The Dark Side of Infrastructure: Roads, Repression, and Land in Authoritarian Paraguay*

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Abstract

Transportation infrastructure is associated with economic development, but it can also be used for social control and to benefit the governing elite. We explore the connection between the construction of road networks, state-led repression, and illegal land allocations in the longest dictatorship in South America: Alfredo Stroessner military regime in Paraguay. Using novel panel data from the truth and reconciliation commission, we show that proximity to newly constructed road networks facilitated state-led repression, illegal allocation of agricultural plots to dictatorship allies, and hindered sustainable economic development in the following decades.

Keywords: roads, repression, land allocations, dictatorship, Paraguay, Alfredo Stroessner.

*This version: October 2023. First version: December 2022. We would like to thank Laura Schechter and Felipe Valencia for comments, suggestions, and for sharing some of the data used in the analysis. We have benefited from presentations at the XVII RIDGE Forum (LACEA-EHN Workshop on Historical Development) and the University of Bergamo. David Bermudez, Andrés Calderón, Felipe Coy, Catalina Duran, Joaquin Ramirez, Juanita Robles, and Gregory Ross provided excellent research assistance. Stéphane Straub and Josepa Miquel-Florensa acknowledge funding from ANR under grant ANR-17-EURE-0010 (Investissements d'Avenir Program). González: Queen Mary University of London, School of Economics and Finance. Miquel-Florensa: Toulouse School of Economics. Prem: Einaudi Institute for Economics and Finance. Straub: World Bank and Toulouse School of Economics. The views expressed in this paper do not represent the views of the World Bank and its members.

1 Introduction

Transportation infrastructure is traditionally associated with development through lower transportation costs and increased economic activity (Hummels, 2007; Redding and Turner, 2015; Roberts et al., 2020). Yet railroads, roads, and highways can also be strategically used to gain additional votes, to secure political and social control of remote locations, and to create rents that benefit the governing elite (Burgess et al., 2015; Voigtländer and Voth, 2022). In low-income countries, where state presence is usually low and corruption high, the construction of transportation networks can potentially facilitate elite capture, authoritarian subordination, and perpetuation in power. This "dark side" of infrastructure has been relatively overlooked by researchers and it is likely to be detrimental for sustainable economic development. In this paper, we examine the connection between the construction of road networks and two prominent characteristics of low-income countries under authoritarian regimes, the prevalence of state-led repression and the misallocation of productive resources, commonly associated with underdevelopment through the creation of fractured societies and lower economic activity (Hsieh and Klenow, 2009).

The context of our study is Paraguay, a relatively understudied country which experienced the longest dictatorship in South America (1954-1989) and exhibits nowadays one of the lowest income per capita in the region. Led by army officer Alfredo Stroessner, the regime has become famous for its human rights violations and for its endemic corruption. At the same time, Stroessner also engaged in the development of ambitious infrastructure projects for both economic reasons and to expand control of remote locations. Among these projects, the construction of a network of paved roads was a prominent strategy to colonize the Eastern part of the country. Using a variety of archival documents, we tracked the evolution of this road network during the Stroessner dictatorship to investigate how the evolving geographic access shaped state-led repression and the misallocation of agricultural land.

To measure the evolution of state repression and misallocation across the Paraguayan territory, we digitize individual-level data on human rights violations in the 1954-1989 period and the illegal allocation of agricultural plots. Following the end of the Stroessner dictatorship in 1989, the discovery of the "terror archives" in 1992 unearthed a massive amount of information documenting its repressive activities. Strong societal demands emerged to investigate human rights violations under the military, and in the early 2000s, the Truth and Justice Commission was created. The Commission produced a report documenting how thousands of people were tortured, killed, disappeared, or detained during Stroessner's authoritarian rule. We structured these data into a panel of 248 districts observed annually during the military dictatorship. The Commission also investigated

the land allocation process and concluded that during this period a large share of the proceedings were plagued by irregularities, leading to the wrongful reallocation of twenty percent of the country's land. We use these data to measure how many plots were illegally allocated by district and year. Importantly, we combine the names of plot beneficiaries with the list of high-ranked military, prominent public servants, and congresspeople to measure the extent to which the dictatorship allies benefited from the process of illegal allocations of land.

We present three main findings. First, we find that Stroessner's road network facilitated the implementation of state-led repression. Our empirical strategy exploits the gradual construction of roads that we observe in the panel structure of the data. We leverage the variation that arises after paved roads were constructed and a subset of districts in the country became easier to access, even when they were not directly crossed by the road. We use this intuition to measure the district-level exposure to the road network. In particular, we provide robust evidence showing that when the distance from a district to the nearest road in the network decreases, state-led repression increases significantly. In terms of magnitude, the results suggest that doubling the distance to the network decreases the number of repression events by 31 percent. We reach the same conclusion when focusing on torture or detention, the main subcategories of repression. Importantly, the results are robust to a wide range of exercises, including controlling for the distance to other hallmark infrastructure projects during this period, namely the Itaipú and Yacyretá dams. We provide suggestive evidence that the increased repression can be explained by an increase in massive events of repression that took place closer than 20 kilometers from newly constructed roads.

Second, we provide evidence that the road network shaped the process of *illegal* land allocation to dictatorship allies. We begin by showing that the military were disproportionally represented among beneficiaries of illegal land allocations and received more and larger agricultural plots. More than 3,000 non-eligible beneficiaries were identified by the Truth Commission. We then exploit the evolving exposure of districts to the construction of the road network by using the panel structure. Our empirical analysis is motivated by the economic intuition that plots are more valuable when they have both high agricultural potential and are easier to access through the road network. Consistent with our hypothesis, we find that plots were more likely to have been illegally allocated when these were located in districts with high potential for cotton production—an important staple at the time in Paraguay—and when these were closer to the road network. Reassuringly, we do not observe this relationship with soybean suitability, less important at the time (Palau, 1986). These results relate to recent research showing that the dictator selected beneficiaries who were central in local networks to control the local population (Bandiera et al., 2023).

Our third and final result relates to the long-run consequences for the development of Paraguay. We argue that the road network facilitated state-led repression to control remote locations, and this process shaped the illegal allocation of highly productive plots. As a consequence, we hypothesize that Paraguay's most productive land ended up misallocated in the hands of the dictatorship allies and prevented sustainable economic development to unfold. After controlling for a large set of characteristics measured before the Stroessner years, we find that districts with more illegal land allocations are nowadays less developed—as proxied by night-time lights, population density, and agricultural production measured with satellite imagery. Moreover, we also observe that in places with more illegal allocations during the dictatorship there are more extractive economic activities—e.g. pollution, wildfires, deforestation, and mining concessions—and more rural conflict in the form of land occupations. We tentatively conclude that by facilitating repression and illegal land allocations, the road network later retarded sustainable development in Paraguay.

Our work contributes to the literature studying the political economy of infrastructure.[1] Scholars have shown that transport networks were often initially designed and located for political and military reasons, especially in non-democratic contexts. In ancient times, the Persian Royal Road, a 2500 km corridor built by King Darius I to connect the Assyrian capital to the Mediterranean, served military and administrative purposes. The primary aim of the Roman roads network, which at its peak reached an extension of 80,000 km, was military control over the Empire, although it also served to facilitate the trade conducted by sea in the Mediterranean hub (Lay, 2009; Dalgaard et al., 2022; Berechman, 2003). The original functions of the road network constructed by the Incas were religious and military, and historians have found no evidence of trade activities (Martincus et al., 2017). When the colonial government of India decided to construct the Indian railroad system in the mid-19th century, it had clear political objectives.[2] And even democratic governments in the 20th century have to some extent displayed similar motivations. When President Franklin D. Roosevelt launched the planning tasks for a national highway system in 1937, the committee in charge "considered a strategic highway network suggested by the War Department, the location of military establishments, interregional traffic demand, and the distribution of population and economic activity at that time." (Duranton and Turner, 2012).

[1] A large literature has documented the impact of transportation infrastructure on economic outcomes (e.g., Fogel 1964; Donaldson 2018; Banerjee et al. 2020), including criminal activity (Agnew 2020; Baires et al. 2020; Calamunci and Lonsky 2022). See Redding and Turner (2015) and Berg et al. (2017) for relatively recent reviews.

[2] Lord Dalhousie, the Governor-General of India, stated: "A single glance... will suffice to show how immeasurable are the political advantages to be derived from the system of internal communication, which would admit of full intelligence of every event being transmitted to the Government... and would enable the Government to bring the main bulk of its military strength to bear upon any given point in as many days as it would now require months, and to an extent which at present is physically impossible." (House of Commons Papers, 1853, cited in Donaldson 2018).

Previous literature has, however, largely ignored the potential long-run economic consequences derived from the political motives behind the construction of large infrastructure projects. We aim to fill this gap by showing that the construction of the road network in Paraguay had direct implications for the allocation of land, a key economic input in the context of a developing country where the primary sector represented close to 40% of GDP in the 1960s and still 10% today. Our results also suggest caution when using early construction plans as sources of exogenous variation for the development of transport networks, a strategy generally grounded on the non-economic goals of the plan. Our results suggest that even though the primary motives behind an infrastructure project can be military or political, initial plans can still generate large-scale economic distortions through the allocation of economic inputs such as land close to the road network. The misallocation of land is likely to have short-, medium-, and long-run economic impacts on local economies, complicating the interpretation of reduced-form estimates linking what was presumed to be exogenous construction plans with long-run outcomes.

Regarding the political motivations themselves, previous work has emphasized how large infrastructure projects can be strategically used by incumbent governments to increase their political strength and gain more votes in upcoming elections. An example of this line of research is the work by Voigtländer and Voth (2022), who show how the construction of highways increased political support for the Nazi party in Germany. Another part of this literature has documented the various ways in which infrastructure projects themselves can be implemented with distortions arising from political incentives (e.g., Cadot et al. 2006; Burgess et al. 2015). A final strand in this literature is related to the workings of corruption in large infrastructure projects (Campos et al., 2021). In contrast to existing research, we focus on the impact of roads on state-led repression and the (mis)allocation of agricultural plots to dictatorship allies. The proposed link between infrastructure and state repression has been emphasized by previous work but only in the context of military buildings (Dube and Naidu, 2015; Bautista et al., 2023).

We also contribute to the empirical literature documenting how repression is implemented by the state, particularly during times of an authoritarian regime. The majority of previous research studies the consequences of repression, particularly its effectiveness in quieting dissent (Davenport, 2007). A relatively smaller research agenda attempts to uncover how repression is deployed on the ground. For example, recent work has emphasized how dictatorships can target specific influential individuals (e.g. union leaders) and shows how politically connected firms can be crucial for this process (Klor et al., 2021). In the same vein, large international events covered by the international media can incentivize dictatorships to temporarily refrain from repression (Scharpf et al., 2022). Yet, beyond these contributions and the previously discussed role of military infrastructure,

transportation networks have been relatively neglected as an important driver of repression.

