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 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 roads facilitated state-led repression and the illegal allocation of agricultural plots to dictatorship allies. These results suggest that infrastructure projects can also hinder economic development.

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

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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 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 and developing countries, where state presence is usually low and corruption high, the construction of transportation networks can potentially facilitate elite capture and authoritarian subordination. This "dark side" of infrastructure is likely to be detrimental for economic growth, but it has been relatively overlooked by researchers. In this paper, we examine the connection between the construction of road networks with 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). Led by army officer Alfredo Stroessner, the regime has become famous for its human right violations and for reallocating two percent of the country's land in a process plagued by wrongdoings. At the same time, Stroessner also engaged in the development of ambitious infrastructure projects for economic reasons and to expand control of remote locations. Among these projects, the construction network of paved roads was a prominent strategy to colonize the east 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 allocation of agricultural land.

To measure the evolution of state repression and misallocation within different parts of the Paraguayan territory, we digitize individual data on human rights abuses in the 1954-1989 period and illegal allocation of agricultural plots. Following the end of the Stroessner dictatorship in 1989, and the discovery of the "terror archives" in 1992, a massive amount of information that documents its repressive activities, strong societal demands appeared to investigate human right violations under the military. In the early 2000s, the Truth and Justice Commission was created. Shortly after, the Commission revealed to the public that 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. Similarly, the Commission also investigated the land allocation process and concluded that during this period the military

benefited from preferential allocation of plots. We use these data to measure how many illegal plots were allocated by district and year. Importantly, we combine the names of beneficiaries with the list of high-ranked military and congresspeople to measure political and military connections to the dictatorship.

We find that Stroessner's road network facilitated the implementation of state-led repression. Our empirical strategy exploits the panel structure of the data. We leverage the variation that arises after paved roads are constructed: a subset of districts in the country become easier to access. 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 events of torture or detention, 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. Overall, the finding can be explained by an increase in massive events of repression which take place closer than 20 kilometers from newly constructed roads.

When studying the land reallocation process, we provide some evidence that the road network helped to shape the process of illegal land allocation to the military. We begin by using our data to confirm that the military benefited from these allocations. Beyond being disproportionally represented among land beneficiaries, we show that within this group the military received more and larger agricultural plots. We then exploit the evolving exposure of districts to the construction of the road network again by using the panel structure. The empirical analysis is motivated by the intuition that high-value plots are agriculturally productive and easier to access. Consistent with our hypothesis, we find that plots were more likely to have been allocated to the military when these were located in districts with soybean production, an important staple produced by the agricultural sector in Paraguay, and close to the road network.

Our work contributes to the literature studying the political economy of infrastructure.[1] 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

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

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., 2022).

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 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 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

The regime of General Alfredo Stroessner, which lasted from 1954 to 1989, is one of the longest and harshest dictatorships in Latin America. This section lays out the main historical elements that characterize this dark period of the Paraguayan history, focusing on three main aspects relevant to our research design: the institutional architecture that sustained the dictatorship over more than three decades, the nature of the state-led repression and asset-grabbing process, and the evolution of the road network over that period.

2.1 Overview of dictatorship in Paraguay

General Alfredo Stroessner came to power in May 1954 through a military coup. Having overthrown Federico Chávez, of his own party, he was confirmed as president by a military board. This 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 government of Stroessner suspended constitutional and civil rights, and relied on 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 (Paz et al., 1994). From the 1970s, when other countries in the region became military dictatorships, Paraguay was also actively coordinating surveillance and repressive activities with its neighbors within the framework of the Operation Condor.[2]

Participation in economic and social activities, such as being a public servant or an active 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 then in 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.[3]

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

To maintain its power, Stroessner from the start relied on a strict repressive apparatus, methodically spying on, detaining, and torturing opponents. Most of what we know about this system comes the

[2]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.

[3]However, such is the grip of the Colorado party on the Paraguayan institutional framework and norms, that 34 years later, it is still in power, completing a 76-year long stretch, with the exception of a short 2008-2012 period.

unearthing in 1992 in various police institutions of a vast amount of documents (around 300,000), known as the "terror archives," with detailed information on activities including denouncements, surveillance reports, detentions, etc.[4]

This material was subsequently exploited by the country's "Truth and Justice Commission," created at the beginning of the 2000s following request from civil society organizations, including victims and human right associations, to investigate the large scale crimes and human rights violations committed during the dictatorship. In their final report (Comision de Verdad y Justicia, 2008), which covered 8 tomes and thousands of pages, the commission documented extensive violations of human rights, as well as lists of victims, and misappropriation of state assets among others. These data are of unique quality across Latin American countries, and paint a grueling picture of the Stroessner regime.

