Blessing or Curse for Organized Crime? The Long-Term Effects of an Energy Transition from Coal to Oil on the Yakuza*

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Abstract

This study investigates the long-term effects of a negative labor demand shock in the coal mining industry on the supply for organized crime. The setting is Japanese criminal organizations called the yakuza. In the 1960s, an energy transition from coal to oil diminished coal mining jobs, thereby depriving mining-associated yakuza, previously involved as labor brokers or protection racketeers, of revenues. I show that yakuza arrest increased in coal-rich areas in the years following the energy transition. An increase in yakuza-involved crime is likely due to mining yakuza switching their economic criminal activities. As mining yakuza's power waned, non-mining yakuza gained prominence, shifting the yakuza power dynamics. Consequently, conflicts among different yakuza organizations intensified in coal-rich areas, which persisted over half a century. Today, areas with greater mining job loss by the energy transition are characterized by a greater number of yakuza members and yakuza organizations. These areas also had juvenile delinquency in the medium- and long-run, hinting at the new labor supply for the yakuza to explain the yakuza's persistence. Taken together, this study reveals that a labor demand shock can have long-lasting effects on organized crime.

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1 Introduction

Resource abundance often emerges as a double-edged sword—while it holds the potential to enhance socioeconomic/political development, it can cast shadows of challenges, often termed the "resource curse" (Sachs and Warner, 2001). Particularly in regions with weak institutions (Mehlum et al., 2006), rather than fostering prosperity, an abundance of resources can inadvertently lead to less socio-economic development. The resource curse is no exception when it comes to the realms of organized crime. In the absence of strong institutions, disputes over resources are likely to arise. This, in turn, escalates the demand for private protection services. Criminal organizations, such as the Italian mafia, exploit these situations by engaging in rent-seeking activities capitalizing on the high demand for organized crime in resource-rich areas (Collier and Hoeffler, 2002; Gambetta, 1993). This body of research generally focuses on permanent structural differences in suitability for natural and agricultural resources to examine their consequences on organized crime, revealing that areas with resource abundance experience the emergence of organized crime (Buonanno et al., 2015; Dimico et al., 2017).

How does a change in the demand for natural resources affect the supply for organized crime in the long-run? This study addresses the question by exploiting a negative labor demand shock that occurred in Japan's coal mining industry in the 1960s. Coal was the primary source of energy in the postwar period in Japan. Despite the mining industry representing only a small fraction of the entire labor market, coal production experienced a massive boom, becoming the backbone of the postwar economic recovery. Coal was often referred to as a "black diamond." In the 1950s, Japan engaged in protective trade, regulating oil imports to protect the coal mining industry. However, once the government recognized that oil was more stable and safer than coal, crude oil imports were liberalized in 1962. As a result of this trade liberalization, oil overtook coal as Japan's energy source. Thus, the energy transition from coal to oil reduced the demand for coal mining jobs, serving as a negative labor demand shock in the mining industry.

Japanese organized crime is commonly referred to as the yakuza. The yakuza's origins can be traced back to sectors such as mining, gambling, street vending, corporate racketeering, media racketeering, pimping, gangs, and dock labor. However, their economic activities extend beyond their origin sectors. Depending on the societal and economic climate, the yakuza have engaged

in a diverse range of illegal and legal revenue activities, including extortion, methamphetamine distribution, construction, infrastructure projects, civil affair interventions, and land sharking (Hill, 2003). Yakuza's income sources had been available throughout history till the 2010s when local governments began implementing policies to curb the demand for yakuza services. Second, unlike in other countries, forming or joining yakuza syndicates is *not* illegal due to the Freedom of Association (Article 21 of the Japanese Constitution). Instead, yakuza organizations are designated by the Japanese government. As of 2023, 25 yakuza syndicates are officially designated, each representing a family/clan. There are a number of smaller-scale yakuza groups, who affiliate with one of these syndicates.

This study hypothesizes that the energy transition from coal to oil in the 1960s has played a role in shaping the geographical distribution of the yakuza in both the short and long terms. The energy transition serves as a negative labor demand shock for mining-associated yakuza organizations and coal miners. Before the transition, some yakuza organizations engaged in the mining sector, often serving roles as labor brokers or protection racketeers. However, the energy transition deprived their revenues. As a result, these mining-associated yakuza members might have sought alternative illicit revenue avenues. Additionally, coal miners, who lost their jobs upon the transition, might have lowered opportunity cost of crime engagement and sorted into yakuza organizations following the energy transition.