Finally, our work also adds to a recent literature showing how infrastructure, in this case information and communication technology (ICT) such as cell phones and internet access, may facilitate coordination of the civil society around mass-protest political events and violent collective action (e.g., Pierskalla and Hollenbach 2013; Manacorda and Tesei 2020; Enikolopov et al. 2020). We show that roads may play a similar role in increasing the incidence of violence, although in the historical case of the Paraguayan dictatorship, this was to the benefit of the repressive state.

2 Historical background

General Alfredo Stroessner was the dictator of Paraguay from 1954 and until 1989, making it the longest dictatorship in South America. In this section, we describe the most important historical elements that characterize this period of the Paraguayan history. We focus on four aspects that are particularly relevant to our research design: the institutional architecture that sustained the dictatorship for more than three decades, the implementation of state-led repression, the illegal allocations of land, and the construction of the road network during the dictatorship period.[3]

2.1 Overview of the Stroessner dictatorship in Paraguay

General Stroessner rose to power in May 1954 through a military coup. Having overthrown Federico Chávez, of his own party, he was confirmed as president of Paraguay by a military board. This process set the stage for the regime's unique characteristic, namely the reliance on a tripartite alliance between the government, the military, and the Asociación Nacional Republicana (ANR), locally known as the Colorado party. Stroessner himself was at the helm of these three institutions, ensuring an extremely tight grip on every aspect of public life in the country.

From the start, the Stroessner regime suspended all constitutional and civil rights, relying on the power of the military police to quash any attempt at resistance or sedition. An extensive network of whistle-blowers quickly reported any criticisms of the regime or suspicious behaviors (Boccia et al., 1994). From the 1970s, when other countries in the region became military dictator-

[3]Paraguay is a relatively rural, low-income, and unequal country in South America. Researchers attribute its relative position to their defeat in the War of the Triple Alliance in the 1860s and the subsequent political control of a small elite. More about the history of Paraguay before the Stroessner dictatorship can be found in Lewis (1993), about the dictatorship in Lewis (1980), and about the Triple Alliance War and its consequences in Leuchars (2002) and Alix-Garcia et al. (2022).

ships, Paraguay was also actively coordinating surveillance and repressive activities in the region within the framework of the Operation Condor.[4] Participation in economic and social activities, such as being a public servant or an entrepreneur, were largely conditional on being a member of the Colorado party. The party pervaded all levels of society and was present in every corner of the territory, in particular through its local antennas, the Seccionales Coloradas. By centralizing control and distributing favors to all these stakeholders, in the form of jobs, public contracts, or assets such as land, the regime made sure that nobody had incentives to bet against its survival.

Stroessner modified the constitution in 1967 and 1977 to ensure perpetual reelection. He was indeed reelected president seven times in fraudulent elections, the last one in 1988. On February 3rd, 1989, he was deposed in a coup led by his close collaborator, and "Compadre," General Andrés Rodriguez. The Colorado party has been in power for 30 of the 34 years since the end of the dictatorship, even though free multi-party elections were held, with 2008-2012 being the exception. The persistent power of the Colorado party since the mid-twentieth century, which has led to more than 75 years of almost uninterrupted power, reveals the strong grip the party still has in the country.

2.2 State-led repression, rent-seeking, and illegal land allocations

To maintain its power, General Stroessner relied on a widespread repressive apparatus. His regime methodically spied on, detained, and tortured opponents to retain control of the Paraguayan society. Most of what we know about these practices was revealed in 1992 when hundreds of thousands of documents were discovered in a locked room in a police station of the country's capital. These documents had been created by the regime's security forces and became popularly known as the "Archives of Terror." The information in the documents revealed many of the systematic activities that were conducted by the regime, including denouncements, surveillance reports, detentions, and many other policies that aimed at controlling people's actions during these years. The repression operated on several levels. It restrained freedoms of expression, gatherings, demonstrations, and organization of any social or political group not completely aligned with the dictatorship. The strategy meant the forceful dispersion of meetings, as well as the targeting of the individuals involved in activities considered as threatening to the regime.

The information in the "Archives of Terror" was used by the country's "Truth and Justice Com-

[4]Military dictatorships prevailed in Brazil from 1960s (1964-1985), and other countries of the Southern cone followed suit in the 1970s: Argentina (1976-1983), Chile (1973-1990), Uruguay (1973-1985), and Bolivia (1971-1978). The documents attesting to the foundational meeting of the cross-state campaign of political repression and terror were actually found in the Paraguayan terror archives described below.

mission," created in the early 2000s following requests from civil society organizations—including victims and human rights associations—to investigate the large-scale crimes and human rights violations committed during the dictatorship. The final report (Comision de Verdad y Justicia, 2008) was composed by eight tomes and thousands of pages, which documented extensive violations of human rights. Importantly for the purposes of our study, the report revealed among others the identity of victims and the misappropriation of state assets. It is hard to over-estimate the detailed information in this individual-level data, which provides an unusually high-quality quantitative picture of a dictatorship. In particular, the report uses a combination of documents from the archive and testimonies from victims and their relatives, to establish a list of close to 10,000 persons, who suffered from either detention, imprisonment, torture, or were killed or disappeared between 1954 and 1989. The report also presents the list of hundreds of victimizers involved in the state-led repression.[5] Finally, the report also revealed that thousands went into exile to neighboring countries and later, when these places became themselves unsafe, to Europe or the United States.

In addition to state-led repression, the commission also analyzed comprehensive data from the country's land allocation agency—Instituto Bienestar Rural (IBR), later rebranded Instituto de Desarrollo Rural y de la Tierra (INDERT)—between 1954 and 2003. Their analysis reveals more than a thousand cases of irregular large land parcel appropriations, which appears to have been one of the main ways in which the regime rewarded its collaborators, particularly high-ranking members of the military. Out of the 12.2 million hectares reallocated during that period, about two-thirds were plagued by grave wrongdoings. These illegal allocations of land represented close to 20 percent of the country's total area. After the dictatorship, governments have done little to recover this ill-gotten land. Land concentration has remained high, intensive agriculture has grown, and hundreds of thousands of small farmers have migrated to cities. Land has become one of the biggest sources of conflict in the post-dictatorship period.

Finally, supporters of the Stroessner regime were also favored through the regular allocation of procurement contracts (Nickson and Lambert, 2002, Auriol et al., 2016, Straub, 2014), a common strategy to extract rents from the state to benefit collaborators (Schoenherr, 2018; Brugués et al., 2023). An extreme form of this way of enriching members of the governing elite happened during the construction of the two large dams, Itaipú and Yacyretá (Straub, 2015). Two of the main contractors amassed immense fortunes and subsequently became presidents of the country: Juan-Carlos Wasmosy (1993-1998) and Raúl Cubas Grau (1998-1999).

[5]The report states that at least 423 people were executed or disappeared under dictatorship, 18,722 were tortured, and 3,470 were forced into exile. The remains of less than 10 percent of those murdered have been found.

2.3 Road construction

At the end of the 1950s, and after a few years in power, General Stroessner decided to launch a colonization process to better control and exploit a large part of the Paraguayan territory. The border with Brazil in the East was until then ill-exploited, mostly unpopulated, and covered by forest (Nickson, 1981). In fact, maps from the 1920s indicate that this Eastern half of the country was at that time inhabited by probably no more than 12,000 inhabitants, or around two percent of the total population. Moreover, all of the eastern territory was difficult to access given the lack of paved roads connecting the area with Asunción and other cities in the rest of the country. Before Stroessner's expansion plan, the paved road network was entirely concentrated around Asunción, and was less than 200 kilometers in length. The only other transportation corridor was a slow train, connecting the capital to Encarnación in the South, across the Paraná river from the Argentinean city of Posadas, where many opposition figures would later find refuge.

The 1960s would became known as the decade of the "March to the East" as the length of the paved road network increased by four. The main new corridors connected Asunción to the border with Brazil in the East—which would then become Ciudad Presidente Stroessner—and part of the corridor to Encarnación. The triangle connecting these three points would be completed in the 1980s, with the paved network then exceeding 2,000 km. In this context, Paraguay signed a treaty with Brazil, which in 1975 led to the start of the construction of the Itaipú dam, the largest in the world in terms of installed power until the building of the three-gorge dam in China in the 2000s. The construction associated with this large infrastructure project gave a huge boost to the Paraguayan economy until the mid-1980s. However, these and related projects also contributed to the deepening of the local corruption and rent-seeking system (Straub, 2014).

3 Data construction

3.1 Repression

The data used to document the extent and evolution of repression was compiled by the Truth and Justice Commission, based on the extensive information included in the "Archives of Terror." It established a nominative list of close to 10,000 victims, which contained whenever available the complete first-, last-name, and gender of each person, a count of the number of repressive episodes he or she suffered, the start and end date of each episode, the district where it took place, and the type of repression: detention, exile, torture, execution, or disappearance. While this list represents

only a fraction of all events of repression, the detailed manner in which the regime recorded its activities and the fact that it apparently failed to destroy any of these archives when the February 3rd, 1989 coup happened, suggest that a significant part was recovered (Boccia et al., 1994). We systematically digitized and organized all these data for the purpose of our analysis.

Figure 1 shows the variation in repressive activity from 1954 until the end of the dictatorship. The spikes in some of the years correspond to instances in which the regime geared up the fight against insurgent groups it suspected of trying to establish an armed resistance movement. The main one in 1976 is the crackdown on the clandestine group "Organización Político Militar", which the regime took as a pretext to also strike any persons or organizations it considered hostile. Unfortunately, some events fail to report the district. However, Figure 1 shows that events with known location show a similar time variation than all events, which include the ones without district. These patterns suggest that the lack of information on the location of some events is unlikely to cause significant problems in terms of sample selection. Descriptive statistics in Table 1 indicate that 5 percent of the 7,688 district-year observations (corresponding to 248 districts over the 31-year period from 1955 to 1985) in our sample have some event of repression listed in the database, with a mean number of events of 0.23, and a maximum of 75 events of state-led repression.

3.2 Road construction

Figure 2 shows the evolution of the paved road network over three decades. As there is no official record of the road network for that period, we reconstruct its evolution based on a host of historical maps and policy documents (See Appendix A for details). We observe six snapshots of the road network and employ linear interpolations within districts across these years to get the full 1955-1985 panel data. Later we show that the interpolation method does not change the main results.

As can be seen, the network is entirely concentrated in the Eastern part of the country. Until 1960, it was limited to the Capital city Asunción, and the Central department around it. In the 1960s, roads number 2 and 7, connecting Asunción all the way to the Brazilian frontier and Foz de Iguaçu in the East were completed with support from outside donors such as USAID, the Japanese foreign aid agency JICA, and the government of Brazil. The new road network set the stage for the colonization of the Eastern part of the country. Finally, in the 1970s and 80s, additional corridors were completed, connecting Villarrica below road 7, and mostly completing the triangle with Encarnación in the South. Figure A.1 shows how localities inside the country became better connected as the road network progressed. In Table 1, we report the average distance of districts to the road, which decreased by more than 50 percent over the 1955-85 period.