In particular, it 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 contains the list of hundreds of victimizers involved in the facts above. Finally, it is known that tens of thousands went into exile, at first in neighboring countries, and later when these places became themselves unsafe, in Europe or the United States.

In addition, the commission also analyzed exhaustive data from the country's land allocation agency (Instituto Bienestar Rural - IBR , later to become Instituto de Desarrollo Rural y de la Tierra - INDERT) between 1954 and 2003. This shows over a thousand cases of irregular large land parcels appropriation, which appear to have been one of the main ways in which the regime rewarded its operatives, especially high-ranking members of the military. Of 12.2 million hectares adjudicated during that period, about two-thirds, representing around 19.3 percent of the country's total area, were plagued by grave wrongdoings.

Finally, supporters of the regime were also favored through the regular allocation of procurement contracts (Nickson and Lambert, 2002, Auriol et al., 2016). 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, 2014).[5]

[4] See https://www.pj.gov.py/contenido/132-museo-de-la-justicia/334, last accessed on 12/6/2022.

[5] Two of the main contractors, who amassed immense fortunes, subsequently became presidents of the country: Juan-Carlos Wasmosy (1993-1998) and Raúl Cubas Grau (1998-1999).

2.3 Road construction

At the end of the 1950s, Stroessner decided to push for the colonization of a large part of the territory in the east, bordering with Brazil, that was until then ill-exploited and covered by forest. Strikingly, maps from the 1920s indicate that this Eastern half of the country contained at that time probably no more than 12,000 inhabitants, or around 2 percent of the total population.

Until the end of the 1950s, the paved road network was entirely concentrated around the nation capital Asunción and totaled less than 200 km. 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 find refuge.

The 1960s would be the decade of the "march to the East," with a four-fold increase in the length of paved roads. The main new corridors connected Asunción to the border with Brazil in the East, which would 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 2000km.

In the context of the movement to the East, Paraguay signed a treaty with Brazil, leading in 1975 to the start of the construction on the Itaipú dam, which remained the biggest one in the world in terms of installed power, until the building of the three-gorge dam in China in the 2000s. The construction gave a huge boost to the Paraguayan economy until the mid-1980s, but also contributed to the deepening of the local corruption and rent-seeking system (Straub, 2014).

3 Empirical strategy

3.1 Data construction

3.1.1 Repression over time

The repression operated on several levels. It restrained freedoms of expression, gathering, demonstrating, and organization, targeting specifically in that case any social or political group, which might not be completely aligned with it. This meant the forceful dispersion of meetings and demonstrations, as well as the targeting of the individuals involved in activities considered as threatening the regime.

The data used to document the extent and evolution of the repression over time was compiled

by the Truth and Justice Commission, based on the extensive information included in the terror archives. 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 it suffered, the start of end date of each episode, the district in which it took place, and the type of repression: detention, exile, torture, execution, and disappearance. There is all reason to believe that this is only a fraction of all actual events of repression. However, the quasi-obsessive manner in which the regime recorded its activities and the fact that it apparently failed to destroy any of these archives, when the Feb.3rd, 1989 coup happened, suggest that a significant part was recovered. We systematically scan and organize that data for the purpose of our analysis.

As Figure 1 shows, from 1954 until the end of the dictatorship, there was ongoing repressive activity. The spikes in some of the years correspond to instances in which the regime geared up the fight against specific insurgent groups 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 also took as a pretext to also strike any persons or organizations it considered hostile.

A number of events lack the precise district location. However, as can be seen in Figure 1, the black line for the events with known localization, tracks quite well the grey one which also includes non-localized events, which is reassuring in terms of potential 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-years 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 max of 75.

3.1.2 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 is 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 Iguacu in the East were completed with support from outside donors such as USAID, The Japanese foreign aid agency JICA, and the government of Brazil. This set the stage for the colonization of

the eastern part of the country. Finally, in the 1970s and 80s, additional corridors were completed, connecting Villarica below Road 7, and mostly completing the triangle with Encarnación in the South.

In Figure A.1, it is apparent 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. It decreased by more than 50 percent over the 1955-85 period.

3.1.3 Illegal land allocations

The Truth and Justice Commission had access to all land allocations over the period 1954-2003 from the institutions responsible (IBR, later to become INDERT) and to the country's land registry. The data 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, it established three main reasons why these allocations may be illegal. The first reason is when the land allocation were given to persons who were not eligible. The second applies when the beneficiaries received more than one lot, and the third when the beneficiaries received a parcel exceeding the maximum size contemplated in the law[6].

Of the 200,705 allocation examined, covering 12.2 million has., 4,241 allocations, for a surface of 7.9 million has., were plagued by irregularities. This concerns 3,336 beneficiaries, who together appropriated approximately 19.3 percent of the country's total area.

