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THE DARK SIDE OF INFRASTRUCTURE: ROADS, REPRESSION AND LAND IN AUTHORITARIAN PARAGUAY*

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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's military regime in Paraguay. Using novel panel data from the Truth and Reconciliation Commission, we show that proximity to newly constructed roads facilitated state-led repression, illegal allocation of agricultural plots to dictatorship allies and hindered sustainable economic development in the following decades.

Influential work has consistently shown that dictators choose policies to benefit supporters and remain in power for extended periods (Bueno de Mesquita *et al.*, 2003; Bueno de Mesquita and Smith, 2011). The construction of infrastructure such as a road network, generally treated as a measure of public goods provision (e.g., Acemoglu and Dell, 2010), stands out as a multifaceted policy that can generate a positive view of a dictator, but also provides benefits for supporters (Burgess *et al.*, 2015), allows control of remote locations and lowers the cost to repress dissent. This 'dark side' of the transportation infrastructure has been relatively overlooked and is likely to be detrimental for sustainable economic development.[1] We empirically examine the prevalence of state-led repression and the misallocation of productive resources to supporters, in the context of the construction of the road network in a low-income country under an authoritarian regime.

We study Paraguay, a country that experienced the longest dictatorship in South America (1954–89) and has nowadays one of the lowest income per capita in the region and the highest levels of land inequality in the world. Led by army officer Alfredo Stroessner, the regime has become famous for its human rights violations and for its endemic corruption. But, Stroessner also engaged in the development of ambitious infrastructure projects. Among these, the construction of a network of paved roads was a prominent strategy to colonise the Eastern part of the country. Using archival documents, we tracked the evolution of Stroessner's road network to investigate how it shaped state-led repression and the misallocation of agricultural land.

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[1] 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). More generally, the 'dark side' of states promoting economic development through active investments has been under-explored.

To measure state repression and misallocation, we digitise individual-level data on human rights violations in the 1954–89 period and the illegal allocation of agricultural plots. Following the end of the Stroessner dictatorship in 1989, the discovery of the 'Archives of Terror' in 1992 unearthed a massive amount of information documenting its repressive activities. The Truth and Justice Commission was subsequently created and reported how thousands of people were tortured, killed, disappeared or detained under Stroessner's rule. We structured these data into a panel of 248 districts observed annually during the dictatorship. The Commission also investigated the land allocation process and concluded that a large share was plagued by irregularities, leading to the wrongful reallocation of 20% of the country's land. We measure how many plots were illegally allocated by district and year. Importantly, we measure the extent to which the dictatorship allies benefited from the process of illegal allocations of land.

We present three findings. First, Stroessner's road network facilitated state repression. Our empirical strategy exploits the gradual construction of roads over time. We leverage the variation that arises after paved roads were constructed and some districts became easier to access. Doubling the distance to the network decreases repression events by 31%. The results are robust to alternative estimation strategies tailored for staggered treatments (Borusyak *et al.*, 2024) and to the use of instrumental variable methods (Banerjee *et al.*, 2020). Second, dictatorship allies were the main beneficiaries of illegal allocations. Moreover, plots were more likely to have been illegally allocated in districts with high potential for cotton production nearby the road network. These results relate to recent research showing that Stroessner selected beneficiaries who were central in local networks to control the local population (Bandiera *et al.*, 2023). Third, districts with more illegal land allocations are nowadays less developed, experience more extractive economic activities and have more rural conflict. Latin America exhibits the most unequal land distribution in the developing world, and Paraguay displays the second highest land Gini and second lowest income in the region (Gáfaro *et al.*, 2023). We tentatively conclude that, by facilitating repression and illegal land allocations, the road network later retarded sustainable development in Paraguay.

We contribute to the literature studying the political economy of infrastructure.[2] Scholars have shown that transport networks are often shaped by political and military considerations, especially in non-democratic contexts (Saiz, 2006; Burgess *et al.*, 2015). In ancient times, the Persian Royal Road, a 2,500 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 road network was military control over the Empire, although it also facilitated trade and persistently changed economic integration in Europe (Berechman, 2003; Lay, 2009; Dalgaard *et al.*, 2022; Flückiger *et al.*, 2022). The original functions of the road network constructed by the Incas were religious and military (Martincus *et al.*, 2017). When the colonial government of India decided to construct the Indian railroad system in the mid-nineteenth century, it had clear political objectives (Donaldson, 2018). Even democratic governments in the twentieth 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, p. 1414)

[2] 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.