3.3 Illegal land allocations and political connections

The Truth and Justice Commission had access to all land allocations over the period 1954-2003 from the institutions in charge (IBR, later to become INDERT) and to the country's land registry. Importantly, the report contains these data, which includes the exact location of the parcel, its size, the name of the beneficiary, and the date of allocation. Based on the prevailing legal frameworks throughout the period, the commission established three main reasons why some of these allocations were illegal. The first reason is when the land allocation was given to a person who was *not* eligible.[6] The second applies when the beneficiaries received more than one plot. The third occurred when beneficiaries received a plot larger than the maximum size contemplated in the law.

As a result of the work by the Commission, *illegal* land allocations were clearly identified from the universe of land allocations that took place under the Stroessner dictatorship. Overall, out of the 200,705 allocations examined by the Commission, which covered more than 12 million hectares, a total of 4,241 allocations were found to be plagued by irregularities. These allocations covered a total surface of almost 8 million hectares and involved 3,336 beneficiaries. These illegal land allocations represented almost 20 percent of the country's total area. We digitized the location and size of these illegal allocations, together with the identity of the beneficiary.

We identified beneficiaries linked to the dictatorship by comparing the names of recipients of illegal allocations with a list of people connected to the regime. We constructed the list from various sources. From the Commission report, we extracted the names of victimizers, identified from the archives or the testimony of surviving victims. We also hand-collected the list of politicians involved in the successive governments of Stroessner, i.e. ministers or directors of important state agencies. We further complement the list with all Congress members (deputies and senators) over the 1954-1989 period, recovered from the Library of the Paraguayan Congress. Finally, we collected the names of all graduates from the National College of War (Colegio Nacional de Guerra, subsequently Instituto de Altos Estudios Estratégicos) over the relevant period.[7] Overall, we recovered the names of one thousand five hundred individuals linked to the Stroessner regime.

[6]The eligibility criteria was to be a farmer or have the intention to farm. Norms were established in the *Decreto Ley* 120 of 1940, replaced by *Ley* 854/63 in 1963 and later by *Ley* 1963/02 in 2002.

[7]The National War College, created in 1968, is the country's highest-level National School of Studies, reporting directly to the President of the National Defense Council. It trains around 30 selected members of the Armed Forces of the Nation, the National Police, civilian officials of the State and the private sector, and foreigners with the doctrinal and methodological knowledge necessary for the future leaders of Paraguay.

3.4 Land suitability and long-run development

We use land suitability measures by district to capture the economic potential of land that was illegally allocated. Cotton has been a traditional crop in Paraguay even before *La Conquista*, when it was cultivated by indigenous populations to produce textiles. By 1870, it was the first export category, and remained the main crop throughout the first part of the twentieth century. By 1981, almost 140 thousand productive units were dedicated to cotton and it represented 44 percent of the country's exports (Palau, 1986). Cotton suitability was therefore likely to be an important criteria in establishing the value of plots to be allocated under the dictatorship period.

Soybean became important for Paraguayan agriculture later, with small areas being cultivated until the 1970s. Since then, there has been an expansion of cultivated areas, mostly in the department of Itapúa and later in Alto Paraná.[8] As soybean requires large areas and mechanized treatment, foreigners mostly from Brazil and Japan became the main producers (Palau, 1986). Soybean suitability could have been relevant for land allocation, but it should have mattered less than cotton given the characteristics of the cultivation process. We measure cotton and soybean suitability by district using data from the well-known FAO Global Agro-Ecological Zones (GAEZ). In particular, we use suitability for rain-fed conditions as was usual at the time.

Finally, we examine long-run development by using several measures that point towards both the productive nature of districts and the prevalence of intense extractive activities at the local level. To measure the former, we use nighttime lights (Henderson et al., 2012; Li et al., 2020) and gridded datasets with information about population density (WorldPop) and agricultural production (Wood-Sichra et al., 2016; Yu et al., 2020).[9] To measure the latter, we use pollution from van Donkelaar et al. (2021), wildfires from NASA's Earth Observing System Data and Information System (EOSDIS), deforestation from Hansen et al. (2013), and mining activity. Information on mines comes from the Catastro Minero conducted by the Ministry of Mines and Energy of Paraguay. The *catastro* contains information on all the licences given by 2022. Paraguay's diverse geology offers a great variety of soils and resources, and the most important minerals exploited are gold, copper, cobalt, iron, precious minerals, and aluminium. Finally, we shed light on the relationship between the dictatorship's land policies, development, and rural conflict in the 2000s by examining land occupations between 1990 and 2019 documented by Kretschmer et al. (2019).

[8] According to the Paraguayan Chamber of Oleaginosas exporters (CAPECO), Paraguay is nowadays the third world exporter of soy and the sixth world producer. Soy production represents around 18 percent of GDP.

[9] The gridded dataset has a granularity of 10×10 kilometers, information by crop, and is available for the years 2000, 2005, and 2010. We use agricultural production (measured in metric tons, per hectare) of the following crops: cassava, groundnuts, cotton, maize, rice, sorghum, soybean, sugarcane, wheat, sesame, and sunflower.

4 Research design

4.1 Estimating equation

We estimate the empirical relationship between the evolving road network, state-led repression, and illegal land allocations in Paraguay using the following panel data regression equation:

$$Y_{dt} = \beta R_{dt} + \phi_d + \phi_t + \varepsilon_{dt} \quad (1)$$

where Y_{dt} is an outcome of interest in one of the 248 districts d in year t. The main right-hand side variable of interest is R_{dt} and it measures the district-level exposure to the road network. Operationally, we use the logarithm of Euclidean distance (in kilometers) from the district's geometric centroid to the closest road, but results are robust to alternative definitions. As shown by Figure 2, variation within district over time arises from the construction of roads. Importantly, note that a district might become more exposed to the road network even without construction taking place within its boundaries. We absorb district-level constant heterogeneity and account for idiosyncratic year changes with the use of fixed effects ϕ_d and ϕ_t. To allow for arbitrary correlation in the error term within districts over time, we cluster standard errors ε_{dt} at the district level.

In terms of dependent variables, we focus on two state actions prominently featured in the recent empirical literature examining authoritarian regimes: state-led repression and misallocation of public policies to favor allies. We begin by studying state repression in both its extensive and intensive margins. For the former, we use an indicator that takes the value of one in a district-year if we observe at least one event of repression in the Truth and Justice Commission report, and zero otherwise. For the latter, we use the hyperbolic sine transformation of the number of state-led repressive events. As we later show the results are robust to alternative measures. We then examine misallocation driven by favoritism with the use of detailed data on illegal land allocations. For each district, we measure whether any land was illegally allocated in a given year with an indicator variable. Similarly, we measure the total number of hectares illegally allocated and relate it to exposure to the road network. To capture favoritism, we determine whether each allocation was received by an individual who was politically connected to the Stroessner regime. We allow connections to be either political or military, and we construct these by combining (i) the list of high-ranked military officers and politicians (including congresspeople) of the dictatorship, with (ii) the list of beneficiaries of illegal land allocations. Overall, the richness of the data allows us to track misallocation and favoritism within Paraguay over a thirty-year period of dictatorship.

4.2 Identification

The parameter of interest in equation (1) is β, which measures the empirical relationship between exposure to the evolving road network and the outcomes of interest within districts over time. That is, this equation econometrically compares a district with itself at different points in time when it was differentially exposed to the network.[10] In order to interpret β as the causal effect of the road network, we need to assume that changes in district-level exposure to the road network are uncorrelated with other district-level and time-varying factors that also affect repression and land allocations. Note that exposure to the network in district $d = k$ might increase even in the absence of road construction in district $d = k$. Therefore, variables such as local state presence over time, which might affect both road construction and repression locally, are not necessarily confounders because when a road is constructed in $d = k$ it can affect districts $d \neq k$.

We consider the main econometric threat to be the distance to other infrastructure projects which took place during this time period, such as the hydroelectric plant in Itaipu. In the following sections, we provide a battery of robustness checks showing that our estimates are robust to take other local projects into account, suggesting that this identification assumption is plausible and then a causal interpretation reasonable.

5 State-led repression

This section shows that higher exposure to the newly developed road network increased local vulnerability to state-led repression. The section ends by showing that the results are robust to a large set of econometric decisions, including those related to specification and measurement.

5.1 The road network facilitated repression

Table 2 presents estimates of equation (1) using different measures of state-led repression as dependent variable. Columns 1-3 begin by examining the extensive margin, i.e. whether at least one event of state-led repression took place in a district-year. The results suggest that exposure to the road network increased the probability of experiencing repression. To gauge the magnitude of this estimate, consider that between 1955 and 1985 the average district went from being 155 kilometers (km) from the closest road to being only 73 km away, a reduction of more than 50 percent in dis-

[10] As a consequence of these comparisons, the few districts not experiencing variation in R_{dt} over time contribute to the efficiency of β by providing information to estimate ϕ_t but have no influence in the point estimate of β.

tance or 50 percent more exposed. Put differently, doubling the distance to the network decreases repression by 1 percentage point. From a baseline of 5 percent, this coefficient can be interpreted as a 20 percent increase in state-led repression when districts become more connected.

The role of the road network in facilitating repression is similar across the three measures of repression that we observe in the Truth and Justice Report. Columns 4-6 repeat the exercise from the previous columns but now using the total number of repression events as dependent variable. The bottom of the table presents the average number of events to ease the assessment of magnitudes. We find that when districts get closer to the road network, they experience more repression. Increasing exposure to roads by 100 percent is associated with 0.14 more events of state-led repression. From a baseline of 0.23 events, this effect corresponds to an increase of 61 percent. This empirical relationship is again statistically significant at conventional levels. Panel B shows that most of the impact of roads is explained by districts that get closer than 20 kilometers from the road network.[11]

What type of state repression is empirically associated with the construction of the road network? Some repression events appear to be isolated in terms of their location in space or happened in unusual periods of time, others are clustered. We label the latter as "massive" events in the sense that we observe multiple events of repression taking place in the same district and year. In Table 3, we explore the impact of roads on massive repression. Based on the distribution of events, we consider three types: (i) a single event, (ii) between 2 and 9 events, and (iii) more than 10 events in the same district and year. Overall, the results show that the road network is increasing the probability of observing more than 10 repression events in a district-year more than that of isolated events. To see this more clearly, the bottom of the table presents the effect size, i.e. the percentage change in the dependent variable as a response to a standardized change in exposure to roads. Given that we do not observe if these events took place in exactly the same place and time within the district, we interpret these findings as suggestive evidence of roads facilitating mass repression.