3.1.4 Political connections

Finally, we compiled lists of people connected to the regime in various forms. From the Truth and Justice Commission reports, we gathered information on the victimizers identified either through the documents in the archives or the testimony of surviving victims. We also hand collected the list of politicians involved in the successive governments of Stroessner as ministers or directors of the main State agencies. We further complement the list of politicians with all the Congress members (deputies and senators) over the 1954-1989 period, recovered from the Library of the Paraguayan Congress. Finally, we hand collected all the graduates from the National College of War (Colegio Nacional de Guerra, subsequently Instituto de Altos Estudios Estratégicos) over the

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

relevant period.[7] Overall, this includes a list of around one thousand five hundred "connected" individuals.

3.2 Econometric design

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 and 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 margin. 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 state-led repressive events, but as we later show the results are robust to different 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 allocated and relate it to exposure to the road network. To capture favoritism, we detect if each allocation was received by an individual who was politically connected to the Stroessner regime. We allow connections to be either political

[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.

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.

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.[8] 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 construct 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 our estimates are robust to take other local projects into account, suggesting that this identification assumption is plausible and then a causal interpretation reasonable.

4 Exposure to the road network

This section presents two sets of findings pointing to the dark side of road infrastructure. First, we show that a higher exposure to the newly developed road network had the undesirable impact of increased local vulnerability to state-led repression. Second, we show that the dictatorship allies were benefited disproportionally from illegal land allocation, with suggestive evidence of the role played by increasing access to the road network in locations with particularly productive land.

4.1 State-led 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 some event

[8] 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.

of repression took place in a district-year. The results suggest that exposure to the road network increased the probability of repression. To gauge the magnitude of this estimate, consider that between 1955 and 1975 the average district went from being 155 kilometers from the closest road to being closer than 80 kms, a reduction of 50 percent in distance 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. These estimates are similar across the three measures of repression observed in the Truth and Justice Report and statistically significant at the 10 percent. Columns 4-6 repeat the exercise 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 0.45 events, this effect corresponds to an increase of 31 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 who get closer than 20 kilometers from the closest point in the road network.

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 repression 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. In all, the results show that the road network is increasing the probability of observing more than 10 repression events in a district-year more than 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 moment, 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 locations 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.

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 variable 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.

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. Column 4 presents results from a demanding specification with department-by-year fixed effects and results remain the same. The inclusion of heterogeneous fixed effects in each one of the seventeen groups of districts is reassuring because it allows us to account for time-varying unobservables affecting repression within Paraguay. Columns 5-7 progressively drop from estimation the largest districts in the country to check whether urban agglomerations explain our results, which would be problematic as these are the locations more likely to benefit from the road network. Reassuringly, results are unchanged when restricting attention to districts with less than 200, 100, or 50 thousand inhabitants. In the same spirit, column 8 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 results are the same. Dropping Asunción (the largest city) or districts being connected by roads from the estimation also makes little difference (columns 9-10).[9] Similarly, in column 11, we keep the 96 districts which experience at least one event of repression and, if anything, results are even stronger. More generally, in the Online Appendix we show that results are the same when we drop single departments (group of districts) or districts

[9]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).

from the estimation (Figures A.2 and A.3).

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 the remaining years. The results indicate that the interpolation method we use to complete the annual panel has no effect on our estimates. Column 12 show 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 inconsistent standard errors associated to serially correlated outcomes (Bertrand et al., 2004). Overall, the results are robust to different specification decisions and are unlikely to be driven by particularly influential locations.

4.2 Illegal land allocations

Data from illegal land allocations reveal that the dictatorship allies benefited disproportionately. We document this preferential treatment by estimating the relationship between the (log) amount of hectares and the number of plots received by each one of the more than 2,500 beneficiaries of 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 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 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.

Was there a role for the road network in the process of allocating illegal land to dictatorship allies? We hypothesize that this might be the case as better access to the road network can increase the returns to ownership of an agricultural plot because, for example, it can facilitate the sale of products. Thus, distance to roads could have motivated part of the land allocation process. We find some suggestive 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 results. Columns 1 and 2 show that allocations did *not* respond on average to proximity to roads. Columns 3 and 4 focus on the sub-sample of allocations given to politically connected individuals. Again, we find little evidence of land allocations being affected by exposure to newly created roads.[10]

Given that not all land is created equal, we further hypothesize that the previous null result could be masking important heterogeneity. Districts with more productive land are more likely to be affected by roads than districts where agricultural production is more difficult or costly. Panel B further checks for the empirical association between roads and land, but now including the agricultural quality of land in the estimation. To proxy for land quality, we classify districts as above or below the median of soybean production, an important staple for the agricultural sector in Paraguay. Columns 1 and 2 show that land allocations were larger in places more distant to the road network, but the relationship reverts in more agriculturally productive districts, although results are not statistically different from zero at conventional levels. However, columns 3-4 suggest that politically connected individuals indeed benefited more from illegal land allocations when the plot was closer to the road network and in a highly productive district.[11] In all, the results in this table support a role for the road network in shaping the illegal allocation of land in places with higher agricultural productivity.