Previous literature has ignored the potential long-run consequences of large infrastructure projects constructed with political motives and has usually interpreted the construction of roads as a measure for the provision of public goods under both democracy and dictatorship (e.g., Deacon, 2009; Acemoglu and Dell, 2010). We show that the construction of roads had direct implications for the allocation of productive land in Paraguay, a key economic input for a developing country where the primary sector represented close to 40% of GDP in the 1960s. Thus, our results show that roads can diverge from the traditional notion of public goods because they can offer private benefits to supporters of a government. Our results also suggest that, even though the primary motives behind a new road can be military or political, it can still generate large-scale economic distortions through the allocation of economic inputs such as land close to the road network.

Recent work has shown how constructing transportation networks can be politically profitable for incumbents. New highways have increased votes for the Nazi party in 1930s Germany (Voigtländer and Voth, 2022) and the incumbent government in Turkey in the 2000s (Akbulut-Yuksel *et al.*, 2024). Related work documents 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) and 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 emphasised by previous work, but mostly in the context of military buildings (Dube and Naidu, 2015; Bautista *et al.*, 2023).

We also contribute to the empirical literature documenting how state repression is implemented, 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 emphasised 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 incentivise dictatorships to temporarily refrain from repression (Scharpf *et al.*, 2023). Yet, beyond these contributions and the previously discussed role of military infrastructure, transportation networks have been relatively neglected as an important driver of repression.

1. The Stroessner Dictatorship

General Stroessner rose to power in May 1954 through a military coup.[3] Having overthrown Federico Chávez, of his own party, he was confirmed as president of Paraguay by a military board. Stroessner relied on a tripartite alliance between the government, the military and the Asociación Nacional Republicana (ANR), locally known as the Colorado party. Stroessner was at the helm of this alliance, ensuring a tight grip on every aspect of public life. From the start, his regime suspended all constitutional and civil rights, relying on the military police to quash any

[3] Paraguay is a relatively rural, low-income and unequal country, which researchers attribute to the War of the Triple Alliance in the 1860s and the subsequent political control of a small elite (Lewis, 1980; 1993; Leuchars, 2002; Alix-Garcia *et al.*, 2022). The history of Paraguay since independence in 1811 is characterised by dictatorships, from Dr. Francia, Carlos Antonio López and his son Mariscal Francisco López in the nineteenth century, to early strongmen such as Franco, Estigarribia and Moriñigo in the 1930s and 1940s, and subsequently Alfredo Stroessner. In the decades before Stroessner, the country experienced a revolution (1936), a civil war (1947) and was politically very unstable.

attempt at resistance. An extensive network of whistle-blowers quickly reported any opposition (Boccia *et al.*, 1994). Participation in economic and social activities, such as being a public servant or an entrepreneur, was 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. By centralising control and distributing favours 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. After modifying the constitution, Stroessner was re-elected seven times in fraudulent elections. On February 3rd, 1989, he was deposed in a coup led by his collaborator, General Andrés Rodriguez.

General Stroessner relied on repression to suppress dissent. His regime methodically spied on, detained and tortured opponents to retain control of the Paraguayan society. Many attempted to topple Stroessner, from initial resistance within the Colorado party (Boccia *et al.*, 1994; Boccia, 2014), to the emergence of rural opposition movements and Marxist movements in the 1960s and 1970s. There were also at least three assassination attempts against him. Most of what we know about state repression during this period was revealed in 1992 when hundreds of thousands of documents were discovered in a locked room in a police station in the country's capital. These documents had been created by the regime's security forces and became popularly known as the 'Archives of Terror'. Repressive activities restrained freedoms of expression, gatherings, demonstrations and organisation of any opposition group. The 'Archives of Terror' were used by the 'Truth and Justice Commission', created in the early 2000s to investigate the crimes committed under Stroessner. The final report (Comision de Verdad y Justicia, 2008) revealed the identity of victims and the misappropriation of state assets. The report also uses testimonies from victims and their relatives to establish a list of close to 10,000 persons repressed between 1954 and 1989.