Overall, we find that exposure to the road network in Paraguay facilitated state-led repression, particularly multiple events in districts closer than 20 kilometers from the network. Is there a causal connection between these two variables? Two additional sets of empirical exercises suggest that the relationship is likely to be causal. First, we show that the exposure to other infrastructure projects is unrelated to state repression. Second, we present a wide range of robustness exercises supporting the previous results and suggesting that a causal interpretation is plausible.

[11] These results remain statistically significant when we use standard errors that take into account unobserved spatial correlation as well as time auto-correlation (Conley, 2010; Colella et al., 2019).

Table 4 shows that other important historical projects or events are unlikely to be confounding the importance of the road network. We begin by showing that the results are robust to the inclusion of controls for the exposure to important infrastructure projects. Columns 1 and 2 add as control variables the distance to the Itaipú and Yacyretá hydroelectric dams after their respective years of construction, and column 3 adds both control variables at the same time. Both are hallmark projects of the Stroessner dictatorship. The former is a large and expensive dam constructed by both Paraguay and Brazil and once selected as one of the seven modern Wonders of the World. The latter is an infrastructure project led by Argentina and Paraguay, originally controversial for ecological reasons. Reassuringly, the impact of roads is unchanged when controlling for distance to these large state-sponsored projects, which suggests that there is something specific about road networks that facilitates state-led repression. We argue that control and access are key. Similarly, column 4 shows that the results are similar when controlling for the cross-border impact from Argentina. The department of Itapúa experienced significant state-led repression in the early years of the Stroessner regime because dissidents migrated from Paraguay to the border region of Misiones in Argentina and attempted to create resistance through the Itapúa region.

5.2 Robustness checks

Table 5 summarizes a series of robustness exercises to show the results are unaffected by specification decisions, influential observations, or unobserved shocks. Columns 1-3 show that results are the same when we use three other functional forms of repression events as dependent variable. Columns 4 and 5 show that the results are unaffected when using Poisson or Negative Binomial regression models. The final robustness exercise in Table 5 is motivated by the fact that we only observe six snapshots of the road network and we employed interpolations to estimate the evolution of the network in other years. The results indicate that the interpolation method we use to complete the annual panel has no effect on our estimates. Column 6 shows estimates of equation (1) using a collapsed version of the annual panel dataset to a six-period panel data. For the initial snapshot in 1955, we examine the total number of repression events in the 1955-1959 period. We do the same for each of the seven years with data on the road network, e.g., 1960-1964 for the 1960 snapshot and so on. The results are equivalent to the ones using the entire annual data. These results also confirm that the statistical significance does not arise because of serially correlated outcomes (Bertrand et al., 2004). Overall, the results are robust to different specification decisions.

More generally, in the Online Appendix, we show that the results are the same when conducting a range of robustness exercises. In Table A.2, we include a large set of predetermined

covariates—measured before the dictatorship—interacted by year indicators to control for time-varying changes across similar districts. We start in columns 1-3 with demographics, education, employment, and housing characteristics from the 1950 Census, for which we build a crosswalk file to ensure the correspondence between the 160 districts that existed in 1950 and the 248 in our analysis. Columns 4-6 include a large set of topographic, climate, and geographic data. Column 7 addresses potential spatial autocorrelation among our districts following Bauman et al. (2018). Finally, in column 8, we select controls following Belloni et al. (2014) where the treatment to select the covariates is the change in log distance to closest road between 1955 and 1985. In all, the results are robust to the inclusion of all or any of these additional covariates as controls.

Columns 1-3 in Table A.3 drop from the estimation the largest districts in the country to check whether urban agglomerations explain our results, which would be problematic as these locations are more likely to benefit from roads. Reassuringly, results are unchanged when restricting attention to districts with less than 50, 30, or 15 thousand inhabitants. Column 4 drops the three departments from the north-west region of the country (Alto Paraguay, Boqueron, Presidente Hayes) which always have the same exposure to the network in the 1955-1985 period, and the results are the same. Dropping Asunción or districts being connected by roads from the estimation also makes little difference (columns 5-6).[12] Column 7 keeps the 96 districts which experience at least one event of repression and, if anything, the results are even stronger. We also verified that results are the same when we drop single departments (group of districts) or districts from the estimation (Figures A.2 and A.3). Overall, the results are unlikely to be driven by particularly influential locations.

Finally, we checked whether the lack of geographic information for some repressive events influences our estimates. Unfortunately, this missing information originates in the primary sources of our data and thus we can only statistically guess where these events must have taken place. To deal with this missing data problem, we perform an exercise in which we assign a district to the repressive events without districts by using the interaction between the total events in that year and the share of total events that the district experienced in the whole period (columns 1-3), or alternatively the interaction between the total events in that year and the share of total events that the district experience in that particular year (columns 4-6). Intuitively, we are using the distribution of events with geographic information to guess the location of the events without location. Reassuringly, Table A.4 shows that the estimates remain similar after using these methods.

[12]Dropping nodes in the network is a common exercise in the literature to assess potential time-varying unobservables driving the location of the infrastructure and outcomes of interest (Banerjee et al., 2020; Forero et al., 2021).

6 Illegal land allocations

This section shows that dictatorship allies benefited disproportionally from illegal land allocations. Moreover, the road network was important to drive illegal allocations when land was particularly valuable to be exploited. We end by providing suggestive evidence that these allocations appear to have hindered economic development and increased the extraction of natural resources.

6.1 Who benefited from illegal land allocations?

We document the preferential treatment of politically connected individuals by estimating the relationship between the amount of land received, measured as the (log) amount of hectares or the number of plots, and the connection to the regime of each one of the more than 2,500 beneficiaries of illegal land during the Stroessner regime. We classify each recipient of land as politically connected or unconnected. Moreover, we distinguish between military connections and other politically connected individuals. We identify these connections by combining the list of land beneficiaries with the list of congresspeople and high-ranked military personnel. Overall, we find that 8 percent were politically connected, two-thirds of which correspond to military connections.

Table 6 presents the results from this empirical exercise. Columns 1-3 in Panel A show that politically connected beneficiaries received almost 33 percent more hectares than unconnected individuals. Given that the average plot size was 3,500 hectares, this coefficient means that those in the dictator's circle received plots that were approximately 1,000 hectares larger. As shown in column 2, this effect is primarily explained by larger plots given to the military (p-value<0.01), although column 3 suggest that congresspeople were also benefited (p-value<0.10). Similarly, we also find that allies of the regime received more plots (column 4). The average beneficiary received 1.3 land allocations, a number that increases to 1.7 among those politically connected. In this case, the additional plots are completely explained by military connections, who received almost 35 percent more plots than other individuals. Panel B repeats this estimation strategy but now using beneficiary-district as the unit of observation and including district-level fixed effects. The previous empirical patterns remain the same. Overall, illegal land allocations benefited the military significantly more than congresspeople and other high-level politicians.

6.2 Was there a role for the road network?

Was there a role for the road network in the process of allocating illegal land to dictatorship allies? We hypothesize that better access to the road network can increase the returns to ownership of an agricultural plot, for example by facilitating access to urban markets for the commercialization of products. Thus, distance to roads could have motivated part of the land allocation process, particularly for valuable plots. We find evidence of this being the case in Paraguay.

To test for this connection, we use the panel data of districts in the 1955-1985 period. Econometrically, we estimate equation (1) using as dependent variable different measures of illegal land allocation. Table 7 presents the results. In Panel A, the dependent variable is a dummy equal to one if any land is illegally allocated in the given district-year, and in Panel B it is the (log of) the hectares illegally allocated. Column 1 in both panels shows that illegal allocations, on average, did *not* respond to changes in the proximity to roads: when districts get closer to the network neither the probability of illegal allocation nor the number of hectares illegally allocated changed.

Given that not all land is created equal, we further hypothesize that the previous null result could be masking important economic heterogeneity. In particular, we hypothesize that districts with more agriculturally productive land were more likely to be affected by the road network than districts where agricultural production was more difficult or costly. Columns 2-3 in Table 7 focus on cotton—the main crop at the time—and columns 4-5 in soybean, which later became increasingly more important in Paraguay. Our goal is to check for the empirical association between roads and illegal land allocations, but now interacting the proximity to roads with agricultural suitability. The intuition is straightforward: land unsuitable for agricultural production benefits less than suitable land from being close to the road network. In other terms, the returns to land ownership should be larger in districts highly suitable for agriculture which are located close to the network.

To proxy for land quality, we use the well-know GAEZ Soil Suitability Indexes, in our case for rain-fed agriculture and high inputs for the two main crops in Paraguay. Columns 2 and 4 use the suitability index while columns 3 and 5 use an indicator when districts have on average high suitability. Consistent with our intuition, columns 2-3 show that illegal land allocation was higher in districts highly suitable for growing cotton that were close to the network. In fact, both the probability of an illegal allocation and the number of hectares allocated increased in these areas. This is consistent with cotton being the main export cash crop at the time. We find a similar but weaker connection with soybean suitability, a relatively newer crop at the time. In all, the results support the role for the road network in shaping the illegal allocation of productive land.

6.3 Persistence and long-run development

Taken together, the evidence suggests that the construction of the road network was a political and military device aimed at accessing and controlling territory. Violent political repression was the first step and, as the regime extended its grip over the whole territory, it grabbed valuable land assets by illegally allocating large, productive plots to its collaborators, especially in higher spheres of government and in the military. We interpret these findings as repression serving first as a policy device to ensure access and control, and later as a means to ensure large-scale grabbing of resources to build a large and stable coalition of supporters (Bueno de Mesquita, 2003).

The high concentration of land in Paraguay is a source of conflict between workers and elites (Hetherington, 2011). We hypothesize that the widespread misallocation of land is likely to have had long-term consequences for the country's development. As discussed, illegal land allocation continued after the end of the dictatorship, as shown by the Truth and Justice Commission, which also covers the following 1990-2003 period. In addition, political parties have strong networks of political brokers who effectively buy votes (Finan and Schechter, 2012; Duarte et al., 2023), an environment in which radical changes to the status quo (e.g. land reform) are unlikely to emerge. As a consequence, it is not surprising that land occupations and conflict are pervasive. Is there a link between Stroessner's illegal land allocations, development after dictatorship, and rural conflict? We end our analysis by providing suggestive evidence of illegal land allocations preventing sustainable economic development to unfold and increasing conflict over land in rural areas.