5 Conclusion

The paper analyzes the perverse effects of the extension of the road network in Paraguay, during the longest dictatorship of South America (1954-1989). Based on extensive data on repression

[10] In the Online Appendix, we show that the pattern is similar when focusing on allocations to the military or other politically connected individuals (see Table A.2 Panel A).

[11] In the Online Appendix, we show that the effect of the interaction term of roads and agricultural productivity is mostly driven by land allocated to the military (see Table A.2 Panel B).

events and land allocation from the country's Truth and Justice Commission, which we match with the evolution of the road network over time, we show that infrastructure development was a major enabling factor for the large-scale human right violations and other wrongdoings that were the hallmark of the Stroessner regime.

We establish that dividing the distance of districts to paved roads by a factor of two, which is approximately the reduction experienced by the average districts over a 30-years period, led to a 20 percent increase in state-led repression. In addition, we also show that the regime massively allocated land disregarding legal provisions, and that this disproportionately favored individuals connected to the regime, and especially members of the military. They received on average 35 percent more plots and these were 33 percent larger than those allocated to other individuals. Overall, over 19 percent of the Paraguayan territory was misappropriated in this way.

These findings raise the question of the long-run consequences of violence, social exclusion, and asset misallocation on the functioning of the economy and of the democratic interactions. We are currently investigating these aspects.

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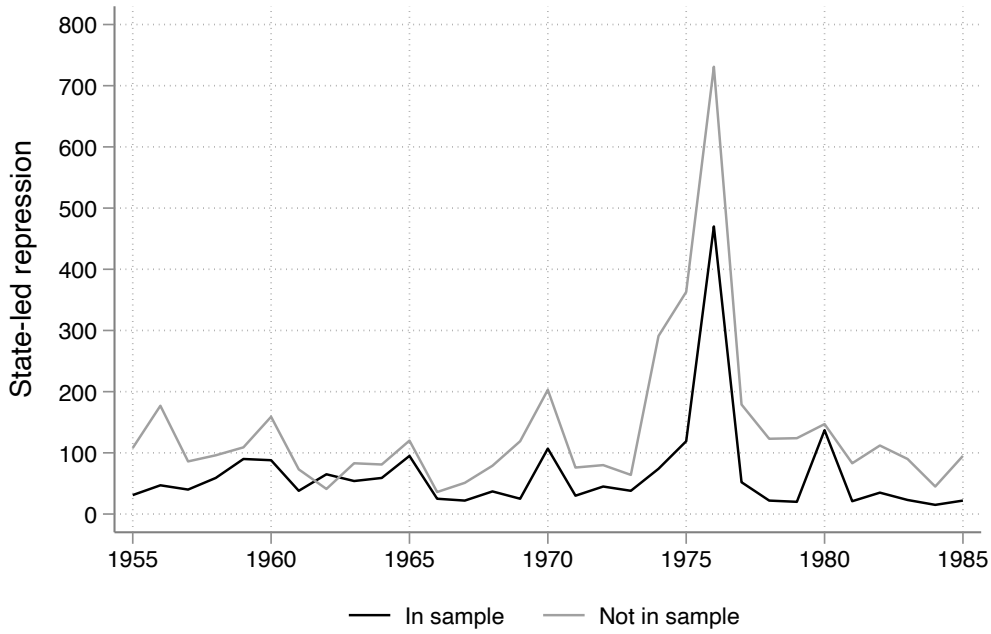
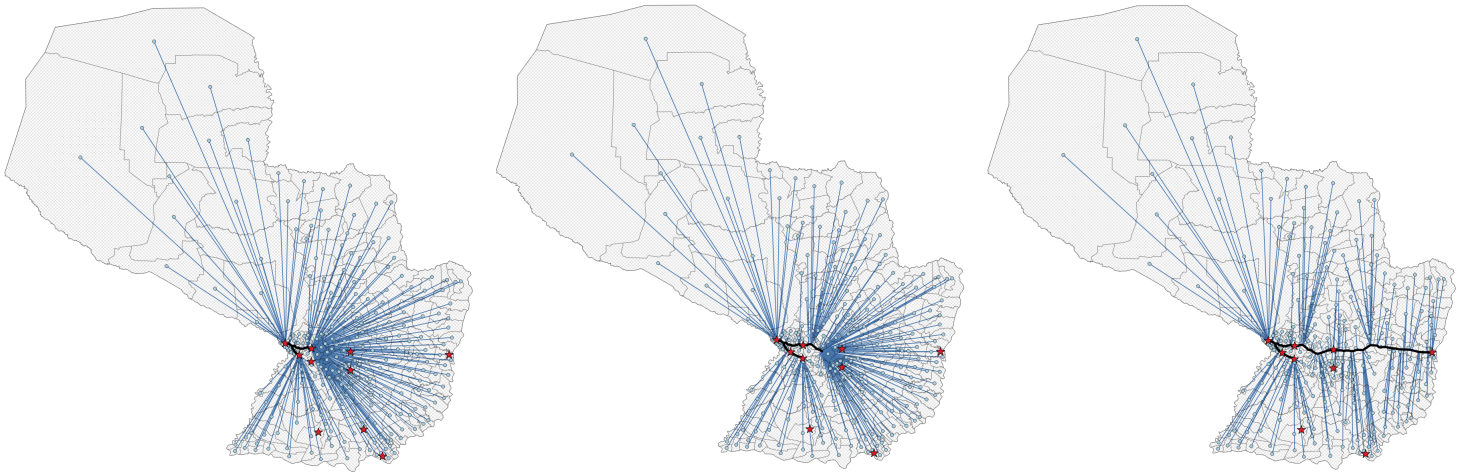
Figure 1: State-led repression over time in Paraguay