Second, the energy transition may also have triggered a shift in power dynamics among yakuza organizations. While yakuza organizations in the mining sector likely lost their power post-transition, the transition may have created a power vacuum or opportunity in these areas, given the demand for the yakuza. Non-mining yakuza organizations could seize this opportunity to expand their power into coal-rich areas. The power shift in turn may have resulted in conflicts among yakuza organizations, and once set in motion, these dynamics could have sustained the yakuza's activities over time.

Third, the trajectories of the yakuza may have been complemented by new labor supply of the yakuza. Young individuals raised in areas with a high yakuza presence are more likely to be exposed to environments conducive to criminal behavior. Consequently, the increase in yakuza activities following the energy transition might have expanded criminal opportunities for these young people, making them more prone to delinquency and reducing the cost of joining yakuza organizations.

The energy transition could have, therefore, contributed to long-term labor pool for the yakuza in coal-rich areas.

The energy transition presents an ideal setting for the current inquiry for three reasons. First, in contrast to economic recessions, the energy transition predominantly affected regions with coal mining sites, which are essentially determined by geographical conditions. Consistent with this notion, pre-treatment covariates are not correlated with the number of mining sites conditionally A. Second, the transition acted as a sector-specific shock, solely affecting the coal mining industry, which accounted for a minor proportion of the overall industry (approximately 1% in the pre-energy transition period). Consequently, at the prefecture level, the transition did not exacerbate overall unemployment rates (see results in Section 3.4). This suggests that behavioral changes due to the energy transition were limited to specific populations. Third, the groups most affected by the transition are notably at a risk of expanding, or affiliating with the yakuza. As highlighted earlier, certain yakuza organizations had stakes in the mining sector. Furthermore, the coal mining sector was marked by an overrepresentation of low-skilled, young males, many of whom exhibited traits like aggression and distinctive full-body tattoos.

To study the yakuza's consequences of the energy transition, I use several identification strategies, with historical data on coal mining in combination with unique data on the yakuza. First, an event-study design compares a change in yakuza-related outcomes in areas with high coal mining availability with areas with low coal availability in the years (resp. decades) leading to and following the energy transition. Using this design, I study the immediate effects of the transition on the yakuza using arrest records of the yakuza from 1957-1970. This increase cannot be explained by enhanced enforcement. After the transition, yakuza arrests increased by 10% in coal-rich areas. This trend persisted for over a decade, and the increase is not likely due to enhanced enforcement. Two channels could contributed to this increase: (i) yakuza members, who previously earned from the mining sector, shifted to other illegal activities, and (ii) coal miners, who lost their jobs and decreased opportunity cost of crime, sorted into yakuza organizations. I exploit the historical presence of mining yakuza organizations to provide suggestive evidence of the channel. In areas with mining-yakuza presence in the pre-transition period, both mining yakuza members and coal miners would change their behavior. By contrast, in areas without mining-yakuza presence, only coal miners would change their behavior. Exploiting a triple-differences design, I find evidence suggesting

that an increase in yakuza activities is due to mining yakuza members committing economic crime that organized crime likely engages in, such as gambling.

Looking at arrests of yakuza members in different sectors, I find that the energy transition reduced the number of yakuza arrests in the mining sector, while it increased the number of yakuza arrests in non-mining sectors. This provides suggestive evidence of a change in the power dynamics of yakuza organizations. One immediate implication of this shift is an increase in conflicts among yakuza organizations. Using yakuza conflict data from the 1920s to the 2010s, I show that yakuza conflict increased in areas with high coal mining availability in the decades following the energy transition, and this effect persisted over half a century later.

Then, I examine the medium- and long-term consequences on a variety of yakzua measures using cross-sectional data. For this cross-sectional setting, I first construct a treatment variable that captures mining job loss induced by the energy transition, following an approach in the spirit of Duflo and Pande (2007); Sequeira et al. (2020). I construct a predicted treatment variable, which is a function of the DiD estimate and the treatment variable. Importantly, the predicted treatment variable is not correlated with geographic as well as pre-existing economic and demographic characteristics, providing suggestive evidence of the exogeneity of coal mining job loss induced by the energy transition. With the predicted treatment variable, I show that areas that experienced greater mining job loss by the energy transition in the 1960s have a higher number of yakuza members and organizations today. This result, in combination with the previous result on yakuza arrests, suggests that while the energy transition expanded the intensive margin of the yakuza (i.e., an increase in criminal activities among mining yakuza members) in the short-term, it also expanded the extensive margin of the yakuza (i.e., an increase in the number of yakuza members) in the long-term.

