This gap in the literature provides the foundation for the present study. By examining whether voters in Colombian municipalities reward or penalize incumbents based on their commitment to sustainability and long-term development goals, this research aims to contribute to a broader understanding of electoral incentives in the context of sustainable governance.

3.3 Data and Specification

3.3.1 Methodology

This paper focuses on examining whether strategic investment influence the voting behavior in Colombian municipalities. Particularly whether likelihood of reelection, incumbent performance and turnout are influenced. Given that immediate reelection is not permitted in Colombia, the focus is on party reelection. While existing literature suggests that the absence of reelection possibilities diminishes the accountability of incumbents, many politicians in Colombia persist in their political careers. Therefore, I argue that incumbents have incentives to perform well in order to enhance or sustain their prospects in their political career (Holm et al., 2003; Gallego, 2018b). The following equation is estimated:

$$Y_{it} = \gamma Inv_{itj} + \beta Violence_{it} + \lambda X_{it} + \alpha_i + \alpha_t + e_{it} \quad (3.1)$$

Where, Y_{it} represents the three dependent variables of interest. Reelection is dummy variable that takes the value of 1 when the incumbent party wins the election in year t . Additionally, to measure incumbent performance, the share of votes of the incumbent party is used, complementing the analysis of reelection, which has been decreasing over time in the territory. For turnout, the share of total votes in the ballot over DANE's (Colombian statistical office) projected population eligible to vote is used.

The time dimension is define by local elections that are held every four years. Therefore, I use the average between election years for all independent variables unless otherwise specified. Inv_{itj} denotes the share of the investment budget allocated to a specific subject j by municipality i . I conduct individual estimations for each specific chapter of investment. $Violence_{it}$ is a vector with variables measuring the intensity of violence in the municipalities used as covariates. This includes the sum of the number of victims of attacks and kidnappings by organized criminal organizations, as well as the number of theft cases to capture non-organized crime.

The vector X encompasses the rest of control variables, including the share of incumbent votes in the previous elections, the number of sanctions issued by the watchdog institution, the *Procuraduría General de la Nación* to individuals in the territory, the the proportion of people aged older than 65, the percentage of rural population and the GDP growth rate of the municipality. Additionally, α_i and α_t denote municipality and time fixed effects, respectively.

Further, two estimation methods are used: panel fixed effects (FE) for the continuous dependent variables incumbent performance and turnout. And a conditional logit (FE logit) for reelection. In both cases, the errors are clustered at municipality level. The investment information of municipalities starts in 2008, limiting the analysis to three periods (2011, 2015, 2019), consequently the baseline present 3287

observations in the case of the panel and 982 in the logit estimation¹.

3.3.2 Data description

To assess whether incumbents are rewarded or penalized based on their performance in office, I construct a panel dataset at the municipality level covering the period from 2003 to 2019. The dataset comprises information compiled from different sources. Electoral results are sourced from the *Registraduría Nacional del Estado Civil (2023)*. The panel starts in 2011², as previous mayoral terms were three years, compared to the current four-year terms. Demographic data is obtained from DANE (2023) (*Departamento Administrativo Nacional de Estadística*).

Information regarding the investment, expenses, and income of municipalities is sourced from the Consolidator of Finance and Public Information (CHIP), an application developed by the *Contaduría General de la Nación (2023)*. This platform enables public access to financial information from any public institution. The CHIP website hosts data from 2008 to 2021. The information was collected through web scraping of the consultation page available to citizens, based on the list of active municipalities on the CHIP platform³. The investment information is categorized into 18 chapters, each focusing on a specific subject. Table 3.A.3 in the appendix illustrates the classification of investment in Colombia, along with the average percentage allocation for each chapter. Additionally, I use data from the operational expenses chapter to quantify expenditure on personnel.

Information on crime and violence is sourced from two distinct sources. Firstly, data from the *Policía Nacional de Colombia* is used to track incidents of theft in the territory, serving as a proxy for insecurity and non-organized crime. Additionally, information from the Center of Historical Memory is employed to quantify the number of attacks and kidnappings perpetrated against the population in the territory.

Satellite data is used to construct control variables such as average temperature and precipitation (Muñoz-Sabater et al., 2021). Additionally, for environmental impact assessment, high-definition satellite data from NASA is used to derive a normalized difference vegetation index (NDVI) Didan (2021). The NDVI, a high-frequency dataset, facilitates the analysis of changes in vegetation quality and coverage, serving as a proxy for environmental damage. To ensure model harmonization, the data is aggregated at the municipality-year level. Moreover, for air quality assessment, the ODIAC dataset is used, a high-spatial resolution global emission data product that captures CO2 emissions from fossil fuel combustion (Oda and Maksyutov, 2015). Similar to the NDVI data, the CO2 emissions data is aggregated at the

¹The conditional logit estimation requires internal variation of the dependent variable to include a municipality in the sample. Due to low variation of reelection towards the end of the series, the sample is limited to less than 1000 observations.

²The information of the 2003 and 2007 elections are used for lagged variables

³It's worth noting that although the information should ideally be consolidated and available on the SISFUT webpage of the National Planning Department (DNP), the webpage was not operational during the data collection period of this project.

municipality level for the period studied.

In order to assess the quality of city hall institutions, two databases are used. Firstly, to proxy corruption levels, I employ data on sanctions issued by the watchdog institution, the *Procuraduría General de la Nación*. These sanctions target public servants or individuals engaged in public functions and provide insights into the role of the sanctioned individual, the type of sanction imposed, as well as the location and date. Unfortunately, the initiation date of the disciplinary process is not provided.

Secondly, I use consolidated information from the Electronic System for Public Procurement (SECOP) to measure patronage and another proxy of corruption. SECOP serves as the official source of information on all procurement conducted with public funds and was established by law in 2007, with progressive implementation thereafter (Colombia Compra Eficiente, 2019, 2022). This dataset enables tracking of all contracts for personnel in the public service, whether in the chapter of Investment or operating expenses. I argue that the city hall's ability to unilaterally sign personnel contracts is used by the incumbent party as a bargaining chip in the council. Additionally, I construct measures of contracts signed through procurement processes that involve competition over the total number of contracts, serving as a proxy for corruption. The reasoning is that while rules may mandate competition, loopholes can be exploited through direct contracts with companies of mixed capital or through agreements (*convenios*) where the second party also contributes monetarily or otherwise to the project.

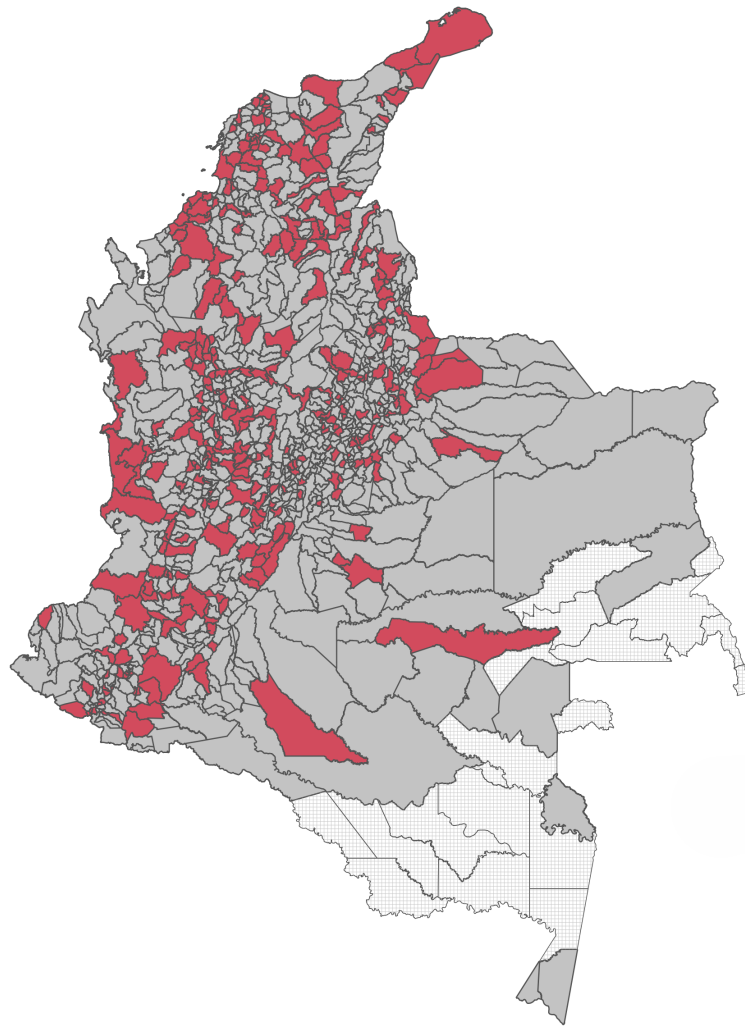
3.3.3 Stylized facts

A brief overview of the main variables of interest is provided. First, voting behavior is analyzed; second, the investment chapters are described to understand the role of city halls; and third, security-related variables are covered. Descriptive statistics for the main variables are presented in Table 3.A.1, with additional details available in Table 3.A.2.

The analysis of voting behavior is focused on three key aspects: reelection likelihood, incumbent performance, and voter turnout. In the country immediate reelection of candidates running for the executive is not allowed, however the candidates can run again after one term hiatus, consequently reelection of the political party is analyzed. Figure 3.1 illustrates the distribution of municipalities that have experienced reelection since 2011, representing 30% of the territory. This figure is indicative of the challenges associated with reelection, reflecting the increasing difficulty incumbent parties face in securing another term. Figure 3.A.1 further shows the evolution of reelection rates over time. In 2000, 43% of municipalities saw the reelection of the incumbent party, whereas by 2019 —the end of our study period— this share had decreased to 9%.

Two key factors may influence this trend: the proliferation of new political parties and growing public mistrust, which could be affecting democratic processes (Keefer and Scartascini, 2022). Due to

Figure 3.1: Municipalities with a reelection since 2011



Note: Author's calculations. Grey areas represent municipalities without reelection

the decrease of successful reelection, the performance of the incumbent party is also analyzed and the evolution follows a similar trend of reelection (Figure 3.A.1).

The expenditure and investment data reported by municipalities are essential for understanding voter behavior concerning the prioritization of various development options. Municipalities report this information to the *Contaduría General de la Nación* using a standardized classification system known as the Territorial Single Form (FUT). Table 3.A.3 describes each of the 18 investment chapters. Additionally, Figure 3.A.2 presents the distribution of total investment allocated to each chapter in 2019. On average, the health chapter accounts for approximately half of the budget, followed by education, transportation, and water and sanitation. Other relatively significant chapters include attention to vulnerable groups and capacity building.

Regarding security concerns, kidnappings and attacks are used as indicators of the presence of illegal armed groups. Figure 3.A.3 illustrates the trends over time, showing a similar evolution for both measures, with violence peaking in the early 2000s after the failed negotiation attempt with the FARC guerrilla group. The subsequent decline in violence coincides with the election of former President Uribe and his policy of democratic security, as well as the peace agreements with the AUC (paramilitary group) in 2004-2006 and the FARC in 2016. In contrast, theft cases, which are used to control for non-organized crime, have increased over time. However, this type of crime is predominantly observed in urban areas.

3.3.4 Investment and SDGs

The alignment of municipal investments with the Sustainable Development Goals (SDGs) is crucial for assessing voting behavior regarding sustainable development. By using the detailed classification provided by the FUT, it is possible to establish a link between municipal investment chapters and specific SDGs. This approach enables an evaluation of how different categories of municipal spending—such as health, education, and infrastructure—contribute to achieving these goals at the local level.

In particular, the direct connection is established using the 169 targets of the SDGs that operationalize each goal, by cross-referencing these targets with the detailed investment classifications in the FUT. For example, SDG 2 (Zero Hunger) includes the target: *“Increase investment, including through enhanced international cooperation, in rural infrastructure, agricultural research and extension services, technology development, and plant and livestock gene banks to enhance agricultural productive capacity in developing countries, particularly in least developed countries.”* This target directly corresponds to municipal investments in the agricultural sector, such as *“Investments aimed at developing programs and projects to provide direct agricultural technical assistance in rural areas of the municipality.”* A similar analysis is made for all SDGs and FUT classifications.

Figure 3.2 illustrates the anticipated contribution of municipal investment to Sustainable Development

Goals (SDGs) based on the previous analysis. Some investment chapters directly align with specific SDGs -represented in solid lines in the diagram-, while others indirectly contribute to various goals -dashed lines-. These matches are derived from an analysis of the individual objectives of each SDG and the detailed classification provided by the FUT.

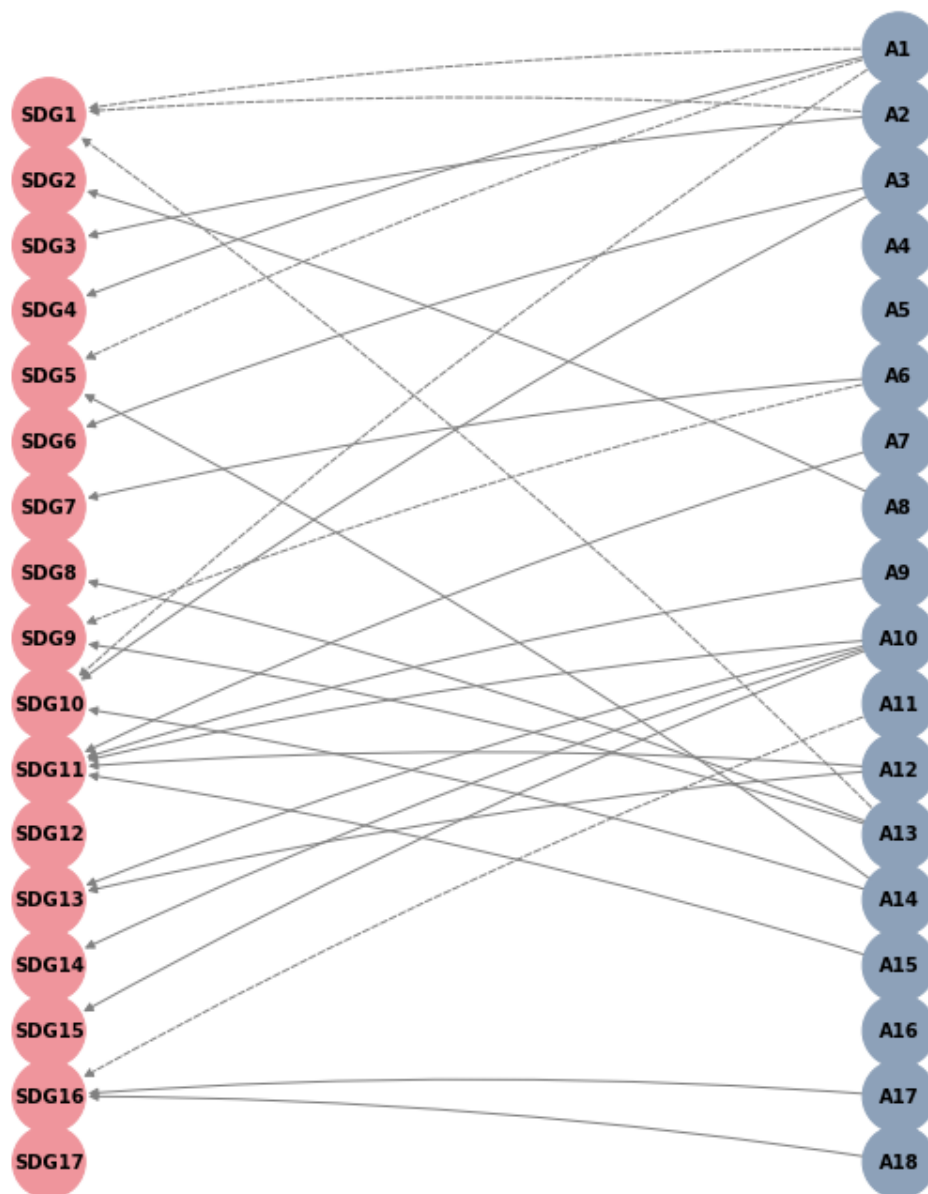
Intriguing patterns are observed in the relationship between investment chapters and their contributions to Sustainable Development Goals (SDGs). Some investment chapters, such as education and water and sanitation, directly align with specific SDGs, notably SDG 4 (Quality Education) and SDG 6 (Clean Water and Sanitation).

A lack of direct investment chapters addressing poverty reduction is observed. While sectors like education, health, and economic incentives indirectly contribute to poverty reduction, the absence of a dedicated investment chapter complicates pinpointing its direct contribution. Similarly, investment chapters related to gender equality (SDG 5) and reduction of inequality (SDG 10) present challenges in discerning their specific contributions. The chapter related to vulnerable groups indirectly addresses SDG 10, yet distinguishing its impact from other SDGs remains challenging. Additionally, the environment-related investment chapter contributes to multiple SDGs, highlighting the relation of environmental sustainability with various development goals.

Moreover, several investment chapters directly contribute to city sustainability (SDG 11), reflecting municipalities' responsibilities toward territorial development. Consequently, municipalities play a role in advancing 15 out of the 17 sustainable development goals, showcasing their multifaceted contributions to sustainable development.

The baseline of the paper focuses on investment chapters that directly contribute to SDGs and those of particular interest in the Colombian context. The initial selection includes investments in the chapters of education (A1), which contributes to quality education; health (A2), which pertains to good health and well-being; water and sanitation (A3), which supports clean water and sanitation; agriculture (A8), which aims at zero hunger; and the environment (A10), which contributes to at least four development goals. This selection is completed with the chapters on justice and security (A18) and transportation (A9). The chapter on justice is particularly relevant in the Colombian context due to the long-standing internal conflict that may shape political outcomes. The transportation sector is included as literature suggests that investments in water and sanitation and transportation influence political behavior in the country Drazen and Eslava (2010).

Figure 3.2: Municipal's Investment Chapters Contribution to SDGs



This figure illustrates the relationship between municipal investment categories and their alignment with the United Nations' Sustainable Development Goals (SDGs). The graph is structured as a bipartite network, where the red nodes on the left represent the 17 SDGs, each addressing a specific aspect of sustainable development, while the blue nodes on the right correspond to different municipal investment categories, which reflect various policy areas at the local level^a. The lines connecting these nodes indicate the contribution of specific investment categories to one or more SDGs, solid lines indicate direct contribution and dashed lines represent indirect contribution.

^aSustainable Development Goals: SDG 1, No Poverty. SDG 2, Zero Hunger. SDG 3, Good Health and Well-being. SDG 4, Quality Education. SDG 5, Gender Equality. SDG 6, Clean Water and Sanitation. SDG 7, Affordable and Clean Energy. SDG 8, Decent Work and Economic Growth. SDG 9, Industry, Innovation, and Infrastructure. SDG 10, Reduced Inequality. SDG 11, Sustainable Cities and Communities. SDG 12, Responsible Consumption and Production. SDG 13, Climate Action. SDG 14, Life Below Water. SDG 15, Life on Land. SDG 16, Peace, Justice, and Strong Institutions. SDG 17, Partnerships for the Goals. Investment chapters: A1, Education. A2, Health. A3, Water and Sanitation. A4, Sport and Leisure. A5, Culture. A6, Public Services except Water. A7, Housing. A8, Agricultural. A9, Transportation. A10, Environment. A11, Correctional Facilities. A12, Disaster Prevention and Response. A13, Development Incentives (Economic). A14, Vulnerable Groups. A15, Equipment. A16, Community Development. A17, Institutional Strengthening. A18, Justice and Security.

3.4 Main Results

The results are organized into three sections. First, I analyze the likelihood of reelection and incumbent performance based on the selected investment chapters. Next, I examine voter turnout, which is considered separately since it does not inherently favor or disadvantage the incumbent but is highlighted in the literature as an indicator of a healthy democracy. Lastly, I discuss the findings related to other, not prioritized investment chapters.

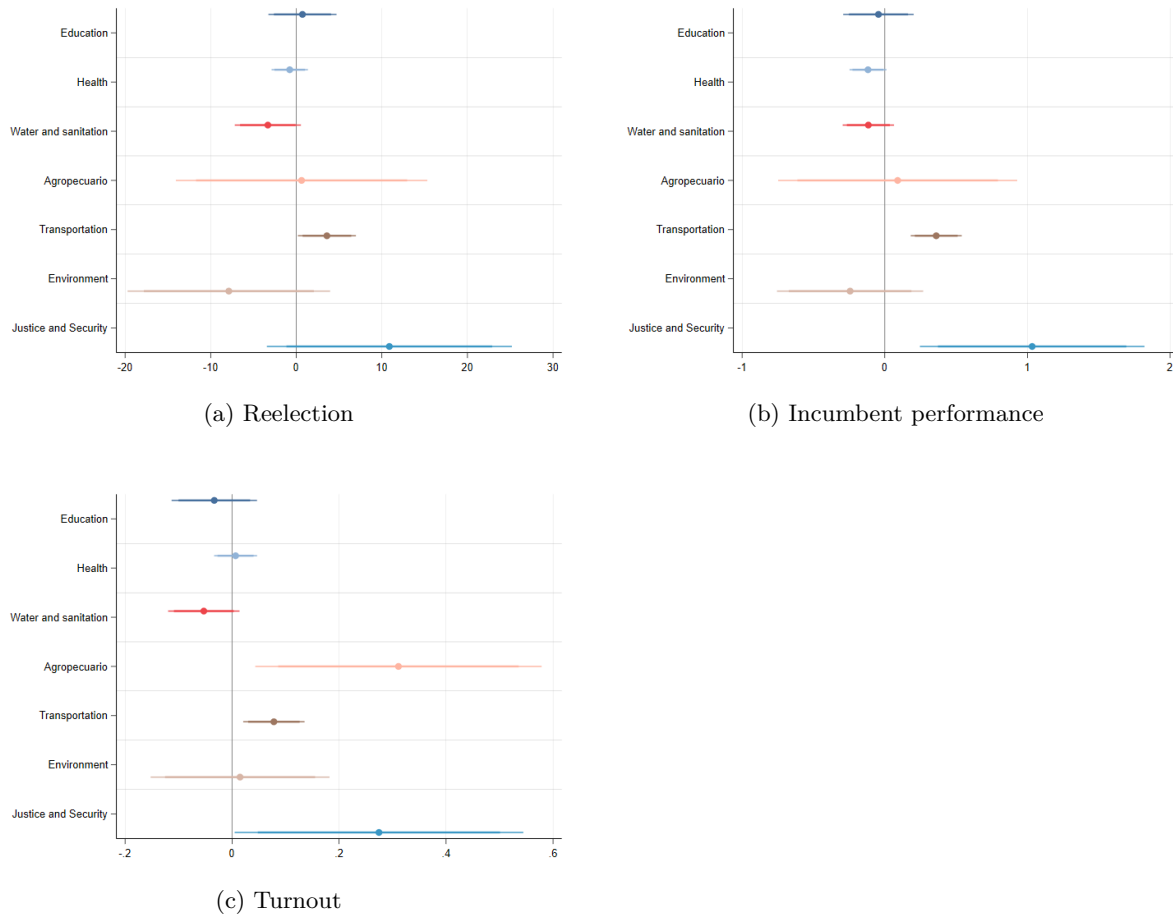
3.4.1 Reelection and incumbent performance

Figure 3.3 presents the baseline results. Individual regressions are used, and the variables of interest correspond to the share of the budget allocated to specific investment chapters. For the likelihood of reelection, only investment in the transportation sector presents a significant effect. The positive effect in the transportation sector aligns with expectations, given that it directly translates into visible infrastructure improvements.

Given the low overall probability of reelection in the Colombian context, I also analyzed the effect of strategic investment on the incumbent's performance. The results show that higher allocations to transportation and security positively impact incumbent performance. The positive effect of transportation investment is consistent with the increased likelihood of reelection. However, while greater investment in security improves incumbent performance, it does not translate into a higher probability of reelection. Additionally, investment in health has a slightly negative effect, significant at the 10% level, but it does not influence the likelihood of reelection.

The control variables behave as expected. A higher vote share for the incumbent in the previous election increases the likelihood of reelection, as does a higher proportion of the population over 65. However, the share of the rural population has a negative effect, although this result is not robust. Furthermore, cases of sanctions occurring during the incumbent's tenure reduce the likelihood of reelection, highlighting voter punishment. The effect of the elderly population is also present in the incumbent's performance, being the only control variable with a significant impact on the incumbent party's vote share.

Figure 3.3: Voting behavior



Coefficient plots from individual regressions examining the effect of different investment categories on voting behavior outcomes. Panel (a) presents the impact on reelection likelihood, panel (b) on incumbent performance, and panel (c) on voter turnout. Each point represents the estimated coefficient of the investment category on the respective outcome, with 90% and 95% confidence intervals. Fixed effects models (municipality and year) with controls are used.

3.4.2 Turnout

Colombia has one of the lowest voter turnouts in Latin America, with turnout levels in the latest parliamentary elections being 15 percentage points lower than the regional average OECD (2024). Turnout is often viewed as a key indicator of democratic health; low turnout can be detrimental to democracy as it may undermine the legitimacy of elections and suggest a lack of representation Franklin (2004).

In this context, I analyzed the impact of specific types of municipal investment on voter turnout in mayoral elections. The results indicate that certain investments do encourage higher voter turnout. Consistent with earlier findings, investments in transportation and security positively affect voter turnout in Colombian municipalities. A similar positive effect is observed in the agriculture sector.

Regarding the controls, several aspects affect participation in the election. Demographic aspects, such as the elderly population and the rural share of the population, reduce turnout. The result may be

driven by the difficulty of these population to access the ballot. The different forms of violence, present a negative effect. while a positive effect is observed when individuals are sanctioned by the watchdog *Procuraduría de la Nación*. This suggests that turnout increases when voters witness the institutions taking action.

Overall, these results suggest that voters are particularly responsive to investments in security and transportation, reflecting their priorities. However, the findings also imply a low voter interest in sustainable development issues. While the agricultural sector is directly related to the SDG of zero hunger, its focus is rural, and the overall allocation to this chapter is relatively low. This suggests that sustainable development goals are not a primary concern for voters.