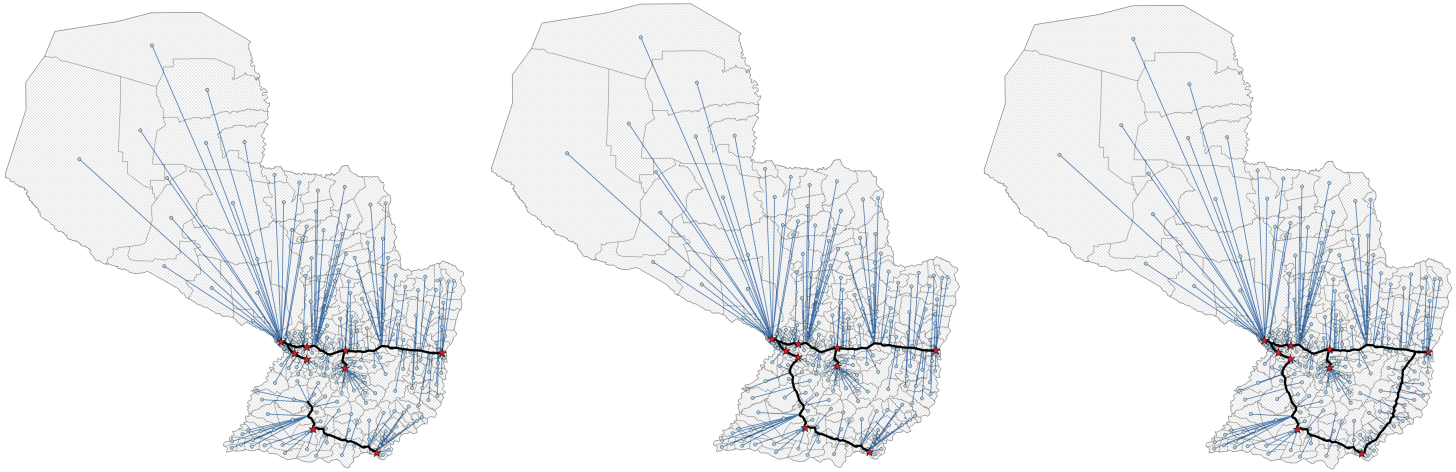


Notes: This figure shows the number of state-led repression events per year as revealed by the *Truth and Justice Commission* in Paraguay. The black line represent the total number of events for which we have information about the district where they took place. The gray line represents the number of 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

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.