To shed light on these findings, I present evidence in line with an increased labor supply for the yakuza. Specifically, areas that underwent mining job losses due to the energy transition have higher rates of juvenile delinquency in both the medium and long term. Notably, these trends do not seem to result from shifts in family structures or local economic conditions. Instead, the results are consistent with the idea that youth growing up in areas with a yakuza presence are more likely to become delinquents, who reduced the opportunity cost of joining yakuza organizations.

I also conduct two supplementary analyses. First, using yakuza organization level data in the

contemporary period, I find that yakuza organizations are more likely to expand their territories in prefectures with greater mining job loss by the energy transition. Second, using municipality level data in the Fukuoka prefecture, which is known for high yakuza's activities, I exploit the minimum distance to a historical mining site, finding that municipalities closer to a historical mining site are more likely to have a yakuza office presence and higher crime rates.

My analyses eliminate a number of alternative channels. For instance, an increase in yakuza arrest following the energy transition could be due to an increase in enforcement. I regress enforcement measures on the treatment in a DiD regression, showing that the coefficients are not statistically significant. Additionally, if the energy transition was a shock to a large population, generating a large number of unemployed people, then the result could be an income effect, which affects overall crime rates, rather than specific to the yakuza. Relatedly, high yakuza's activities today may be a consequence of areas being poor as a result of the energy transition. I partially eliminate these possibilities by showing that the energy transition does not affect overall unemployment rates in either the short-run or long-run; and the energy transition does not affect poverty rates. I evaluate the institution channel. Research highlights the key for the emergence of organized crime in areas with resource abundance is the presence of poor institution. I show that the effect of mining job loss by the energy transition does not varies by pre-existing differences in government expenditures.

This study shows that a historical energy transition, which triggers a negative labor demand shock in the coal mining industry, has long-lasting effects on shaping the geography of the yakuza, and the study contributes to several strands of literature. First, this study contributes to the literature on natural resources and crime. Previous research highlights the role of organized crime as a provider of private protection for natural resources (Gambetta, 1993), implying that resource abundance generates demand for organized crime. Buonanno et al. (2015) focus on sulfur, Sicily's valuable commodity, finding that the mafia is more likely to be present in areas with sulfur availability in the 19th century. Dimico et al. (2017) find that the mafia's presence is higher in areas with abundant orange and lemon crops in the 19th century. These studies focus on permanent structural differences in natural resources. Research also considers events during critical junctures to better understand their consequences on individual and organized crime, as well as conflict. Couttenier et al. (2017) examine the effects of mineral discoveries before and after the establishment of formal

institutions in the U.S., finding that mineral discoveries before, but not after, formal institution increased interpersonal violence, with this effect persisting in the long run. They interpret their results as consistent with the self-defense mechanism in the absence of formal institutions that can enforce property rights. Although their focus is not on natural resources, Acemoglu et al. (2020) argue that a severe drought brought about the rise of the Peasant Fasci, which increased demand for the mafia in the 19th century. These studies highlight defense mechanisms to explain a rise in (organized) crime and conflict in response to resource availability and critical junctures. To complement these studies, this study considers an energy transition from coal to oil as an external negative labor demand shock affecting the supply of the yakuza.

Second, this study contributes to the economics of crime, which posits that participation in illegal activities depends on the accessibility of legal economic opportunities (Becker, 1968). More recently, research examines the role of commodity prices and industrial structures in shaping organized crime and illegal markets. Dube et al. (2016) find that a decline in corn prices leads to marijuana growing and increases homicide in Mexico. Dube and Vargas (2013) examine differential effects of commodity prices on conflict in Colombia, showing that an increase in the price of coffee (labor-intensive) decreases violence, whereas an increase in the price of oil (less labor-intensive) increases violence. Dell et al. (2019) find that a decline in manufacturing jobs caused by global trade with China increases drug-related violence in Mexico. These studies consider the contemporaneous effects of natural resources/agricultural goods on criminal activities. To complement these studies, this research focuses on a historical decline in the coal mining industry and present-day organized crime to shed light on the long-term consequences for organized crime.