The Truth Commission also analysed comprehensive data from the country's land allocation agency between 1954 and 2003. Their analysis reveals thousands of irregular appropriations, one of the main ways in which the regime rewarded its collaborators. Out of the 12.2 million hectares reallocated during that period, about two-thirds involved ineligible beneficiaries or plots larger than the legal size, close to 20% 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.[4]

At the end of the 1950s, Stroessner launched a colonisation process to the East. The border with Brazil was until then ill exploited, mostly unpopulated and covered by forest (Nickson, 1981). Maps from the 1920s indicate that this part was inhabited by probably no more than 12,000 inhabitants, 2% of the total population. The eastern territory was difficult to access, given the lack of paved roads connecting the area with the main cities. Before Stroessner's expansion plan, the paved road network was entirely concentrated around Asunción and was less than 200 km in length.[5] The 1960s became known as the decade of the 'March to the East' as the length of the paved road network increased by a factor of four. The new corridors connected Asunción to the

[4] Supporters of the Stroessner regime were also favoured through the regular allocation of procurement contracts (Nickson and Lambert, 2002; Straub, 2014; Auriol *et al.*, 2016), a common strategy to extract rents from the state to benefit collaborators (Schoenherr, 2018; Brugués *et al.*, 2024). For example, during the construction of the Itaipú and Yacyretá dams (Straub, 2015), two of the main contractors amassed immense fortunes and subsequently became presidents of the country: Juan-Carlos Wasmosy (1993–8) and Raúl Cubas Grau (1998–9).

[5] 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.

border with Brazil and to the border with Argentina (Encarnación). The triangle connecting these three points was 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, at the time the largest in the world. Large infrastructure projects gave a boost to the economy until the mid-1980s, but contributed to the deepening of local corruption and the rent-seeking system (Straub, 2014).

2. Data Construction

2.1. *Repression*

The Truth and Justice Commission documents close to 10,000 victims of repression under Stroessner. We use events of repression, and for each, we observe the name of the victim, date, district and whether it was a detention, exile, torture, execution or disappearance. The regime recorded activities in detail and failed to destroy these archives when the 1989 coup happened, suggesting that most repression is covered (Boccia *et al.*, 1994). We digitised and organised these data.[6] Online Appendix Table A.2 indicates that 5% of the 7,688 district-year observations in our sample have some event of repression, with a mean of 0.23 and a maximum of 75 events.

2.2. *Road Network*

Figure 1 shows the evolution of the paved road network over three decades. As there is no official record of the road network, we reconstruct its evolution based on a host of historical maps and policy documents (see Online Appendix A.1 and Table A.1). We observe six snapshots of the road network and employ linear interpolations within districts across these years to get the full 1955–85 panel data. Until 1960, the network was limited to Asunción and nearby areas. In the 1960s, new roads connected Asunción with the Brazilian frontier, with support from international donors (including Brazil). The new network helped to colonise the East. Finally, in the 1970s and 1980s, additional corridors were completed, connecting Villarrica, and mostly completing the triangle with Encarnación in the South. Online Appendix Figure A.2 shows how localities inside the country became better connected as the road network progressed. Online Appendix Table A.2 reports the average distance of districts to the road, which decreased by more than 50% over the 1955–85 period.

2.3. *Illegal Land Allocations*

The Truth and Justice Commission had access to all land allocations over the period 1954–2003 and to the country's land registry. For each plot, the report presents the location, size, name of the beneficiary and date of allocation. Based on the prevailing legal frameworks throughout the period, the commission established three main reasons why some allocations were illegal:

[6] Online Appendix Figure A.1 shows repressive activity under Stroessner. Spikes correspond to instances in which the regime geared up the fight against insurgent groups. The main one in 1976 was the crackdown on the clandestine group 'Organización Político Militar', which the regime took as a pretext to also strike any persons or organisations it considered hostile. Unfortunately, some events fail to report the district. However, Online Appendix Figure A.1 shows that events with a known location show a similar time variation to all events, which include those without a 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.