Table 8 presents cross-sectional evidence showing that districts with more illegal allocations, measured as the logarithm of hectares illegally allocated between 1955 and 1985, have significantly different outcomes related to economic development in the years from 2000 until 2020. Panel B adds the change in roads as an additional predictor variable for robustness and comparison purposes. Overall, districts with more illegal allocations under dictatorship appear to be less developed, as proxied by night time lights (column 1), population density (column 2), and agricultural production per hectare (column 3). Importantly, this relationship holds after accounting for a large set of geographic and socioeconomic characteristics of districts, including how rural districts were, measured before the Stroessner dictatorship began. We reach the same conclusion when using an index that combines the three development outcomes (column 4). Moreover, districts with more illegal allocations exhibit higher levels of pollution (column 5) and are more subject to wildfires (column 6), a common way to clear forested land for extensive cultivation (Harding et al., 2022). Illegal allocations are also associated with more mining activities (column 8) and with an index of

extractive activities that combines all previous outcomes (column 9).[13]

The unequal distribution of land, together with the underdevelopment of areas with more illegal allocations, suggests that conflict over land is likely to take place. Indeed, land occupations have been on the rise and researchers have argued that the source of these actions is related to the conflict between the elite and peasants over the control of scarce resources in the countryside (Mangonnet et al., 2023). Are land occupations related to illegal land beneficiaries? Using novel data with information on land occupations in the 2000s, we find evidence consistent with rising conflict arising from illegal land allocations. Column 10 in Table 8 shows that districts with more illegal allocations during 1955-1985 are more likely to experience land occupations in the 2000s.

7 Conclusion

We have shown the perverse effects of the extension of the road network in Paraguay under the longest dictatorship in South America. Based on unusually high-quality data documenting state-led repression, and plot-level information documenting illegal allocations of land, we show that infrastructure development can facilitate large-scale human rights violations under dictatorship, enable the misallocation of productive agricultural land, and lead to underdevelopment. We interpret these findings as repression paving the way to control territories which previously had little state presence. Once controlled, access to productive economic resources to benefit supporters of the regime followed.

Our findings suggest caution when evaluating large infrastructure projects taking place under dictatorships. Although the economic benefits associated with road networks in democratic periods have been extensively documented, the "dark side" of infrastructure can be larger than previously thought, particularly during authoritarian times. The associated challenges are immense, especially given the absence of checks and balances, questioning the opportunity to allocate funding for infrastructure projects to dictatorial regimes. In any case, a better understanding of policy implementation under dictatorships can help to improve the lives of millions of people currently ruled by authoritarian governments.

Our analysis opens new questions regarding the role of infrastructure projects in helping dictatorships to maintain their power. On the one hand, large projects can increase economic growth and empower (or create new) economic elites, potentially debilitating the dictator's power. On

[13] Table A.5 shows that results are robust to excluding outliers in the distribution of outcomes related to development and extractive activities. The results are the same after winsorizing each distribution at the 1% and 5%.

the other hand, these projects can facilitate the control of territory and generate rents to be allocated. If these rents are allocated to collaborators, then a sufficiently large coalition of supporters can emerge and enable the dictator to sustain his power for a prolonged period of time (Bueno de Mesquita, 2003). Therefore, how much to invest is constrained by how forward-looking the dictator is and how much benefits he derives from holding on to power. More research is needed to understand the benefits and costs that dictators face when investing in large infrastructure projects.

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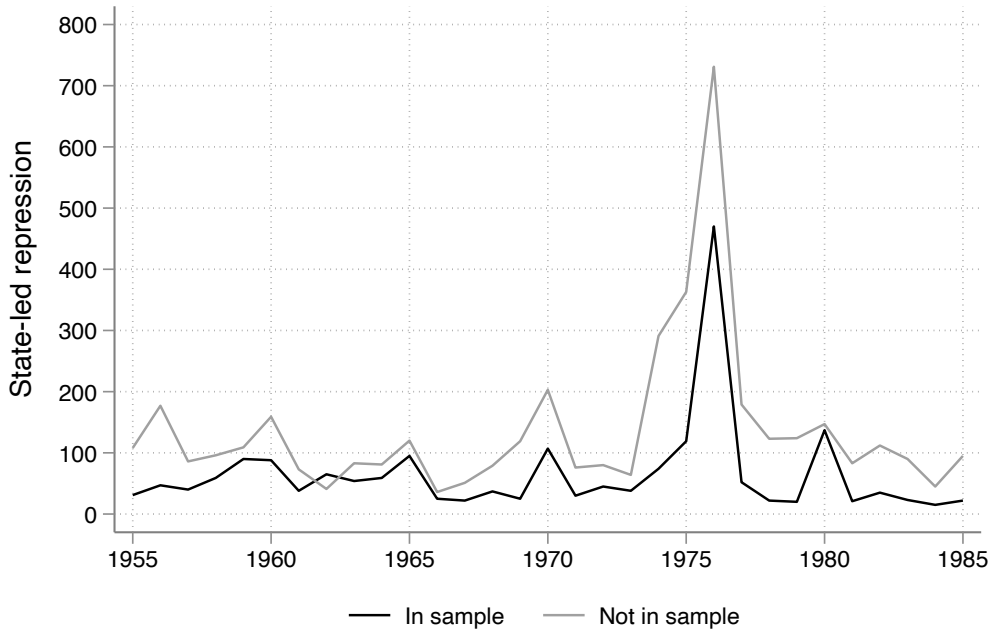
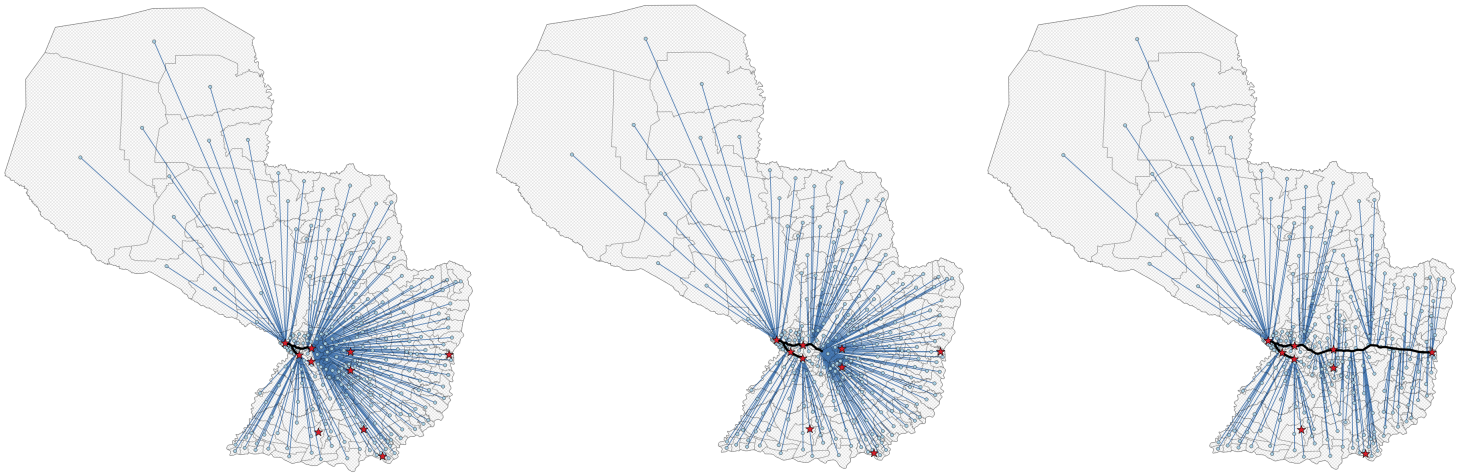
Figure 1: State-led repression over time in Paraguay

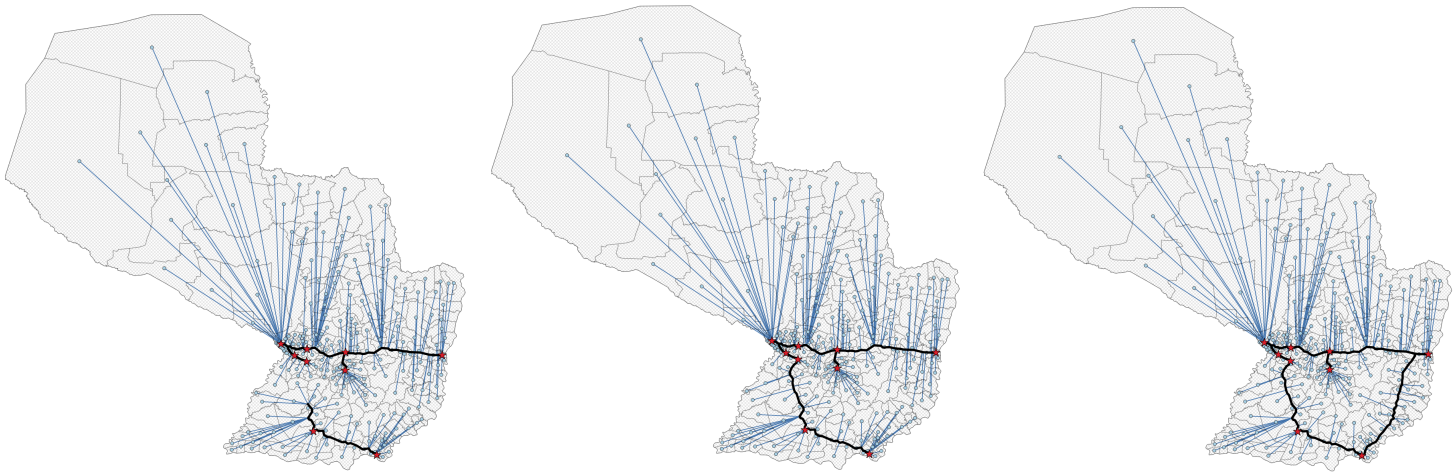


Notes: This figure shows the number of state-led repression events per year as revealed by the *Truth and Justice Commission* in Paraguay. The black line represent the total number of events for which we have information about the district where they took place. The gray line represents the number of events without district information.

Figure 2: Construction of paved roads in Paraguay, 1955-1985



(a) 1955 (b) 1960 (c) 1965



(d) 1970 (e) 1975 (f) 1985

Notes: These maps show the construction of paved roads in black lines (—) in Paraguay from 1955 to 1985. Polygons represent districts. Red stars (★) mark main districts being connected by paved roads. Blue lines (—) represent the closest distance from a district's geographic centroid to the road network.

Table 1: Descriptive statistics

	Mean	Median	St. Dev	Min	Max	Observations
Panel A – State-led repression	(1)	(2)	(3)	(4)	(5)	(6)
Indicator repression	0.05	0.00	0.22	0.00	1.00	7,688
Indicator torture	0.05	0.00	0.21	0.00	1.00	7,688
Indicator detention	0.05	0.00	0.21	0.00	1.00	7,688
Number of repression events	0.23	0.00	2.32	0.00	75.00	7,688
Number of torture events	0.20	0.00	2.01	0.00	64.00	7,688
Number of detention events	0.20	0.00	2.06	0.00	70.00	7,688
Panel B – Distance to closest road (in kms)						
In year 1955	155	157	105	0.55	645	248
In year 1960	139	138	105	0.54	645	248
In year 1965	106	77	105	0.46	645	248
In year 1970	79	40	103	0.11	645	248
In year 1975	79	39	103	0.11	645	248
In year 1985	73	30	105	0.11	645	248
Panel C – Illegal land allocations						
Years 1954-1959	1224.88	400	2643.35	0.00	16500	50
Years 1960-1964	2094.44	400	4783.38	0.00	52233	154
Years 1965-1969	1561.04	225	4107.59	0.00	56246	368
Years 1970-1974	1409.25	532	4144.49	0.00	85732	533
Years 1975-1984	3825.86	624	12598.63	0.00	148499	1437
Years 1985-1989	4449.29	4000	12592.65	0.00	143683	398

Notes: This table presents descriptive statistics for the main variables used in the analysis. Panel A describes state-led repression in the panel data of 248 districts observed yearly between 1955 and 1985. Panel B describes the distance (in kilometers) to the closest paved road in each of 6 years in the period 1955-1985. Panel C describes the illegal land allocations showing the average area (in Hectares) of the illegally allocated plots.