Third, this study speaks to research that examine the diversification of criminal activities and the entry/exit of criminal organizations. Battiston et al. (2022) find that a crackdown on Mexican drug trafficking organizations led to an increase in oil theft and the entry of new criminal organizations in areas with pipelines. Hoshino and Kamada (2020) investigate indirect enforcement against the yakuza in Japan, which prohibits citizens and firms from associating with the yakuza to cut money flow funding, causing current and former yakuza members to switch income sources from extortion to organized fraud. These studies examine the effects of enforcement on the diversification of criminal activities and the entry/exit of criminal organizations. Instead, this study considers that a negative labor demand shock changes the composition of yakuza organizations from those

in the mining sector to those in non-mining sectors, and expands their territory.

The rest of this paper is organized as follows. Section 2 provides background information on the yakuza. Section 3 provides data, identification strategies, and results for three sets of analyses. Section 4 concludes.

2 Yakuza: Institutional Background

2.1 Background on Yakuza

I provide the background information about the yakuza. This review is not comprehensive. See Hill (2003, 2004) for a more comprehensive review.

Yakuza Organizations: The yakuza refers to as Japanese criminal organization and their members. There are currently 25 designated yakuza organizations throughout Japan, and there are many and smaller-scaled organizations affiliated with one of the designated organizations. In this sense, each yakuza organization acts like a clan. Under the anti-yakuza laws enacted in 1992, the yakuza are designated by the authorities, according to several criteria. These criteria are: (i) the yakuza organization has a hierarchical organizational structure, (ii) its members use violence to make money, and (iii) its members have criminal records. Unlike other countries, it is not illegal to join or form a yakuza organization in Japan due to the Freedom of Association (the Constitution of Japan, Article 21). However, their economic activities are strictly prohibited under the anti-yakuza laws.

The local groups are the primary operational units of the yakuza (Hill, 2003; NPA, 2007). Yakuza groups are the basic building blocks of yakuza syndicates, which typically take the shape of nested, multi-layered pyramids: individual local groups control territory within a city and are affiliated to a higher-layer group made up of multiple local groups. At the top of the standard pyramidal structure is the boss of the syndicate who is surrounded by a number of advisors and underbosses.

Activities of Yakuza: The yakuza's origins can be historically traced back to various sectors, including mining, gambling, street vending, corporate racketeering, media racketeering, pimping,

gangs, or dock labor. However, their economic market extends beyond their original sector, as the yakuza engage in a diverse range of both legal and illegal income sources. For example, *Taishu-kai*, one of the 24 designated yakuza organizations today, has its roots in the mining sector. Its predecessor groups, *Ota*-group and *Taishu-kai*, were formed in 1954 and 1960, respectively. During the 1960s and 1970s, *Taishu-kai* expanded its business operations into clubs/bars, entertainment, and illegal taxi services. As a result of this growth and diversification, *Taishu-shokai* evolved into *Taishu-kai*, which continues to exist today.

The demand for the yakuza had been around throughout history, depending on the social landscape and time period (Hill, 2003). Since Japan's economic boom in the 1950s, the yakuza began engaging in protection racketeering, targeting business entities as a source of income (*mikajimery=o*). Additionally, they made money through illegal extortion, gambling activities, and by operating in entertainment areas and tourist spots. During the economic boom, the yakuza had significant influence over coal mining, infrastructure, and construction sectors. Conflicts among rival yakuza groups escalated in the 1960s, peaking in 1963 with around 184,000 members. The yakuza's economic activities expanded further in the 1970s and 1980s, leading to their label as the "economic yakuza" (Hill, 2003, 2004). They profited from illegal high-interest lending, corporate blackmail, and interference in civil disputes, with some non-yakuza citizens even choosing to have the yakuza resolve their problems due to slow and costly official legal processes (Milhaupt and West, 2000).

However, starting from 2010 and 2011, prefectures began enacting yakuza exclusion ordinances, which indirectly imposed economic sanctions on the yakuza by prohibiting non-yakuza citizens from assisting them. Consequently, the yakuza faced difficulties in conducting businesses that relied on non-yakuza citizens.