3.4.3 Other investment chapters

Figure 3.A.4 presents the results of voter behavior in response to investment in various municipal sectors that do not directly contribute to the SDGs. Only investment in disaster prevention and response decreases the likelihood of reelection showcasing the difficulty to secure the power in consecutive terms via strategic investment allocation. The negative impact of disaster prevention and response is more likely tied to the occurrence of adverse events, which typically reduce the chances of reelection, as suggested by prior research Dodlova and Zudenkova (2021).

In a similar line, none of the investment chapters seem to improve the incumbent party's share of votes. In terms of voter turnout, disaster related investments and investment to increase the capacity of the government lower the participation in the election.

3.5 Heterogeneity analysis

A heterogeneity analysis is conducted to determine whether voting behaviors vary based on the characteristics of the municipalities. It is expected that voters in municipalities with differing attributes would prioritize different sets of goods and services from their local governments. The analysis covers five distinct cases, dividing municipalities based on key characteristics: rurality, income, education level, safety, and the presence of natural resources. Figures 3.A.5 present a distribution of the municipalities based on these characteristics.

3.5.1 Rural areas

I test whether voter preferences differ based on the level of rurality within a municipality. The quality of basic services may be lower and less accessible in rural areas, further, the population living in rural areas is only 23.7% of the total population DANE (2022). Hence it could be expected that such factors

influence voting behavior.

The municipalities are divided based on the percentage of population that lives in rural areas using the median as the threshold. The results suggest that the likelihood of reelection is slightly reduced when investing in environmental issues in rural areas, albeit this result is not found in the incumbent performance. As in the baseline, allocation of resources in transportation has a positive effect on incumbent performance. Interestingly none of the the chapters of the baseline increases the participation, although some of the none prioritize investment chapter affect turnout.

In more urban municipalities two chapters mobilize the voters, transportation and security issues. Indeed security and justice increase the chances of reelection, improve the incumbent performance and increase the participation in the ballot while transportation improve the performance of the incumbent and turnout. Hence the results suggest that transportation and security issues are more importance in places with higher density.

3.5.2 Income

The municipalities are further divided based on their GDP per capita to analyze whether voter behavior changes with differing levels of economic development. For this analysis, municipalities are categorized into high and low GDP per capita groups, corresponding to the top 75th and bottom 50th percentiles, respectively.

The results in Table 3.A.5 indicate that, in municipalities with higher GDP per capita, only transportation investments influence the likelihood of reelection. Only investments in transportation and health impact incumbent performance, with the latter having a negative effect. Additionally, voter turnout increases with investments in transportation, and security.

In contrast, municipalities with lower GDP per capita show slightly different patterns. Investments in water and sanitation reduce both the chances of reelection and the performance of the incumbent, this result maybe driven by unfinished projects. While investments in transportation and justice and security improve incumbent performance, only transportation increase participation in the ballot. Interestingly, investment in housing increases the likelihood of reelection, although this effect does not translate into a significant improvement in incumbent performance.

Overall, the results suggest that the level of economic development does not fundamentally alter voter perceptions regarding the allocation of resources for sustainable development.

3.5.3 Education level

The heterogeneity of the results is also tested with respect to the quality of education in the municipalities. To achieve this, the scores from the ICFES test, a national exam required for access to tertiary education, are used. Due to limited data availability, the sample is divided based on the median ICFES scores from 2019.

In municipalities with relatively low-quality education, there is a weaker response to the strategic allocation of resources. While investment in education increases the likelihood of reelection, it does so only at the 10% significance level, and it does not improve incumbent performance. However, the results do indicate a concern among the population for the poor quality of education, as the ICFES scores are widely recognized by the public. Incumbent performance and the likelihood of reelection are improved by investment in transportation. Additionally, voter turnout is only increased by investment in justice and security.

In municipalities with relatively high-quality education, voters are more responsive to strategic resource allocation. The likelihood of reelection is improved by investment in security issues, while it is reduced by investment in water and sanitation. These effects are also reflected in the performance of the incumbent. Additionally, incumbent performance is improved by investment in the transportation sector and reduced by investment in health. Furthermore, voter turnout is increased by investment in the agriculture and transportation sectors, but reduced by investment in water and sanitation.

The findings indicate that voter behavior is indeed influenced by the level of educational attainment within municipalities. In areas with lower educational quality, there is a limited response to strategic investments, suggesting that these populations may prioritize immediate and tangible benefits (as the case of transportation sector) or may be less informed about the impacts of specific investments. Conversely, in municipalities with higher educational quality, voters demonstrate a more nuanced response to strategic resource allocation, with significant effects observed across various sectors. This suggests that in more educated populations, there is a greater awareness or concern for how different investments can affect their community, leading to more discerning voting behavior.

3.5.4 Mining municipalities

To further understand voting behavior, the sample is divided based on the presence of the mining sector in the territory. As mentioned earlier, the mining sector generates royalties that are managed through a separate budget. If the sector plays a significant role in a municipality, voting behavior might not align with the allocation of the municipal budget, as the General Royalties System (SGR) could be a major source of investment. To address this, I identified "mining municipalities" as those involved in the

extraction of oil and gas, according to the (Agencia Nacional de Hidrocarburos, 2024)(ANH), and those accounting for 99% of royalties from mineral and metal mining according to the (Agencia Nacional de Minería, 2017). This definition covers 23% of the sample as extractive municipalities.

The results in Table 3.A.7 suggest that in mining regions, voters do not respond significantly to strategic investments. Only agriculture and water and sanitation investments show an effect on voter participation, and even then, only at the 10% significance level. In non-mining regions, investment in the transportation section improves the likelihood of reelection. Transportation and security investments improve the incumbent's performance, while health and water and sanitation investments decrease it.

These findings in mining regions could imply two things. First, as previously mentioned, municipalities may rely heavily on royalties to provide services, so the municipal budget may not reflect the incumbent's priorities for voters. Second, voters in these areas may not be influenced by strategic resource allocation in local development programs. To test the first hypothesis, I analyzed data from the SGR. The results in table 3.A.8 indicate that voters do not respond to resource allocation, investment in environmental issues improve the likelihood of reelection, but none of the budget chapters improve the incumbent's performance. Participation on the ballot is increase by projects in water and sanitation and agriculture while reduced by projects in security issues, showing a trend opposite to the results regarding security concerns.

Consequently, it appears that the lack of voter response in mining regions is driven more by disinterest or disengagement with the investments made by city halls, as incumbents are neither punished nor rewarded for their actions in office. Uncovering the underlying reasons for this lack of voter engagement in mining areas will require further research.

3.5.5 Relative security concerns

The internal conflict has affected most municipalities in the territory; however, the impact has been more severe in some areas than in others. As a result, it can be argued that voters in municipalities with relatively low security concerns may prioritize different types of investments. To explore this, the sample is divided based on the presence of violent acts in the territory. The first group, labeled as "low security concerns," consists of municipalities where no violent events (such as kidnappings, attacks, or selective killings) have occurred since 2000. The second group includes municipalities where such events have taken place.

The results in Table 3.A.9 show that these two groups of municipalities have different concerns. In municipalities with a history of violent events, voters respond positively to investments in justice and security, which increase the chances of reelection, improve the incumbent's performance, and boost voter turnout. Education investments also raise the likelihood of reelection in these municipalities, although

this effect is not reflected in the incumbent's performance. Additionally, investments in transportation improve the incumbent's performance, while health investments have a negative impact.

In contrast, in municipalities without violent events since 2000, investments in justice and security do not influence voter behavior. Instead, voters in these areas respond to other factors such as water and sanitation and transportation. Interestingly, education investments reduce the likelihood of reelection in these municipalities, contrary to the trend in areas with high security concerns, although this effect does not affect the incumbent's performance.

Overall, the results indicate that in areas where security concerns are prevalent, the population prioritizes safety, with voters responding most strongly to investments in justice and security. However, in municipalities where security is not a primary concern, voter interests are more diverse. In these territories, investments in sectors like water and sanitation, transportation and health, play a significant role in increasing the likelihood of reelection, this effect is also noted in investment chapters not prioritized such as culture and sport, reflecting a broader range of priorities among the electorate.

To conclude, the heterogeneity analysis highlights that voter priorities differ significantly based on municipal characteristics, such as security concerns, rural population, and education quality. Indeed, in municipalities with higher quality of education voters demonstrate a more nuanced response to strategic resource allocation, with significant effects observed across various sectors. Further, in municipalities where security is a pressing issue, voters prioritize investments in justice and security, reflecting an urgent need for safety and stability. Conversely, in areas with fewer security concerns, voters demonstrate a broader range of interests, focusing on other aspects like infrastructure, education, and community services.

3.6 Robustness

The robustness of the results is tested across three key dimensions. First, the sensitivity of the results to additional covariates is tested. Second, the analysis delves deeper into the funding restrictions that may face the municipalities by analyzing the role of restricted and unrestricted funds. Finally, a brief discussion of potential endogeneity issues are addressed.

3.6.1 Additional covariates

Political variables

Three additional variables are introduced to control for specific electoral characteristics: the alignment of the incumbent party with the current president, the number of candidates in the election, and the margin of victory. The first variable is a dummy that takes a value of 1 when the incumbent party

is the same as the president's. This alignment may improve communication and coordination with the national government, potentially enhancing the incumbent's performance. The second variable, the number of candidates, is continuous and captures electoral competition, as a higher number of candidates is expected to reduce the incumbent's chances of success. Finally, the margin of victory is calculated as the difference between the vote share of the winner and that of the runner-up. This variable can serve as an indicator of how difficult the election was to win and as a signal of the party's chances of maintaining power.

Table 3.A.10, 3.A.11 and 3.A.12 present the results of covariate sensitivity. The inclusion of these variables does not substantially alter the core results. Investment in transportation increases the likelihood of reelection and enhances incumbent performance. Investment in security-related issues improves both incumbent performance and voter participation. Unlike the baseline results, security investments also increase the likelihood of reelection, reinforcing the importance of security-related spending in voter decisions. Meanwhile, investment in water and sanitation has a negative effect on reelection, although only at the 10% significance level, and this result is not robust to the inclusion of additional covariates.

Regarding the additional covariates, alignment with the presidency improves both the incumbent party's performance and its likelihood of reelection. Interestingly, the number of candidates does not affect reelection chances but does negatively impact the incumbent's performance. Lastly, the margin of victory does not appear to influence voting behavior.

In terms of voter participation, presidential alignment is associated with lower turnout, as is a higher number of candidates. This decline in participation may be interpreted as a consequence of a lack of clear leadership, leading to voter disengagement. In the case of presidential alignment, voters may perceive the election as less competitive, which could result in reduced turnout.

Geographical controls

I further control for coca cultivation in the territory. While the baseline includes controls for violence, I do not directly control for the presence of drugs because drug consumption is legal in Colombia, the national police do not maintain statistics on drug-related crimes, and controlling for crimes related to illegal groups helps address this issue, as these groups are often involved in drug-related networks.

Nevertheless, one could argue that coca cultivation may influence elections beyond its association with violent crimes. To account for this possibility, we include data on coca cultivation areas from the *Observatorio de Drogas* of the Ministry of Defense. The results remain unchanged, and the variable does not exhibit a significant effect.

Additionally, I introduce environmental controls that may shape voting behavior. This vector includes CO2 emissions and the Normalized Difference Vegetation Index (NDVI) to capture pollution and land

degradation caused by deforestation or other environmental pressures. It also includes temperature and precipitation to control for geographical conditions that may influence voter behavior. The baseline results remain unchanged as well.

Quality of institutions

Using information from SECOP the unique portal for public funding procurement, I create four proxies for quality of institution. *competition* is share of contracts where competition is allow over total amount of contracts, the reasoning is that while SECOP is based on the principle of transparency and competition, different exception exist to allocate contracts without proper competition, while the practice is legal, it may lead to patronage, hence evidencing low quality of institutions. *mediumterm* and *longterm*, stands for the share of contracts with a length superior to 2 and 4 years respectively. I argue that city halls with relatively longer contracts should have a higher capacity as long term projects are harder to formulate and approve. Furthermore, structural changes in the municipalities should require long term projects too, hence these measure account for the capacity of the governors to manage this kind of projects. *personnel(SECOP)* stands for the share of contracts that correspond to personnel of the city hall to account for productivity and patronage as the allocation of this contracts do not require any kind of competition. Last, *personnel(CHIP)* account for the expenses per capita on personnel based on information of CHIP.

The implementation of SECOP began gradually in 2004, leading to our dataset starting in 2007 and being highly unbalanced toward municipalities with higher capacity, hence differing from the baseline. Consequently, I interpret the results, particularly those related to reelection, with caution. The baseline results are slightly different, while the likelihood of reelection is now increase by investments on security issues. Security and transportation remain a driver for incumbent performance and voter participation. Nevertheless the agriculture sector is not longer significant for the latter. Regarding the response of voters to quality of institutions, table 3.A.13 suggest that concerns about the quality of institutions do not seem to affect the performance of incumbents or their reelection probabilities. However, the share of medium-term projects has a positive effect on voter turnout.

Corruption concerns are quite significant in the political debate in Colombia. The lack of significance in incumbent performance suggests that perception, rather than technical indicators of corruption, plays a crucial role in modifying voting behavior. A possible extension of this paper is to analyze the changes in voting behavior or voter perception based on exposure to news related to corruption. This could provide deeper insights into how information dissemination and media coverage impact electoral outcomes in the context of corruption scandals.

3.6.2 Short-Term Electoral Incentives

One could argue that voting behavior is influenced more by decisions and investments made closer to the election rather than throughout the entire tenure of the incumbent. To address this concern, investment variables are reconstructed using weighted averages instead of simple averages over the election cycle. Greater weight is assigned to investments made in the election year, as elections are traditionally held in October, with decreasing weights for previous years. Specifically, the weight assigned to the election year is 8, the year before is 4, the second year before is 2, and the first year of the term is assigned a weight of 1.

Table 3.A.14 presents the results of this short-term voting behavior analysis. The likelihood of reelection increases with investment in transportation, as observed in the baseline model, although the effect remains significant only at the 10% level. Incumbent performance, however, improves with investments in both transportation and security. The magnitude of the effect is similar to the baseline findings. For instance, the coefficient for transportation investment in the baseline model is 0.361, indicating that a one-percentage-point increase in transportation investment improves incumbent performance by 0.36 percentage points. Under this alternative weighting approach, the effect size decreases slightly to 0.344.

Moreover, voter turnout increases with investments in agriculture and security. Unlike the baseline results, health investments now have a positive effect, whereas water and sanitation investments exhibit a negative impact. Adjusting the weights to place more emphasis on earlier years—using 0.4 for the election year, 0.3 for the previous year, and so on—does not substantially alter the results. Transportation investment continues to shape voting behavior, while security concerns remain insignificant (results available upon request).

3.6.3 Restricted and unrestricted funds

One can argue that the resources may be artificially biased due to restricted funds. Indeed, the national government allocates resources to targeted areas of development through a system called the *Sistema General de Participaciones* (SGP) or General Participation System⁴. Additionally, other resources, such as fines, may have restricted destinations. Since the purpose of analyzing strategic investment is to understand the preferences of the rulers, these restricted resources could obscure true preferences.

To address this issue, I analyze the sources of investment for each chapter in city halls and select only unrestricted funds to replicate the baseline results. These unrestricted resources include local taxes, credits, and the unrestricted portion of the SGP. I allocate these resources into the same investment

⁴SGP is the set of resources that the Nation transfers by mandate of Articles 356 and 357 of the Political Constitution. The General Participation System is composed of four special allocations (school meals, municipalities bordering Magdalena river, indigenous reserves and the National Pension Fund for Territorial Entities (Fonpet)) and another set of sectoral allocations (education, health, potable water and basic sanitation and a general purpose participation) DNP (2024).

chapters but use investment per capita instead of the share of investment, as these unrestricted funds do not account for 100% of the investment chapter and significant differences exist between municipalities.

The results are presented in Table 3.A.15 and partially align with the baseline findings for voter turnout and incumbent performance. Notably, the strategic investment of non-restricted funds does not alter the likelihood of reelection. However, the performance of the incumbent improves with increased investments in health, agriculture, justice and security and slightly with environment. While the positive results in agriculture and security were anticipated, the positive effect in the health sector is particularly interesting. In the baseline analysis, health investments had a negative impact, albeit at the 10% significance level. The difference in results may be attributed to the nature of non-restricted funds, which better reflect the priorities of both incumbents and voters. The health sector typically benefits from a share of the Sistema General de Participaciones (SGP) funds dedicated to ensuring free service, so the positive effect of non-restricted funds suggests a genuine interest in improving the sector, though this does not necessarily translate into better chances of reelection. The transportation sector shows a positive effect, although it is not statistically significant.

In terms of turnout, investments in agriculture and transport sectors continue to increase electoral participation. However, sectors with restricted fund allocations, such as water and sanitation, now exhibit a positive effect, which contrasts with the baseline. Additionally, investment in security no longer significantly impacts voter turnout.

Regarding other investment chapters, the likelihood of reelection decreases with increased allocation of resources to other public services, which often includes electricity infrastructure, though this effect is only significant at the 10% level. Interestingly, these chapters do not translate into poor performance for the incumbent. In fact, several chapters related to community investments show a positive impact on incumbent performance.

In terms of voter turnout, investments in culture and housing are associated with higher electoral participation. This suggests that while some sectors may have a negative impact on reelection chances, they do not necessarily reflect a broader dissatisfaction with the incumbent's overall performance. Instead, the results show that incumbent performance is not negatively influenced by allocation of non-restricted funds in any investment chapter.

Overall, several investment chapters related to sustainable development enhance incumbent performance and increase voter participation. However, this does not translate into higher chances of reelection, suggesting that while strategic allocation of resources toward sustainable development may influence governance and civic engagement, it does not necessarily serve as a decisive factor in electoral success.

3.6.4 Addressing endogeneity

It may be argued that the strategic allocation of resources —the variable of interest— is influenced by election outcomes. Previous robustness tests have partially addressed this concern by re-weighting the data and filtering investment funds. In this section, I explore the use of royalties as an exogenous source of funding for development projects in municipalities. The argument is that these resources are independent of municipal voting behavior and therefore provide a clear indication of the priorities of incumbents.

The Sistema General de Regalías (General Royalties System, SGR) is a framework governing the distribution and use of revenue generated from the exploitation of non-renewable natural resources DNP (2022). It was established by Legislative Act 05 of 2011 and regulated by Law 1530 of 2012. While Colombia had a royalty scheme prior to this, the reform aimed to promote a more equitable distribution of revenues across territories compared to the previous model and to establish rules for revenue allocation from non-renewable natural resources⁵.

Royalty distribution follows a fixed deduction model, with funds allocated among fixed and variable components. The fixed funds—comprising the Peace Fund, the Territorial Pension Savings Fund, and the Science, Technology, and Innovation Fund—account for 24% of resources after deductions. The remaining funds are distributed across a Savings and Stabilization Fund (up to 30%) and three regional chapters Gómez (2023).

The three regional chapters allocate resources as follows: direct municipal assignments (20% of the remainder), the Regional Development Fund (32%), and the Regional Compensation Fund (48%). These allocations depend on the performance of the mining sector, which determines royalty revenues, as well as the characteristics of the territories.

As a result, municipal royalty revenues are independent of local economic performance. Additionally, the distribution of mining activity is not determined by municipalities themselves, as the location of natural resources is exogenous to political boundaries, and mining permits are issued at the national level. SGR funds operate outside municipal budgets, follow a biannual budget cycle, and are subject to specialized oversight institutions. Consequently, SGR functions as a parallel investment source dedicated exclusively to development projects. This is particularly relevant for non-producing municipalities, where royalty revenues represent an exogenous and relatively new investment source, making them less susceptible to electoral manipulation.

I exploit the dataset of projects financed using SGR as exogeneous variable, using the information of category of investment and the names of the projects I map the projects to the investment chapters

⁵The SGR underwent further modifications through Legislative Acts 04 of 2017 and 05 of 2019, which included provisions related to the 2016 peace agreement.

of the municipalities. As a result categories of jails (A11), Disaster prevention and response (A12), and Community development (A16) are omitted. The data is harmonize at municipality, year, category, by summing the value of the projects. Note that the SGR started in 2012, consequently the regressions include only 2015-2019.

The accumulated project values over these years serve as the independent variable. An instrumental variable approach is not employed, as a logit model cannot incorporate IV, and a probit model with fixed effects would be biased. Consequently, replicating the reelection baseline framework is not feasible. Instead, the exogenous SGR variable is used in place of municipal investment chapters.

Table 3.A.16 presents the results for all municipalities. Overall, royalty-funded investments do not influence the likelihood of reelection. The incumbent's performance improves only with investments in health, while voter participation increases with investments in agriculture and water and sanitation. Excluding mining regions yields similar results (results available upon request), with education also becoming significant at the 10% level. However, the effects remain small. SGR project values are measured in hundreds of millions of pesos, with the average amount varying from 0.006 for security-related projects to 1.5 for transportation projects. Given these magnitudes, the impact on incumbent performance is minimal in most cases.

These findings suggest that although SGR resources are exogenous to the political cycle, they do not strongly influence voting behavior. Thus, the baseline results -using investment funded by municipality resources- remain the preferred interpretation.

3.6.5 Budget manipulation and political cycle

I investigate whether incumbents strategically adjust their expenditures to align with the political cycle. This behavior may be indicative of budget manipulation aimed at improving their performance on the ballot. This approach differs from previous methods as it considers the amount invested during election years and focuses on incumbents' behavior rather than voters' responses. The issue is addressed following the approach outlined by Drazen and Eslava (2010). To assess the presence of an electoral cycle, Equation 3.2 is estimated using a dynamic panel model. Given the model's nature, a system GMM⁶ is employed.

$$Investment_{it} = \alpha Investment_{it-1} \beta Election_t + \lambda X_{it} + e_{it} \quad (3.2)$$

Where $Investment_{it}$ is the share of investment in a particular topic with its dynamic effect. $Election_t$ represent the year when elections are held. The vector X encompasses control variables, including the

⁶The command `xtabond2` in Stata is used with a robust two-step estimator developed by Roodman (2009).

people aged older than 65, rural population, the standard conflict variables, sanctions cases, incumbent performance in the last election, average temperature and precipitation, CO2 emissions, and NDVI. In this case, t is continuous years and is not restricted to only years of election as in equation 3.1.

The results, presented in graph 3.A.6, reveal important variations in the budget allocations of city halls. Most investment chapters experience an increase. Moreover, it appears that the funding for these increases in different investment chapters comes from reductions in capacity building and health expenditures, with the latter experiencing a relatively large decrease compared to the variations in other investment subjects.

The effect on transportation and water and sanitation is relatively bigger compared to other chapters. This result is consistent with the findings of Drazen and Eslava. Overall, these outcomes imply strategic expenditure adjustments by incumbents during election years, particularly in projects with tangible outputs that may not necessarily align with SDGs.

While investments in water and sanitation are directly linked to the SDGs, the contribution of the transportation sector may be more limited, especially if focused on maintenance rather than expansion or improvement. Additionally, while projects with visible benefits can support sustainable development, concerns arise when budgets are manipulated to align with the electoral cycle. Since elections occur every four years, incumbents may prioritize short-term projects that yield immediate benefits, potentially at the expense of longer-term sustainability.

3.7 Conclusion

In this study, the primary objective is to analyze the factors influencing voting behavior in Colombian municipalities. Specifically, I explore the likelihood of reelection while also examining other relevant aspects of electoral behavior, such as incumbent performance and voter turnout. Fixed-effects models are used to estimate these outcomes, considering various investment allocations aligned with sustainable development and security concerns.

The findings indicate that strategic resource allocation does influence reelection prospects, particularly through visible infrastructure investments. For instance, investment in transportation is associated with a higher likelihood of reelection, suggesting that voters reward infrastructure projects that provide immediate and tangible benefits. Similarly, incumbent performance improves with increased transport-related spending, while security investments are also positively received by voters, underscoring the significance of public safety in electoral outcomes. However, the overall effect of strategic resource allocation on reelection remains moderate, indicating that while infrastructure investments matter, they are not the sole determinant of electoral success.

Given Colombia's relatively low voter participation rates, understanding the drivers of turnout is crucial, as higher turnout strengthens government legitimacy and ensures broader representation. The results suggest that voter participation increases with greater investment in transportation, security, and the agricultural sector, highlighting the role of these investments in mobilizing voters.

While strategic investment allocation does shape electoral behavior, the findings reveal that Colombian voters generally do not prioritize sustainable development-related investments when casting their votes. Expenditures on areas such as education, health, and the environment only influence voting behavior in specific instances, and these effects are not robust. In contrast, investments in visible infrastructure, such as transportation, consistently sway voter preferences. This lack of responsiveness to sustainable development is concerning given Colombia's current trajectory. The country has worsened in over 30% of its SDG targets, and its overall performance in achieving the SDGs remains below the regional average (Sachs et al., 2024). These findings highlight the urgency of addressing sustainable development challenges at both the local and national levels, particularly as voter preferences do not currently incentivize policymakers to prioritize them.

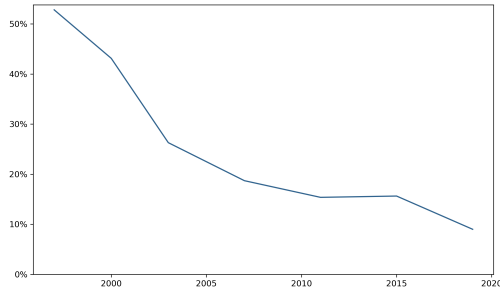
Further, evidence of election-cycle-driven budget manipulation raises concerns about the long-term sustainability of local government projects. Given Colombia's four-year electoral cycle, the prioritization of short-term projects aligned with election incentives may hinder municipalities from establishing sustainable development strategies necessary to achieve the SDGs. This pattern suggests that electoral considerations often take precedence over long-term planning, potentially limiting the effectiveness of local governance.