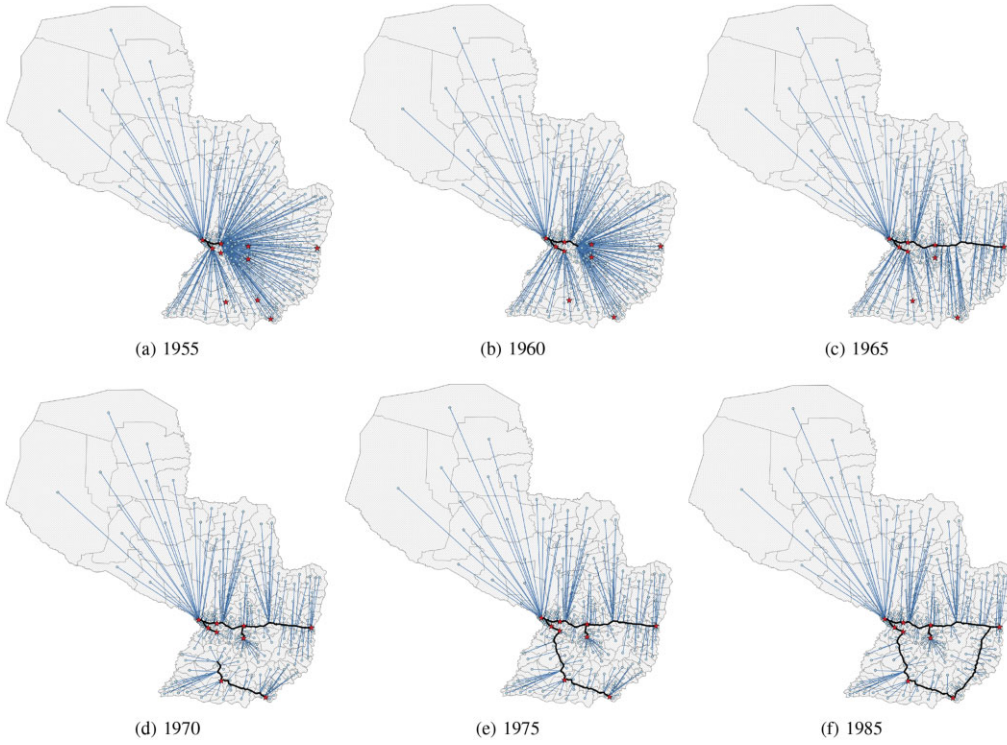

Fig. 1. *Construction of Paved Roads in Paraguay, 1955–1985.*
Notes: The maps in panels (a) through (f) show the construction of paved roads in black lines in Paraguay from 1955 in panel (a) to 1985 in panel (f). Polygons represent districts. Stars mark main districts being connected by paved roads. Straight lines represent the closest distance from a district's geographic centroid to the road network.

(1) the beneficiary was *not* eligible,[7] (2) the beneficiary received more than one plot and (3) the beneficiary received a plot larger than the legal size. A total of 4,241 of the 200,705 allocations examined were found to be illegal. These allocations involved 3,336 beneficiaries and covered almost 8 million hectares, almost 20% of the country's total area. We observe 3,766 illegal allocations and 2,544 beneficiaries under dictatorship. We digitised 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 victimisers, 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 complemented the list with all Congress members (deputies and senators) over the 1954–89 period, recovered from the Library of the Paraguayan Congress. Finally, we collected the names of all graduates from the National College of War (Colegio

[7] 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.

Nacional de Guerra, subsequently Instituto de Altos Estudios Estratégicos) over the relevant period.[8] Overall, we recovered the names of 1,500 individuals linked to the Stroessner regime.

3. Research Design

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

$$Y_{dt} = \beta R_{dt} + \phi_d + \phi_t + \varepsilon_{dt}, \tag{1}$$

where Y_{dt} is an outcome in district 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 the Euclidean distance (in kilometres) from the district's geometric centroid to the closest road, but the results are robust to alternative definitions. The use of the logarithm assumes that, from the point of view of the Stroessner regime, the cost of exerting repression is non-linear in the distance to the road network. Below, we provide evidence supporting this non-linear relationship. As shown by Figure 1, 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 SEs 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 favour 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 number of state-led repressive events. We show that the results are robust to alternative measures. We then examine misallocation driven by favouritism 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 favouritism, 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 favouritism within Paraguay over a thirty-year period of dictatorship.

The parameter of interest in (1) is β, which measures the empirical relationship between exposure to the evolving road network and the outcomes of interest within districts over time.[9] In order to interpret β as the causal effect of the road network, we need to assume that changes in

[8] 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 Defence Council. It trains around thirty selected members of the Armed Forces of the Nation, the National Police, and civilian officials of the State and the private sector with the doctrinal and methodological knowledge necessary for the future leaders of Paraguay.

[9] 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 on the point estimate of β.