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)
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)
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)
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. 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 which 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)	Logarithm of events per 10,000 inhab.	Asinh of events	Department-year fixed effects	Districts with less than 200,000 inhab.	Districts with less than 100,000 inhab.	Districts with less than 50,000 inhab.	Drops departments in the north-west region	Drops connecting districts	Drops Asunción from estimation	Only districts with some repression	Collapse to periods with roads data
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A – Repression												
Log distance to closest road	-0.018**	-0.018**	-0.022**	-0.124*	-0.117**	-0.114*	-0.119*	-0.147**	-0.110*	-0.109**	-0.253**	-0.864**
	(0.009)	(0.009)	(0.011)	(0.071)	(0.058)	(0.058)	(0.061)	(0.068)	(0.059)	(0.054)	(0.123)	(0.387)
Panel B – Torture												
Log distance to closest road	-0.018**	-0.018**	-0.022**	-0.113*	-0.109**	-0.107**	-0.109*	-0.133**	-0.102*	-0.101**	-0.231**	-0.793**
	(0.008)	(0.008)	(0.011)	(0.065)	(0.053)	(0.053)	(0.056)	(0.060)	(0.054)	(0.050)	(0.110)	(0.355)
Panel C – Detention												
Log distance to closest road	-0.017**	-0.017**	-0.021**	-0.108*	-0.020*	-0.102**	-0.104*	-0.129**	-0.094*	-0.096**	-0.222**	-0.752**
	(0.008)	(0.008)	(0.010)	(0.065)	(0.011)	(0.051)	(0.055)	(0.059)	(0.053)	(0.048)	(0.108)	(0.342)
Observations	7,688	7,688	7,688	7,657	7,595	7,440	7,037	7,223	7,409	7,657	2,976	1,240
Districts	248	248	248	247	245	240	227	233	239	247	96	248
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	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 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

Recipient:	Anyone		Connected	
	Any land	Log total hectares	Any land	Log total hectares
	(1)	(2)	(3)	(4)
Panel A				
Log distance to closest road	0.007	0.062	-0.002	-0.012
	(0.008)	(0.060)	(0.002)	(0.017)
Panel B				
Log distance to closest road × Agr. land	-0.007	-0.079	-0.006*	-0.055**
	(0.010)	(0.083)	(0.004)	(0.026)
Log distance to closest road	0.012	0.117	0.003	0.027
	(0.009)	(0.073)	(0.003)	(0.021)
Observations	7,688	7,688	7,688	7,688
Districts	248	248	248	248
District fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
R-squared	0.316	0.335	0.120	0.125
Mean dependent variable	0.112	768.1	0.014	53.97

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. Columns 1-2 present the results for all illegal land allocations, while columns 3 and 4 present them for allocations given to connected individuals. *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. *Agr. land* is an indicator that takes the value one if the district has a share of land used for soybean production above median, as measured in the 2008 Censo Agropecuario. Standard errors are clustered by district. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.

ONLINE APPENDIX

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

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

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A Mapping the road network development

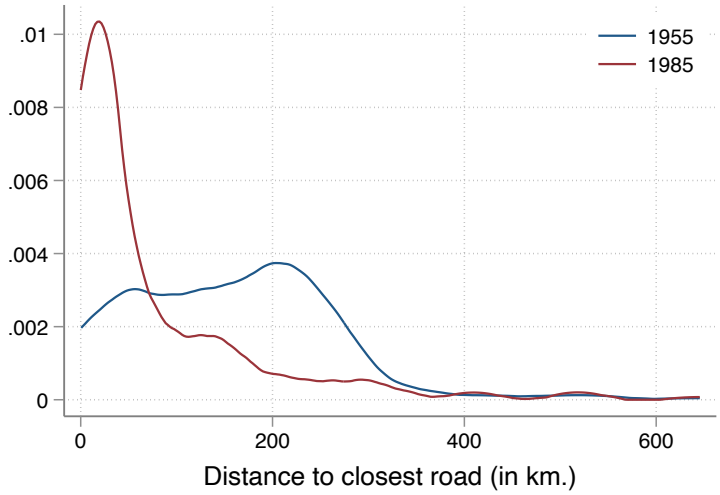
For the period of interest, no official road maps providing a distinction between dirt, gravel, and paved roads are available. Similarly, sources on the main road segments generally fail to indicate at which time they were actually paved. In order to reconstruct the evolution of the paved network from 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 kms in 1980, and 2076.6 kms 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 160km in the department of Itapúa, and 90 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 kms.