However, this study underscores the significant impact of strategic investment allocation on voter behavior in local elections, particularly in shaping reelection prospects and voter turnout. Notably, in areas where educational quality is higher, voters tend to be more engaged and responsive, reflecting a stronger understanding of the state's role in local development. Additionally, in regions with relatively low security concerns, a broader range of policy issues becomes relevant to voters, opening opportunities for sustainable development to play a more central role in electoral decision-making.

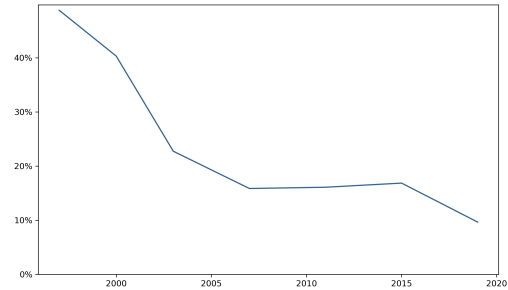
Thus, policies aimed at improving education and reducing insecurity may not only enhance voter engagement but also foster greater public support for long-term sustainable development strategies at the municipal level. Strengthening civic awareness and broadening the scope of voter priorities beyond short-term infrastructure gains could be key to aligning electoral incentives with sustainable development objectives.

3.8 Appendix

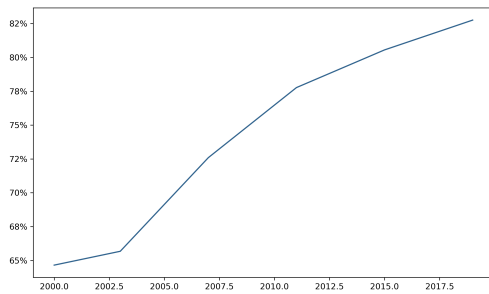
Figure 3.A.1: Evolution over time of voting behavior



(a) Reelection evolution



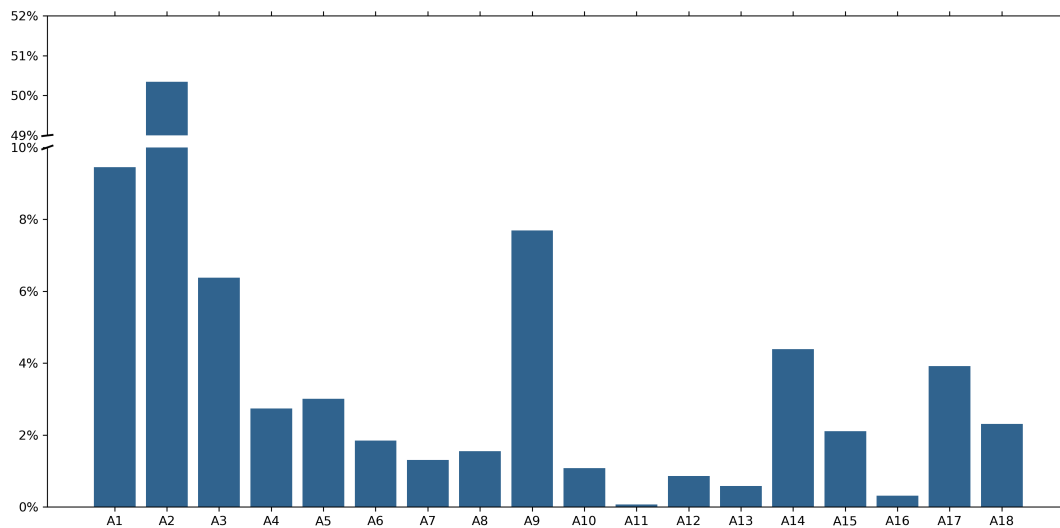
(b) Incumbent performance evolution



(c) Turnout

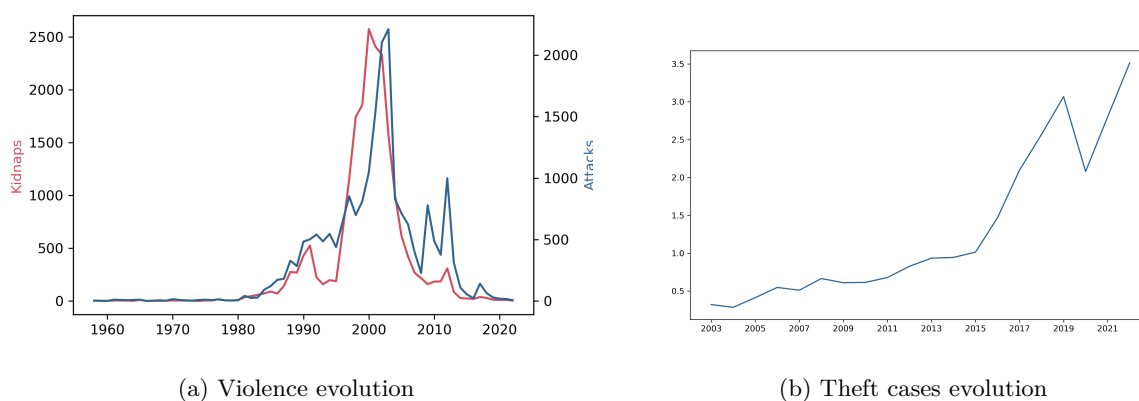
Note: The evolution over time of the average among municipalities for each variable is presented. Reelection is a dummy variable equal to 1 if the same party wins consecutive elections. Incumbent performance is measured as the share of votes received by the incumbent party over the total number of votes. Turnout is the share of votes cast relative to the projected number of eligible voters. Author's calculations.

Figure 3.A.2: Share of investment chapter over total investment budget



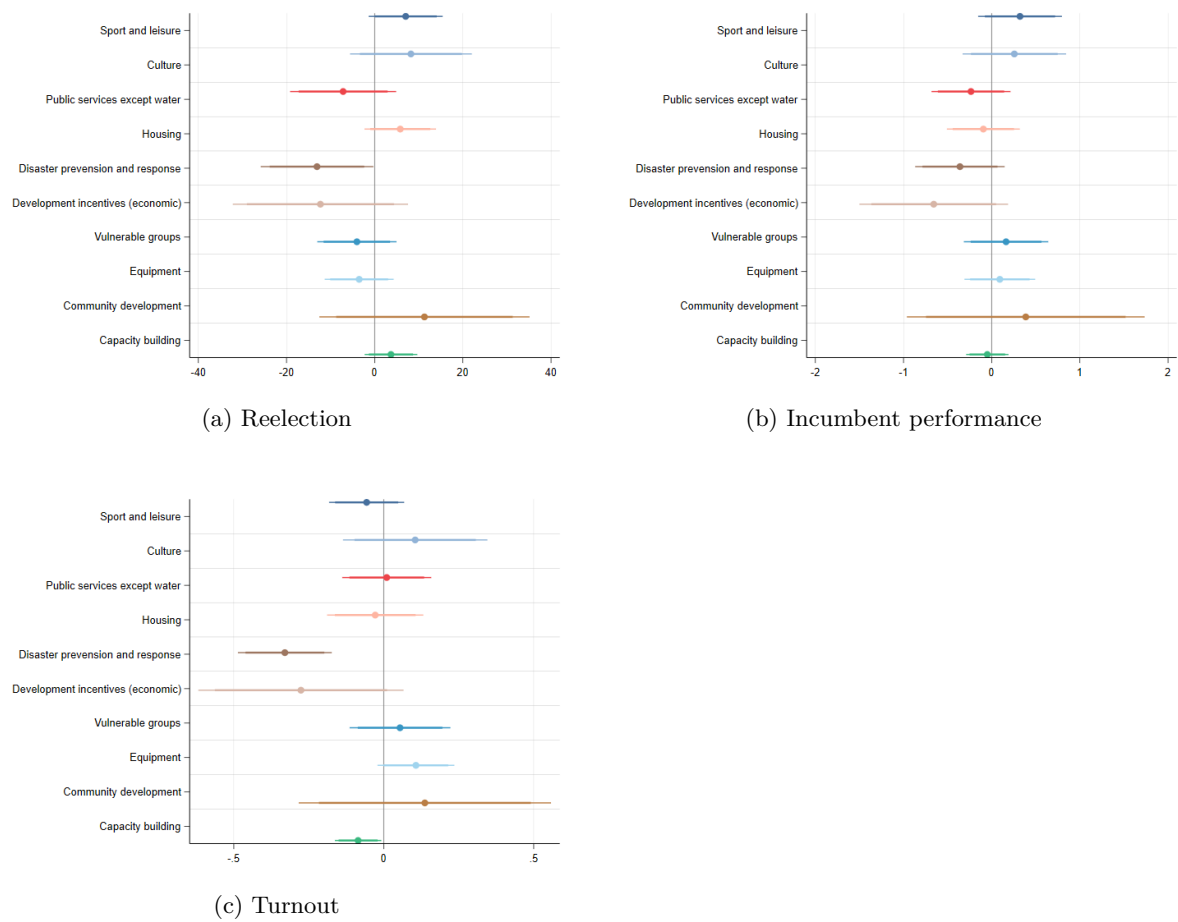
Note: Author's calculation. Complete list of chapters names in table 3.A.3. Selected caption: A1, Education. A2, Health. A3, Water and Sanitation. A9, Transportation. A14, Vulnerable Groups. A17, Institutional Strengthening. A18, Justice and Security.

Figure 3.A.3: Evolution over time of security related variables



Note: Author's calculation. Violence measure in sum of cases. Theft measure in cases per 100,000 inhabitants.

Figure 3.A.4: Voting behavior results: other investment chapters



Coefficient plots from individual regressions examining the effect of different investment categories on voting behavior outcomes. Panel (a) presents the impact on reelection likelihood, panel (b) on incumbent performance, and panel (c) on voter turnout. Each point represents the estimated coefficient of the investment category on the respective outcome, with 90% and 95% confidence intervals. Fixed effects models (municipality and year) with controls are used.

Figure 3.A.5: Different characterization of municipalities

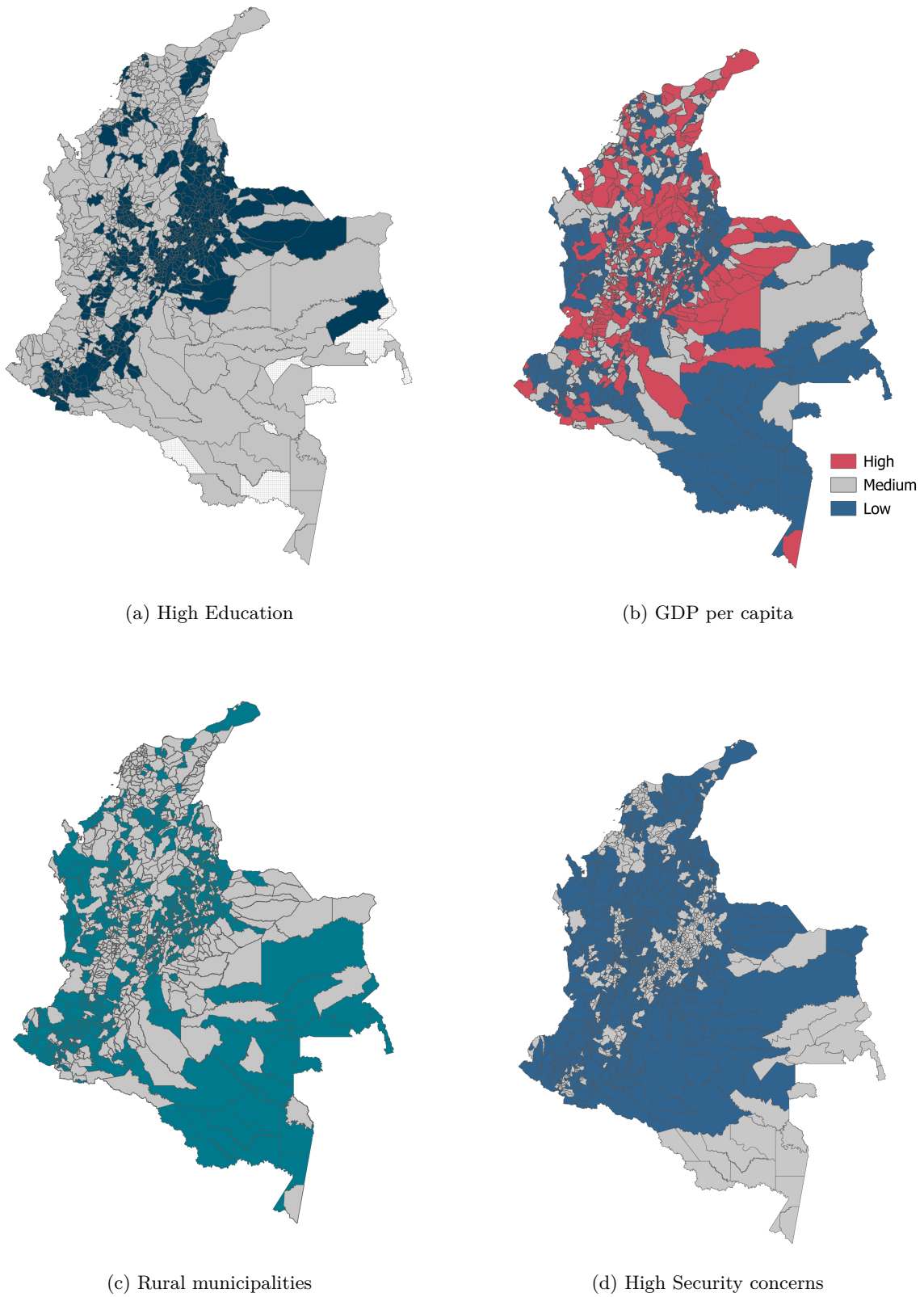
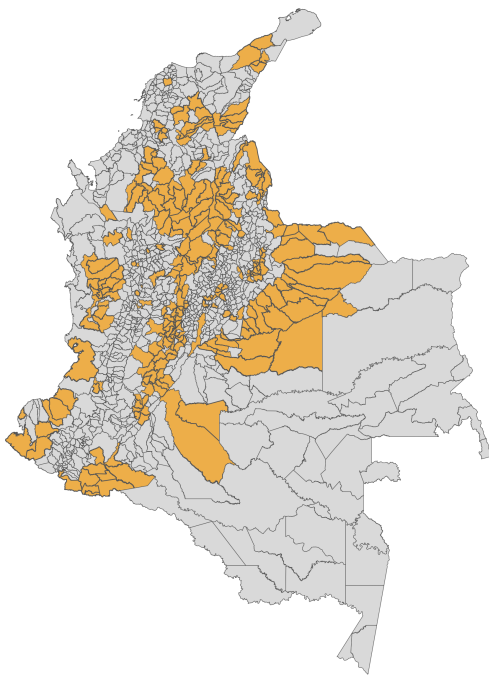


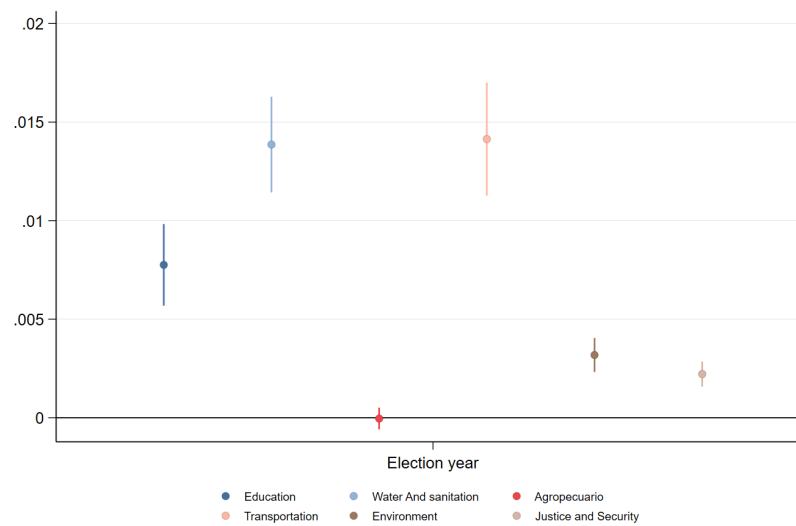
Figure 3.A.5: Different characterization of municipalities



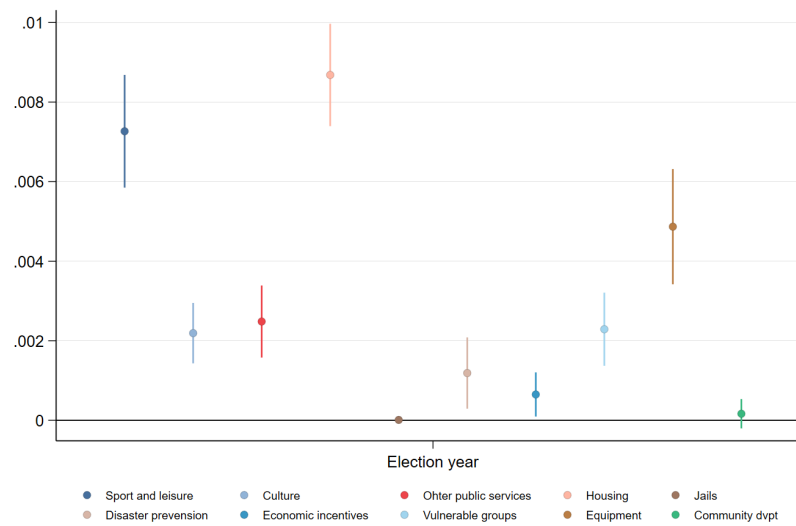
(e) Mining municipalities

The maps represent the division of municipalities for the heterogeneity analysis. (3.A.5a) shows municipalities with high education levels, based on ICFES results. (3.A.5b) represents municipalities in the top 25% based on GDP per capita ("High") and the bottom 50% ("Low"). (3.A.5c) depicts the half of municipalities with the largest rural populations. (3.A.5d) shows municipalities that have experienced at least one case of violence (excluding theft) since 2000. (3.A.5e) represents municipalities involved in oil extraction or those accounting for 99% of royalties from mineral and metal mining.

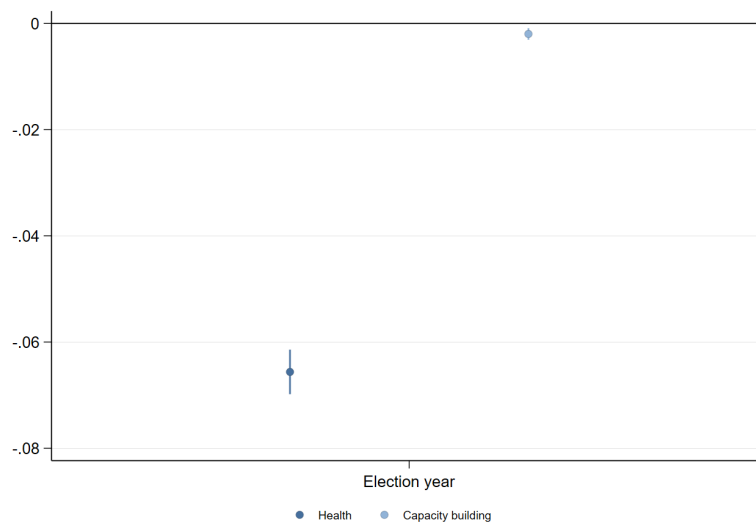
Figure 3.A.6: Coefficient plot: Electoral cycle



(a) Baseline investment chapters



(b) Other investment chapters



(c) Negative investment chapters

Effect of electoral year on municipalities budget. Coefficient plot of individual regression for each investment category as dependent variable using a two-step GMM. Variable of interest plotted: Election year

Table 3.A.1: Descriptive statistics

Variable	Obs	Mean	Std. dev.	Min	Max
Year	5,605	2011	5.65	2003	2019
Reelection	5,303	0.17	0.37	0.00	1.00
Turnout	5,303	0.76	0.18	0.08	2.16
Incumbent performance	5,303	0.16	0.21	0.00	0.92
Theft cases	5,598	53.89	91.83	0.00	1176.20
Kidnaps (victims)	5,605	2.23	10.21	0.00	245.00
Attacks (victims)	5,605	2.69	12.44	0.00	283.00
Share of population over 65	5,598	6.93	1.12	-0.29	13.33
Share of rural population	5,598	8.80	0.90	5.29	12.02
GDP growth	5,581	0.14	0.25	-0.38	5.13
CO2 emissions	5,605	5.54	21.14	0.00	518.70
NDVI	5,605	6008.15	954.95	2403.99	8028.75
Temperature	5,595	19.82	5.09	8.26	28.99
Precipitation	5,595	0.0044	0.0036	0.0005	0.0323
Sanction cases	6,726	1.61	19	0	1,289
Competition	2,175	0.01	0.01	0.00	0.11
Medium term	2,175	0.51	3.92	0.00	118.00
Long term	2,175	0.06	0.46	0.00	15.00
Personnel (SECOP)	2,175	0.00	0.01	0.00	0.07
Personnel (expenses)	3,303	11.19	1.35	7.34	23.48
edu (dummy)	5,560	0.50	0.50	0.00	1.00
rural (dummy)	5,605	0.49	0.50	0.00	1.00
extractive (dummy)	5,605	0.18	0.38	0.00	1.00
violent (dummy)	5,605	0.52	0.50	0.00	1.00

Table 3.A.2: Variables dictionary

Variable	Description	Source
Reelection	1 if Same party wins election in t, 0 otherwise	Registraduría Nacional
Turnout	Percentage of votes over population able to vote (older than 18 years old)	Registraduría Nacional and DANE
Incumbent performance	Share of votes of incumbent party or higher share of candidate if several candidates from the same incumbent party	Registraduría Nacional
Theft cases	Mean of theft cases	National police
Kidnaps (victims)	Sum of kidnaps victims	Center of Historical Memory (CHM)
Attacks (victims)	Sum of attacks victims	Center of Historical Memory (CHM)
Share of population over 65	Population over 65 y/o over total population	DANE
Share of rural population	Rural population over total population	DANE
GDP growth	GDP growth	Author's construction with DANE data
CO2 emissions	CO2 emissions	ODIAC
NDVI	Normalized difference vegetation index. The index indicates how green is a pixel is and is a proxy for forest degradation and/or deforestation	NASA
Temperature	Average temperature in celcius	(Muñoz-Sabater et al., 2021)
Precipitation	Average precipitation in meters	(Muñoz-Sabater et al., 2021)
Sanction cases	Number of sanctions to individuals given by Procuraduría Nacional in the municipality	Author's construction with Procuraduría data
Competition	Share of contracts of SECOP where competition is allowed	Author's construction with SECOP data
Medium term	Share of contracts of SECOP with length 2-4 years	Author's construction with SECOP data
Long term	Share of contracts of SECOP with length superior to 4 years	Author's construction with SECOP data
Personnel (SECOP)	Share of contracts of SECOP of personnel without competition	Author's construction with SECOP data
Personnel (expenses)	Value of expenses in personnel	Author's construction with contaduría data
edu (dummy)	1 if municipality has high score in ICFES test based on the national median and zero otherwise	Author's construction with ICFES data
rural (dummy)	1 if municipality has high share of rural population based on national median and zero otherwise	Author's construction with DANE data
extractive (dummy)	One if municipality has a oil or gas field, or it is a top contributor of royalties in the mining sector	Author's construction with ANH and ANM data
violent (dummy)	One if municipality has at least one violent event (kidnaps, attacks or killings) since 2000 and zero otherwise	Author's construction with CHM data

Table 3.A.3: Description of investment chapters

Code	Name	Mean
A1	Education	10.8%
A2	Health	44.9%
A3	Water and sanitation	8.7%
A4	Sport and leisure	2.6%
A5	Culture	2.6%
A6	Public services except water	1.8%
A7	Housing	1.9%
A8	Agricultural	1.7%
A9	Transportation	9.8%
A10	Environment	1.3%
A11	Jails	0.1%
A12	Disaster prevention and response	1.0%
A13	Development incentives (economic)	0.6%
A14	Vulnerable groups	3.8%
A15	Equipment	2.2%
A16	Community development	0.4%
A17	Capacity building	3.7%
A18	Justice and Security	2.1%

Mean refers to the average participation of the chapters in the total investment.