Table 1. *Road Construction and State-Led Repression in Paraguay.*

	Indicator for at least one event of:			Total events of:		
	Repression (1)	Torture (2)	Detention (3)	Repression (4)	Torture (5)	Detention (6)
Panel A: linear distance						
Log distance to the closest road	−0.010*	−0.010*	−0.010*	−0.143**	−0.130**	−0.125**
	(0.006)	(0.006)	(0.006)	(0.065)	(0.058)	(0.057)
Panel B: non-linear distance						
Distance to road < 10 km	0.043*	0.042*	0.047**	0.632**	0.576**	0.548**
	(0.023)	(0.023)	(0.022)	(0.264)	(0.236)	(0.226)
Distance to road [10, 20] km	0.062**	0.052**	0.060**	0.350**	0.300**	0.300**
	(0.030)	(0.023)	(0.028)	(0.152)	(0.131)	(0.131)
Distance to road [20, 30] km	0.029*	0.036**	0.034**	0.241*	0.217*	0.208*
	(0.016)	(0.017)	(0.016)	(0.125)	(0.111)	(0.111)
Distance to road [30, 40] km	0.003	0.006	0.003	0.060	0.052	0.049
	(0.011)	(0.012)	(0.011)	(0.089)	(0.077)	(0.077)
Distance to road [40, 50] km	−0.008	−0.007	−0.008	−0.024	−0.024	−0.026
	(0.009)	(0.009)	(0.009)	(0.098)	(0.087)	(0.088)
Distance to road [50, 60] km	0.002	0.010	0.006	−0.077	−0.074	−0.068
	(0.019)	(0.018)	(0.022)	(0.168)	(0.143)	(0.144)
Panel C: within 30 km						
Distance to road < 30 km Borusyak *et al.* (2024)	0.040***	0.038***	0.040***	0.277***	0.249***	0.237***
	(0.014)	(0.013)	(0.014)	(0.066)	(0.061)	(0.057)
Distance to road < 30 km Callaway and Sant'Anna (2021)	0.040**	0.038**	0.040**	0.277***	0.249***	0.237***
	(0.017)	(0.016)	(0.016)	(0.088)	(0.079)	(0.075)
Distance to road < 30 km Sun and Abraham (2021)	0.027**	0.020	0.026**	0.402**	0.354**	0.342**
	(0.013)	(0.013)	(0.013)	(0.173)	(0.157)	(0.151)
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 1955–85. The unit of observation is a district in a given 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 the dependent variable. SEs are clustered by district. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

district-level exposure to the 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 that district. 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 $d \neq k$. Additionally, the staggered nature of evolving roads suggests that we should pay close attention to the comparisons behind our estimated parameter. Below, we use recent econometric methods to diagnose and check for the robustness of our results.

4. State-Led Repression

Panel A in Table 1 presents estimates of (1) using different measures of state-led repression as the dependent variable. Columns (1)–(3) examine 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 km from the closest road to being only 73 km away, a reduction of 50% in distance or equivalent increase in exposition. Put differently, doubling the distance to the network decreases repression by 1 percentage point. From a baseline of 5%, this coefficient can be interpreted as a 20% 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 the dependent variable. We find that, when districts get closer to the road network, they experience more repression. Increasing exposure to roads by 100% 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%. This empirical relationship is again statistically significant at conventional levels. Panel B in Table 1 uses a flexible bin model for the distance in kilometres that reveals that most of the impact of roads is explained by districts that get closer than 20 km from the road network.[10]

Our interest in a treatment variable that changes over time within units raises additional concerns. De Chaisemartin and d'Haultfoeuille (2020) and Goodman-Bacon (2021) showed that if treatment effects are heterogeneous then estimators such as ours can be biased because some control units could actually be early-treated or always-treated units. The authors proposed methods to assess the magnitude of this issue. We use their methods with a treatment indicator for districts closer than 30 km and find that around 75% of our comparisons are correct, with the remaining share comparing late-treated units to either early-treated or always-treated units. Reassuringly, panel C in Table 1 shows that we obtain similar estimates when using estimators that restrict attention only to comparisons of treated and untreated units (Callaway and Sant'Anna, 2021; Sun and Abraham, 2021; Borusyak *et al.*, 2024). Online Appendix Figure A.3 uses the method by Borusyak *et al.* (2024) to show similar pre-trends across treated and control districts.