3 Data, Research Design, and Result

My empirical analyses broadly take three steps. First, with an event-study design and prefecture-level panel data, I examine the short- and long-run effects of the energy transition on the yakuza exploiting regional variation in the number of coal mining sites in the pre-transition period and before and after the energy transition. Second, I turn my attention to other yakuza and crime

measures. Some measures are based on cross-sectional data, and other measures are based on panel data. However, all these measures—whether cross-sectional or panel—are available after the 1970s, which limit my ability to implement the event-study design. Instead, in the spirit of Duflo and Pande (2007); Sequeira et al. (2020), I construct a treatment variable that captures mining job loss induced by the energy transition. Using a DiD variation and census data on the share of mine workers, I construct a treatment variable, which is a function of the DiD coefficient and the treatment variable. Using this constructed treatment variable, I examine the way in which the energy transition affects the yakuza and other crime outcomes is through mining job loss. Lastly, I run two supplementary analyses. The first supplementary analysis uses municipality level data in the Fukuoka prefecture and exploits the minimum distance to a historical mining site. The second supplementary analysis uses yakuza organization-level data to provide suggestive evidence for territory expansion. Throughout each analysis, I provide data and identification strategies in relevant sections. Table 1 presents summary statistics of the variables used in this study.

Japan consists of forty-seven prefectures, each forming the first level of jurisdiction and serving as an administrative division. Notably, Okinawa, which was part of U.S. territories until 1972, is excluded from this study.