Table 3.A.4: Heterogeneity analysis: rural and urban

	Rural			Not rural		
	Reelection	Incumbent	Turnout	Reelection	Incumbent	Turnout
Baseline						
Education	1.440 (0.38)	-0.0474 (-0.23)	0.0291 (0.42)	2.341 (0.91)	0.00229 (0.01)	-0.0630 (-1.25)
Health	0.124 (0.07)	-0.110 (-1.06)	-0.0183 (-0.62)	-2.137 (-1.49)	-0.141 (-1.57)	0.0240 (0.85)
Water and sanitation	-5.150 (-1.59)	-0.267 (-1.63)	-0.0600 (-1.05)	-0.771 (-0.28)	-0.0110 (-0.10)	-0.0378 (-0.90)
Agropecuario	-2.716 (-0.23)	-0.209 (-0.41)	0.0800 (0.56)	5.923 (0.57)	0.262 (0.33)	0.414 (1.48)
Transportation	2.052 (0.81)	0.347*** (2.63)	0.0342 (0.94)	3.794 (1.51)	0.340*** (2.68)	0.120*** (2.76)
Environment	-13.75* (-1.65)	-0.199 (-0.57)	-0.0155 (-0.21)	-5.025 (-0.51)	-0.465 (-1.02)	0.0655 (0.35)
Justice and Security	-15.99 (-1.14)	0.960* (1.66)	0.0433 (0.23)	24.09** (2.34)	0.977* (1.71)	0.479** (2.35)
Other investment chapters						
Sport and leisure	16.62** (2.35)	0.420 (1.02)	0.0833 (0.74)	0.298 (0.05)	0.211 (0.70)	-0.177** (-2.54)
Culture	23.28** (1.97)	0.121 (0.34)	0.0650 (0.51)	3.454 (0.37)	0.366 (0.73)	0.158 (0.81)
Public services except water	-8.767 (-0.84)	-0.299 (-0.81)	0.00964 (0.07)	-5.008 (-0.63)	-0.251 (-0.76)	-0.0715 (-0.73)
Housing	7.880 (1.22)	0.0993 (0.27)	-0.192 (-1.33)	5.302 (0.92)	-0.114 (-0.45)	0.129 (1.43)
Jails	-196.1 (-1.46)	0.192 (0.30)	0.218** (2.00)	78.14 (0.78)	4.845** (2.39)	0.108 (0.13)
Disaster prevension and response	-14.98 (-1.49)	-0.248 (-0.82)	-0.324*** (-3.66)	-12.14 (-1.37)	-0.548 (-1.27)	-0.345*** (-2.83)
Development incentives (economic)	-13.33 (-0.81)	-1.414** (-1.98)	-0.101 (-0.41)	-13.19 (-0.99)	-0.453 (-0.86)	-0.384* (-1.76)
Vulnerable groups	5.994 (0.80)	0.589 (1.49)	0.215* (1.94)	-6.465 (-0.96)	-0.165 (-0.54)	-0.0831 (-0.75)
Equipment	-6.579 (-1.10)	0.0886 (0.29)	0.0884 (1.01)	-1.277 (-0.23)	0.119 (0.42)	0.123 (1.29)
Community development	2.190 (0.10)	0.317 (0.29)	0.976*** (2.96)	16.22 (1.04)	0.353 (0.38)	-0.388 (-1.29)
Capacity building	4.304 (0.95)	-0.103 (-0.34)	0.117 (1.29)	4.415 (0.96)	0.0641 (0.49)	-0.131*** (-2.76)
Observations	457	1526	1526	474	1764	1764

Note: Rural cover those municipalities with share of rural population higher than the national median. For Turnout and Incumbent performance, a panel FE estimation is used. In the case of Reelection a FE logit is performed. Coefficient shows the variable of interest, each regression is performed using usual control variables, each chapter of investment correspond to an individual regression. Errors clustered at municipality level when allowed. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.A.5: Heterogeneity analysis: High - Low GDP

	High GDP			Low GDP		
	Reelection	Incumbent	Turnout	Reelection	Incumbent	Turnout
Baseline						
Education	1.340 (0.43)	-0.0220 (-0.12)	-0.00805 (-0.14)	-1.608 (-0.41)	-0.182 (-0.93)	-0.110 (-1.59)
Health	-2.227 (-0.93)	-0.238* (-1.87)	-0.0296 (-0.72)	1.589 (0.97)	-0.0702 (-0.73)	0.0374 (1.22)
Water and sanitation	-1.753 (-0.42)	-0.0180 (-0.11)	-0.0675 (-1.08)	-5.251* (-1.77)	-0.347** (-2.57)	-0.0489 (-1.04)
Agropecuario	5.539 (0.29)	0.683 (0.51)	0.657 (1.60)	-5.499 (-0.58)	0.125 (0.25)	0.251 (1.61)
Transportation	7.169* (1.70)	0.703*** (3.58)	0.120** (2.14)	1.424 (0.62)	0.277** (2.47)	0.0683* (1.73)
Environment	-19.07 (-1.15)	-0.655 (-0.99)	0.234 (1.16)	-10.58 (-1.39)	-0.373 (-1.07)	-0.0239 (-0.17)
Justice and Security	29.32 (1.29)	0.824 (1.00)	0.759* (1.81)	7.507 (0.87)	1.128** (2.21)	0.0685 (0.45)
Other investment chapters						
Sport and leisure	4.052 (0.49)	0.111 (0.24)	-0.0147 (-0.14)	8.756 (1.46)	0.399 (1.19)	-0.0983 (-1.04)
Culture	-35.40* (-1.65)	-0.644 (-0.94)	0.968*** (2.88)	19.24** (2.15)	0.344 (0.88)	-0.163 (-1.50)
Public services except water	19.87 (1.34)	0.0643 (0.14)	0.148 (1.01)	-26.45** (-2.35)	-0.212 (-0.61)	-0.00471 (-0.04)
Housing	-7.004 (-0.62)	-0.151 (-0.38)	0.186 (1.47)	11.74** (2.06)	0.149 (0.48)	-0.150 (-1.25)
Jails	378.6 (1.35)	7.760* (1.76)	0.564 (0.59)	-83.32 (-0.84)	0.619 (0.50)	0.0943 (0.23)
Disaster prevension and response	-12.44 (-0.88)	-0.511 (-0.67)	-0.278 (-1.29)	-13.69 (-1.47)	-0.00855 (-0.03)	-0.342*** (-3.41)
Development incentives (economic)	-3.832 (-0.23)	-0.308 (-0.40)	-0.270 (-0.73)	-47.44** (-2.24)	-1.513** (-2.09)	-0.312 (-1.41)
Vulnerable groups	-4.126 (-0.33)	0.362 (0.76)	0.232 (1.51)	-4.349 (-0.69)	0.0452 (0.13)	-0.0342 (-0.26)
Equipment	7.613 (0.69)	0.295 (0.71)	-0.110 (-0.83)	-5.432 (-1.08)	0.138 (0.48)	0.185** (2.02)
Community development	-16.07 (-0.43)	1.108 (0.61)	0.174 (0.50)	13.33 (0.84)	0.0966 (0.09)	0.460 (1.27)
Capacity building	-1.619 (-0.26)	-0.0345 (-0.21)	-0.113*** (-2.66)	2.372 (0.51)	0.0362 (0.13)	-0.106 (-1.00)
Observations	204	836	836	482	1616	1616

Note: High GDP corresponds to municipalities in the top 75th percentile by GDP per capita, while low GDP corresponds to those in the bottom 50th percentile. For Turnout and Incumbent performance, a panel FE estimation is used. In the case of Reelection a FE logit is performed. Coefficient shows the variable of interest, each regression is performed using usual control variables, each chapter of investment correspond to an individual regression. Errors clustered at municipality level when allowed. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.A.6: Heterogeneity analysis: Education level

	High quality of education			Low quality of education		
	Reelection	Incumbent	Turnout	Reelection	Incumbent	Turnout
Baseline						
Education	-5.101 (-1.57)	-0.156 (-0.92)	0.00368 (0.08)	5.326* (1.91)	0.196 (1.03)	-0.0327 (-0.48)
Health	-0.978 (-0.49)	-0.202* (-1.89)	-0.0354 (-1.29)	-0.814 (-0.62)	-0.101 (-1.19)	0.0175 (0.63)
Water and sanitation	-6.470** (-2.01)	-0.364** (-2.45)	-0.136*** (-3.47)	-2.167 (-0.84)	0.0735 (0.62)	0.0139 (0.28)
Agropecuario	4.849 (0.42)	0.747 (1.35)	0.503*** (3.10)	-0.677 (-0.07)	-0.536 (-0.82)	0.113 (0.54)
Transportation	3.117 (1.11)	0.452*** (3.46)	0.0771** (2.03)	3.790* (1.67)	0.252** (2.02)	0.0652 (1.58)
Environment	-11.19 (-1.30)	-0.300 (-0.78)	0.0764 (0.79)	-5.916 (-0.61)	-0.425 (-1.28)	-0.118 (-0.80)
Justice and Security	21.84** (2.32)	1.412** (2.57)	0.0925 (0.67)	-8.182 (-0.59)	0.581 (1.00)	0.484* (1.94)
Other investment chapters						
Sport and leisure	8.357 (1.36)	0.473 (1.51)	-0.00259 (-0.04)	6.131 (0.99)	0.141 (0.39)	-0.115 (-1.09)
Culture	31.06*** (2.58)	0.450 (1.08)	0.211 (1.44)	-3.038 (-0.31)	0.179 (0.43)	0.0880 (0.48)
Public services except water	3.566 (0.34)	0.0720 (0.23)	0.115 (1.37)	-11.10 (-1.38)	-0.517 (-1.61)	-0.0592 (-0.48)
Housing	6.847 (1.07)	0.00149 (0.01)	-0.0176 (-0.23)	4.352 (0.78)	-0.230 (-0.68)	-0.0602 (-0.40)
Jails	-125.8 (-0.94)	-0.103 (-0.20)	0.356** (2.42)	27.96 (0.28)	5.490** (2.34)	-0.776 (-0.78)
Disaster prevension and response	-0.222 (-0.02)	-0.0514 (-0.11)	-0.218** (-2.27)	-18.31** (-2.21)	-0.376 (-1.21)	-0.329*** (-3.20)
Development incentives (economic)	-6.330 (-0.48)	-0.658 (-0.85)	-0.251 (-1.47)	-19.84 (-1.20)	-0.501 (-1.05)	-0.191 (-0.66)
Vulnerable groups	5.931 (0.75)	0.694** (2.02)	0.259*** (2.60)	-6.723 (-1.13)	-0.171 (-0.55)	-0.0707 (-0.57)
Equipment	-0.526 (-0.10)	0.0170 (0.07)	0.141 (1.63)	-7.311 (-1.18)	0.0907 (0.27)	-0.00413 (-0.04)
Community development	5.302 (0.25)	-0.0328 (-0.04)	-0.0917 (-0.38)	14.80 (0.97)	0.628 (0.59)	0.265 (0.71)
Capacity building	7.733 (1.37)	0.211 (1.04)	-0.0485 (-0.84)	2.432 (0.65)	-0.216 (-1.13)	-0.102* (-1.74)
Observations	425	1661	1661	537	1626	1626

Note: High education quality refers to those municipalities with an average score of the ICFES test higher than the median. For Turnout and Incumbent performance, a panel FE estimation is used. In the case of Reelection a FE logit is performed. Coefficient shows the variable of interest, each regression is performed using usual control variables, each chapter of investment correspond to an individual regression. Errors clustered at municipality level when allowed. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.A.7: Heterogeneity analysis: Extractive industry

	Extractive industry			No extractive industry		
	Reelection	Incumbent	Turnout	Reelection	Incumbent	Turnout
Baseline						
Education	6.487 (0.92)	0.155 (0.69)	-0.0410 (-0.42)	2.662 (1.12)	0.00581 (0.03)	-0.00655 (-0.16)
Health	-2.025 (-0.81)	-0.131 (-1.07)	0.00977 (0.20)	-1.846 (-1.41)	-0.168** (-2.03)	0.00805 (0.37)
Water and sanitation	1.902 (0.43)	0.0919 (0.60)	-0.117* (-1.91)	-2.983 (-1.20)	-0.225* (-1.86)	-0.0323 (-0.90)
Agropecuário	22.75 (0.90)	0.158 (0.14)	0.729* (1.84)	-4.162 (-0.50)	0.0312 (0.07)	0.277* (1.92)
Transportation	-1.363 (-0.27)	0.213 (1.06)	0.0629 (0.76)	3.220* (1.65)	0.376*** (3.58)	0.0718** (2.24)
Environment	15.20 (0.68)	0.485 (0.69)	0.328 (1.05)	-9.409 (-1.41)	-0.413 (-1.42)	-0.0518 (-0.65)
Justice and Security	-10.44 (-0.40)	-0.899 (-1.10)	0.209 (0.54)	9.128 (1.17)	1.316*** (2.81)	0.267** (2.04)
Other investment chapters						
Sport and leisure	4.029 (0.32)	0.216 (0.39)	-0.0176 (-0.13)	8.635* (1.84)	0.349 (1.27)	-0.0565 (-0.77)
Culture	18.32 (0.94)	0.139 (0.20)	0.482 (1.29)	12.85 (1.63)	0.468 (1.32)	0.0340 (0.30)
Public services except water	-0.996 (-0.10)	-0.696* (-1.77)	0.00968 (0.06)	-11.68 (-1.56)	-0.191 (-0.65)	-0.0777 (-0.91)
Housing	2.355 (0.21)	-0.0667 (-0.19)	0.206 (1.45)	5.163 (1.11)	-0.137 (-0.55)	-0.0874 (-0.90)
Jails	1.460 (0.01)	0.259 (0.23)	-0.0348 (-0.08)	-35.00 (-0.39)	1.060 (0.96)	0.410* (1.88)
Disaster prevention and response	2.683 (0.11)	-0.523 (-0.89)	-0.0343 (-0.19)	-16.14** (-2.18)	-0.336 (-1.16)	-0.422*** (-4.32)
Development incentives (economic)	-22.15 (-0.64)	-0.388 (-0.56)	-0.763 (-1.18)	-2.003 (-0.17)	-0.341 (-0.61)	-0.140 (-0.87)
Vulnerable groups	-6.729 (-0.51)	0.00548 (0.01)	0.227 (1.39)	-3.952 (-0.74)	0.313 (1.01)	-0.00599 (-0.06)
Equipment	-6.600 (-0.49)	-0.0391 (-0.11)	-0.0638 (-0.41)	-1.943 (-0.44)	0.126 (0.51)	0.158** (2.12)
Community development	30.10 (0.86)	-0.163 (-0.09)	-0.468 (-0.83)	5.639 (0.41)	0.415 (0.57)	0.168 (0.71)
Capacity building	9.162 (0.81)	0.273 (0.65)	0.0177 (0.10)	6.333* (1.67)	-0.00940 (-0.07)	-0.0987** (-2.42)
Observations	152	671	671	764	2619	2619

Note: Extractive industry represents municipalities involved in oil extraction or those accounting for 99% of royalties from mineral and metal mining. For Turnout and Incumbent performance, a panel FE estimation is used. In the case of Reelection a FE logit is performed. Coefficient shows the variable of interest, each regression is performed using usual control variables, each chapter of investment correspond to an individual regression. Errors clustered at municipality level when allowed. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.A.8: Heterogeneity analysis: Strategic allocation of royalties of mining municipalities

	Reelection	Incumbent	Turnout
Education	0.000474 (0.38)	0.00000429 (0.49)	-6.64e-08 (-0.01)
Health	-0.00130 (-1.00)	-0.0000127 (-0.62)	0.00000425 (0.41)
Water and sanitation	0.00828 (0.43)	0.000000483 (0.15)	0.0000186*** (17.97)
Agropecuario	0.000560 (0.83)	-0.00000710 (-0.82)	0.0000113** (1.98)
Transportation	0.0000780 (0.67)	-0.00000195 (-0.84)	0.00000123 (0.99)
Environment	0.00651** (2.25)	0.0000156 (1.01)	-0.00000359 (-0.86)
Justice and Security	0.0118 (0.46)	-0.0000182 (-0.23)	-0.0000185* (-1.95)
Observations	84	512	512

Note: Variables of interest are the sum of the value of projects funded by royalties divided by in the standard investment chapters. For Turnout and Incumbent performance, a panel FE estimation is used. In the case of Reelection a FE logit is performed. Coefficient shows the variable of interest, each regression is performed using usual control variables, each chapter of investment correspond to an individual regression. Errors clustered at municipality level when allowed. t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.A.9: Heterogeneity analysis: Violence level

	High security concerns			Low security concerns		
	Reelection	Incumbent	Turnout	Reelection	Incumbent	Turnout
Baseline						
Education	7.135** (2.17)	0.133 (0.81)	-0.0437 (-0.81)	-6.357** (-2.09)	-0.254 (-1.24)	-0.0273 (-0.44)
Health	-1.697 (-1.12)	-0.187** (-2.26)	-0.0219 (-0.86)	0.364 (0.22)	-0.0428 (-0.40)	0.0380 (1.13)
Water and sanitation	-0.899 (-0.35)	-0.0777 (-0.66)	-0.0519 (-1.16)	-6.644** (-2.06)	-0.200 (-1.35)	-0.0380 (-0.73)
Agropecuario	-19.15 (-1.38)	-1.081* (-1.72)	0.216 (0.98)	11.47 (1.19)	0.860 (1.50)	0.349** (2.01)
Transportation	1.877 (0.71)	0.383*** (2.72)	0.0706* (1.81)	5.763** (2.39)	0.365*** (3.01)	0.0821* (1.91)
Environment	-11.38 (-1.20)	0.0120 (0.03)	-0.0738 (-0.58)	-4.073 (-0.47)	-0.553 (-1.58)	0.108 (0.91)
Justice and Security	23.16* (1.88)	1.342** (2.23)	0.438* (1.89)	5.942 (0.62)	0.785 (1.46)	0.169 (1.05)
Other investment chapters						
Sport and leisure	3.067 (0.42)	0.284 (0.83)	0.0214 (0.24)	9.944* (1.79)	0.355 (1.04)	-0.0986 (-1.05)
Culture	-8.756 (-0.72)	0.109 (0.20)	0.463* (1.91)	20.73** (2.16)	0.366 (0.99)	-0.0742 (-0.67)
Public services except water	-14.65 (-1.54)	-0.483 (-1.54)	0.108 (1.06)	-0.666 (-0.09)	-0.00323 (-0.01)	-0.0783 (-0.67)
Housing	5.724 (0.94)	-0.203 (-0.69)	0.0722 (0.79)	7.036 (1.22)	0.0758 (0.25)	-0.130 (-0.95)
Jails	132.5 (0.83)	0.880 (1.06)	0.300 (1.60)	-108.7 (-1.07)	2.263 (0.82)	0.169 (0.16)
Disaster prevension and response	-30.37** (-2.19)	-1.027** (-2.45)	0.0294 (0.23)	-9.948 (-1.31)	-0.111 (-0.36)	-0.519*** (-4.33)
Development incentives (economic)	-11.65 (-0.81)	-0.598 (-0.89)	-0.298 (-1.12)	-17.85 (-1.21)	-0.631 (-1.14)	-0.256 (-1.11)
Vulnerable groups	1.426 (0.18)	0.693** (2.20)	0.120 (1.13)	-8.327 (-1.32)	-0.394 (-1.17)	0.0184 (0.14)
Equipment	-5.683 (-0.91)	0.282 (1.01)	0.0915 (1.06)	-3.717 (-0.70)	-0.0772 (-0.27)	0.0923 (0.92)
Community development	25.51 (1.17)	0.939 (0.77)	0.165 (0.42)	-0.359 (-0.02)	0.0629 (0.08)	0.151 (0.60)
Capacity building	6.220 (1.44)	0.0960 (0.53)	-0.0644 (-1.46)	0.929 (0.19)	-0.194 (-1.10)	-0.105 (-1.36)
Observations	471	1746	1746	491	1544	1544

Note: High security concerns refers to municipalities where an act of violence (kidnaps, attacks or selective killings) has occurred since 2000. Low security refers to those municipalities without an act of violence since 2000. For Turnout and Incumbent performance, a panel FE estimation is used. In the case of Reelection a FE logit is performed. Coefficient shows the variable of interest, each regression is performed using usual control variables, each chapter of investment correspond to an individual regression. Errors clustered at municipality level when allowed. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.A.10: Robustness: sensitivity to covariates of reelection

	(1)	(2)	(3)	(4)
	Reelection	Reelection	Reelection	Reelection
Education	0.916 (0.41)	0.731 (0.32)	0.731 (0.32)	-1.260 (-0.36)
Health	-0.802 (-0.72)	-0.779 (-0.70)	-0.779 (-0.70)	-0.830 (-0.51)
Water and sanitation	-3.818* (-1.71)	-3.333 (-1.48)	-3.333 (-1.48)	-5.490 (-1.52)
Agropecuario	1.388 (0.20)	0.649 (0.10)	0.649 (0.10)	4.892 (0.56)
Transportation	3.576* (1.87)	3.587** (2.03)	3.587** (2.03)	4.654 (1.56)
Environment	-7.317 (-1.29)	-7.893 (-1.54)	-7.893 (-1.54)	-2.908 (-0.32)
Justice and Security	12.91* (1.88)	10.87 (1.50)	10.87 (1.50)	25.91* (1.84)
Observations	960	962	962	466
Controls:				
Standard	✓	✓	✓	✓
Political	✓			
Coca cultivation		✓	✓	
Environment			✓	
Institutional				✓

Note: The table presents the results of investment chapters from individual regressions. Standard controls include the share of the rural population, the share of the elderly population, GDP growth, the share of the incumbent party in previous elections, and the total number of sanction cases recorded by the *Procuraduría* (the national watchdog organization). Political controls include a dummy for presidential party alignment, the number of candidates in the election, and the margin of victory in the previous election. Coca cultivation is measured as the total area of coca crops in the municipality. Environmental controls include CO2 emissions, NDVI, temperature, and precipitation. Institutional controls consist of the share of contracts with competitive bidding, the share of medium-term contracts, the share of long-term contracts, the share of personnel contracts funded by investment, the total share of personnel contracts, and the value of personnel expenses. Unless otherwise specified, all variables are averaged across election cycles. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.A.11: Robustness: sensitivity to covariates of incumbent performance

	(1)	(2)	(3)	(4)
	Incumbent	Incumbent	Incumbent	Incumbent
Education	-0.0119 (-0.10)	-0.0424 (-0.34)	-0.0424 (-0.34)	0.0123 (0.07)
Health	-0.101 (-1.56)	-0.119* (-1.80)	-0.119* (-1.80)	-0.137 (-1.43)
Water and sanitation	-0.111 (-1.24)	-0.114 (-1.24)	-0.114 (-1.24)	-0.0357 (-0.28)
Agropecuário	0.160 (0.38)	0.0928 (0.22)	0.0928 (0.22)	-0.0242 (-0.04)
Transportation	0.337*** (3.64)	0.361*** (3.95)	0.361*** (3.95)	0.311** (2.38)
Environment	-0.239 (-0.95)	-0.244 (-0.93)	-0.244 (-0.93)	-0.194 (-0.43)
Justice and Security	0.971** (2.46)	1.037*** (2.58)	1.037*** (2.58)	1.913*** (3.11)
Observations	3288	3290	3290	1792
Controls:				
Standard	✓	✓	✓	✓
Political	✓			
Coca cultivation		✓	✓	
Environment			✓	
Institutional				✓

Note: The table presents the results of investment chapters from individual regressions. Standard controls include the share of the rural population, the share of the elderly population, GDP growth, the share of the incumbent party in previous elections, and the total number of sanction cases recorded by the *Procuraduría* (the national watchdog organization). Political controls include a dummy for presidential party alignment, the number of candidates in the election, and the margin of victory in the previous election. Coca cultivation is measured as the total area of coca crops in the municipality. Environmental controls include CO2 emissions, NDVI, temperature, and precipitation. Institutional controls consist of the share of contracts with competitive bidding, the share of medium-term contracts, the share of long-term contracts, the share of personnel contracts funded by investment, the total share of personnel contracts, and the value of personnel expenses. Unless otherwise specified, all variables are averaged across election cycles. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.A.12: Robustness: sensitivity to covariates of turnout

	(1)	(2)	(3)	(4)
	Turnout	Turnout	Turnout	Turnout
Education	-0.0300 (-0.73)	-0.0336 (-0.82)	-0.0336 (-0.82)	-0.0667 (-1.08)
Health	0.00950 (0.46)	0.00680 (0.33)	0.00680 (0.33)	0.00590 (0.20)
Water and sanitation	-0.0534 (-1.57)	-0.0531 (-1.56)	-0.0531 (-1.56)	-0.0802 (-1.57)
Agropecuario	0.308** (2.26)	0.311** (2.28)	0.311** (2.28)	0.267 (1.33)
Transportation	0.0752** (2.55)	0.0784*** (2.68)	0.0784*** (2.68)	0.0990** (2.22)
Environment	0.0146 (0.17)	0.0152 (0.18)	0.0152 (0.18)	0.163 (1.10)
Justice and Security	0.272** (2.00)	0.274** (1.99)	0.274** (1.99)	0.599** (2.39)
Observations	3288	3290	3290	1792
Controls				
Standard	✓	✓	✓	✓
Political	✓			
Coca cultivation		✓	✓	
Environment			✓	
Institutional				✓

Note: The table presents the results of investment chapters from individual regressions. Standard controls include the share of the rural population, the share of the elderly population, GDP growth, the share of the incumbent party in previous elections, and the total number of sanction cases recorded by the *Procuraduría* (the national watchdog organization). Political controls include a dummy for presidential party alignment, the number of candidates in the election, and the margin of victory in the previous election. Coca cultivation is measured as the total area of coca crops in the municipality. Environmental controls include CO2 emissions, NDVI, temperature, and precipitation. Institutional controls consist of the share of contracts with competitive bidding, the share of medium-term contracts, the share of long-term contracts, the share of personnel contracts funded by investment, the total share of personnel contracts, and the value of personnel expenses. Unless otherwise specified, all variables are averaged across election cycles. Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.A.13: Robustness: Quality of Institutions

	Reelection	Incumbent	Turnout
Competition	1.454 (0.05)	0.718 (0.60)	-0.0747 (-0.21)
Medium term	-0.456 (-1.39)	-0.000150 (-0.17)	0.000474** (2.21)
Long term	1.132 (0.90)	-0.00581 (-0.90)	0.00123 (0.50)
Personnel (SECOP)	24.72 (1.23)	0.783 (0.63)	-0.629* (-1.77)
Personnel (CHIP)	-0.0365 (-0.47)	-0.00253 (-0.62)	-0.000806 (-0.58)
Controls	✓	✓	✓
<i>N</i>	466	1791	1791

Note: The regression using security and justice chapter is displayed, similar results are found using other investment chapters. For Turnout and Incumbent performance, a panel FE estimation is used. In the case of Reelection a FE logit is performed. The table shows the variable of interest, each regression is performed using usual control variables. Errors clustered at municipality level when allowed. Years: 2011- 2019. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.A.14: Robustness: Short-term incentives

	Reelection	Incumbent	Turnout
Education	-0.365 (-0.18)	-0.0767 (-0.72)	-0.0177 (-0.50)
Health	-0.806 (-0.94)	-0.0693 (-1.45)	0.0402*** (2.71)
Water and sanitation	-2.990 (-1.58)	-0.0655 (-0.77)	-0.0787*** (-2.86)
Agropecuário	-0.0576 (-0.01)	0.330 (0.77)	0.225* (1.86)
Transportation	2.876* (1.74)	0.344*** (4.31)	0.0169 (0.71)
Environment	-7.926 (-1.46)	-0.305 (-1.04)	-0.0147 (-0.17)
Justice and Security	6.798 (1.04)	0.772*** (2.58)	0.236** (2.25)
Observations	962	3290	3290

Note: For Turnout and Incumbent performance, a panel FE estimation is used. In the case of Reelection a FE logit is performed. Coefficient shows the variable of interest, each regression is performed using usual control variables. Errors clustered at municipality level. Investment chapters are constructed with weighted average prioritizing the year of election and most recent years. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.A.15: Robustness: Non restricted funds

	Reelection	Incumbent	Turnout
Baseline			
Education	-0.00510 (-0.36)	0.000955 (1.08)	0.000530* (1.79)
Health	0.0168 (1.35)	0.00155** (2.31)	0.000317 (1.49)
Water and sanitation	0.00352 (0.33)	0.000515 (0.90)	0.000426** (2.40)
Agropecuário	0.0187 (0.54)	0.00560** (2.18)	0.00185*** (2.85)
Transportation	-0.00437 (-0.11)	0.00338 (1.26)	0.00159** (2.38)
Environment	0.0149 (0.92)	0.00158* (1.70)	0.000294 (1.02)
Justice and Security	0.0450 (1.11)	0.00495** (2.43)	0.000127 (0.13)
Other investment chapters			
Sport and leisure	-0.0193 (-1.45)	0.000250 (0.30)	0.000335 (1.25)
Culture	0.00343 (0.21)	0.00192** (1.99)	0.00109*** (3.45)
Public services except water	-0.0313* (-1.74)	-0.000497 (-0.62)	0.0000214 (0.09)
Housing	0.0210 (1.23)	0.000812 (0.90)	0.000623** (2.34)
Jails	-0.000649 (-0.05)	0.000480 (0.82)	-0.000314 (-1.55)
Disaster prevention and response	-0.0188 (-0.69)	0.00107 (0.69)	-0.000162 (-0.31)
Development incentives (economic)	0.0128 (0.95)	0.00124* (1.72)	0.000184 (0.82)
Vulnerable groups	0.0127 (0.28)	0.00593** (2.19)	0.00116 (1.48)
Equipment	0.0569 (1.52)	0.00630*** (3.44)	0.000614 (1.10)
Capacity building	0.0114 (0.24)	0.00274 (1.07)	0.000864 (1.22)
Observations	962	3290	3290

Note: For Turnout and Incumbent performance, a panel FE estimation is used. In the case of Reelection a FE logit is performed. Coefficient shows the variable of interest, each regression is performed using usual control variables. Errors clustered at municipality level. Each chapter correspond to per capita unrestricted funds of city halls based on investment chapters. Years: 2011- 2019. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3.A.16: Robustness: exogenous investment fund

	(1)	(2)	(3)
	Reelection	Incumbent	Turnout
Education	0.185 (1.52)	0.00261 (1.18)	-0.000337 (-0.30)
Health	-0.0520 (-0.57)	0.000491** (2.32)	0.0000868 (1.04)
Water and sanitation	0.666 (1.38)	0.000296 (0.38)	0.00483*** (12.63)
Agropecuaria	-0.0423 (-0.37)	-0.00214 (-1.10)	0.00240* (1.79)
Transportation	-0.00862 (-0.47)	-0.000688 (-1.26)	0.000294 (1.17)
Environment	-0.189 (-0.85)	0.000908 (0.32)	-0.000119 (-0.17)
Justice and Security	1.684 (0.95)	0.0179 (0.74)	-0.00453 (-1.19)
Observations	392	2197	2197

Note: For Turnout and Incumbent performance, a panel FE estimation is used. In the case of Reelection a FE logit is performed. Coefficients of the variable SGR investment per capita during the tenure in hundred million pesos. Each regression is performed using usual control variables. Errors clustered at municipality level. Years: 2015- 2019. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

General Conclusion

General conclusion

Climate change and sustainable development, particularly poverty, are the defining challenges of our time. Governments face the key task of combating climate change while ensuring the preservation of resources for future generations. This issue is urgent, as the world is already experiencing the effects of climate change, such as rising temperatures and the increasing frequency and intensity of natural disasters. Moreover, scenarios aiming to limit climate change to within 2°C indicate that current trends fall short of the goal, requiring significant efforts. However, despite these challenges, addressing climate change presents an opportunity, especially for countries with the resources to drive decarbonization.