Table 2: Road construction and state-led repression in Paraguay

	Indicator for at least one event of:			Total events of:		
	Repression	Torture	Detention	Repression	Torture	Detention
Panel A	(1)	(2)	(3)	(4)	(5)	(6)
Log distance to closest road	-0.010*	-0.010*	-0.010*	-0.143**	-0.125**	-0.125**
	(0.006)	(0.006)	(0.006)	(0.065)	(0.057)	(0.057)
	[0.012]	[0.017]	[0.013]	[0.085]	[0.089]	[0.080]
Panel B						
Indicator for distance to road < 20km	0.043**	0.033*	0.042**	0.418**	0.375**	0.363**
	(0.020)	(0.018)	(0.020)	(0.165)	(0.146)	(0.143)
	[0.000]	[0.000]	[0.000]	[0.022]	[0.030]	[0.022]
Indicator for distance to road < 60km	0.006	0.010	0.008	0.047	0.040	0.038
	(0.010)	(0.010)	(0.010)	(0.100)	(0.087)	(0.087)
	[0.188]	[0.078]	[0.171]	[0.193]	[0.215]	[0.235]
Observations	7,688	7,688	7,688	7,688	7,688	7,688
Districts	248	248	248	248	248	248
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Mean dependent variable	0.054	0.047	0.048	0.233	0.197	0.202

Notes: This table presents the empirical relationship between distance to the closest road and state-led repression in the period 1955-1985. The unit of observation is a district-year. Columns 1-3 use indicators for at least one event of repression as dependent variables. Columns 4-6 use the total number of repression events as dependent variable. Standard errors are clustered by district. In square brackets, we present p-values from standard errors that take into account spatial correlation as well as time autocorrelation (Conley, 2010; Colella et al., 2019). In particular, we use a cut-off of 100km and one-year auto-correlation. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Massive events of state-led repression

	Indicator for *X* events of								
	Repression			Torture			Detention		
	1 event	2-9	≥10	1 event	2-9	≥10	1 event	2-9	≥10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Log distance to closest road	-0.003	-0.004	-0.003**	-0.004	-0.003	-0.003**	-0.004	-0.003	-0.003**
	(0.004)	(0.003)	(0.001)	(0.004)	(0.003)	(0.001)	(0.004)	(0.003)	(0.002)
Effect size	11.80	20.15	50.76	15.55	16.92	70.76	17.14	15.47	72.56
Observations	7,688	7,688	7,688	7,688	7,688	7,688	7,688	7,688	7,688
Districts	248	248	248	248	248	248	248	248	248
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.098	0.146	0.503	0.085	0.144	0.421	0.089	0.147	0.370
Avg. dependent variable	0.027	0.021	0.005	0.023	0.019	0.005	0.024	0.020	0.004

Notes: This table presents the empirical relationship between distance to the closest road and state-led repression in the period 1955-1985. The unit of observation is a district-year. Standard errors are clustered by district. All dependent variables are indicators for different types of events of repression. *Effect size* is computed as β over the average of the dependent variable times a 100. Thus, it can be interpreted as how much the probability of an event changed when the distance to a road was reduced by half. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Other infrastructure projects and Itapúa

Additional control for:	Dependent variable: Total number of repression events			
	Distance to Itaipú dam	Distance to Yacyretá dam	Distance to Both dams	Indicator Itapúa in 1955–1976
	(1)	(2)	(3)	(4)
Log distance to closest road	-0.155**	-0.143**	-0.155**	-0.167**
	(0.069)	(0.065)	(0.069)	(0.070)
Observations	7,688	7,688	7,688	7,688
R-squared	0.456	0.456	0.456	0.457
Districts	248	248	248	248
District fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Avg. dependent variable	0.233	0.233	0.233	0.233

Notes: This table presents the empirical relationship between distance to the closest road and state-led repression in the period 1955-1985. The unit of observation is a district-year. The dependent variable is the total number of repression events. Column 1 controls for the log distance to the Itaipu dam interacted with an indicator that takes the value one before 1974 and zero otherwise. Column 2 controls for the log distance to the Yacyretá dam interacted with a dummy that takes the value one after 1983. Column 3 adds both controls from columns 1 and 2. Column 4 adds as a control a dummy for the Itapúa department interacted with a dummy that takes the value one from 1955 to 1975. Standard errors are clustered by district. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Robustness of main results

Robustness exercise:	Logarithm of (1+event)	Asinh of events	Number of events per 1,000 inhab.	Poisson	Negative binomial	Collapse to periods with roads data
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A – Repression						
Log distance to closest road	-0.018**	-0.022**	-0.016**	-0.513**	-0.292***	-0.862**
	(0.009)	(0.011)	(0.007)	(0.246)	(0.053)	(0.386)
Panel B – Torture						
Log distance to closest road	-0.018**	-0.022**	-0.014**	-0.562**	-0.324***	-0.792**
	(0.008)	(0.011)	(0.007)	(0.264)	(0.056)	(0.354)
Panel C – Detention						
Log distance to closest road	-0.017**	-0.021**	-0.014**	-0.538**	-0.305***	-0.750**
	(0.008)	(0.010)	(0.006)	(0.246)	(0.056)	(0.341)
Observations	7,688	7,688	7,688	2,852	2,852	1,240
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Districts	248	248	248	92	92	248

Notes: This table presents robustness exercises for the empirical relationship between roads and state-led repression. The unit of observation is a district-year. Each robustness exercises is described in the header of the corresponding column. Standard errors are clustered by district. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Illegal land allocation and connections to the regime

	Log hectares			Number of plots		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Individual level						
Connected	0.326***			0.448***		
	(0.053)			(0.068)		
Military connected		0.347***			0.496***	
		(0.058)			(0.068)	
Politically connected			0.215*			0.136
			(0.128)			(0.130)
Observations	2,544	2,544	2,544	2,544	2,544	2,544
R-squared	0.008	0.007	0.001	0.021	0.022	0.000
Mean dependent variable	7.483	7.483	7.483	1.319	1.319	1.319
Panel B: Within district						
Connected	0.224***			0.310***		
	(0.051)			(0.090)		
Military connected		0.245***			0.351***	
		(0.057)			(0.096)	
Politically connected			0.087			0.092
			(0.098)			(0.172)
Observations	2,259	2,259	2,259	2,259	2,259	2,259
R-squared	0.462	0.462	0.460	0.074	0.074	0.066
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Mean dependent variable	7.119	7.119	7.119	1.280	1.280	1.280

Notes: This table presents the empirical relationship between the log number of hectares and number of plots on a dummy on political connections to the dictatorship. In panel A, the unit of observation is an individual receiving illegal lands, while in panel B, is an individual receiving illegal lands in a given district. *Connected* is a dummy that takes the value one if an individual is connected to the dictatorship, while *Military (Politically) connected* is a dummy that takes the value one if the individual is part of the army (congress or minister). Panel B includes district level fixed effects. Robust standard errors are presented in parenthesis. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Roads and illegal land allocation

Suitability:		Cotton		Soy	
		Continuous	Discrete	Continuous	Discrete
	(1)	(2)	(3)	(4)	(5)
Panel A: Any land					
Log distance to closest road × Suitability		-0.016***	-0.027**	-0.005	-0.025
		(0.006)	(0.013)	(0.004)	(0.017)
Log distance to closest road	0.007	0.013*	0.015*	0.004	0.008
	(0.008)	(0.007)	(0.008)	(0.008)	(0.008)
R-squared	0.316	0.317	0.317	0.316	0.316
Mean dependent variable	0.112	0.112	0.112	0.112	0.112
Panel B: Log total hectares					
Log distance to closest road × Suitability		-0.117***	-0.198**	-0.028	-0.177
		(0.045)	(0.095)	(0.040)	(0.154)
Log distance to closest road	0.062	0.105*	0.121*	0.047	0.071
	(0.060)	(0.062)	(0.064)	(0.063)	(0.061)
Observations	7,688	7,688	7,688	7,688	7,688
R-squared	0.335	0.336	0.335	0.335	0.335
Mean dependent variable	0.819	0.819	0.819	0.819	0.819
Districts	248	248	248	248	248
District fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes

Notes: This table presents the empirical relationship between road construction and the illegal allocation of agricultural land. *Any land* is a dummy that takes the value one if there was at least one land allocation in that district-year. *Log total hectares* is the hyperbolic sine transformation for the total number of hectares allocated in a year-district. The unit of observation is a district-year. Columns 2 and 3 (4 and 5) present the soil suitability for cotton (soy) based on the GAEZ Soil Suitability index classes for rain-fed conditions and high inputs. Columns 2 and 4 present the results for a standardized index, while columns 3 and 5 present it for a dummy that takes a value of one for a suitability higher than three (i.e., less than moderate constraints to grow the crop). Standard errors are clustered by district. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

Table 8: Illegal land allocations and long-run development

Outcome:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Development				Extractive activities					
	Ln Nighttime lights	Ln Population density	Agricultural production	Score (standardized)	Pollution	Wild fires	Deforestation	Any mine	Score (standardized)	Land invasion
Panel A										
Log hectares	-0.031***	-0.047***	-0.009**	-0.044***	0.016*	0.011**	-0.001	0.007*	0.018*	0.010**
	(0.011)	(0.018)	(0.005)	(0.015)	(0.009)	(0.005)	(0.002)	(0.004)	(0.010)	(0.005)
Panel B										
Log hectares	-0.031***	-0.048***	-0.011**	-0.046***	0.018**	0.012**	-0.001	0.008*	0.019*	0.011**
	(0.011)	(0.017)	(0.004)	(0.014)	(0.009)	(0.005)	(0.002)	(0.004)	(0.010)	(0.005)
Change in roads distance	-0.006	-0.032	-0.053**	-0.043	0.062	0.027	0.002	0.014	0.059*	0.026
	(0.052)	(0.081)	(0.024)	(0.063)	(0.038)	(0.019)	(0.006)	(0.014)	(0.036)	(0.017)
Observations	248	248	248	248	248	248	248	248	248	248
R-squared	0.507	0.528	0.629	0.553	0.852	0.528	0.602	0.179	0.652	0.218
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socio-demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean dep var	1.851	4.016	0.779	0	15.20	0.880	0.287	0.0887	0	0.165