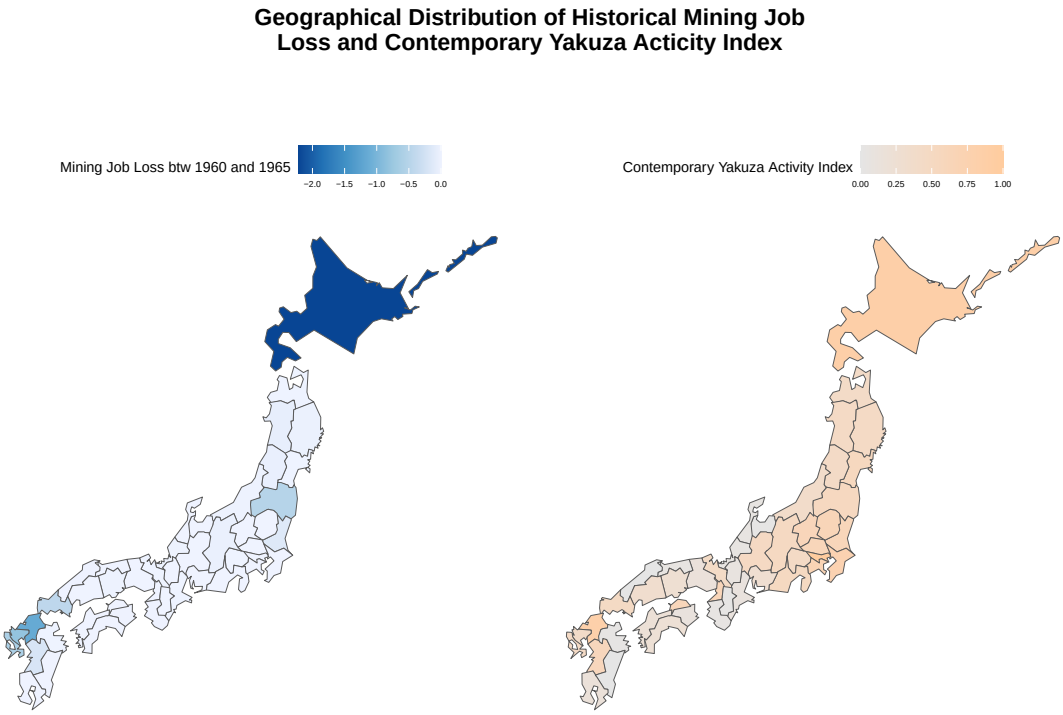
Table 1: Summary Statistics

		Mean	St.Dev.
Data Source	**Cross-sectional Data on Yakuza**		
	Yakuza Member Index	0	1
	Yakuza Organization Index	0	1
Prefectural Police Department	Yakuza Member per 100,000 (2008-2014)	43.711	20.369
Crime Statistics	Yakuza Member per 100,000 (1977)	79.690	38.139
Statistical Survey on Correction by the Ministry of Justice	Yakuza Incarceration per 100,000 (2006-2016)	0.649	0.386
Boryokudan Josei	# of Yakuza Orgs. (2008)	3.085	1.763
White Paper on Crime	# of Yakuza Orgs. (1995)	2.822	1.632
	Yakuza Org. Fragmentation Index	0.409	0.297
	Yakuza Org. Formed after 1962	0.122	0.328
	Yakuza Org. Formed before 1962	0.143	0.351
	Panel Data on Yakuza		
Wikipedia	Yakuza Conflict (1920-2010)	0.078	0.268
Kosohi	Yakuza Conflict (1940-2000)	0.127	0.333
Crime Statistics	Yakuza Arrest Case (1957-1970)	60.577	47.346
Crime Statistics	Yakuza Arrest Person in Mining Sector (1957-1970)	0.177	0.805
Crime Statistics	Yakuza Arrest Person in Non-Mining Sector (1957-1970)	42.006	26.419
	Data on Mining		
Census	Share of Mine Workers (1955 and 1970)	0.895	1.322
Japan Mining Archive	# of Coal Mining Areas	79.270	215.571

Figure 1 provides the descriptive pattern of historical mining job loss between 1960 and 1965 and contemporary yakuza index (composite index of both yakuza member and organization measures

from a principal component analysis). Darker color indicates either greater mining job loss or higher yakuza activities. The correlation coefficient of these two variables is -0.316, indicating that prefectures that experienced greater mining job loss historically tend to have higher yakuza activities today.

Figure 1: Geographical Distribution of Historical Mining Job Loss between 1960 and 1965 and Contemporary Yakuza Index



Data on Coal Mining Availability (Unit: Prefecture): I use the number of coal mining sites in the pre-energy transition period as a proxy for coal mining availability across prefectures. To minimize measurement error, I calculate the average number of coal mining sites over three specific census years: 1950, 1955, and 1960. This is cross-sectional variation that I use for event-study designs. I obtain this data from Mining Yearbook of Japan.

3.1 Event-Study and Triple-Differences Designs

In this section, I use prefecture-level panel data to examine the effects of the energy transition on yakuza arrest/conflict across year/decades.

Data on Yakuza Arrest (Unit: Prefecture-by-Year): I use panel data on yakuza arrests based on criminal statistics from 1957 to 1970. The time span for this is based on data availability. Here the outcome of interest is the number of yakuza arrest per 100,000 residents.

Data on Yakuza Conflict (Unit: Prefecture-by-Decade): I construct panel data on conflicts of the yakuza based on Wikipedia and Nagata (2011). The former dataset covers from the 1920 o 2010s, and the latter one covers from the 1940 to 2000s. Both sources document major conflicts between rival yakuza organizations, but excludes small-scale or minor conflicts associated with the major ones. For both sources, I made sure of relevant information based on yakuza related books, magazines, and website, and coded information on the time and place of each yakuza conflict. Given longer time spans, I use a dataset constructed from Wikipedia. But I provide the robustness of the result using data from Nagata (2011) in Appendix I. Given the rarity of major yakuza conflicts, I aggregate the data at the prefecture and decade level and generate a binary indicator that equals 1 if a prefecture experienced a yakuza conflict in a given decade and equals 0 otherwise.

Specification: I use the following event-study specification that exploits two sources of variation: (i) cross-sectional variation in the number of coal mining sites in the pre-energy transition period and (ii) years/decades leading to and following the energy transition.

$$yakuza_{i,r(i),t} = \sum_{t=k}^{l} \alpha_t mine_i \times \mathbf{1}_t + \mu_i + \lambda_{r(i),t} + \epsilon_{i,r(i),t}, \tag{1}$$

$yakuza_{i,r(i),t}$ is either the number of yakuza arrest cases per 100,000 residents in prefecture i and year t, or a binary indicator for conflict among different yakuza organizations in prefecture i and decade t. Event-study dummies $\mathbf{1}_t$ are from $k = 1957$ to $l = 1970$ for yakuza arrest data, while they are from $k = 1920$ to $l = 2010$ for yakuza conflict data. $mine_i$ is the number of coal mining sites before the energy transition period. α_t are time-varying coefficients. In the case of yakuza arrest data, I use 1961 as the reference period; in the case of yakuza conflict data, I use 1950 as the reference period. The coefficients are interpreted as a comparison to one time period before the energy transition. An identifying assumption here is the parallel trends assumption, which states that in the absence of the energy transition, yakuza-related outcomes would change at similar rates in coal-rich prefectures and coal-scarce prefectures. To indirectly check this assumption, the