While resource wealth should, in theory, boost economic development, a large body of literature—the resource curse—suggests otherwise. The idea that countries rich in natural resources often underperform economically is still debated. Particularly, the effects of non-renewable resource extraction at the sub-national level remain underexplored, especially regarding resources other than fossil fuels and in emerging and developing countries.

This thesis contributes to the growing but limited literature on the resource curse at the subnational level, specifically in the context of non-fossil fuel mining in Latin America. It examines how mining influences sustainable development in regions and further explores public attitudes toward sustainable development when confronted with competing priorities.

Chapter 1 of this thesis investigates the impact of energy transition metal (ETM) mining on the regional quality of institutions in Latin America and the Caribbean (LAC), a region with high potential to meet global ETM demand. The literature on resource curse suggests that mining may deteriorate the quality of institutions. To analyze this, we employ a Synthetic Difference-in-Differences approach to evaluate the effect of the mining sector on the quality of institutions. We constructed a novel dataset covering departments in 18 Latin American countries. Additionally, we developed an institutional quality index based on Latinobarometer data, encompassing three key dimensions: trust, corruption, and government effectiveness. We find that there is no overall decline in institutional quality, however we observe a consistent negative effect on control of corruption, indicating increased perceived corruption. We conclude that the mining sector may pose a threat to long-term development by undermining the

quality of institutions.

Chapter 2 analyzes the impact of mining on sustainable development in the context of Mexico. Specifically, it examines whether mining affects various dimensions of sustainable development, including income, economic inequality, education, and environmental quality. Using household data from 2,403 municipalities as well as satellite data, we apply a staggered difference-in-difference design to analyze the effect of mine openings on municipalities. We find that the mining sector has mixed effects on sustainable development. While there is a limited positive effect on the income of neighboring households, mining also generates negative environmental spillovers. Moreover, mining does not significantly impact economic inequality or education. In sum, this study provides a more nuanced understanding of the impact of mining on sustainable development, contributing to ongoing debates regarding the relationship between natural resource extraction and sustainable development in emerging economies.

Finally, Chapter 3 analyzes voting behavior in the context of various concerns. In particular, I investigate the interplay between electoral dynamics, security concerns, and sustainable development investments in Colombian municipalities. Using a panel dataset spanning from 2003 to 2019, key factors influencing the reelection probabilities of incumbent parties, among other aspects of electoral dynamics, are analyzed. Strategic investments in projects aimed at achieving sustainable development goals (SDGs) do not appear to influence voters. However, the analysis of investment allocations shows that voters react to investments in specific areas, particularly those with tangible projects offering immediate benefits. The findings suggest that voters prioritize security concerns and tangible projects over SDGs. However, in municipalities with relatively higher educational quality, voters are more responsive to strategic resource allocation, and in areas where security is not a primary concern, voters react to a broader range of issues.

In summary, this thesis explores the relationship between climate change, sustainable development, and natural resource extraction, highlighting the importance of a regional approach, while considering the quality of institutions, and taking account of the community expectations.

Several policy implications can be drawn from this thesis. First, institutional quality is a key determinant of the impact of the mining sector on regional development. Therefore, strategies aimed at improving institutional quality are essential. These should include enhancing governance, increasing transparency, and reducing corruption in mining regions to avoid the potential negative effects of the sector.

Second, while the mining sector has the potential to significantly contribute to sustainable development, its impact in LAC has been limited. Promoting long-term sustainability in the extractive industry is crucial to achieving development objectives. Policymakers should implement policies that mitigate environmental degradation caused by mining, while ensuring that the sector's revenues contribute to sustainable development. Mining companies can also play a role by adopting practices that prioritize local employment, promote equal opportunities, and reduce environmental impacts, such as water consumption

and pollution.

Third, sustainable development does not seem to be a priority for many communities within countries. Thus, fostering education and raising awareness about sustainable development is essential. This can help shift public attitudes towards the trade-offs of different projects, including the role of government and the mining sector's impact on the environment and society.

This thesis unveils opportunities for extensions and additional research. The local effects of artisanal mining are still largely unexplored from a quantitative perspective. Cust and Poelhekke (2015) suggests that artisanal mining has negative environmental effects while offering limited economic benefits. However, it can lead to positive outcomes in Africa, particularly in the mining of gold (Bazillier and Girard, 2020; Girard et al., 2022). The increasing use of satellite data to map artisanal mining opens new research avenues to better understand its role in local development on a larger scale. Nevertheless, this topic remains significantly understudied in the Latin American context.

In the context of climate change, a substantial reduction in fossil fuel consumption is anticipated, which will likely result in the closure of many mines. While the socio-economic impacts of mine closures—such as reduced household incomes, migration, and environmental challenges—are widely acknowledged by international institutions (Michael et al., 2018; Commission and Environment, 2021; Haney and Shkaratan, 2003) and scholars (Strambo et al., 2019; Bainton and Holcombe, 2018), the literature quantifying these effects remains relatively scarce. Recent studies have revealed mixed outcomes, including environmental improvements like increased water availability in China (Ma et al., 2024), as well as negative effects (Wysocka et al., 2022), such as rising crime rates (Marais et al., 2022). However, significant room remains for further research. For instance, under a strong decarbonization path, a rapid decline in fossil fuel demand and prices could lead to the early closure of fossil-related mining projects. The effects of such sudden closures present an important area for investigation particularly in developing countries (Strambo et al., 2019), as understanding and preparing for these scenarios will be crucial in meeting climate targets.

Furthermore, a deeper analysis of mining's impact on the quality of local institutions is needed. The resource curse theory suggests that resource windfalls may deteriorate institutional quality. While evidence of corruption has been observed in Africa following the initiation of mining activities (Knutsen et al., 2016), the effects in Latin America and the Caribbean may differ. Additionally, understanding whether changes in public attitudes towards institutional quality are based on perception or data-driven realities remains unclear, particularly in the case of Colombia.

Bibliography

Acemoglu, D. and Robinson, J. A. (2012), *Why nations fail : the origins of power, prosperity and poverty*, Profile Books, , Cop.

Agencia Nacional de Hidrocarburos (2024), ‘Mapa de Tierras - Agencia Nacional de Hidrocarburos’.

URL: <https://www.anh.gov.co/es/hidrocarburos/mapa-de-tierras/>

Agencia Nacional de Minería (2017), ‘ANM Volúmen de Explotación de Minerales Asociados a Pagos de Regalías’.

URL: https://www.datos.gov.co/Minas-y-Energ-a/ANM-Vol-men-de-Explo-ta-ci-n-de-Mineral-es-A-soci-ados-/r85m-vv6c/about_data

Aragon, F. M., Chuhan-Pole, P. and Land, B. C. (2015), ‘The Local Economic Impacts of Resource Abundance: What Have We Learned?’.

URL: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2609380

Aragón, F. M. and Rud, J. P. (2013), ‘Natural Resources and Local Communities: Evidence from a Peruvian Gold Mine’, *American Economic Journal: Economic Policy* **5**, 1–25.

URL: <https://www.jstor.org/stable/43189326>

Aragón, F. M. and Rud, J. P. (2015), ‘Polluting Industries and Agricultural Productivity: Evidence from Mining in Ghana’, *The Economic Journal* **126**, 1980–2011.

URL: https://www.dartmouth.edu/neudc2012/docs/paper_7.pdf

Arezki, R., Pattillo, C. A., Quintyn, M. G., Zhu, M. and Frankel, J. A. (2012), *Commodity Price Volatility and Inclusive Growth in Low-Income Countries*, INTERNATIONAL MONETARY FUND.

Arkhangelsky, D., Athey, S., Hirshberg, D. A., Imbens, G. W. and Wager, S. (2021), ‘Synthetic Difference-in-Differences’, *American Economic Review* **111**(12), 4088–4118.

URL: <https://pubs.aeaweb.org/doi/10.1257/aer.20190159>

- Auty, R. and Warhurst, A. (1993), ‘Sustainable development in mineral exporting economies’, *Resources Policy* **19**(1), 14–29.
- Axbard, S., Benshaul-Tolonen, A. and Poulsen, J. (2021), ‘Natural resource wealth and crime: The role of international price shocks and public policy’, *Journal of Environmental Economics and Management* **110**.
- Badeeb, R. A., Lean, H. H. and Clark, J. (2017), ‘The evolution of the natural resource curse thesis: A critical literature survey’, *Resources Policy* **51**, 123–134.
- Bainton, N. and Holcombe, S. (2018), The Social Aspects of Mine Closure: A Global Literature Review., Technical report, Centre for Social Responsibility in Mining (CSRMI), Sustainable Minerals Institute (SMI), Brisbane.
- Bazillier, R. and Girard, V. (2020), ‘The gold digger and the machine. Evidence on the distributive effect of the artisanal and industrial gold rushes in Burkina Faso’, *Journal of Development Economics* **143**, 102411.
- Beine, M., Coulombe, S. and Vermeulen, W. N. (2015), ‘Dutch Disease and the Mitigation Effect of Migration: Evidence from Canadian Provinces: The Economic Journal’, *The Economic Journal* **125**(589), 1574–1615.
URL: <https://academic.oup.com/ej/article/125/589/1574-1615/5078085>
- Benshaul-Tolonen, A. (2018), ‘Local Industrial Shocks and Infant Mortality’, *The Economic Journal* **129**, 1561–1592.
- Bhattacharyya, S. and Hodler, R. (2010), ‘Natural resources, democracy and corruption’, *European Economic Review* **54**, 608–621.
- Bloomberg, p. (2023), ‘COP28 Local Climate Action Summit’.
URL: <https://www.bloomberg.org/cop28-local-climate-action-summit/>
- Bonnet, P. and Olper, A. (2024), ‘Party affiliation, economic interests and U.S. governors’ renewable energy policies’, *Energy Economics* **130**, 107259.
- Boschini, A. D., Pettersson, J. and Roine, J. (2007), ‘Resource Curse or Not: A Question of Appropriability*’, *The Scandinavian Journal of Economics* **109**(3), 593–617.
URL: <https://onlinelibrary.wiley.com/doi/10.1111/j.1467-9442.2007.00509.x>
- Brunnschweiler, C. and Poelhekke, S. (2021), ‘Pushing One’s Luck: Petroleum Ownership and Discoveries’, *SSRN Electronic Journal*.

Callaway, B. and Sant’Anna, P. H. (2020), ‘Difference-in-Differences with multiple time periods’, *Journal of Econometrics* **225**.

Calvin, K., Dasgupta, D., Krinner, G., Mukherji, A., Thorne, P. W., Trisos, C., Romero, J., Aldunce, P., Barrett, K., Blanco, G., Cheung, W. W., Connors, S., Denton, F., Diongue-Niang, A., Dodman, D., Garschagen, M., Geden, O., Hayward, B., Jones, C., Jotzo, F., Krug, T., Lasco, R., Lee, Y.-Y., Masson-Delmotte, V., Meinshausen, M., Mintenbeck, K., Mokssit, A., Otto, F. E., Pathak, M., Pirani, A., Poloczanska, E., Pörtner, H.-O., Revi, A., Roberts, D. C., Roy, J., Ruane, A. C., Skea, J., Shukla, P. R., Slade, R., Slangen, A., Sokona, Y., Sörensson, A. A., Tignor, M., Van Vuuren, D., Wei, Y.-M., Winkler, H., Zhai, P., Zommers, Z., Hourcade, J.-C., Johnson, F. X., Pachauri, S., Simpson, N. P., Singh, C., Thomas, A., Totin, E., Arias, P., Bustamante, M., Elgizouli, I., Flato, G., Howden, M., Méndez-Vallejo, C., Pereira, J. J., Pichs-Madruga, R., Rose, S. K., Saheb, Y., Sánchez Rodríguez, R., Ürges Vorsatz, D., Xiao, C., Yassaa, N., Alegría, A., Armour, K., Bednar-Fiedl, B., Blok, K., Cissé, G., Dentener, F., Eriksen, S., Fischer, E., Garner, G., Guivarch, C., Haasnoot, M., Hansen, G., Hauser, M., Hawkins, E., Hermans, T., Kopp, R., Leprince-Ringuet, N., Lewis, J., Ley, D., Ludden, C., Niamir, L., Nicholls, Z., Some, S., Szopa, S., Trewin, B., Van Der Wijst, K.-I., Winter, G., Witting, M., Birt, A., Ha, M., Romero, J., Kim, J., Haïtes, E. F., Jung, Y., Stavins, R., Birt, A., Ha, M., Orendain, D. J. A., Ignon, L., Park, S., Park, Y., Reisinger, A., Cammaramo, D., Fischlin, A., Fuglestvedt, J. S., Hansen, G., Ludden, C., Masson-Delmotte, V., Matthews, J. R., Mintenbeck, K., Pirani, A., Poloczanska, E., Leprince-Ringuet, N. and Péan, C. (2023), IPCC, 2023: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland., Technical report, Intergovernmental Panel on Climate Change (IPCC). Edition: First.

URL: <https://www.ipcc.ch/report/ar6/syr/>

Caselli, F. and Michaels, G. (2013), ‘Do Oil Windfalls Improve Living Standards? Evidence from Brazil’, *American Economic Journal: Applied Economics* **5**, 208–238.

Cavalcanti, T., Da Mata, D. and Toscani, F. (2019), ‘Winning the oil lottery: the impact of natural resource extraction on growth’, *Journal of Economic Growth* **24**, 79–115.

Central Bank of Ecuador (2021), ‘Cuentas Provinciales Anuales’. Backup Publisher: Sector Real.

URL: <https://www.bce.fin.ec/index.php/informacioneconomica/sector-real>

Charron, N., Lapuente, V. and Annoni, P. (2019), ‘Measuring quality of government in EU regions across space and time’, *Papers in Regional Science* **98**, 1925–1953.

Clarke, D., Paila  ir, D., Athey, S. and Imbens, G. (2023), ‘Synthetic Difference In Differences Estimation’.

Version Number: 3.

URL: <https://arxiv.org/abs/2301.11859>

Colombia Compra Eficiente (2019), ‘SECOP II - Procesos de Contrataci  n’.

URL: https://www.datos.gov.co/Gastos-Gubernamentales/SECOP-II-Procesos-de-Contrataci  n/p6dx-8zbt/about_data

Colombia Compra Eficiente (2022), ‘SECOP I - Procesos de Compra P  blica | Datos Abiertos Colombia’.

URL: https://www.datos.gov.co/Gastos-Gubernamentales/SECOP-I-Procesos-de-Compra-P  blica/f789-7hwg/about_data

Comisi  n Nacional del Agua (2023), ‘Calidad del agua en M  xico’.

URL: <https://www.gob.mx/conagua/articulos/calidad-del-agua>

Commission, E. and Environment, D.-G. f. (2021), *Guidelines for mine closure activities and calculation an periodic adjustment of financial guarantees*, Publications Office.

CONAPO (2018), ‘Proyecciones de la Poblaci  n de M  xico y de las Entidades Federativas, 2016-2050 - datos.gob.mx/busca’. Backup Publisher: Datos Abiertos de Mexico.

URL: <https://datos.gob.mx/busca/dataset/proyecciones-de-la-poblacion-de-mexico-y-de-las-entidades-federativas-2016-2050>

Contadur  a General de la Naci  n (2023), ‘CHIP’.

URL: <https://www.chip.gov.co/>

Copernicus Climate Change Service (2017), ‘ERA5: Fifth generation of ECMWF atmospheric reanalyses of the global climate’.

Cotet, A. M. and Tsui, K. K. (2013), ‘Oil and Conflict: What Does the Cross Country Evidence Really Show?’, *American Economic Journal: Macroeconomics* **5**, 49–80.

Couttenier, M. (2008), ‘Relationship Between Natural Resources and Institutions’.

URL: <https://shs.hal.science/halshs-00332490>

Couttenier, M., Grosjean, P. and Sangnier, M. (2017), ‘The Wild West is Wild: The Homicide Resource Curse’, *Journal of the European Economic Association* **15**, 558–585.

Cunningham, C. G., Zientek, M. L., Bawiec, W. J. and Orris, G. J. (2005), ‘Geology and Nonfuel Mineral Deposits of Latin America and Canada. Geological Survey Open-File Report 2005-1294B’.

URL: <http://pubs.usgs.gov/of/2005/1294/b>

- Cust, J. and Harding, T. (2019), ‘Institutions and the Location of Oil Exploration’, *Journal of the European Economic Association* **18**.
- Cust, J. and Poelhekke, S. (2015), ‘The Local Economic Impacts of Natural Resource Extraction’, *Annual Review of Resource Economics* **7**(1), 251–268.
URL: <https://www.annualreviews.org/doi/10.1146/annurev-resource-100814-125106>
- Cárdenas, M. and Orozco, S. (2023), ‘The challenges of climate mitigation in Latin America and the Caribbean: Some proposals for action’, *UNDP LAC PDS* .
URL: <https://www.undp.org/latin-america/publications/challenges-climate-mitigation-latin-america-and-caribbean-some-proposals-action>
- DANE (2018), ‘Mejoras en retroproyecciones de población con base en el CNPV 2018’. Backup Publisher: Dane.gov.co.
URL: <https://www.dane.gov.co/index.php/estadisticas-por-tema/demografia-y-poblacion/proyecciones-de-poblacion>
- DANE (2022), ‘Situación de las mujeres rurales desde las estadísticas oficiales’. Backup Publisher: dane.gov.co.
URL: <https://www.dane.gov.co/files/investigaciones/notas-estadisticas/oct-2022-nota-estadistica-mujer-rural-presentacion.pdf>
- DANE (2023), ‘Proyecciones de población’.
URL: <https://www.dane.gov.co/index.php/estadisticas-por-tema/demografia-y-poblacion/proyecciones-de-poblacion>
- de Chaisemartin, C. and D’Haultfoeuille, X. (2022), ‘Difference-in-differences estimators of intertemporal treatment effects’. Issue: 29873.
URL: <http://www.nber.org/papers/w29873>
- De Haas, R. and Poelhekke, S. (2019), ‘Mining matters: Natural resource extraction and firm-level constraints’, *Journal of International Economics* **117**, 109–124.
URL: <https://linkinghub.elsevier.com/retrieve/pii/S002219961930008X>
- Didan, K. (2021), ‘MODIS/Terra Vegetation Indices 16-Day L3 Global 250m SIN Grid V061’.
URL: <https://doi.org/10.5067/MODIS/MOD13Q1.061>
- DISGESTYC - El Salvador (2021), ‘El Salvador Estimaciones y Proyecciones de Población’.
URL: <http://www.digestyc.gob.sv/index.php/novedades/avisos/1022-proyecciones-y-estimaciones-de-poblacion-nacional-y-departamental.html>

DNP (2022), ‘DNP-ProyectosSGR’.

URL: https://www.datos.gov.co/Economia-y-Finanzas/DNP-ProyectosSGR/mzgh-shtp/about_data

DNP (2024), ‘Sistema General de Participaciones (SGP)’.

URL: <https://www.dnp.gov.co:443/LaEntidad/subdireccion-general-inversiones-seguimiento-evaluacion/direccion-programacion-inversiones-publicas/Paginas/sistema-general-de-participaciones.aspx>

Dodlova, M. and Zudenkova, G. (2021), ‘Incumbents’ performance and political extremism’, *Journal of Public Economics* **201**, 104473.

Drazen, A. and Eslava, M. (2010), ‘Electoral manipulation via voter-friendly spending: Theory and evidence’, *Journal of Development Economics* **92**, 39–52.

Dunning, T. (2008), *Crude Democracy: Natural Resource Wealth and Political Regimes*, 1 edn, Cambridge University Press.

URL: <https://www.cambridge.org/core/product/identifier/9780511510052/type/book>

ECLAC (2021), ‘Share of real Exports of Primary Products according to Renewable and Non-Renewable Natural Resources, and Manufacturing Products in total exports (percentages)’. Backup Publisher: CEPALSTAT | Bases de Datos y Publicaciones Estadísticas.

URL: <https://statistics.cepal.org/portal/cepalstat/dashboard.html?theme=3&lang=en>

Epo, B. N. and Nochi Faha, D. R. (2019), ‘Natural Resources, Institutional Quality, and Economic Growth: an African Tale’, *The European Journal of Development Research* **32**, 99–128.

ETC (2023), Material and Resource Requirements for the Energy Transition, Technical report, Energy Transitions Commission.

FAO (2021), *The impact of disasters and crises on agriculture and food security: 2021*, FAO.

URL: <http://www.fao.org/documents/card/en/c/cb3673en>

Ferejohn, J. (1986), ‘Incumbent Performance and Electoral Control’, *Public Choice* **50**, 5–25.

URL: <https://www.jstor.org/stable/30024650>

Fiva, J. H. and Natvik, G. J. (2013), ‘Do re-election probabilities influence public investment?’, *Public Choice* **157**, 305–331.

URL: <https://www.jstor.org/stable/42003204>

- Frankel, J. (2010), 'The Natural Resource Curse: A Survey', *National Bureau of Economic Research Working Paper Series* **15836**.
- Franklin, M. N. (2004), *Voter turnout and the dynamics of electoral competition in established democracies since 1945*, Cambridge Univ. Press.
- Frederiksen, T. and Banks, G. (2022), 'Can Mining Help Deliver the SDGs: Discourses, Risks and Prospects', *The Journal of Environment & Development* **32**, 107049652211397.
- Friedl, M. and Sulla-Menashe, D. (2022), 'MODIS/Terra+Aqua Land Cover Type Yearly L3 Global 0.05Deg CMG V061'.
URL: <https://lpdaac.usgs.gov/products/mcd12c1v061/>
- FUNDESA (2020), 'Índice de Competitividad Local'. Backup Publisher: www.fundesa.org.gt.
URL: <https://www.fundesa.org.gt/indices-y-evaluaciones-de-pais/indice-de-competitividad-local>
- Galindo-Silva, H. (2015), 'New parties and policy outcomes: Evidence from Colombian local governments', *Journal of Public Economics* **126**, 86–103.
- Gallego, J. (2018a), 'Civil conflict and voting behavior: Evidence from Colombia', *Conflict Management and Peace Science* **35**, 601–621.
URL: <https://www.jstor.org/stable/26959419>
- Gallego, J. (2018b), 'Natural disasters and clientelism: The case of floods and landslides in Colombia', *Electoral Studies* **55**, 73–88.
URL: <https://www.sciencedirect.com/science/article/pii/S0261379418301987>
- Girard, V., Molina-Millán, T. and Vic, G. (2022), 'Artisanal mining in Africa', *Novafrica* .
URL: <https://novafrica.org/research/artisanal-mining-in-africa/>
- Goodman-Bacon, A. (2021), 'Difference-in-differences with variation in treatment timing', *Journal of Econometrics* **225**.
URL: <https://www.sciencedirect.com/science/article/abs/pii/S0304407621001445>
- Gylfason, T. (2001), 'Natural resources, education, and economic development', *European Economic Review* **45**, 847–859.
URL: <https://www.sciencedirect.com/science/article/pii/S0014292101001271>
- Gómez, A. P. (2023), 'Fondos regionales de desarrollo productivo: análisis del Sistema General de Regalías (SGR) de Colombia'.