Notes: This table shows the relationship between land allocations and long-term outcomes. The dependent variables are all computed from 2000 until 2020. Log hectares is the logarithm of the sum of illegal land allocations from 1955 to 1985. Change in roads distance is the change in the log distance to the closest roads in 1985 minus 1955. Robust standard errors are presented in parenthesis. The set of geographic controls include: average elevation, average slope of the terrain, ruggedness, average precipitation and temperature, the standard deviation of temperature, isothermality index, and the distance to rivers. The socio-demographic controls based on the 1950 Census include: share of rural population, share of female population, share of people that speaks an indigenous language, share of illiterate population, share of children going to school, share of population that finished secondary education, share of households with agriculture as the main income, share of population working in agriculture, share of population that owns a house, share of houses with electricity, and share of houses with running water. Robust standard errors presented in parenthesis. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

ONLINE APPENDIX

The Dark Side of Infrastructure: Roads, Repression, and Land in Authoritarian Paraguay

Felipe González, Josepa Miquel-Florensa, Mounu Prem, and Stéphane Straub

List of Figures

List of Tables

A Mapping the road network development

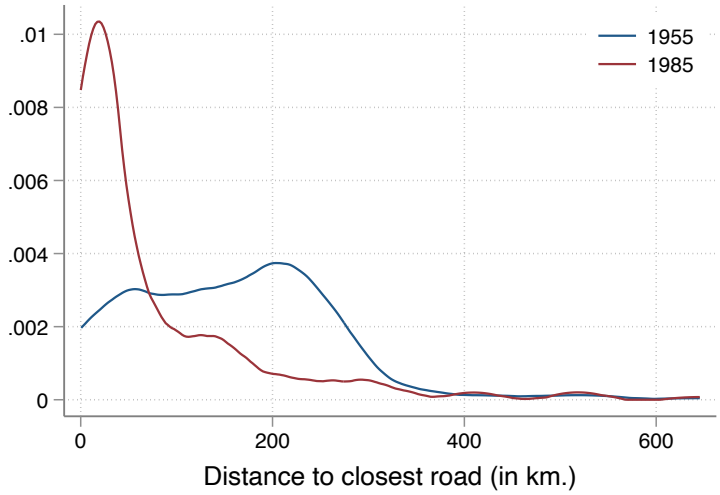
For the period of interest, no official road maps providing a distinction between dirt, gravel, and paved roads are available. Similarly, sources on the main road segments generally fail to indicate at which time they were actually paved. In order to reconstruct the evolution of the paved network from the 1940s, we turn to historical national development plan documents for the transport and communications sectors (Secretaria General de Planificación, 1970) as well as economic memorandum from the World Bank (World Bank, 1979, 1981, 1991) and from the Japanese foreign development assistance (Japanese International Cooperation Agency, 1997, 2000).

We establish the extension of the paved road network at different dates in time, crossing information on the total extension of the paved network (World Bank, 1991), on the extension of that network by departments (Secretaria General de Planificación, 1970), as well as additional information from on both realized and planned works on different road segments contained in these different documents, and double-checking resulting figures with both online sources and direct consultations. This allows us to first develop Table A.1, which details the extension of paved roads by departments from 1940 to 1975.

Beyond 1975, information on the extension of paved roads by departments is not available. World Bank (1991) reports the following total extension of roads at the country level: 1,469.4 km in 1980, and 2076.6 km in 1985. In one noteworthy addition to the network, by 1985, road number 6, which links the crossing at km 30 near Ciudad del Este to Encarnación, was constructed. This corresponded to an additional 160 km in the department of Itapúa, and 90 km in the department of Alto Paraná. The remaining newly paved roads mostly correspond to a densification of the asphalt network around Asuncion and in the Central department, and have little incidence on the distance to the roads for the large majority of districts in the analysis. The next big push occurred in the 1990s, with the paving of part of the trans-Chaco road in the West, road 4 to Pilar, and roads 3 and 4 in the North, connecting Concepción and Pedro Juan Caballero. By 2000, the paved network would exceed 3,000 km.

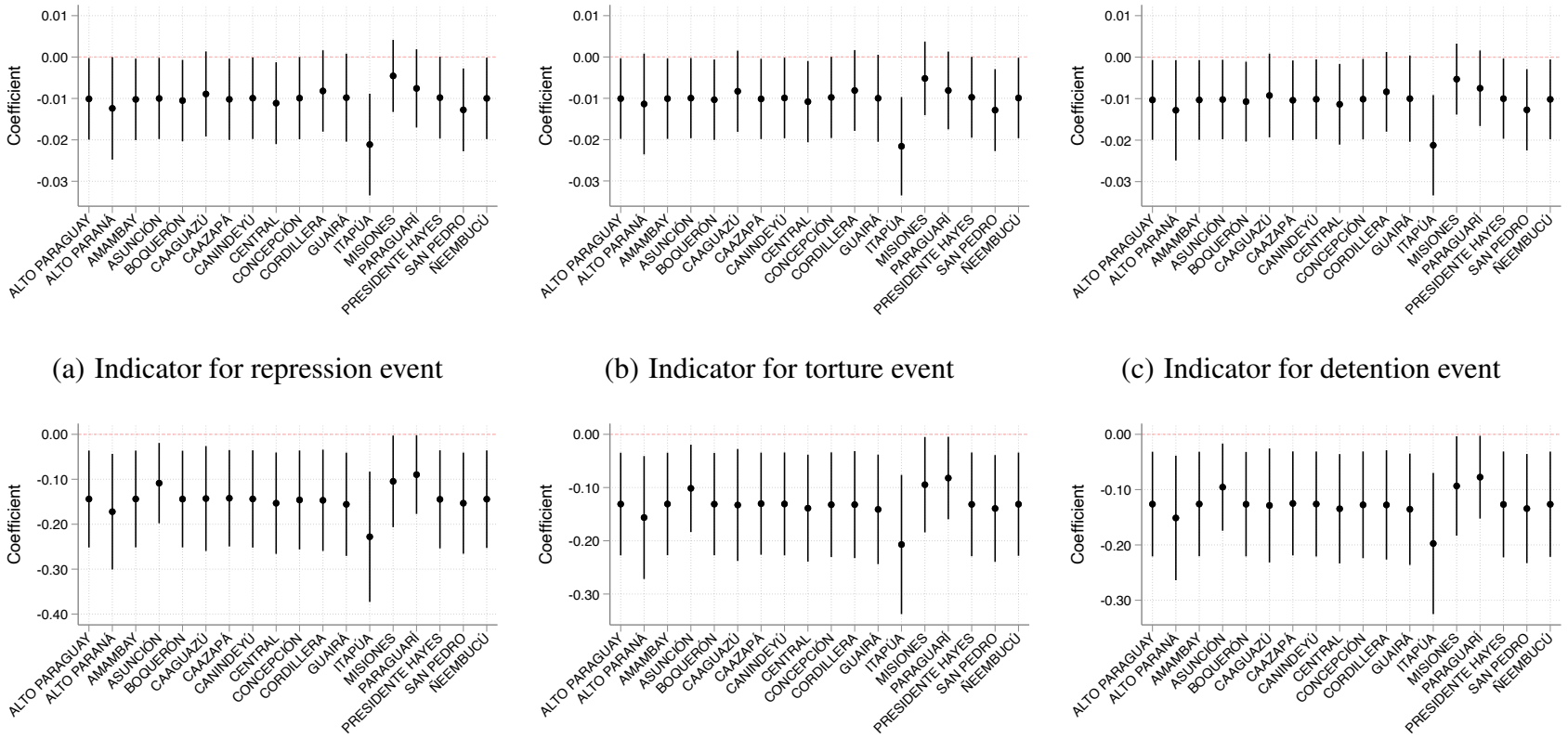
This allows us to identify 6 snapshots (1950-55, 1960, 1965, 1970, 1975, and 1985), which we digitize and georeference. The resulting paved road network at five-years intervals, and the distance of each district to the paved road network in each period, is represented in Figure 2. Figure A.1 shows that the distance to the road network across the sample of 248 districts included in the analysis decreased significantly between 1955 and 1985.

Figure A.1: Descriptive statistics, distance to closest road



Notes: This figure shows the distribution of distance to the closest paved road across 248 districts in Paraguay. The blue lines shows the distribution in 1955 and the red line in 1985.