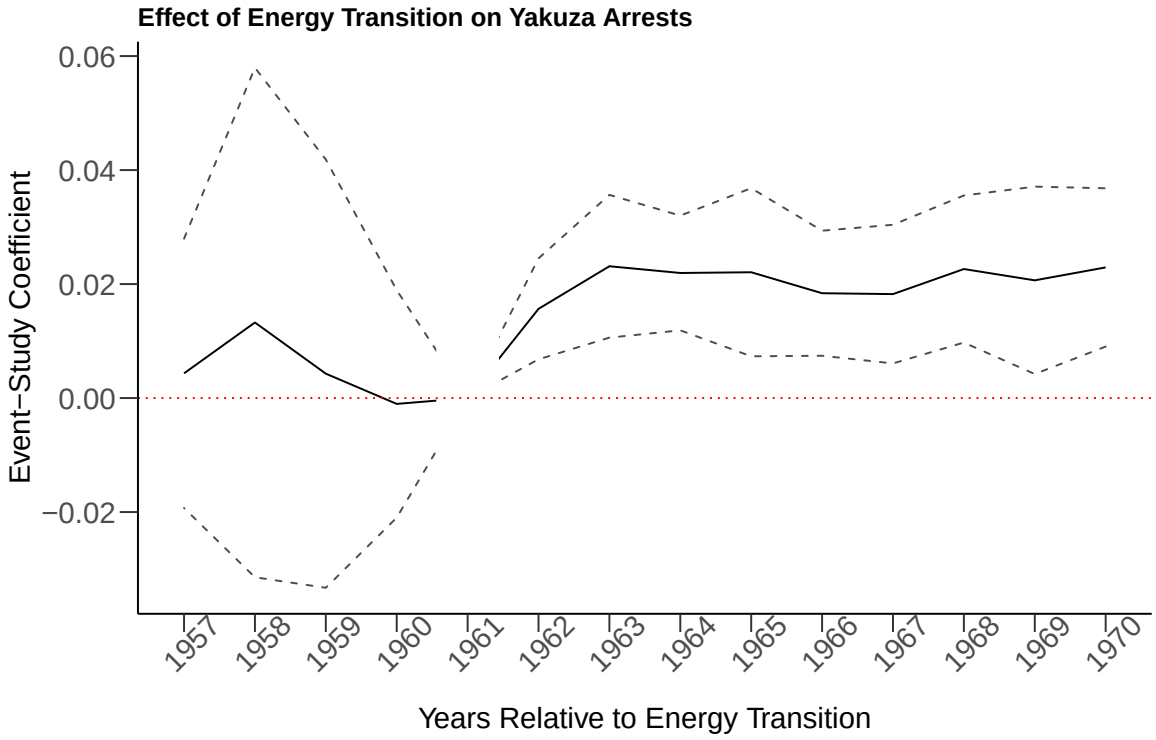
coefficients on the lead treatment variables need to be indistinguishable from zero. If the energy transition had persistent effects, then the coefficients on the contemporaneous and lag treatment indicators should be large in magnitude. μ_i is prefecture fixed effects, and $\lambda_{r(i),t}$ region-by-year fixed effects (for yakuza arrest), or region-by-decade fixed effects (for yakuza conflict).[1] Region-by-time fixed effects force me to compare prefectures with varying degrees of coal mining sites within the region and time period, conditional on prefecture fixed effects. I use two-way clustering standard errors at the prefecture and decade levels to account for the serial correlation as well spatial correlation in the error term.

Result on Short-Run Effect of Energy Transition on Yakuza Arrest: Figure 2 shows the short-run effect of the energy transition on the number of overall yakuza arrests per 100, 000 residents. It presents event-study estimates and the 95% confidence intervals of the effects of the energy transition on yakuza arrests from 1957 to 1970. First, before 1962, there are not differential trends in yakuza arrest rates across prefecture with varying degrees of coal mining sites, suggesting that the parallel trends assumption likely holds. Second, in the years after 1962, yakuza arrest rates increase in prefectures with high mining availability, and the effect of the energy transition on yakuza arrest persists over the subsequent 10 years. The magnitude of this effect is both statistically and economically significant. Comparing prefectures in the 90th percentile of the coal mining site distribution to comparing them in the 75th percentile of the distribution, I find, on average, a roughly 10% increase in yakuza arrest rates relative to the baseline mean in the energy transition period.