URL: <https://www.cepal.org/es/publicaciones/48773-fondos-regionales-desarrollo-productivo-analisis-sistema-general-regalias-sgr>

Haber, S. and Menaldo, V. A. (2012), ‘Natural Resources in Latin America: Neither Curse Nor Blessing’, *Oxford Handbook of Latin American Political Economy*.

URL: <https://ssrn.com/abstract=1625504>

Hainmueller, J. (2012), ‘Entropy Balancing for Causal Effects: A Multivariate Reweighting Method to Produce Balanced Samples in Observational Studies’, *Political Analysis* **20**, 25–46.

Haney, M. and Shkaratan, M. (2003), Mine closure and its impact on the community : five years after mine closure in Romania, Russia and Ukraine (English), Technical report, World Bank Group.

URL: <http://documents.worldbank.org/curated/en/500791468776712950/Mine-closure-and-its-impact-on-the-community-five-years-after-mine-closure-in-Romania-Russia-and-Ukraine>

Hilson, G. and Maconachie, R. (2019), ‘Artisanal and small-scale mining and the Sustainable Development Goals: Opportunities and new directions for sub-Saharan Africa’, *Geoforum* **111**.

Holm, A., Cridland, S. and Roderick, M. (2003), ‘The use of time-integrated NOAA NDVI data and rainfall to assess landscape degradation in the arid shrubland of Western Australia’, *Remote Sensing of Environment* **85**, 145–158.

Holmberg, S., Rothstein, B. and Nasiritousi, N. (2009), ‘Quality of Government: What You Get’, *Annual Review of Political Science* **12**, 135–161.

Holmes, J. S. and Gutiérrez de Piñeres, S. A. (2013), ‘Security and economic voting: support for incumbent parties in Colombian presidential elections’, *Democratization* **20**, 1117–1143.

Humphreys, M., Sachs, J. and Stiglitz, J. E. (2007), *Escaping the resource curse*, Columbia University Press.

IBGE-Brazil (2018), ‘Population Projection | IBGE’. Backup Publisher: www.ibge.gov.br.

URL: <https://www.ibge.gov.br/en/statistics/social/population/18176-population-projection.html?&t=resultados>

ICFES (2019), ‘Saber 11° 2019-2’.

URL: https://www.datos.gov.co/Educacion/Saber-11-2019-2/ynam-y c42/abou_t_data

IEA (2021), The Role of Critical World Energy Outlook Special Report Minerals in Clean Energy Transitions, Technical report, International Energy Agency.

URL: <https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions>

IEA (2023a), Latin America Energy Outlook 2023, Technical report, IEA, Paris.

URL: <https://www.iea.org/reports/latin-america-energy-outlook-2023>

IEA (2023b), The Oil and Gas Industry in Net Zero Transitions, Technical report, IEA, Paris.

URL: <https://www.iea.org/reports/the-oil-and-gas-industry-in-net-zero-transitions>

INDEC-Argentina (2015), 'Estimaciones de población por sexo, departamento y año calendario 2010-2025.'. Edition: 1.

URL: https://www.indec.gov.ar/ftp/cuadros/poblacion/proyeccion_departamento_10_25.pdf

INE-Bolivia (2020), 'Producto Interno Bruto Departamental'.

URL: <https://www.ine.gob.bo/index.php/estadisticas-economicas/pib-y-cuentas-nacionales/producto-interno-bruto-departamental/producto-interno-bruto-departamental/>

INE-Bolivia (2021), 'Estimaciones y proyecciones de población de Bolivia, departamentos y municipios'.

INE-Chile (2019), 'Estimaciones y proyecciones de la población de Chile 2002-2035 totales regionales, población urbana y rural'.

URL: <https://www.ine.cl/estadisticas/sociales/demografia-y-vitales/proyecciones-de-poblacion>

INE-Guatemala (2020), 'Proyecciones Departamentales 2010-2050'.

URL: <https://www.ine.gob.gt/ine/proyecciones/>

INE-Honduras (2021), *XVII Censo Nacional de Población y VI de Vivienda 2013: PROYECCIONES DE POBLACIÓN POR DEPARTAMENTO 2013-2030*, Vol. 10, Instituto Nacional de Estadísticas.

URL: <https://www.ine.gob.hn/V3/proyecciones-por-departamento-2014-2030/>

INE-Paraguay (2015), 'Paraguay. Proyección de la Población por Sexo y Edad, según Departamento, 2000-2025. Revisión 2015'.

URL: https://www.ine.gov.py/Publicaciones/Biblioteca/documento/b8e6_Proyecciones%20Departamentales%20-%20final.pdf

INE-Uruguay (2014), 'Estimaciones y proyecciones de la población de Uruguay: metodología y resultados Revisión 2013'.

URL: <https://www.ine.gub.uy/web/guest/estimaciones-y-proyecciones>

INE-Venezuela (2021), ‘Proyecciones de poblacion con base al censo 2011’.

URL: http://www.ine.gov.ve/index.php?option=com_content&view=category&id=98&Itemid=51

INEC-Costa Rica (2021), ‘Estadísticas demográficas. 2011 – 2025. Proyecciones nacionales. Población total proyectada al 30 de junio por grupos de edades, según provincia y sexo’. Backup Publisher: Instituto nacional de estadística y censos de Costa Rica.

URL: <https://www.inec.cr/poblacion/estimaciones-y-proyecciones-de-poblacion>

INEC-Ecuador (2012), ‘Proyección por edades Provincias 2010-2020 y nacional’.

URL: <https://www.ecuadorencifras.gob.ec/proyecciones-poblacionales/>

INEC-Panama (2013), ‘Estimaciones y proyecciones de la población total del país, por provincia, comarca indígena, distrito y corregimiento, según sexo y edad: Años 2010-20’.

URL: https://www.inec.gob.pa/publicaciones/Default3.aspx?ID_PUBLICACION=556&ID_CATEGORIA=3&ID_SUBCATEGORIA=10

INEI-Peru (2019), ‘Perú: Estimaciones y Proyecciones de la Población Nacional, 1950-2070’. Backup Publisher: www.inei.gob.pe.

URL: <https://www.inei.gob.pe/estadisticas/indice-tematico/poblacion-y-vivienda/>

INIDE-Nicaragua (2021), ‘Anuarios Estadísticos 2010-2019’. Backup Publisher: www.inide.gob.ni.

URL: <https://www.inide.gob.ni/Home/Anuarios>

International Monetary Fund (2012), ‘Fiscal regimes for Extractive Industries—Design and Implementation’.

URL: <https://www.imf.org/external/np/pp/eng/2012/081512.pdf>

IPCC (2022), *Global Warming of 1.5°C: IPCC Special Report on Impacts of Global Warming of 1.5°C above Pre-industrial Levels in Context of Strengthening Response to Climate Change, Sustainable Development, and Efforts to Eradicate Poverty*, 1 edn, Cambridge University Press.

URL: <https://www.cambridge.org/core/product/identifier/9781009157940/type/book>

Ishiyama, J., Martinez, M. and Ozsut, M. (2018), ‘Do “Resource-Cursed States” Have Lower Levels of Social and Institutional Trust? Evidence from Africa and Latin America’, *Social Science Quarterly* **99**(3), 872–894.

URL: <https://onlinelibrary.wiley.com/doi/10.1111/ssqu.12474>

Keefer, P. and Scartascini, C., eds (2022), *Trust: The Key to Social Cohesion and Growth in Latin America and the Caribbean*, Inter-American Development Bank. Backup Publisher: flagships.iadb.org.

- URL:** <https://flagships.iadb.org/en/DIA2021/Trust-The-Key-to-Social-Cohesion-and-Growth-in-Latin-America-and-the-Caribbean>
- Klašnja, M. and Titunuk, R. (2017), ‘The Incumbency Curse: Weak Parties, Term Limits, and Unfulfilled Accountability’, *American Political Science Review* **111**, 129–148.
- URL:** <https://pdfs.semanticscholar.org/d0b3/2b531c5182283b9b97e07d0e0ab59a651a7c.pdf>
- Knutsen, C. H., Kotsadam, A., Olsen, E. H. and Wig, T. (2016), ‘Mining and Local Corruption in Africa’, *American Journal of Political Science* **61**, 320–334.
- Konte, M. and Vincent, R. C. (2021), ‘Mining and quality of public services: The role of local governance and decentralization’, *World Development* **140**, 105350.
- URL:** <https://linkinghub.elsevier.com/retrieve/pii/S0305750X20304782>
- Kraay, A., Kaufmann, D. and Mastruzzi, M. (2010), *The worldwide governance indicators : methodology and analytical issues*, World Bank. Backup Publisher: Policy Research Working Papers.
- URL:** <http://info.worldbank.org/governance/wgi/pdf/WGI.pdf>
- Kroll, C. and Zipperer, V. (2020), ‘The Political Economy of the Sustainable Development Goals (SDGs): Does Performance on the SDGs Affect Re-Election?’, *Sustainability* **12**, 6445.
- Kukolowicz, P. and Górecki, M. A. (2017), ‘When incumbents can only gain: economic voting in local government elections in Poland’, *West European Politics* **41**, 640–659.
- Lei, Y.-H. and Michaels, G. (2014), ‘Do giant oilfield discoveries fuel internal armed conflicts?’, *Journal of Development Economics* **110**, 139–157.
- Leite, C. A. and Weidmann, J. (1999), ‘Does Mother Nature Corrupt? Natural Resources, Corruption, and Economic Growth’, *IMF Working Papers Working Paper No. 99/85*.
- URL:** <https://www.imf.org/en/Publications/WP/Issues/2016/12/30/Does-Mother-Nature-Corrupt-Natural-Resources-Corruption-and-Economic-Growth-3126>
- List, J. A. and Sturm, D. M. (2006), ‘How Elections Matter: Theory and Evidence from Environmental Policy’, *The Quarterly Journal of Economics* **121**, 1249–1281.
- URL:** <https://www.jstor.org/stable/25098826>
- Llop, M. and Arauzo Carod, J. M. (2024), ‘Quantifying the Contribution of the Oil Refining Industry to World Gross Production’.
- URL:** <https://www.ssrn.com/abstract=4877549>

- Loveridge, S. and Jackson, R., eds (1999), *Regional Governance, Institutions and Development*, WVU Research Repository. Backup Publisher: 1999.
URL: <https://researchrepository.wvu.edu/rri-web-book/30/>
- Ma, R., Gao, J., Guan, C. and Zhang, B. (2024), ‘Coal mine closure substantially increases terrestrial water storage in China’, *Communications Earth & Environment* **5**(1), 418.
URL: <https://www.nature.com/articles/s43247-024-01589-z>
- Maizland, L. (2023), ‘Global Climate Agreements: Successes and Failures | Council on Foreign Relations’.
URL: <https://www.cfr.org/backgroundunder/paris-global-climate-change-agreements>
- Mamo, N., Bhattacharyya, S. and Moradi, A. (2019), ‘Intensive and extensive margins of mining and development: Evidence from Sub-Saharan Africa’, *Journal of Development Economics* **139**, 28–49.
- Marais, L., Ndaguba, E., Mmbadi, E., Cloete, J. and Lenka, M. (2022), ‘Mine closure, social disruption, and crime in South Africa’, *The Geographical Journal* **188**(3), 383–400.
URL: <https://rgs-ibg.onlinelibrary.wiley.com/doi/10.1111/geoj.12430>
- Mehlum, H., Moene, K. and Torvik, R. (2006), ‘Institutions and the Resource Curse’, *The Economic Journal* **116**, 1–20.
- Merino-Saum, A., Baldi, M. G., Gunderson, I. and Oberle, B. (2018), ‘Articulating natural resources and sustainable development goals through green economy indicators: A systematic analysis’, *Resources, Conservation and Recycling* **139**, 90–103.
- Michael, S., Strongman, J., Perks, R., Nguyen, H. B. T., Cunningham, W., Schmillen, A. and McCormick, M. (2018), *Managing Coal Mine Closure : Achieving a Just Transition for All*, Technical report, World Bank Group.
URL: <http://documents.worldbank.org/curated/en/484541544643269894/Managing-Coal-Mine-Closure-Achieving-a-Just-Transition-for-All>
- MINERPA (2021), ‘Producto Interno Bruto real provincial’.
URL: <https://minerpa.com.pa/producto-interno-bruto-real-provincial/>
- Ministerio de Hacienda Argentina (2021), ‘Indicadores de Demanda’. Backup Publisher: Datos Provinciales.
URL: <https://datosproductivos.mecan.gov.ar/>
- Mitchell, K. N., Ramos Gómez, M. S., Guerrero Barrera, A. L., Yamamoto Flores, L., Flores de la Torre, J. A. and Avelar González, F. J. (2016), ‘Evaluation of Environmental Risk of Metal Contam-

- inated Soils and Sediments Near Mining Sites in Aguascalientes, Mexico’, *Bulletin of Environmental Contamination and Toxicology* **97**, 216–224.
- Monzalvo-Santos, K., Catalina, M., Chapa-Vargas, L., Castro-Larragoitia, J. and Rodríguez-Estrella, R. (2016), ‘Arsenic and lead contamination in soil and in feathers of three resident passerine species in a semi-arid mining region of the Mexican plateau’, *Journal of Environmental Science and Health, Part A* **51**, 825–832.
- Morales, M. and Belmar, F. (2022), ‘Clientelism, Turnout and Incumbents’ Performance in Chilean Local Government Elections’, *Social Sciences* **11**, 361.
- Moshiri, S., & Oslash;stenstad, G. and Vermeulen, W. (2020), ‘Manufacturing in a Natural Resource Based Economy: Evidence from Canadian Plants’, *SSRN Electronic Journal* .
URL: <https://www.ssrn.com/abstract=3722253>
- Muñoz-Sabater, J., Dutra, E., Agustí-Panareda, A., Albergel, C., Arduini, G., Balsamo, G., Boussetta, S., Choulga, M., Harrigan, S., Hersbach, H., Martens, B., Miralles, D. G., Piles, M., Rodríguez-Fernández, N. J., Zsoter, E., Buontempo, C. and Thépaut, J.-N. (2021), ‘ERA5-Land: a state-of-the-art global reanalysis dataset for land applications’, *Earth System Science Data* **13**(9), 4349–4383.
URL: <https://essd.copernicus.org/articles/13/4349/2021/>
- NASA (2024a), ‘Effects - NASA Science’.
URL: <https://science.nasa.gov/climate-change/effects/>
- NASA (2024b), ‘Evidence - NASA Science’.
URL: <https://science.nasa.gov/climate-change/evidence/>
- North, D. (1990), *Institutions, Institutional Change and Economic Development*, London: Cambridge University Press.
- Oda, T. and Maksyutov, S. (2015), ‘ODIAC Fossil Fuel CO2 Emissions Dataset Version: ODIAC2022’.
URL: [10.17595/20170411.001](https://doi.org/10.17595/20170411.001)
- OECD (2019), *Strong Foundations for Quality and Equity in Mexican Schools*, Implementing Education Policies, OECD.
URL: https://www.oecd.org/en/publications/strong-foundations-for-quality-and-equity-in-mexican-schools_9789264312548-en.html
- OECD (2020a), ‘Regional Economy’.
URL: https://stats.oecd.org/Index.aspx?DataSetCode=REGION_ECONOM

OECD (2020b), *A Territorial Approach to the Sustainable Development Goals*, OECD. Backup Publisher: OECD Urban Policy Reviews.

URL: <https://www.oecd.org/cfe/cities/SDGs-policy-highlights.pdf>

OECD (2024), *Government at a Glance: Latin America and the Caribbean 2024*, OECD.

ONE-Dominic Republic (2016), ‘Estimaciones y proyecciones de la población total por año calendario, según región y provincia, 2000-2030’.

URL: <https://www.one.gob.do/datos-y-estadisticas/temas/estadisticas-demograficas-y-sociales/demograficas/poblacion-y-migracion/estimaciones-y-proyecciones-demograficas/>

OTU, OPP (2018), ‘Participación Departamental en la Actividad Económica (%)’. Backup Publisher: Observatorio territorio Uruguay - OPP.

URL: https://otu.opp.gub.uy/filtros/buscar_indicadores

Papirakis, E. and Pellegrini, L. (2019), ‘The Resource Curse in Latin America’, *Oxford Research Encyclopedia of Politics*.

Pelzl, P. and Poelhekke, S. (2021), ‘Good mine, bad mine: Natural resource heterogeneity and Dutch disease in Indonesia’, *Journal of International Economics* **131**, 103457.

URL: <https://linkinghub.elsevier.com/retrieve/pii/S0022199621000349>

Peterson, G. E. (1997), ‘Decentralization in Latin America Learning through Experience’, *World Bank Latin American and Caribbean Studies*.

Pettorelli, N., Vik, J. O., Mysterud, A., Gaillard, J.-M., Tucker, C. J. and Stenseth, N. C. (2005), ‘Using the satellite-derived NDVI to assess ecological responses to environmental change’, *Trends in Ecology & Evolution* **20**, 503–510.

Policía Nacional de Colombia (2018), ‘Estadística delictiva’.

URL: <https://www.policia.gov.co/estadistica-delictiva>

Procuraduría General de la Nación (2020), ‘Antecedentes de SIRI’.

URL: https://www.datos.gov.co/en/Funcion-p-blica/Antecedentes-de-SIRI/iaeu-rcn6/about_data

Rau, T., Urzúa, S. and Reyes, L. (2015), ‘Early Exposure to Hazardous Waste and Academic Achievement: Evidence from a Case of Environmental Negligence’, *Journal of the Association of Environmental and Resource Economists* **2**, 527–563.

- Registraduría Nacional del Estado Civil (2023), ‘Histórico de resultados electorales’. Backup Publisher: Registraduría Nacional.
URL: <https://www.registraduria.gov.co/-Historico-de-resultados-electorales-.html>
- Registraduría Nacional del Estado Civil (2024), ‘Cronología del voto en Colombia’.
URL: <https://www.registraduria.gov.co/Cronologia-del-voto-en-Colombia-636.html>
- Rodrik, D., Subramanian, A. and Trebbi, F. (2004), ‘Institutions Rule: The Primacy of Institutions Over Geography and Integration in Economic Development’, *Journal of Economic Growth* **9**, 131–165.
- Rodríguez-Pose, A. (2013), ‘Do Institutions Matter for Regional Development?’, *Regional Studies* **47**, 1034–1047.
- Roodman, D. (2009), ‘How to do Xtabond2: An Introduction to Difference and System GMM in Stata’, *The Stata Journal: Promoting communications on statistics and Stata* **9**(1), 86–136.
URL: <http://journals.sagepub.com/doi/10.1177/1536867X0900900106>
- Ross, M. L. (2001), ‘Does Oil Hinder Democracy?’, *World Politics* **53**, 325–361.
- Ross, M. L. (2015), ‘What Have We Learned about the Resource Curse?’, *Annual Review of Political Science* **18**(1), 239–259.
URL: <https://www.annualreviews.org/doi/10.1146/annurev-polisci-052213-040359>
- Rosser, A. (2006), ‘The Political Economy of the Resource Curse: A Literature Survey’.
URL: <https://open.do.cs.ids.ac.uk/open-docs/bitsstream/handle/20.500.12413/4061/Wp268.pdf?sequence=1&isAllowed=y>
- Saade Hazin, M. (2013), ‘Desarrollo minero y conflictos socioambientales: los casos de Colombia, México y el Perú’, *Serie Macroeconomía del Desarrollo* **137**.
URL: <https://repositorio.cepal.org/handle/11362/5369>
- Sachs, J. D. and Warner, A. M. (2001), ‘The curse of natural resources’, *European Economic Review* **45**, 827–838.
URL: <https://www.sciencedirect.com/science/article/pii/S0014292101001258>
- Sachs, J., Lafortune, G. and Fuller, G. (2024), ‘The SDGs and the UN Summit of the Future. Sustainable Development Report 2024’.
URL: <https://www.tara.tcd.ie/handle/2262/108572>
- Sakurai, S. N. and Menezes-Filho, N. A. (2008), ‘Fiscal policy and reelection in Brazilian municipalities’, *Public Choice* **137**, 301–314.

- Sala-i Martin, X. and Subramanian, A. (2013), ‘Addressing the Natural Resource Curse: An Illustration from Nigeria’, *Journal of African Economies, Centre for the Study of African Economies (CSAE)* Vol **22**, 570–615.
- Salas-Muñoz, S., Valdez-Valdez, E., MauricioCastillo, J. A., SalazarBadillo, F. B., VegaCarrillo, H. R. and SalasLuevano, M. A. (2022), ‘Accumulation of As and Pb in vegetables grown in agricultural soils polluted by historical mining in Zacatecas, Mexico’, *Environmental Earth Sciences* **81**, 374.
URL: <https://doi.org/10.1007/s12665022104974>
- Secretaría de Economía de Mexico (2022), ‘Manual del Inversionista en el Sector Minero Mexicano’.
URL: https://www.economia.gob.mx/files/gobmx/mineria/manual_del_inversionista.pdf
- Sinnot, E., Nash, J. and de la Torre, A. (2011), ‘Natural Resources in Latin America and the Caribbean : Beyond Booms and Busts?’, *World Bank Latin American and Caribbean Studies* .
URL: <https://openknowledge.worldbank.org/handle/10986/2482?locale-attribute=es>
- Smith, B. (2015), ‘The resource curse exorcised: Evidence from a panel of countries’, *Journal of Development Economics* **116**, 57–73.
- Smits, J. and Permanyer, I. (2019), ‘The Subnational Human Development Database’, *Scientific Data* **6**.
URL: <https://www.nature.com/articles/sdata201938>
- Strambo, C., Thazin Aung, M. and Atteridge, A. (2019), ‘Navigating coal mining closure and societal change: learning from past cases of mining decline’, *SEI working paper* .
- Sun, L. and Abraham, S. (2021), ‘Estimating dynamic treatment effects in event studies with heterogeneous treatment effects’, *Journal of Econometrics* **225**(2), 175–199.
URL: <https://www.sciencedirect.com/science/article/pii/S030440762030378X>
- Sánchez-Reaza, J. and Rodríguez-Pose, A. (2002), ‘The Impact of Trade Liberalization on Regional Disparities in Mexico’, *Growth and Change* **33**, 72–90.
- Tetreault, D. (2022), ‘Two sides of the same coin: increasing material extraction rates and social environmental conflicts in Mexico’, *Environment, Development and Sustainability* **24**.
- Toscani, F. (2017), ‘The Impact of Natural Resource Discoveries in Latin America and the Caribbean: A Closer Look at the Case of Bolivia’, *IMF Working Papers* .
URL: <https://www.imf.org/en/Publications/WP/Issues/2017/02/10/The-Impact-of-Natural-Resource-Discoveries-in-Latin-America-and-the-Caribbean-A-Closer-Look-44652>

- Trejo Nieto, A. (2020), ‘Regional disparities in Mexico and the spatially cumulative effects of national development and economic cycles, 1940–2013’, *Regional Science Policy & Practice* **13**.
- UN General Assembly (2023), ‘Progress towards the Sustainable Development Goals: Towards a Rescue Plan for People and Planet’.
- URL:** https://sdgs.un.org/sites/default/files/2023-04/SDG_Progress_Report_t_Special_Edition_2023_ADVANCE_UNEDITED_VERSION.pdf
- UNDP (2020), ‘Informe Nacional sobre Desarrollo Humano Paraguay 2020: Desarrollo Humano y Energía’. Backup Publisher: UNDP - Paraguay.
- URL:** <https://www.py.undp.org/content/paraguay/es/home/library/informe-nacional-sobre-desarrollo-humano—paraguay-2020-desarr.html>
- UNDP, University of Costa Rica (2020), ‘Atlas de de desarrollo humano cantonal 2020 de Costa Rica’.
- URL:** <https://www.cr.undp.org/content/costarica/es/home/atlas-de-desarrollo-humano-cantonal.html>
- United Nations (2024), The Sustainable Development Goals Report 2024, Technical report, United Nations.
- United Nations Environment Programme (2023), *Emissions Gap Report 2023: Broken Record – Temperatures hit new highs, yet world fails to cut emissions (again)*, United Nations Environment Programme.
- URL:** <https://wedocs.unep.org/20.500.11822/43922>
- U.S. Geological Survey (2020), ‘Mineral commodity summaries 2020’, *Mineral Commodity Summaries* .
- Vahabi, M. (2017), ‘A critical survey of the resource curse literature through the appropriability lens.’, *hal-01583559* .
- URL:** <https://hal.science/hal-01583559>
- von der Goltz, J. and Barnwal, P. (2018), ‘Mines: The local wealth and health effects of mineral mining in developing countries’, *Journal of Development Economics* .
- Watkins, M. H. (1963), ‘A staple theory of economic growth’, *Canadian Journal of Economics and Political Science/Revue canadienne de economiques et science politique* **29**(2), 141–158.
- World Bank (2017), The Growing Role of Minerals and Metals for a Low Carbon Future, Technical report, World Bank, USA.

World Bank (2021), World Bank Group Climate Change Action Plan 2021–2025: Supporting Green, Resilient, and Inclusive Development., Technical report, World Bank Group, Washington, DC.