Is there a causal connection between roads and repression? Three exercises suggest that the relationship is likely to be causal. First, two-stage least squares using hypothetical straight roads connecting locations delivers similar results. Online Appendix Table A.4 presents the results and Online Appendix Figure A.4 the lines used. This is a common strategy in the transportation literature (Faber, 2014; Banerjee *et al.*, 2020) that helps to assuage concerns about measurement error in the network. Second, columns 1–3 in Online Appendix Table A.5 show that unobserved factors driving the construction of the Itaipú and Yacyretá hydroelectric dams are unlikely to be confounders.[11] Similarly, column 4 shows similar results when controlling for the cross-border impact of Argentina on Itapúa. Stroessner repressed heavily early on as dissidents migrated from

[10] We find similar results defining direct exposure to roads as the network passing through or being closer than 20 km, and as indirect exposure, if roads were constructed in neighbouring districts or closer than 20–30 km (Online Appendix Table A.3). In addition, all results remain statistically significant when we use SEs that take into account unobserved spatial correlation as well as time auto-correlation (Conley, 2010; Colella *et al.*, 2019). For simplicity, we use the logarithm of the distance and robust SEs clustered by district in the remainder of the analysis.

[11] These dams are hallmark projects of the Stroessner dictatorship. The former is a large and expensive dam constructed by both Paraguay and Brazil and was 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.

Paraguay to Misiones in Argentina and attempted to create resistance through the Itapúa region.[12] Third, we now present a wide range of robustness exercises supporting the previous results and suggesting that a causal interpretation is plausible.

Online Appendix Table A.7 shows that the results are unaffected by modelling decisions, influential observations or unobserved shocks. Columns 1–3 assess the sensibility of results to the scale of the dependent variable. Recent work shows that log-like specifications can arbitrarily affect estimates of the average treatment effect (Mullahy and Norton, 2022; Chen and Roth, 2024). We avoid log-like specifications and follow the recommendations of Chen and Roth (2024) to show that results are similar when using repression events per capita as the dependent variable, and to model the data-generating process explicitly as a Poisson or negative binomial model. Column 4 shows that potential measurement error arising from the interpolation of the six years in which we observe the road network is unlikely to affect our estimates: we obtain the same results when we restrict attention to the six years with observed roads. For the initial snapshot in 1955, we use the total number of repression events in the 1955–9 period. We do the same for each of the seven years with data on the road network, e.g., 1960–4 for the 1960 snapshot, and so on.

Online Appendix Table A.8 shows similar results after including covariates measured before the dictatorship interacted by year indicators to control for time-varying changes. Columns 1–3 add demographic 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 topographic, climate and geographic covariates. Column 7 addresses potential spatial autocorrelation following Bauman *et al.* (2018). Column 8 selects controls following Belloni *et al.* (2014) where the treatment to select the covariates is the change in the log distance to the closest road between 1955 and 1985. Moreover, Online Appendix Table A.9 shows the robustness of the results to potentially influential districts. Columns 1–3 show similar results, 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) that always have the same exposure to the network in the 1955–85 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).[13] Column 7 keeps the ninety-six districts that experience at least one event of repression and, if anything, the results are even stronger. We also verified that the results are the same when dropping single departments (group of districts) or districts from the estimation (Online Appendix Figures A.5 and A.6).

Finally, we checked whether missing geographic information for some repressive events influences our estimates. The missing information originates in primary sources and thus we can only assess this problem statistically. Online Appendix Table A.10 shows that events with missing location are more likely to be detentions in the 1980s; we observe the location of almost every other event. Reassuringly, we find similar results across events with different rates of missing location (Table 1), when restricting attention to the 1955–79 period (Online Appendix Table A.11), and when using different econometric models to impute the most likely location to events with missing information (Online Appendix Table A.12).

[12] The results also remain similar after controlling for the distance to railroads interacted with indicators for each decade after their nationalisation in 1961 (Online Appendix Table A.5). Online Appendix Figure A.4 presents a map of the railroad network.

[13] 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).