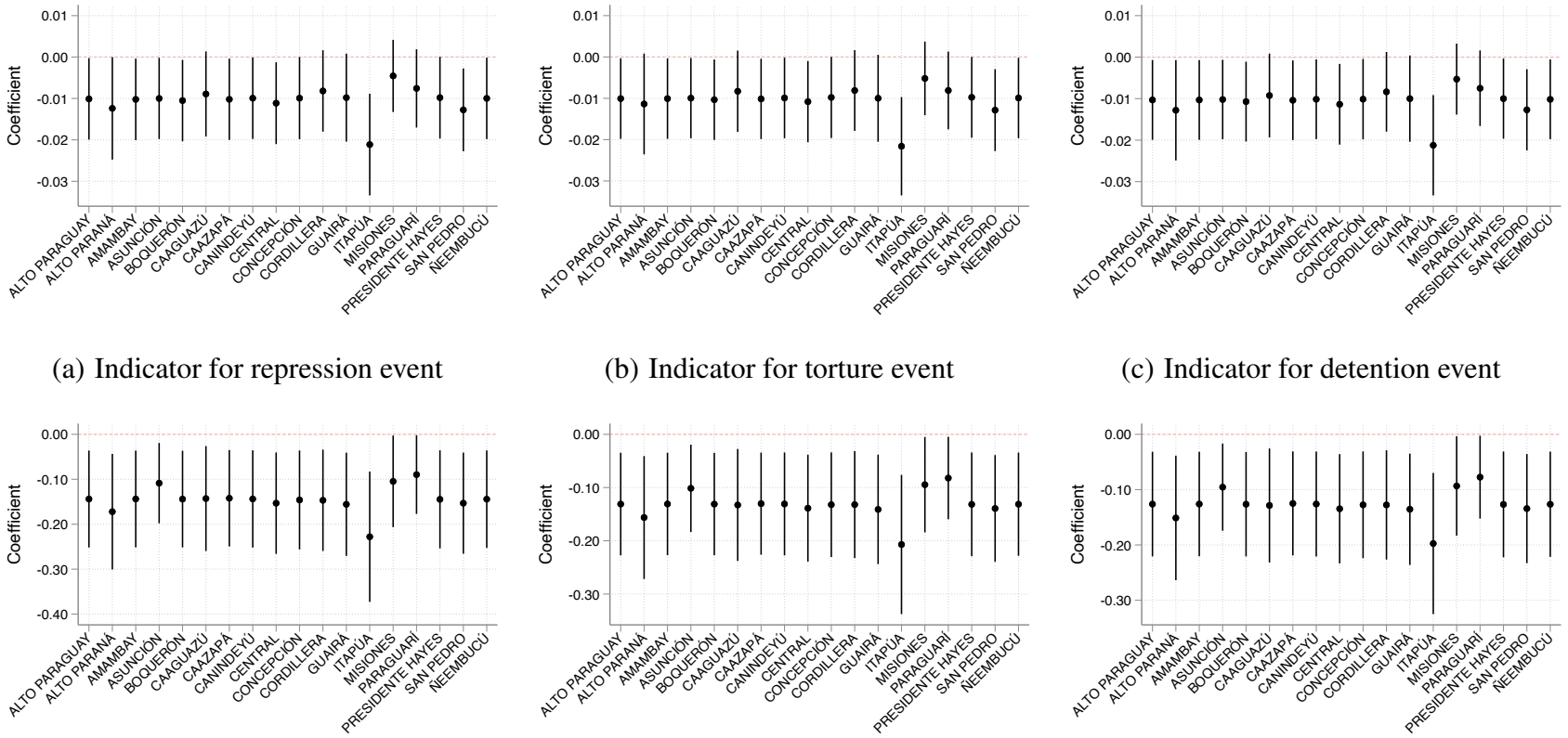
This allows us to identify 6 snapshots (1950-55, 1960, 1965, 1970, 1975, and 1985), which we digitize and georeference. The resulting paved road network at five-years intervals, and the distance of each district to the paved road network in each period, is represented in Figure 2. Figure A.1 shows that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