URL: <http://hdl.handle.net/10986/35799>

World Bank (2022), Climate and Development: an Agenda for Action - Emerging Insights from World Bank Group 2021-22 Country Climate and Development Reports, Technical report, World Bank, Washington, DC.

URL: <http://hdl.handle.net/10986/38220>

World Economic Forum, Columbia Center on Sustainable Investment and UNDP (2016), Mapping Mining to the Sustainable Development Goals: An Atlas, Technical report, World Economic Forum.

World Gold Council (2024), ‘Global mine production by country’.

URL: <https://www.gold.org/goldhub/data/gold-production-by-country>

World Meteorological Organization (2023), State of the Climate in Latin America and the Caribbean, Technical Report WMO-No. 1351, WMO, Geneva.

Wysocka, M., Nowak, S., Chałupnik, S. and Bonczyk, M. (2022), ‘Radon Concentrations in Dwellings in the Mining Area—Are There Observed Effects of the Coal Mine Closure?’, *International Journal of Environmental Research and Public Health* **19**(9), 5214.

URL: <https://www.mdpi.com/1660-4601/19/9/5214>

Résumé français

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Changement climatique

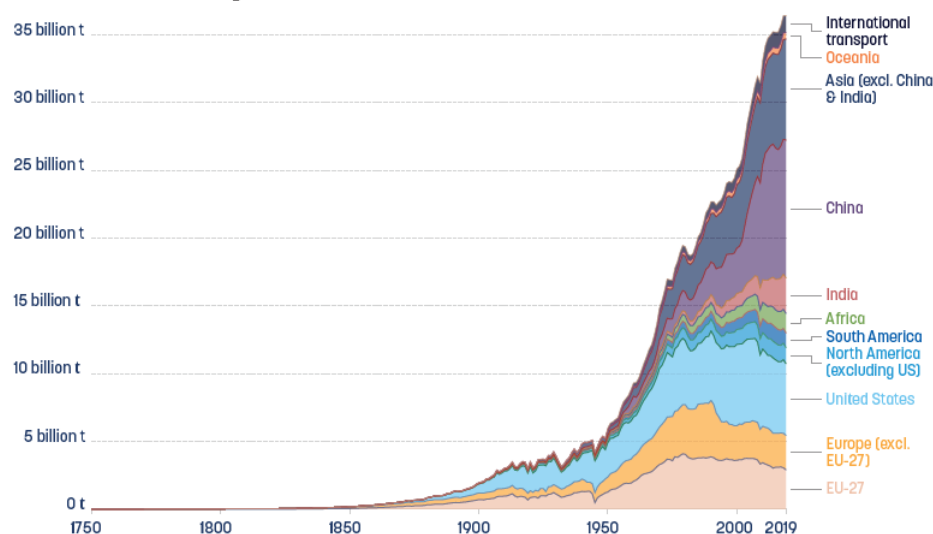
« Il est indéniable que l'influence humaine a conduit au réchauffement de l'atmosphère, les océans et les terres » (Calvin et al., 2023). En effet, on estime que les activités humaines ont provoqué un réchauffement climatique d'environ 1,0°C par rapport aux niveaux préindustriels, et cette augmentation pourrait atteindre 1,5°C entre 2030 et 2052 si les tendances actuelles se poursuivent (IPCC, 2022).

Bien que le climat de la Terre ait naturellement fluctué au cours de l'histoire, avec des cycles de périodes glaciaires et de périodes plus chaudes au cours des 800 000 dernières années, la tendance actuelle au réchauffement est fondamentalement différente. Le réchauffement rapide observé depuis le milieu du XIXe siècle est directement attribuable aux activités humaines, telles que la combustion de combustibles fossiles et la déforestation. Contrairement aux cycles naturels, ce réchauffement anthropique se produit à un rythme sans précédent, posant un défi majeur pour la civilisation humaine et les écosystèmes de la planète (NASA, 2024b).

L'effet de serre est le mécanisme principal derrière ce réchauffement rapide. Les émissions mondiales de gaz à effet de serre (GES) ont continué d'augmenter, atteignant un record de 57,4 gigatonnes d'équivalent CO₂ en 2022, soit une hausse de 1,2% par rapport à 2021 (Figure 1). Le CO₂ issu de la combustion de combustibles fossiles et des processus industriels reste le principal contributeur, représentant environ deux tiers des émissions totales de GES (United Nations Environment Programme, 2023). Malgré la croissance des énergies renouvelables, notamment grâce aux ajouts de capacité solaire, les investissements dans les combustibles fossiles se poursuivent. Inquiétant, les gouvernements mondiaux projettent toujours de produire plus du double de combustibles fossiles d'ici 2030, un niveau incompatible avec les objectifs de l'Accord de Paris.

L'inégalité dans les émissions basées sur la consommation est évidente à la fois entre et au sein des pays. À l'échelle mondiale, les 10% de la population les plus riches, en termes de revenus, sont responsables de près de la moitié (48%) des émissions totales, dont les deux tiers se trouvent dans les pays développés. En revanche, les 50% les plus pauvres de la population mondiale n'ont contribué qu'à 12% des émissions

FIGURE 1 : Evolution de GES



Émissions annuelles totales de CO₂ par région du monde. Source : World Bank (2021)

totales.

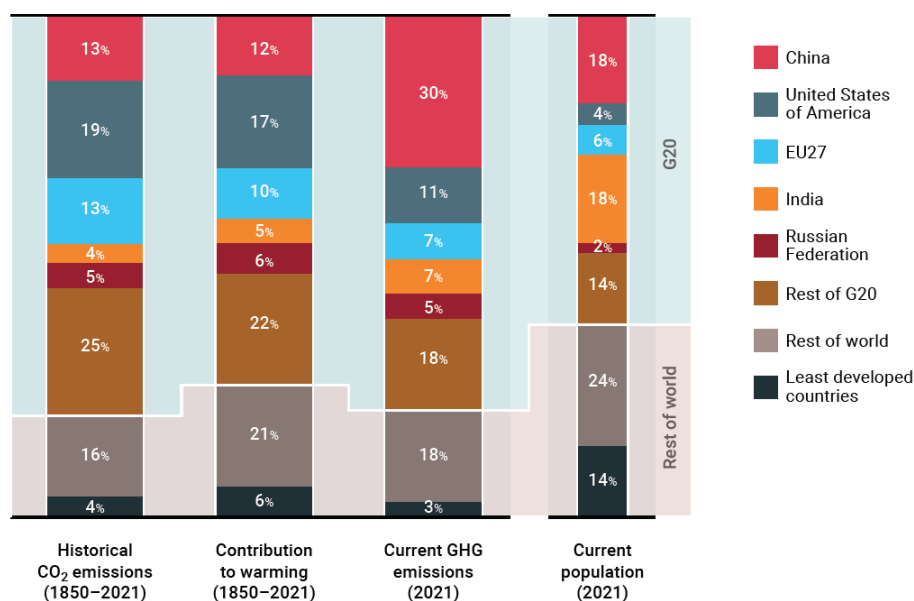
Les émissions historiques et les contributions au réchauffement climatique varient également considérablement selon les pays et les groupes de pays. Près de 80% des émissions cumulées historiques de CO₂ issues des combustibles fossiles et de l'utilisation des terres et des forêts (LULUCF) proviennent des pays du G20, avec les plus grandes contributions provenant de la Chine, des États-Unis et de l'Union européenne. En revanche, les pays les moins avancés n'ont contribué qu'à 4% de ces émissions historiques (Figure 2).

Le réchauffement climatique causé par l'homme a déjà déclenché de nombreux changements observables dans le système climatique terrestre. L'une des conséquences les plus marquantes a été la hausse des températures mondiales, qui a entraîné des vagues de chaleur plus fréquentes et plus intenses dans de nombreuses régions. En parallèle, le réchauffement global a intensifié le cycle hydrologique, entraînant des événements de précipitations abondantes plus fréquents et plus sévères à l'échelle mondiale. À l'inverse, certaines régions sont confrontées à des risques accrus de sécheresse, les changements de régimes météorologiques perturbant les niveaux de précipitations traditionnels.

Le changement climatique a déjà entraîné des impacts négatifs répandus, tant pour la nature que pour les populations. Les communautés vulnérables, en particulier celles qui ont historiquement le moins contribué au changement climatique, sont touchées de manière disproportionnée (IPCC, 2022). Environ 3,3 à 3,6 milliards de personnes vivent dans des contextes hautement vulnérables. Par exemple, de 2010 à 2020, la mortalité liée aux inondations, aux sécheresses et aux tempêtes a été 15 fois plus élevée dans les régions très vulnérables que dans celles à faible vulnérabilité.

Les dommages économiques causés par le changement climatique ont été détectés dans des secteurs

FIGURE 2 : Contributions actuelles et historiques au changement climatique



Source : United Nations Environment Programme (2023)

clés tels que l'agriculture, la foresterie, la pêche, l'énergie et le tourisme. Par exemple, la hausse du niveau des mers menace l'existence même des petites nations insulaires (NASA, 2024a), et l'insécurité alimentaire s'aggrave en Afrique (FAO, 2021).

Au cours des dernières décennies, la communauté internationale a réalisé des progrès significatifs dans la lutte contre le changement climatique, grâce à une série d'accords et d'initiatives marquants. Ces cadres visent à réduire les émissions de gaz à effet de serre, à protéger les écosystèmes vulnérables et à encourager la coopération mondiale face à cette menace. Parmi ces efforts, on peut citer le Protocole de Montréal pour la protection de la couche d'ozone, l'Accord de Paris, et les initiatives issues des conférences de la COP. Ces actions témoignent d'une reconnaissance croissante de l'urgence d'une réponse globale et coordonnée au changement climatique.

Parmi ces accords, l'Accord de Paris se distingue comme une étape cruciale dans la politique climatique, marquant un effort collectif des gouvernements pour limiter le réchauffement mondial à bien moins de 2°C et poursuivre des efforts pour le maintenir en dessous de 1,5°C. Cet accord non seulement fixe des objectifs ambitieux, mais jette également les bases de la transition vers la décarbonisation, une étape essentielle pour répondre à la demande énergétique tout en réduisant la dépendance aux combustibles fossiles. La section suivante explorera les implications de la décarbonisation et la demande croissante d'énergies renouvelables, qui sont essentielles pour atteindre les objectifs fixés dans l'Accord de Paris.

L'Accord de Paris vise à limiter le réchauffement climatique à bien en dessous de 2°C, avec pour objectif idéal de le maintenir à 1,5°C. Atteindre cet objectif nécessite une transformation profonde du

système énergétique mondial. La figure 3 illustre divers scénarios visant différents seuils de réchauffement climatique, allant de 1,5°C à 4,4°C. Ces scénarios sont caractérisés par une réduction significative des émissions de gaz à effet de serre (GES), avec des projections montrant une neutralité carbone autour de 2050, suivie de niveaux variables d'émissions négatives de CO₂ (IPCC, 2022).

Répondre à cet ambitieux défi exige un système énergétique propre, principalement axé sur l'électrification verte. Cela implique le déploiement rapide de technologies d'énergie propre au cours de cette décennie et au-delà. La consommation mondiale d'électricité devrait connaître une hausse spectaculaire, passant d'environ 28 000 TWh en 2022 à près de 110 000 TWh d'ici 2050, avec plus de 75% de cette électricité provenant de l'énergie éolienne et solaire. Parallèlement, une expansion massive des réseaux électriques sera nécessaire, ainsi qu'une décarbonisation quasi complète du parc automobile mondial d'ici 2050 (ETC, 2023).

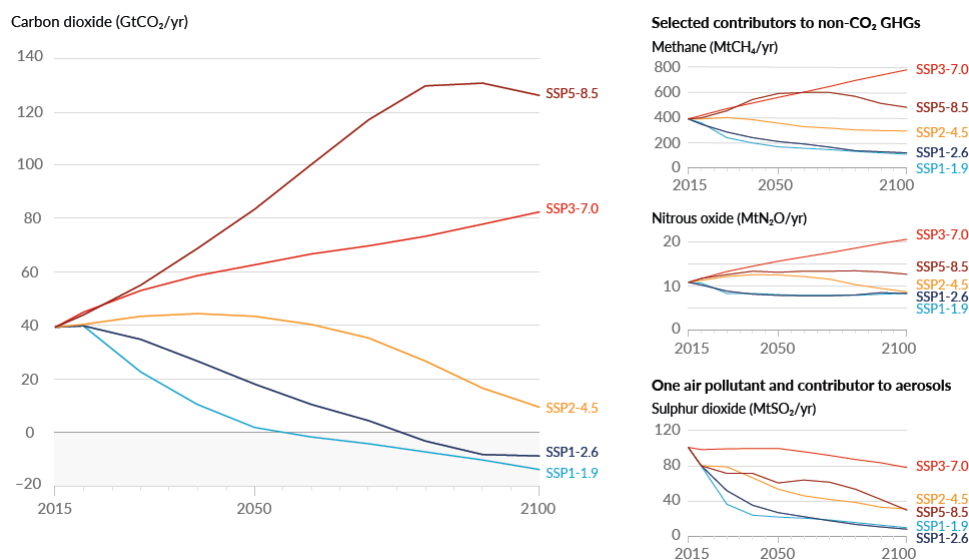
Cependant, le déploiement des énergies vertes dépend fortement des métaux et minéraux nécessaires à la transition énergétique (MTE). Le tableau 1 présente les matériaux clés utilisés pour l'énergie éolienne et solaire, ainsi que pour les batteries électriques. Les technologies d'énergie propre devraient considérablement augmenter la demande pour certains de ces matériaux essentiels (ETC, 2023). Par exemple, World Bank (2017) suggère que, selon le scénario, la demande de certains éléments pourrait augmenter de 150% à plus de 1,000%, notamment pour les métaux nécessaires à la fabrication de batteries électriques.

Cette hausse de la demande met en lumière le rôle crucial que joueront des métaux comme le lithium, le cobalt et le nickel dans la transition énergétique mondiale. Entre 2022 et 2050, la transition énergétique pourrait nécessiter environ 6,5 milliards de tonnes de matériaux, avec l'acier, le cuivre et l'aluminium représentant 95% de ce total. Bien que ces matériaux soient requis en grande quantité, d'autres, tels que le lithium, nécessiteront environ 20 millions de tonnes sur cette période. Malgré ces besoins importants, les ressources minérales connues sur Terre sont suffisantes pour répondre à la demande future jusqu'en 2050 (ETC, 2023).

Néanmoins, certains matériaux, comme le cuivre, le nickel et l'argent, pourraient faire face à des pénuries si la demande augmente rapidement sans avancées technologiques, gains d'efficacité ou recyclage. Dans ce cas, les réserves devraient croître de 30% pour le cuivre, de 70% pour le nickel et de 90% pour l'argent afin de répondre aux besoins estimés dans tous les secteurs d'ici 2050 (ETC, 2023). Actuellement, en tenant compte des mines existantes et de celles en construction, la capacité installée ne couvrirait que la moitié de la demande prévue pour le lithium et le cobalt, et 80% de celle pour le cuivre nécessaires aux objectifs climatiques d'ici 2030 (IEA, 2021).

Pour surmonter cette pression sur l'offre, des investissements dans l'exploration et la construction de nouvelles mines seront nécessaires afin de diversifier les chaînes d'approvisionnement et répondre à la demande croissante. À cet égard, les pays en développement disposent d'opportunités stratégiques

FIGURE 3 : Future annual GHGs emissions



pour jouer un rôle central dans les chaînes d'approvisionnement nécessaires à la réalisation des objectifs climatiques. World Bank (2017) met en évidence un manque de données fiables et actualisées concernant la cartographie des ressources minérales et métalliques dans ces pays. De plus, il existe des opportunités liées à la production de métaux par rapport aux réserves estimées. Si les pays relativement développés jouent un rôle majeur dans la production de certaines ressources, les réserves des éléments critiques sont largement concentrées dans les pays en développement.

TABLE 1 : Matériaux clés pour les technologies vertes sélectionnées

	Wind	Solar	Batteries
Aluminium	X	X	X
Chrome	X		
Cobalt			X
Cuivre	X	X	
Terres rares		X	
Fer	X	X	
Plomb	X	X	X
Lithium			X
Manganèse	X		X
Nickel	X	X	X
Argent		X	
Acier	X		X
Zinc	X	X	

L'Amérique latine, le changement climatique et les MTE

L'ALC (Amérique Latine et les Caraïbes) représentent environ 7% des émissions mondiales de gaz à effet

de serre (GES). Cela reste relativement faible comparé à des pays comme la Chine (30%), les États-Unis (11%) et l'Inde (7%). Dans la région, les principaux émetteurs sont l'Argentine, le Brésil, le Mexique et le Venezuela, qui génèrent ensemble 70% des émissions de l'ALC (Cárdenas et Orozco, 2023).

L'ALC se distingue par une composition spécifique de ses émissions. Le CO₂ représente 43% des émissions totales en équivalent CO₂, bien en dessous de la moyenne mondiale (74%). Par contre, le secteur agricole, forestier et l'utilisation des terres (AFOLU) constitue 40% des émissions totales de la région, presque le double de la moyenne mondiale. Cette tendance s'explique par la présence d'industries nécessitant beaucoup de terres et par une matrice énergétique plus propre, où environ 60% de l'électricité provient de sources renouvelables (Cárdenas et Orozco, 2023).

Comme d'autres régions, l'ALC ressent déjà les effets du changement climatique. En 2023, la région a connu des températures moyennes record, des anomalies de précipitations fréquentes et un recul des glaciers. Le sud-est de l'Amérique du Sud est particulièrement touché, avec une augmentation des vagues de chaleur, une baisse probable des vagues de froid, et plus de précipitations moyennes et intenses (World Meteorological Organization, 2023).

Les événements météorologiques extrêmes, comme les tempêtes tropicales, fortes pluies, inondations et glissements de terrain, sont de plus en plus fréquents. En 2023, des sécheresses ont frappé durement l'Amérique centrale, le Mexique, l'Amazonie, ainsi que plusieurs régions du sud du continent. Ces sécheresses ont été accompagnées de vagues de chaleur et d'incendies de forêt. Rien qu'en 2023, les événements climatiques ont causé 909 morts et affecté 11 millions de personnes (World Meteorological Organization, 2023).

Le secteur agricole est particulièrement vulnérable. L'Amérique latine a connu les pertes les plus importantes en termes de production agricole et animale, entraînant la plus forte réduction de l'apport calorique par rapport à d'autres régions (FAO, 2021).

Malgré ces défis, la lutte contre le changement climatique offre des opportunités pour plusieurs pays de la région. L'Amérique latine est bien placée pour devenir un acteur clé de la transition énergétique mondiale. Le Brésil, le Chili, l'Argentine et le Pérou sont parmi les pays les mieux positionnés, et la Bolivie pourrait également en tirer parti si elle réussit à exploiter pleinement ses vastes ressources en lithium. La région dispose d'avantages stratégiques dans la production de cuivre, de minerai de fer, d'argent et de lithium, et joue également un rôle important dans les secteurs de l'aluminium, du nickel, du manganèse et du zinc (World Bank, 2017). D'autres pays de la région possèdent également des mines en exploitation et des réserves probables de ces métaux essentiels (Figure 4).

Alors que la demande mondiale de MTE augmente, l'Amérique latine jouera un rôle essentiel dans la transition énergétique mondiale. Cependant, cette opportunité s'accompagne de défis. Les organisations internationales reconnaissent de plus en plus les bénéfices potentiels du secteur pour le développement

FIGURE 4 : Activité minière des métaux de transition énergétique (MTE)



Élaboration de l'auteur. Source : U.S. Geological Survey (2020)

économique, mais elles sous-estiment souvent les impacts négatifs sur les communautés locales. Une vaste littérature souligne les effets néfastes de l'extraction des ressources naturelles, comme les faibles performances économiques. Ces aspects seront explorés en détail dans la section suivante.

Malédiction des ressources naturelles et développement

En 1993, Auty et Warhurst a introduit le terme de « malédiction des ressources naturelles » pour décrire la corrélation négative entre la dépendance aux ressources naturelles et les faibles performances économiques. Plus tard, Sachs et Warner (2001) a approfondi ce concept en montrant qu'entre les années 1970 et le début des années 2000, de nombreux pays riches en ressources ont connu une stagnation de leur croissance économique. Ce paradoxe a suscité une vaste littérature sur le sujet. Par exemple, des pays comme Hong Kong, le Japon, la Corée du Sud et Singapour, qui possèdent très peu de ressources naturelles, ont atteint un niveau de vie équivalent à celui des pays occidentaux. En revanche, de nombreux pays riches en ressources, notamment en Afrique, au Moyen-Orient et en Amérique latine, malgré leur abondance en pétrole, minéraux et autres ressources, ont obtenu des résultats économiques bien moins satisfaisants.

La littérature attribue ces résultats préoccupants à divers mécanismes. Les ressources naturelles présentent des caractéristiques spécifiques qui les rendent uniques. Contrairement à d'autres secteurs, elles ne

sont généralement pas produites, mais extraites, ce qui signifie qu'il n'y a pas de processus de production conventionnel. Ainsi, la richesse en ressources naturelles peut émerger indépendamment des autres activités économiques d'un pays (Humphreys et al., 2007). Cela est particulièrement vrai pour l'extraction des hydrocarbures, qui nécessite des équipements spécialisés et un capital humain souvent absent des zones d'extraction. De plus, de nombreuses ressources naturelles sont non renouvelables, ce qui implique que leur extraction entraîne l'épuisement des actifs d'un pays. Pour assurer une croissance durable, il est donc essentiel que les revenus tirés de ces ressources soient réinvestis dans d'autres formes de capital, garantissant ainsi que les générations actuelles et futures puissent en bénéficier.

Les secteurs des matières premières, notamment ceux des hydrocarbures et des métaux, génèrent des rentes élevées, mais cette dépendance aux ressources peut entraîner des risques économiques. Un de ces risques est le phénomène de la *Dutch disease* (Gylfason, 2001), où l'augmentation des exportations de matières premières entraîne une appréciation du taux de change réel, détournant ainsi des ressources d'autres secteurs économiques. Sachs et Warner (2001) a démontré que l'abondance de ressources provoque une hausse des prix domestiques, rendant la compétition des industries manufacturières sur les marchés internationaux plus difficile.

La volatilité des prix des ressources naturelles constitue également un frein au développement. Lorsque les pays sont fortement dépendants des matières premières, cette volatilité accroît l'incertitude et les risques, décourageant les investissements. De plus, les politiques budgétaires procycliques adoptées par les gouvernements en période de hausse des prix des matières premières peuvent avoir des effets néfastes à long terme. En effet, lorsque les prix sont élevés, les gouvernements ont tendance à augmenter leurs dépenses, ce qui crée des difficultés lorsque les prix baissent. L'incapacité à ajuster les dépenses publiques face à la chute des prix internationaux peut significativement réduire les recettes de l'État, exacerbant ainsi la nature cyclique de l'économie.

Enfin, les rentes élevées issues des ressources naturelles peuvent affaiblir la qualité des institutions. La relation entre ressources naturelles et institutions a été largement discutée dans la littérature, souvent à travers deux effets principaux : l'effet antidémocratique Ross (2001); Frankel (2010) et l'augmentation de la corruption (Knutsen et al., 2016; Sala-i Martin et Subramanian, 2013; Sinnot et al., 2011; Leite et Weidmann, 1999).

Qualité des institutions et de la gouvernance

Bien que la littérature sur la malédiction des ressources naturelles explique comment ces dernières peuvent conduire à de faibles performances économiques et à des institutions faibles, elle ne tient pas pleinement compte des cas où des pays riches en ressources ont réussi à obtenir de bons résultats économiques. Plusieurs tentatives ont été faites pour réconcilier ces résultats divergents, en mettant l'accent sur

l'importance des liens économiques (ou linkages) et de la qualité des institutions dans la détermination de l'impact économique des ressources naturelles.

L'une des premières tentatives pour expliquer ces résultats positifs est la *Staple Theory*. Cette théorie montre comment les liens économiques créés par les matières premières (*staples*) favorisent le développement économique (Watkins, 1963). Selon cette théorie, les industries basées sur les ressources naturelles génèrent des liens en amont et en aval qui stimulent les investissements liés à la matière première, ainsi que des liens liés à la demande générée par les revenus du secteur des matières premières.

Ces liens peuvent favoriser la diversification et le développement économique. Cependant, en l'absence de ces liens, un pays peut tomber dans ce que l'on appelle un piège des produits de base (*staple trap*), où la diversification économique échoue à se concrétiser (Vahabi, 2017). Le succès d'un pays à développer ces liens dépend souvent des caractéristiques de la ressource elle-même et de sa capacité à stimuler des activités économiques plus larges par son extraction et sa transformation.

Une vision plus contemporaine et largement acceptée dans la littérature est que les ressources naturelles peuvent être une bénédiction ou une malédiction en fonction de la qualité des institutions. Comme le soutiennent Boschini et al. (2007), l'impact des ressources n'est pas déterminé uniquement par l'abondance des ressources, mais plutôt par l'interaction entre le type de ressources dont un pays dispose et la qualité de ses institutions.

Cette approche conditionnelle suggère que les ressources naturelles peuvent soit stimuler, soit freiner la croissance économique en fonction de l'environnement institutionnel. Si un pays dispose d'institutions de haute qualité, favorables à la production, les ressources naturelles contribueront positivement à la croissance économique en garantissant que les rentes tirées des ressources soient efficacement investies dans le développement à long terme. En revanche, en présence d'institutions faibles ou orientées vers la prédation—où la recherche de rentes et la corruption dominent—les ressources naturelles peuvent aggraver la mauvaise gouvernance et freiner le développement.

De nombreuses études soutiennent cette perspective. Par exemple, Mehlum et al. (2006) et Bhattacharyya et Hodler (2010) montrent que la qualité des institutions joue un rôle crucial dans la détermination de l'impact des ressources naturelles, qu'il soit positif ou négatif. Ils soutiennent que les institutions influencent la gestion des rentes des ressources : des institutions solides favorisent la transparence, la responsabilité et l'investissement productif, tandis que des institutions faibles encouragent la recherche de rentes, la corruption et la mauvaise gestion des ressources. De même, Cust et Harding (2019) et Coutenier et al. (2017) renforcent cette vue en fournissant des preuves montrant que la bonne gouvernance aide à atténuer les effets néfastes de la dépendance aux ressources.