Table 2. *Illegal Land Allocation and Connections to the Regime.*

	Log hectares			Number of plots		
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: individual level						
Connected	0.462***			0.083		
	(0.117)			(0.086)		
Military connected		0.592***			0.163	
		(0.144)			(0.111)	
Politically connected			0.184			−0.103
			(0.164)			(0.083)
Observations	2,544	2,544	2,544	2,544	2,544	2,544
R^2	0.005	0.006	0.000	0.000	0.001	0.000
Mean dependent variable	7.483	7.483	7.483	1.319	1.319	1.319
Panel B: within district						
Connected	0.272***			−0.034		
	(0.101)			(0.086)		
Military connected		0.279**			0.026	
		(0.133)			(0.116)	
Politically connected			0.230*			−0.157*
			(0.123)			(0.088)
Observations	2,259	2,259	2,259	2,259	2,259	2,259
R^2	0.461	0.461	0.460	0.066	0.066	0.066
Mean dependent variable	7.119	7.119	7.119	1.280	1.280	1.280
District fixed effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: This table presents the empirical relationship between the log number of hectares (columns (1)–(3)) or the number of plots (columns (4)–(6)) and an indicator for beneficiaries with political connections to the dictatorship. In panel A, the unit of observation is an individual receiving illegal allocations, while in panel B the unit of observation is an individual receiving illegal lands in a given district. Missing district information for 396 allocations, and the lack of within-district variation for another thirty, explain the decrease in the number of observations between panels A and B. *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 SEs are reported in parentheses. Statistical significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

5. Illegal Land Allocations

Table 2 shows that individuals who were politically connected to Stroessner disproportionally benefited from illegal land allocations. Overall, 7.4% of beneficiaries were connected, 71.1% of which were military connections. Column (1) in panel A shows that politically connected beneficiaries received 46-log-point (58%) more hectares than unconnected individuals, i.e., each beneficiary in the dictator's inner circle received on average 2,000 more hectares. Column (2) in the same panel shows that this effect is explained by larger plots given to the military, although the statistically insignificant point estimate in column (3) suggests that politicians could have benefited as well. Columns (1)–(3) in panel B repeat the estimation, but now using the beneficiary in a given district as the unit of observation and including district fixed effects. Missing district information for 396 allocations, and the lack of within-district variation for another thirty, explain the decrease in the number of observations between the two panels. Panel B shows that connected beneficiaries obtained plots that were 27 log points (31%) larger, a result that is similar across types of connections. Columns (4)–(6) repeat the analysis, but now using as the dependent variable the number of plots received by each beneficiary. We find that politically connected and unconnected beneficiaries received a similar number of plots. These results are consistent with hectares being a strong predictor of agricultural production in Paraguay (Bravo-Ureta and Evenson, 1994).

Table 3. *Roads and Illegal Land Allocation.*

Suitability:		Cotton		Soy	
	(1)	Continuous (2)	Discrete (3)	Continuous (4)	Discrete (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^2	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^2	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 observation. *Log total hectares* is the hyperbolic sine transformation for the total number of hectares allocated in a district in a given year. The unit of observation is a district-year pair. 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 standardised index, while columns (3) and (5) present the results 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). SEs are clustered by district. Statistical significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Overall, Table 2 shows that illegal land allocations benefited the military significantly in terms of hectares, with suggestive evidence of congresspeople and other high-level politicians also benefiting.

Did the road network shape illegal allocations to dictatorship allies? Better access to roads can increase the returns to owning a plot by facilitating market access. Thus, the distance to roads could have motivated part of the land allocation process, particularly for valuable plots. We find evidence of this being the case. We estimate (1) using illegal allocations as the dependent variable. Column (1) in Table 3 shows that, when districts get closer to the network, neither the probability of illegal allocation nor the hectares allocated changed. However, districts with more agriculturally productive land were more likely to be affected by roads. Columns (2)–(3) in Table 3 focus on cotton—the main crop at the time—and columns (4)–(5) on soybean, important later on. 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. Columns (2) and (4) use the GAEZ suitability index, while columns (3) and (5) use an indicator when districts have on average high suitability (see Online Appendix A.2). 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. We find a similar, but weaker connection with soybean suitability, a relatively newer crop at the time. In all, the results support the role of the road network in shaping the illegal allocation of productive land.

The high land concentration in Paraguay is a source of conflict (Hetherington, 2011).[14] Political parties have strong networks of political brokers (Finan and Schechter, 2012; Duarte *et al.*, 2023); thus, changes to the status quo (e.g., land reform) are unlikely to emerge. As a consequence, rural conflict is pervasive. Is there a link between Stroessner's illegal land allocations, long-run development and rural conflict? Table 4 shows that districts with more illegal land allocations between 1955 and 1985 have worse development outcomes after the year 2000. Panel B adds the change in roads as an additional predictor variable for comparison purposes. Districts with more illegal allocations under dictatorship are less developed, as proxied by nighttime lights (column (1)), population density (column (2)) and agricultural production per hectare (column (3)). This relationship holds after accounting for a large set of geographic and socioeconomic characteristics, including how rural districts were measured before the Stroessner dictatorship began. Using an index that combines the three development outcomes delivers similar results (column (4)). Moreover, districts with more illegal allocations exhibit more pollution (column (5)), more wildfires (column (6))—one way to clear forested land for extensive cultivation (Harding *et al.*, 2024)—but similar deforestation rates (column (7)).[15] 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)).[16] These reduced-form relationships are likely to be explained by both direct effects (e.g., land quality) and changes in human behaviour (e.g., migration towards roads).