Figure A.2: Robustness, excluding single departments from estimation



(a) Indicator for repression event

(b) Indicator for torture event

(c) Indicator for detention event

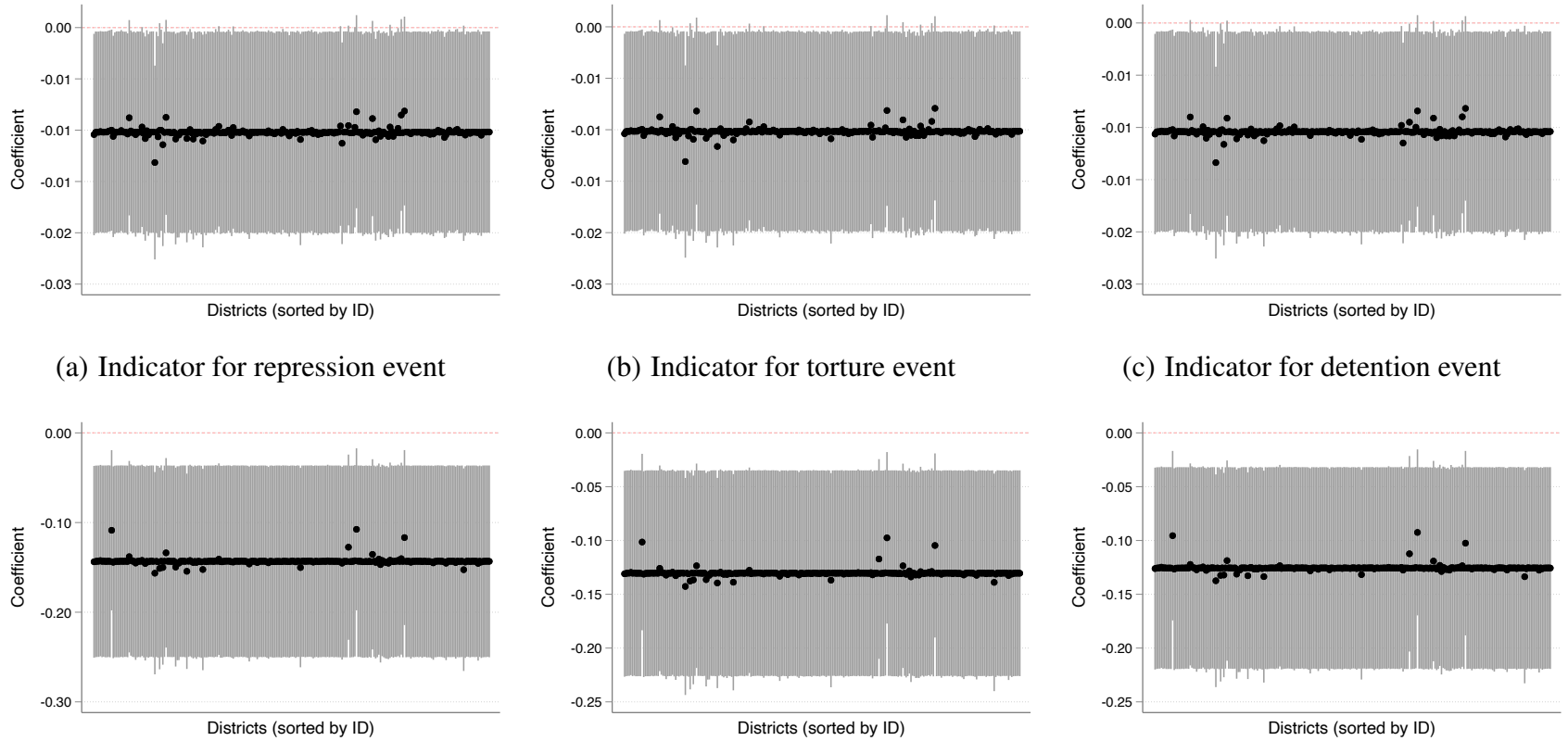
(d) Number of repression events

(e) Number of torture events

(f) Number of detention events

Notes: This figure shows the robustness of the empirical relationship between roads and state-led repression to dropping different departments (groups of contiguous districts) from the estimation. Each figure corresponds to a dependent variable. The *y*-axis measures the coefficient and the *x*-axis specifies which group of districts were dropped from the estimation. Black dots correspond to point estimates and vertical lines denote 90 percent confidence intervals.

Figure A.3: Robustness, excluding single districts from estimation



(a) Indicator for repression event

(b) Indicator for torture event

(c) Indicator for detention event

(d) Number of repression events

(e) Number of torture events

(f) Number of detention events

Notes: This figure shows the robustness of the empirical relationship between roads and state-led repression to dropping each one of the 248 districts. Black dots correspond to point estimates and vertical lines denote 90 percent confidence intervals.

Table A.1: Extension of the road network over time by department

	1940	1950	1955	1960	1965	1969	1975	1985
Región Central								
Central XI	12	88.5	95	114.5	150.8	232.7	232.7	248.7
Cordillera III	0	0	0	60	60.4	64.3	64.3	109.3
Guairá IV	0	0	0	0	0	40	40	108
Paraguarí IX	0	0	0	20	23.9	28.6	123.6	152.6
Caazapá VI	0	0	0	0	0	0	0	0
Región Itapúa								
Itapúa VII	0	0	0	0	0	94.1	94.1	281.1
Región Alto Paraná								
Caaguazú V	0	0	0	0	151	151.5	151.5	167.5
Alto Paraná X	0	0	0	0	84.5	84.5	84.5	204.5
Amambay XIII	0	0	0	0	0	0	0	0
Región Misiones								
Misiones VIII	0	0	0	0	0	114.3	114.3 1	164.3
Ñeembucú XII	0	0	0	0	0	0	0	0
Región Concepción - San Pedro								
Concepción I	0	0	0	0	0	0	0	0
San Pedro II	0	0	0	0	0	0	0	38
Región Bajo Chaco								
Pte. Hayes XIV	0	0	0	0	0	0	0	56
Región Chaco Norte								
Boquerón XV	0	0	0	0	0	0	0	0
Olimpo XVI	0	0	0	0	0	0	0	0
Total	12	88.5	95	194.5	470.6	810	905	1530

Notes: This table presents the evolution of the kilometers of paved roads by department from 1940 to 1985. Departments are grouped by region, according to the pre-1992 division, which comprises 16 departments in 7 regions. The Capital district Asunción, which does not belong to any region, is not included. For 1985, urban roads in Asunción and the Central department are not included as no detailed record are available, explaining the difference with the total of over 2,000 km stated above.

Table A.2: Robustness to different covariates

Covariates:	Demographic	Economic	Development	Geographic	Lat/lon polynomials	Average distance	Moran I	LASSO selected
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A – Repression								
Log distance to closest road	-0.137**	-0.137**	-0.109**	-0.206**	-0.179**	-0.140**	-0.174**	-0.182**
	(0.062)	(0.062)	(0.054)	(0.091)	(0.078)	(0.065)	(0.083)	(0.079)
Panel B – Torture								
Log distance to closest road	-0.127**	-0.125**	-0.102**	-0.182**	-0.160**	-0.127**	-0.155**	-0.160**
	(0.057)	(0.055)	(0.050)	(0.080)	(0.071)	(0.058)	(0.076)	(0.072)
Panel C – Detention								
Log distance to closest road	-0.122**	-0.120**	-0.097**	-0.179**	-0.154**	-0.123**	-0.151**	-0.155**
	(0.055)	(0.054)	(0.048)	(0.080)	(0.069)	(0.057)	(0.074)	(0.070)
Observations	7,688	7,688	7,688	7,688	7,688	7,688	7,688	7,688
Districts	248	248	248	248	248	248	248	248
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents robustness exercises for the empirical relationship between roads and state-led repression by adding different sets of controls interacted with year fixed effects. The unit of observation is a district-year. Column 1 includes the share of population that lives in rural areas, is female, speaks Guaraní, is illiterate, has at least secondary education, and children that go to school. Column 2 includes the share of population that economically active and works in the agriculture sector, as well as the share of households that mainly depend on agriculture. Column 3 includes the share of home ownership, and the share of houses with electricity and with access to clean water. Characteristics for columns 1 to 3 come from the 1950 Census. Column 4 includes average elevation, average slope, terrain ruggedness, the precipitation average and standard deviation precipitation, the isothermality, and distance to the closest river. Column 5 includes a second-degree polynomial of latitude and longitude. Column 6 adds the log average distance of the districts to the centroide to all the rest of the districts. Column 7 includes the Moran I eigenvectors with an eigenvalue greater than 0.01 with the aim of capturing spatial autocorrelation among our districts (Bauman et al., 2018). In column 8, we select controls following Belloni et al. (2014) where the treatment to select the covariates is the change in log distance to closest road between 1955 and 1985. Standard errors are clustered by district. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

Table A.3: Robustness to sample composition

Robustness exercise:	Districts with less than 50,000 inhab.	Districts with less than 30,000 inhab.	Districts with less than 15,000 inhab.	Drops departments in the north-west region	Drops connecting districts	Drops Asunción from estimation	Only districts with some repression
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A – Repression							
Log distance to closest road	-0.110**	-0.118**	-0.122**	-0.147**	-0.110*	-0.109**	-0.253**
	(0.054)	(0.058)	(0.059)	(0.068)	(0.059)	(0.054)	(0.123)
Panel B – Torture							
Log distance to closest road	-0.103**	-0.111**	-0.112**	-0.133**	-0.102*	-0.101**	-0.231**
	(0.050)	(0.053)	(0.055)	(0.060)	(0.054)	(0.050)	(0.110)
Panel C – Detention							
Log distance to closest road	-0.019*	-0.103**	-0.104**	-0.129**	-0.094*	-0.096**	-0.222**
	(0.010)	(0.051)	(0.053)	(0.059)	(0.053)	(0.048)	(0.108)
Observations	7,626	7,440	6,634	7,223	7,409	7,657	2,976
Districts	246	240	214	233	239	247	96
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents robustness exercises for the empirical relationship between roads and state-led repression. The unit of observation is a district-year. Each robustness exercises is described in the header of the corresponding column. Standard errors are clustered by district. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

Table A.4: Road construction and state-led repression: Imputations

Imputation	Based on overall share:			Based on yearly share:		
	Repression	Torture	Detention	Repression	Torture	Detention
Panel A	(1)	(2)	(3)	(4)	(5)	(6)
Log distance to closest road	-0.159**	-0.138**	-0.144**	-0.297**	-0.260**	-0.267**
	(0.067)	(0.059)	(0.062)	(0.133)	(0.117)	(0.117)
Panel B						
Indicator for distance to road < 20km	0.518***	0.445***	0.467***	0.866**	0.745**	0.766**
	(0.194)	(0.167)	(0.176)	(0.339)	(0.292)	(0.297)
Indicator for distance to road < 60km	0.022	0.015	0.012	0.099	0.083	0.083
	(0.098)	(0.086)	(0.086)	(0.205)	(0.180)	(0.177)
Observations	7,688	7,688	7,688	7,688	7,688	7,688
R-squared	0.464	0.429	0.454	0.464	0.429	0.454
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Mean dependent variable	0.494	0.423	0.411	0.494	0.423	0.411

Notes: This table presents the empirical relationship between distance to the closest road and state-led repression in the period 1955-1985. The unit of observation is a district-year. All columns use the total number of repression events as dependent variable. In columns 1-3, we impute the repression events without district by using the interaction between the total events in that year and the share of total events that the district experience in the whole period. In columns 4-6, we impute the repression events without district by using the interaction between the total events in that year and the share of total events that the district experience in that particular year. Standard errors are clustered by district. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

Table A.5: Illegal land allocations and long-term development: Robustness to outliers

Outcome:	Development				Extractive activities					
	Ln Nighttime lights	Ln Population density	Agricultural production	Score (standardized)	Pollution	Wild fires	Deforestation	Any mine	Score (standardized)	Land invasion
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Panel A: Winsorized at 1%										
Log hectares	-0.031***	-0.047***	-0.009**	-0.044***	0.014	0.012**	-0.001	0.007*	0.018*	0.010**
	(0.011)	(0.018)	(0.005)	(0.015)	(0.009)	(0.005)	(0.002)	(0.004)	(0.010)	(0.005)
Panel A: Winsorized at 5%										
Log hectares	-0.029***	-0.037**	-0.009**	-0.042***	0.011	0.013**	-0.000	0.007*	0.022**	0.010**
	(0.011)	(0.016)	(0.004)	(0.015)	(0.009)	(0.005)	(0.002)	(0.004)	(0.011)	(0.005)
Observations	248	248	248	248	248	248	248	248	248	248
Geographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Socio-demographic controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table shows the relationship between land allocations and long-term outcomes. The dependent variables are all computed from 2000 until 2020. Log hectares is the logarithm of the sum of land allocations from 1955 to 1985. Change in roads distance is the change in the log distance to the closest roads in 1985 minus 1955. Robust standard errors are presented in parenthesis. The set of geographic controls include: average elevation, average slope of the terrain, ruggedness, average precipitation and temperature, the standard deviation of temperature, isothermality index, and the distance to rivers. The socio-demographic controls based on the 1950 Census include: share of rural population, share of female population, share of people that speaks an indigenous language, share of illiterate population, share of children going to school, share of population that finished secondary education, share of households with agriculture as the main income, share of population working in agriculture, share of population that owns a house, share of houses with electricity, and share of houses with running water. Robust standard errors presented in parenthesis. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.