Cette approche institutionnelle est de plus en plus reconnue comme un moyen de réconcilier les résultats contrastés dans la littérature sur la malédiction des ressources. Des chercheurs tels que Acemoglu et

Robinson (2012), North (1990) et Rodrik et al. (2004) soutiennent que la qualité institutionnelle est le facteur le plus déterminant pour un développement durable. Selon ces chercheurs, des institutions bien fonctionnelles créent un cadre dans lequel la richesse en ressources peut être exploitée à des fins productives, notamment l'investissement dans les infrastructures, l'éducation et la diversification de l'économie.

En résumé, la littérature souligne de plus en plus que les résultats économiques liés à la richesse en ressources naturelles ne sont pas prédéterminés par la ressource elle-même, mais par la qualité des institutions en place. De bonnes institutions permettent de canaliser les rentes des ressources vers des investissements productifs qui favorisent la croissance à long terme, tandis que des institutions faibles créent un terrain fertile pour la recherche de rentes, la corruption et la stagnation économique.

Bien que la littérature sur la malédiction des ressources se concentre traditionnellement sur les résultats au niveau national, il est de plus en plus reconnu qu'il est important d'analyser la dépendance aux ressources et ses effets à un niveau infranational. Dans les pays riches en ressources, la concentration des activités extractives varie souvent considérablement d'une région à l'autre, entraînant des résultats économiques, sociaux et institutionnels divergents. Les régions infranationales fortement dépendantes des ressources naturelles peuvent connaître des dynamiques similaires à celles observées au niveau national, telles que la stagnation économique ou l'affaiblissement institutionnel.

De plus, la qualité institutionnelle peut différer au sein d'un même pays, certaines régions affichant une meilleure gouvernance que d'autres. Un exemple typique est celui de l'Italie, où la qualité des institutions est plus élevée dans les régions du nord. La qualité institutionnelle locale peut jouer un rôle significatif dans le contexte de la malédiction des ressources, bien que la littérature à ce sujet reste relativement limitée, et encore plus lorsqu'il s'agit de prendre en compte les institutions. Cela dit, cette question mérite une attention particulière : Knutsen et al. (2016) montrent que les régions minières présentent des niveaux de corruption plus élevés.

Compte tenu de la complexité de la malédiction des ressources, il est essentiel d'analyser ces questions non seulement au niveau national, mais également au niveau infranational pour bien comprendre comment la richesse en ressources naturelles affecte le développement économique et la qualité institutionnelle dans des régions spécifiques. Cette approche infranationale permet une analyse plus fine des canaux par lesquels les ressources peuvent conduire à des résultats positifs ou négatifs.

ALC et la malédiction des ressources

L'Amérique latine et les Caraïbes (ALC) représentent une région clé, à la fois pour leurs vastes réserves et l'exploitation de ressources naturelles non renouvelables. Comme mentionné précédemment, l'ALC dispose de réserves importantes de ressources critiques indispensables à la transition vers les énergies vertes. Des pays comme le Chili, le Mexique et le Pérou possèdent de grandes réserves de MTE. De

plus, la région détient près de 15% des réserves mondiales de pétrole et de gaz, bien qu'elle ne contribue qu'à moins de 1% des ressources mondiales de charbon. Le Brésil, le Venezuela, le Mexique, l'Argentine et la Colombie comptent parmi les principaux exportateurs de pétrole, la Colombie étant également le principal fournisseur de charbon (IEA, 2023a).

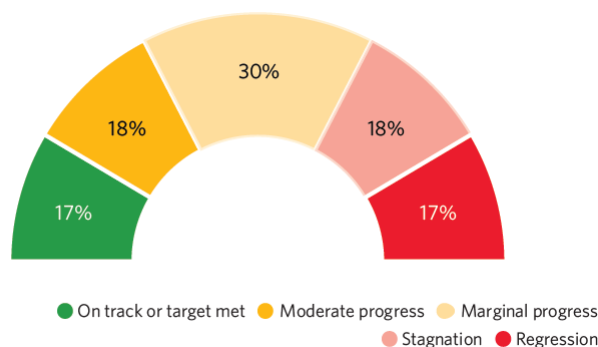
Pour ce qui est des métaux précieux, des pays comme le Pérou et le Mexique figurent parmi les dix plus grands exportateurs mondiaux, tandis que le Brésil, la Colombie et la Bolivie occupent également une place importante en tant que fournisseurs (World Gold Council, 2024). Étant donné l'abondance des ressources dans la région, il devient crucial d'analyser les effets potentiels, positifs comme négatifs, des activités minières.

La littérature sur la malédiction des ressources en Amérique latine offre un tableau contrasté, soulignant que ce phénomène n'est pas strictement déterministe. Ce n'est pas tant l'abondance des ressources que leur dépendance qui semble poser des défis au développement. Dunning (2008) affirme que les ressources ont été une bénédiction pour l'Amérique latine, tandis que d'autres chercheurs, comme Sinnot et al. (2011); Papyrakis et Pellegrini (2019), estiment que les ressources ne sont ni une bénédiction ni une malédiction. Haber et Menaldo (2012) observe que les ressources n'ont pas d'effet direct sur la démocratie dans la région, en contraste avec les conclusions mondiales plus larges (Frankel, 2010; Ross, 2015).

Les exemples du Venezuela et du Chili illustrent la complexité de l'hypothèse de la malédiction des ressources en Amérique latine. Une explication avancée par Ross (2015) est que cette malédiction pourrait être particulièrement liée à l'industrie pétrolière, bien que cette théorie ne fournisse pas encore une explication complète de ses effets globaux. Par ailleurs, la littérature souligne l'importance d'examiner l'extraction des ressources à un niveau régional. Les populations vivant à proximité des sites d'extraction peuvent rencontrer des défis socio-environnementaux (Papyrakis et Pellegrini, 2019) ou bénéficier des booms économiques du secteur (Ishiyama et al., 2018), tandis que la qualité des institutions peut souffrir d'une mauvaise gestion des redevances (Sinnot et al., 2011).

Dans ce contexte, il est important d'étudier le phénomène de la malédiction des ressources à un niveau infranational. Cette approche revêt une importance particulière face à l'exploitation émergente et encore peu explorée des matériaux critiques pour la transition énergétique. L'analyse des résultats à l'échelle locale pourrait offrir une compréhension plus nuancée de l'impact de la malédiction des ressources en Amérique latine, notamment en lien avec le développement des énergies vertes.

FIGURE 5 : Overall progress across SDG's targets based on 2015–2024



Source : United Nations (2024)

Développement durable et l'industrie minière

Les Nations Unies définissent le développement durable comme un développement qui répond aux besoins du présent sans compromettre la capacité des générations futures à répondre aux leurs. Cette définition large englobe la croissance économique, l'inclusion sociale et la protection de l'environnement.

Une étape importante en matière de durabilité a été atteinte lors du sommet de 2015, où les membres ont adopté l'Agenda 2030 pour le développement durable et ses 17 Objectifs de Développement Durable (ODD). Cet engagement vise à éradiquer la pauvreté, à réduire les inégalités et à préserver la planète.

Cependant, "la réalisation des ODD est en péril" (United Nations, 2024). Les progrès ont stagné, voire régressé, en raison de plusieurs facteurs, tels que la pandémie de COVID-19, les conflits actuels et l'augmentation des chocs climatiques, ce qui compromet les efforts des pays membres. La figure 5 présente l'état d'avancement des 135⁷ cibles. Seuls 17% sont en bonne voie pour atteindre les objectifs, tandis que 18% montrent des progrès modérés.

Cette situation souligne l'urgence d'adopter des mesures concrètes pour atteindre les objectifs de développement durable. Dans ce contexte, les contributions des gouvernements, des communautés et des industries sont cruciales. Les gouvernements, en particulier, reconnaissent l'importance de solutions locales adaptées et soutiennent les départements et les municipalités dans cette démarche. Ainsi, dans la zone OCDE, les gouvernements locaux représentent près de 60% de l'investissement public total consacré à la réalisation des ODD (OECD, 2020b).

L'industrie extractive joue également un rôle majeur dans cet effort. Non seulement elle fournit des ressources essentielles à l'économie et à la transition verte, mais elle est souvent implantée dans des régions éloignées et sous-développées, apportant des investissements vitaux pour un développement durable à long terme. En outre, ce secteur contribue de manière significative aux investissements directs étrangers, aux exportations et aux recettes publiques.

⁷Sur les 169 cibles, 135 peuvent être évaluées à partir des données disponibles (UN General Assembly, 2023)

Le secteur minier peut avoir un impact positif sur l'ensemble des ODD. Bien qu'il influence directement le changement climatique et le développement économique, une approche inclusive et l'adoption des meilleures pratiques peuvent permettre au secteur de contribuer également à la réduction de la pauvreté, à la lutte contre les inégalités et à la promotion de la durabilité environnementale (World Economic Forum et al., 2016).

Cependant, la littérature sur la malédiction des ressources présente une perspective contraire. Il est largement reconnu que le secteur extractif est un contributeur majeur aux émissions de carbone, à la dégradation de l'environnement et au déplacement des communautés.

Ainsi, une compréhension plus approfondie des effets du secteur minier est nécessaire, notamment dans le cas de l'ALC, où les impacts sont contrastés. En particulier, il existe un manque notable de recherches qui explorent ces effets au niveau infranational, où les communautés peuvent connaître des résultats positifs ou négatifs.

Tisser les liens : Durabilité, changement climatique et exploitation minière

"Le changement climatique, la pauvreté et les inégalités sont les défis majeurs de notre époque. Il est crucial de les affronter ensemble, en reconnaissant les liens entre les personnes, la planète et l'économie" (World Bank, 2022).

Les gouvernements doivent relever le défi de lutter contre le changement climatique tout en préservant les ressources pour les générations futures. Agir contre le changement climatique représente à la fois une opportunité et une obligation pour cette génération d'assurer la durabilité. Les effets du changement climatique freinent considérablement les efforts pour atteindre les ODD et impactent plus largement le bien-être, aggravant diverses formes de privation comme l'insécurité alimentaire, le manque d'accès à l'eau potable et les menaces sur le patrimoine culturel.

La relation entre le développement durable et le changement climatique devient encore plus urgente lorsqu'on considère que les pays à faible revenu et à forte pauvreté sont particulièrement vulnérables à ses effets. Bien que le changement climatique touche l'ensemble de la population, les projections montrent qu'il augmentera de manière disproportionnée la pauvreté monétaire, creusera les inégalités de genre, réduira les performances économiques et aggravera l'insécurité alimentaire, en particulier dans les pays pauvres (World Bank, 2022). Cette dynamique menace de compromettre le développement durable à long terme.

Ce défi mondial concerne particulièrement l'industrie minière, qui joue un rôle clé à la fois en contribuant à ces problèmes et en aidant à les atténuer. D'une part, l'exploitation minière fournit des matières premières essentielles à la croissance économique et à la transition vers les énergies vertes. D'autre part, elle est une source majeure de dégradation environnementale, d'émissions de carbone et de perturbations sociales, surtout dans des régions en développement comme l'Amérique latine et les Caraïbes (ALC).

L'industrie extractive est donc une arme à double tranchant : bien qu'elle offre des opportunités de développement et des matières premières indispensables aux solutions climatiques, elle présente aussi des risques pour le développement durable si elle n'est pas gérée correctement. Dans les régions riches en ressources, les activités minières peuvent entrer en conflit avec les actions climatiques et les objectifs de développement durable, notamment lorsque leurs opérations entraînent une perte de biodiversité, de la pollution ou le déplacement de populations, exacerbant ainsi les vulnérabilités locales face aux impacts climatiques.

Dans les pays d'ALC, où les ressources naturelles occupent une place importante dans l'économie, l'industrie minière se trouve au cœur des efforts de lutte contre la pauvreté et les inégalités. Le défi est d'exploiter les avantages de l'industrie minière tout en minimisant ses effets néfastes, afin de garantir que ce secteur contribue positivement aux objectifs de durabilité et aux actions climatiques.

La lutte contre le changement climatique devrait augmenter la demande d'ETM, et l'ALC est bien positionnée pour répondre à cette demande. L'expansion de l'industrie minière représente une grande opportunité pour la région. Cependant, l'acceptation de ces projets et la gestion des revenus qui en résultent dépendent fortement des priorités et des préférences des communautés locales.

Contribution de la recherche

Cette thèse se situe à l'intersection du changement climatique, du développement durable et de l'extraction des ressources naturelles, avec un accent particulier sur l'exploitation minière. La demande croissante de métaux de transition énergétique (ETM), liée aux efforts de lutte contre le changement climatique, devrait profiter aux pays riches en ressources. Cependant, les effets de l'exploitation minière au niveau infranational restent largement inexplorés dans la littérature, surtout pour les ressources autres que les combustibles fossiles. Cette thèse se concentre sur la région de l'ALC, où les recherches existantes sont rares et donnent des résultats mitigés.

Le premier chapitre examine la malédiction des ressources à ce niveau, en analysant si l'impact de l'exploitation minière sur le développement économique des régions de l'ALC est influencé par la qualité des institutions locales, comme le suggère la théorie de la malédiction des ressources. Le deuxième chapitre explore l'impact du lancement d'activités minières dans les municipalités mexicaines sur le déve-

loppement durable. Enfin, le troisième chapitre s'intéresse à la manière dont les communautés priorisent le développement durable face à des enjeux concurrents, tels que les préoccupations en matière de sécurité. Cette analyse se base sur l'évaluation du comportement électoral en réponse à différentes allocations d'investissement.

Chapitre 1 : Exploitation minière et qualité institutionnelle en Amérique latine : Le côté obscur de la transition verte

Pour limiter l'augmentation de la température mondiale à moins de 2°C, objectif central de la lutte contre le changement climatique, une décarbonisation drastique de l'économie est nécessaire, ce qui entraînera une augmentation importante de la demande en minéraux de transition énergétique (MTE). Cependant, les effets potentiels de l'exploitation de MTE, en particulier au niveau infranational, restent largement inexplorés, notamment en ce qui concerne son impact sur la qualité institutionnelle locale. Ce chapitre examine l'effet de l'exploitation des MTE sur la qualité des institutions en Amérique latine et dans les Caraïbes (ALC), une région ayant un fort potentiel pour répondre à la demande mondiale de MTE. Nous soutenons que le secteur minier peut nuire à la qualité institutionnelle, compromettant ainsi le développement à long terme, car la littérature suggère que la qualité des institutions est un facteur clé des résultats de développement.

Pour aborder cette question, nous avons construit un nouvel ensemble de données couvrant les départements (ou unités administratives équivalentes comme les États) dans 18 pays d'Amérique latine et développé un indice de qualité institutionnelle basé sur les données de Latinobarómetro. Cet indice capture trois dimensions clés de la qualité institutionnelle : la confiance, la corruption et l'efficacité gouvernementale. À notre connaissance, il s'agit de la première tentative de création d'un indice de qualité institutionnelle au niveau infranational en Amérique latine. Nous avons également intégré d'autres sources de données, telles que des images satellites, des données minières géolocalisées et divers ensembles de données provenant des offices statistiques nationaux, pour élaborer des indicateurs clés de développement. Nous employons une approche de Différence-en-Différences Synthétique. Le groupe de traitement se compose des régions de l'ALC où une mine de MTE commence à opérer pour la première fois, tandis que le groupe de contrôle inclut les régions sans activité de MTE.

Nos résultats indiquent qu'il n'y a pas de réduction globale de la qualité des institutions. Cependant, nous constatons un effet négatif persistant sur le contrôle de la corruption, c'est-à-dire une augmentation de la perception de la corruption par la population. Dans certains cas, la confiance dans les institutions est également affectée. Ces effets se manifestent principalement dans les régions où l'exploitation minière est relativement importante par rapport à la population, soulignant ainsi le rôle de l'échelle dans les dyna-

miques institutionnelles. Une analyse plus approfondie montre que, dans certains contextes, l'exploitation minière peut contribuer à l'amélioration de la qualité des institutions, bien que ce résultat ne puisse être généralisé.

Nous concluons que l'exploitation minière peut représenter une menace pour le développement à long terme en affaiblissant la qualité institutionnelle. Pourtant, une attention particulière aux cadres de gouvernance et institutionnels est essentielle dans les nouvelles régions minières.

Chapitre 2 : Développement durable et industrie extractive. Une évaluation du cas mexicain

Aborder le changement climatique est une urgence qui nécessite la décarbonisation de l'économie mondiale. Atteindre les objectifs climatiques implique de réduire la consommation de combustibles fossiles et d'accroître l'utilisation des minéraux de transition énergétique (MTE). De nombreux pays d'Amérique latine et des Caraïbes (ALC) pourraient bénéficier de la demande croissante pour ces minéraux. Parmi eux, le Mexique occupe une position clé grâce à ses ressources abondantes en argent, zinc, cuivre et autres minéraux. Toutefois, bien que le secteur extractif soit reconnu pour son potentiel à générer des revenus importants pour les gouvernements et à fournir des inputs essentiels à l'économie, son rôle dans le développement durable, en particulier dans les régions de l'ALC, reste peu compris.

L'objectif de ce chapitre est d'analyser l'impact de l'industrie extractive sur le développement durable dans les municipalités mexicaines, en adoptant une approche holistique couvrant diverses dimensions de la durabilité. Le Mexique a été choisi pour cette analyse en raison de la transformation significative de son secteur minier après la promulgation de la nouvelle loi minière et la libéralisation apportée par l'ALENA, qui a considérablement accru les investissements dans ce secteur.

Pour évaluer les effets de l'industrie minière, nous utilisons une approche en différences-différences échelonnées. Notre groupe de traitement est constitué des municipalités où une mine a commencé ses opérations, tandis que le groupe de contrôle comprend des municipalités sans activité minière. Nous examinons l'impact du secteur sur les revenus des ménages, l'inégalité économique, l'éducation et la dégradation environnementale. Notre base de données comprend des informations provenant des recensements municipaux mexicains, de la NASA et de Minex. Pour mesurer les dommages environnementaux, nous utilisons l'Indice de Végétation par Différence Normalisée (NDVI), en postulant que la dégradation des terres due à l'activité minière devrait se refléter par une baisse de la qualité de la végétation, indiquée par une diminution du NDVI.

Les résultats montrent que le secteur minier n'a pas d'effet significatif sur l'éducation ou l'inégalité économique. Cependant, nous observons un impact positif sur les revenus des ménages, bien que les tests

de robustesse suggèrent que cet effet pourrait être temporaire. De plus, il existe des preuves claires de dégradation environnementale. Ces conclusions sont robustes face à des estimateurs alternatifs, aux effets de débordement, ainsi qu'à différentes mesures des dommages environnementaux.

Nous concluons que l'industrie extractive représente une menace pour la durabilité locale. Bien que les activités minières puissent augmenter les revenus des ménages, ces avantages semblent de courte durée, et les dommages environnementaux associés sont significatifs. Cela explique les conflits qui surgissent souvent dans les communautés lorsque de nouveaux projets miniers sont proposés, car les préoccupations locales concernant la durabilité et la dégradation environnementale sont justifiées.

Chapitre 3 : Priorités Électorales : Sécurité, Durabilité et Investissements Stratégiques dans les Municipalités Colombiennes

Le sommet local organisé dans le cadre de la COP28 a marqué une étape importante, soulignant le rôle essentiel des administrations régionales dans la réalisation des objectifs liés au changement climatique et, plus largement, des objectifs de développement durable fixés par les nations. Alors que les discours nationaux mettent fréquemment en avant l'importance du développement durable, les priorités locales ne s'alignent pas toujours sur cette trajectoire. Par exemple, certains objectifs de développement durable peuvent être en conflit les uns avec les autres. De plus, les dirigeants locaux peuvent privilégier des politiques répondant aux préférences des électeurs plutôt qu'aux exigences du développement durable, dans le but de sécuriser leur carrière politique.

Ce chapitre aborde cette problématique en analysant le comportement électoral en lien avec le développement durable et les enjeux de sécurité en Colombie. Je me concentre sur la Colombie en raison de son système de gouvernement décentralisé, qui permet une autonomie dans l'allocation des ressources en fonction des besoins locaux, et de son long conflit interne, qui offre un contexte idéal pour analyser la manière dont les électeurs priorisent des biens tels que le développement durable, la sécurité, et d'autres. Je soutiens que, bien qu'il n'y ait pas de conflits intrinsèques entre ces objectifs politiques, le développement durable peut être relégué au second plan lorsque des préoccupations plus immédiates prédominent.

Pour étudier le comportement électoral dans les municipalités colombiennes, j'ai construit une nouvelle base de données couvrant 1 120 municipalités sur la période de 2003 à 2019. J'utilise les données d'allocation des investissements fournies par la *Contaduría Nacional* de chaque municipalité pour identifier les investissements directement orientés vers le développement durable, en faisant correspondre les chapitres d'investissement aux objectifs de développement durable. L'analyse évalue la probabilité de réélection des partis au pouvoir, leur performance électorale et la participation des électeurs en réponse aux investissements dans le développement durable. J'utilise une estimation à effets fixes afin de contrôler

les caractéristiques non observées.

Les résultats montrent que les électeurs colombiens tendent à accorder la priorité aux préoccupations de sécurité et aux investissements visibles, au détriment de ceux axés sur le développement durable. Une conclusion clé de l'analyse de l'hétérogénéité est que les municipalités présentant des niveaux d'éducation plus élevés sont plus réceptives à l'allocation stratégique des ressources. De même, les municipalités où les préoccupations de sécurité sont moindres présentent un comportement similaire. Ces résultats restent robustes face à l'inclusion de covariables et à l'utilisation de mesures alternatives d'investissement pour répondre aux préoccupations d'endogénéité potentielles.

Je conclus que l'investissement dans le développement durable n'est pas la principale préoccupation dans les municipalités colombiennes. Les électeurs réagissent davantage aux enjeux de sécurité et aux investissements visibles. De plus, des inquiétudes subsistent quant à la nature à court terme des projets, en raison du cycle politique, ce qui peut compromettre la durabilité. Cependant, en abordant les problèmes immédiats et en améliorant l'éducation, qui favorise une meilleure compréhension des actions de l'exécutif, il est possible d'encourager les électeurs à reconsidérer la manière dont ils évaluent leurs dirigeants.

José RIASCOS BENAVIDES

Ressources Naturelles, Institutions et Développement Durable : une Analyse Régionale en Amérique Latine

Résumé :

Cette thèse contribue à la littérature sur la malédiction des ressources au niveau local, en se concentrant sur l'exploitation minière en Amérique latine dans le contexte du changement climatique. Elle explore comment l'exploitation minière influence le développement durable et examine les attitudes du public face à des priorités concurrentes. Le premier chapitre analyse l'impact de l'exploitation des métaux de transition énergétique (MTE) sur la qualité des institutions en Amérique latine. Un nouvel indice de qualité institutionnelle au niveau local est créé. Ce chapitre utilise une méthode de différence-en-différence synthétique. Le groupe de traitement comprend les régions où l'exploitation des métaux de transition énergétique (MTE) a commencé. Les résultats montrent que cette exploitation minière accroît la corruption au sein du gouvernement et, dans certains cas spécifiques, diminue la confiance dans les institutions. On en conclut que l'augmentation de la corruption pourrait compromettre le développement à long terme, car des institutions solides sont essentielles. Le deuxième chapitre étudie la contribution du secteur minier au développement durable dans les municipalités mexicaines. En utilisant une approche en différences-différences échelonnées, avec les municipalités minières comme groupe de traitement, les résultats montrent que l'exploitation minière n'a pas d'effet significatif sur les inégalités économiques ou l'éducation, a peu d'impact sur les revenus des ménages, mais cause une dégradation de l'environnement. Cela révèle des compromis négatifs possibles pour les communautés minières. Enfin, le troisième chapitre examine les attitudes des électeurs face aux investissements pour le développement durable en Colombie. L'analyse montre que, lorsqu'ils sont confrontés à d'autres préoccupations, les électeurs privilégient la sécurité et les infrastructures visibles plutôt que les investissements durables. Toutefois, dans les municipalités où la sécurité est moins préoccupante ou où le niveau d'éducation est plus élevé, les priorités des électeurs varient davantage, ce qui montre que le contexte influence fortement leurs préférences.

Mots clés : Changement climatique, Malédiction des ressources, Développement durable, Développement régional, Mines et développement, Comportement électoral, Qualité des institutions, Amérique latine.

Natural Resources, Institutions, and Sustainable Development: A Regional Analysis in Latin America

Abstract :

This thesis contributes to the literature on the resource curse at the subnational level, focusing on mining in Latin America within the context of climate change. It examines how mining influences sustainable development and explores public attitudes toward sustainable development in the face of competing priorities. The first chapter analyzes the impact of energy transition metal (ETM) mining on the quality of institutions in Latin America. A novel institutional quality index dataset at the subnational level is constructed. Using a synthetic difference-in-differences approach, with the treatment group consisting of regions where ETM mining begins, the findings indicate that mining increase the perception of corruption and in some cases trust. This decline in institutional quality may potentially compromise long-term development, given the key role of strong institutions. Chapter 2 investigates the contribution of the mining sector to sustainable development in Mexican municipalities. Employing a staggered difference-in-differences design, with municipalities where mining operations occur as the treatment group, the results suggest that mining does not significantly affect economic inequality or education and has a limited impact on household income but does lead to environmental degradation. These findings highlight potential negative trade-offs for mining communities. Lastly, Chapter 3 examines voter attitudes toward investments aimed at sustainable development in Colombia. The analysis reveals that when confronted with competing concerns, voters prioritize security and visible infrastructure over sustainability-focused investments. However, municipalities with lower security concerns or higher levels of education exhibit more diverse priorities, suggesting that context significantly influences voter preferences.

Keywords : Climatic change, Resource curse, Sustainable development, Regional development, Mining and Development, Vote behavior, Quality of institutions, Latin America.