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.*, 2024). 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 4 shows that districts with more illegal allocations during 1955–85 are more likely to experience land occupations in the 2000s.

6. Conclusion

We have shown the perverse effects of a large road network in Paraguay under the longest dictatorship in South America. Infrastructure development such as roads can facilitate large-scale human rights violations under dictatorship, enable the misallocation of resources and prevent sustainable development to unfold. These findings suggest caution when evaluating infrastructure projects, particularly under dictatorship, and constitute a warning sign to interpreting the construction of road networks simply as provision of public goods. Although the economic benefits associated with road networks in democratic periods have been extensively documented, the 'dark side' of

[14] Rigorous evaluations of land reform programs have consistently confirmed the relationship between land ownership and rural conflict across countries in Latin America (e.g., Albertus and Kaplan, 2012; Albertus *et al.*, 2018; Albertus, 2020; Jaimovich and Toledo, 2023).

[15] As a percentage of area, Paraguay is one of the countries most affected by wildfires and deforestation in Latin America (Graesser *et al.*, 2015; United Nations, 2021). Deforestation in the East was widespread before 2003, but it decreased after regulation (Huang *et al.*, 2007; Ponte *et al.*, 2017). Wildfires and deforestation are weakly correlated across districts in the 2000s because deforestation shifted towards the less regulated West (Baumann *et al.*, 2017).

[16] Outcomes are measured with satellite imagery and are thus unaffected by potential reporting bias caused by roads (see Online Appendix A.3 for details). Online Appendix Table A.13 shows that results are robust to excluding outliers in the distribution of these outcomes.

Table 4. *Illegal Land Allocations and Long-Run Development.*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Development				Extractive activities					
Outcome:	Ln nighttime lights	Ln population density	Agricultural production	Score (standardised)	Pollution	Wild fires	Deforestation	Any mine	Score (standardised)	Land occupation
Panel A: allocations										
Log hectares	−0.037***	−0.054***	−0.009**	−0.051***	0.016*	0.015**	−0.000	0.008*	0.023**	0.009*
	(0.011)	(0.018)	(0.005)	(0.015)	(0.009)	(0.006)	(0.002)	(0.004)	(0.011)	(0.005)
Panel B: allocations conditional on construction of roads										
Log hectares	−0.037***	−0.055***	−0.011**	−0.052***	0.017*	0.016***	−0.000	0.008**	0.024**	0.010*
	(0.011)	(0.017)	(0.004)	(0.014)	(0.009)	(0.006)	(0.002)	(0.004)	(0.011)	(0.005)
Change in roads distance	−0.021	−0.050	−0.054**	−0.061	0.062	0.035*	0.002	0.014	0.068*	0.025
	(0.053)	(0.082)	(0.024)	(0.065)	(0.038)	(0.020)	(0.006)	(0.014)	(0.036)	(0.017)
Observations	248	248	248	248	248	248	248	248	248	248
R^2	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 dependent variable	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. The set of geographic controls include average elevation, average slope of the terrain, ruggedness, average precipitation and temperature, the SD of temperature, the isothermality index and the log distance to rivers. The socio-demographic controls based on the 1950 census include the rural population share, female population share, share of people that speak an indigenous language, illiterate population share, share of children going to school, share of the population that finished secondary education, share of households with agriculture as the main income, share of the population working in agriculture, share of the population that owns a house, share of houses with electricity and the share of houses with running water. Robust SEs are reported in parentheses. Statistical significance: *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

infrastructure can be larger than previously thought. Limited checks and balances under dictatorship give rise to legitimate questions regarding funding for infrastructure projects that might strengthen autocrats. A better understanding of policy implementation under dictatorship can help to improve the lives of millions of people currently ruled by authoritarian governments.

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Additional Supporting Information may be found in the online version of this article:

Online Appendix
Replication Package

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