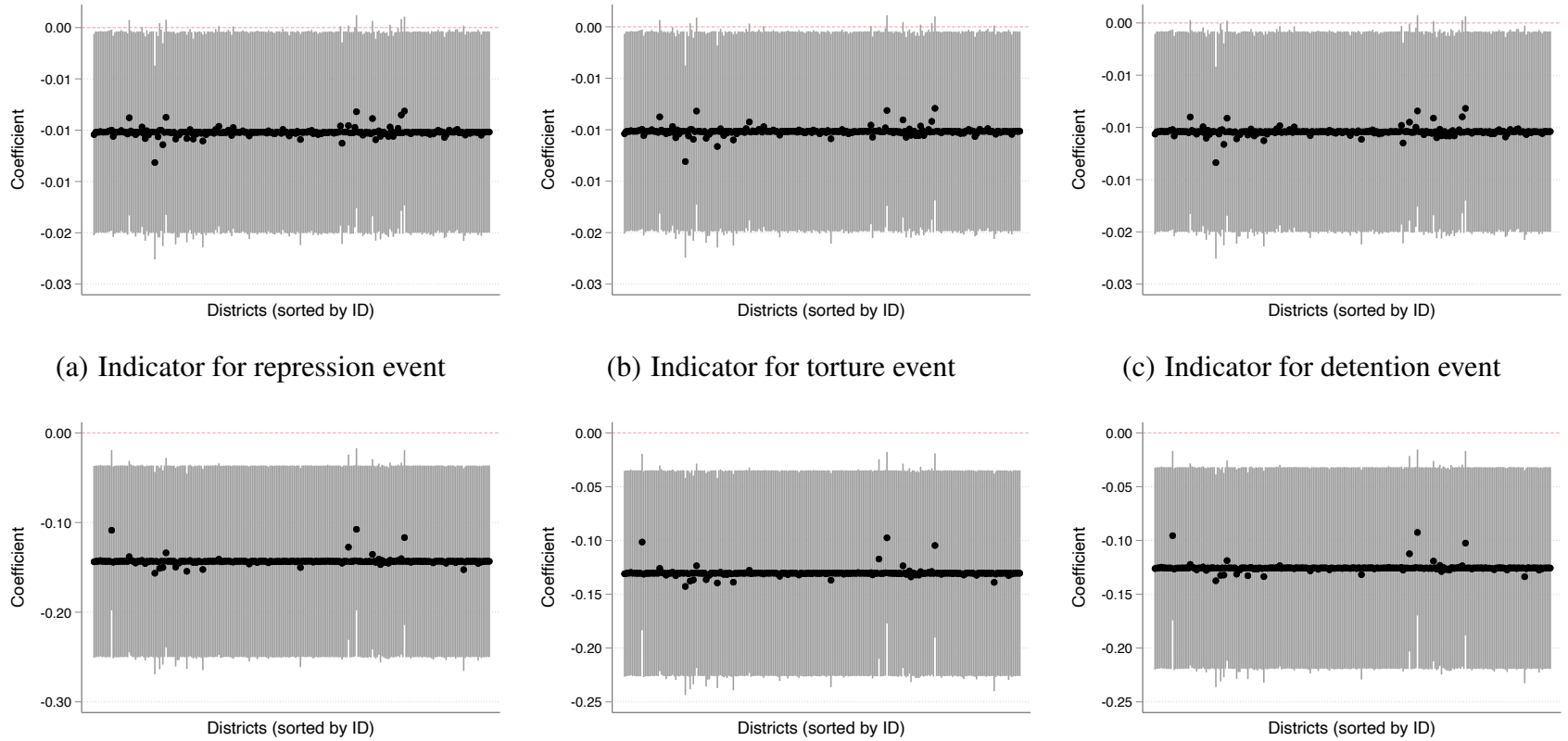
(d) Number of repression events

(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
Región Central							
Central XI	12	88.5	95	114.5	150.8	232.7	232.7
Cordillera III	0	0	0	60	60.4	64.3	64.3
Guairá IV	0	0	0	0	0	40	40
Paraguarí IX	0	0	0	20	23.9	28.6	123.6
Caazapá VI	0	0	0	0	0	0	0
Región Itapúa							
Itapúa VII	0	0	0	0	0	94.1	94.1
Región Alto Paraná							
Caaguazú V	0	0	0	0	151	151.5	151.5
Alto Paraná X	0	0	0	0	84.5	84.5	84.5
Amambay XIII	0	0	0	0	0	0	0
Región Misiones							
Misiones VIII	0	0	0	0	0	114.3	114.3
Ñeembucú XII	0	0	0	0	0	0	0
Región Concepción - San Pedro							
Concepción I	0	0	0	0	0	0	0
San Pedro II	0	0	0	0	0	0	0
Región Bajo Chaco							
Pte. Hayes XIV	0	0	0	0	0	0	0
Región Chaco Norte							
Boquerón XV	0	0	0	0	0	0	0
Olimpo XVI	0	0	0	0	0	0	0
Total	12	88.5	95	194.5	470.6	810	905

Notes: This table presents the evolution of the kilometers of paved roads by department from 1940 to 1975. 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.

Table A.2: Roads and illegal land allocation by type of connection

Connection:	Military		Politically	
	Any land	Log total hectares	Any land	Log total hectares
	(1)	(2)	(3)	(4)
Panel A				
Log distance to closest road	-0.002	-0.018	0.001	0.007
	(0.002)	(0.015)	(0.001)	(0.007)
Panel B				
Log distance to closest road × Agr. land	-0.006*	-0.050**	-0.002	-0.017*
	(0.003)	(0.025)	(0.001)	(0.009)
Log distance to closest road	0.002	0.018	0.002*	0.019*
	(0.003)	(0.019)	(0.001)	(0.010)
Observations	7,688	7,688	7,688	7,688
Districts	248	248	248	248
District fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
R-squared	0.115	0.120	0.072	0.072
Mean dependent variable	0.011	768.1	0.005	0.038

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 1 and 2 (3 and 4) present the results for illegal land allocations to *Military (Politically) connected* individuals. *Agr. land* is an indicator that takes the value one if the district has a share of land used for soybean production above median, as measured in the 2008 Censo Agropecuario. Standard errors are clustered by district. Statistical significance: *** p<0.01, ** p<0.05, * p<0.1.