Note, however, that this result may reflect a change in enforcement. To indirectly eliminate this possibility, Appendix 3.4 provides tentative results, indicating that the energy transition does not change enforcement level. Thus, I interpret this result as evidence indicating that the energy transition increases yakuza's activities.

[1] Here, following the convention, Japan is divided into seven regions: Hokkaido-Tohoku, Kanto, Chubu, Kansai, Chugoku, Shikoku, and Kyushu.

Figure 2: Event-Study Analysis: Short-Run Effect on Yakuza Arrest



Note: **Outcome**: # of Yakuza arrest per 100,000 residents (baseline mean before 1962: 75.424). **Treatment**: # of mining sites. 50th percentile: 4. 75th percentile: 20. 90th percentile:282. 95th percentile: 450. **Standard errors**: two-way clustered at the prefecture and year levels. **Observations**: 644 = 46 (prefecture) × 14 (year).

Channel—Mining Yakuza Members or Coal Miners: Next, I examine whether an increase in yakuza's activities is due to two channels: (i) mining yakuza members who lost their revenues from the mining sector and switched their economic activities or (ii) coal miners who decreased the opportunity cost of crime and sorted into yakuza organizations. To this end, I exploit the historical presence of mining yakuza organizations. In prefectures with mining-yakuza presence in the pre-transition period, both mining yakuza members and coal miners would change their behavior. By contrast, in prefectures without mining-yakuza presence, only coal miners would change their behavior. Using the historical presence of mining yakuza organizations, I estimate the

following triple-differences specification:

$$yakuza_{i,r(i),t} = \tilde{\alpha}\, ad\, mine_i \times post_t + \tilde{\beta} ad\, mine_i \times post_t \times mining\, yakuza_i \tag{2}$$

$$+ \tilde{\gamma}\, ad\, mine_i \times post_t \times other sector\, yakuza_i + \mathbf{FE} + \tilde{\epsilon}_{i,r(i),t}, \tag{3}$$

$mining\, yakuza_i$ takes the value one if a prefecture has at least one yakuza arrest in the mining sector in the pre-energy transition period (1957-1961), and this indicator is then interacted with the treatment variable $ad\, mine_i \times post_t$, where $post_t$ takes value one after 1962 and zero otherwise. Because mining yakuza organizations are far more likely to be present in prefectures with a greater number of mining sites, as shown in Figure A2, prefectures with and without the historical presence of yakuza organizations are not comparable. For this reason, I make the following adjustment for $ad\, mine_i$: (i) adjusted by the baseline mining population and (ii) then standardized, by mining yakuza status, to mean = 0 and standard deviation = 1. **FE** includes prefecture fixed effects, the mining yakuza presence dummy interacted with year fixed effects, the coal mining availability interacted with post dummy, which is then further interacted with yakuza in other sectors, and region-by-year fixed effects.

Result on Channel: Table 2 provides triple-differences estimates. It examines four different outcomes. Column (1) shows overall yakuza arrests; Column (2) shows yakuza arrests for economic crime, which includes theft and fraud; Column (3) shows yakuza arrests for violent crime, which includes robbery, murder, assault, threat, and extortion; and Column (4) shows yakuza arrests for organized crime, which includes gambling, prostitution, drug trade. Note that, due to data limitation, the sample period only covers from 1963 to 1970 for yakuza arrests for organized crime, so I cannot include prefecture level fixed effects when examining this outcome. The results indicate that the coefficients on the treatment variable interacted with mining yakuza is positive for total crime, economic crime, and organized crime, while the coefficients on the treatment variable not interacted with the mining yakuza dummy are not statistically significant. This provides suggestive evidence that an increase in yakuza's activities is likely due to mining yakuza members committing economic motivated crime, such as theft, fraud, gambling, prostitution, and drug trade.

Therefore, the results are thus consistent with the following perspective: rather than coal miners

who lost their jobs upon the energy transition reduced the opportunity cost of crime and sorted into yakuza organizations, mining yakuza members who lost their revenues from the mining sector switched their economic activities to illicit activities upon the energy transition.

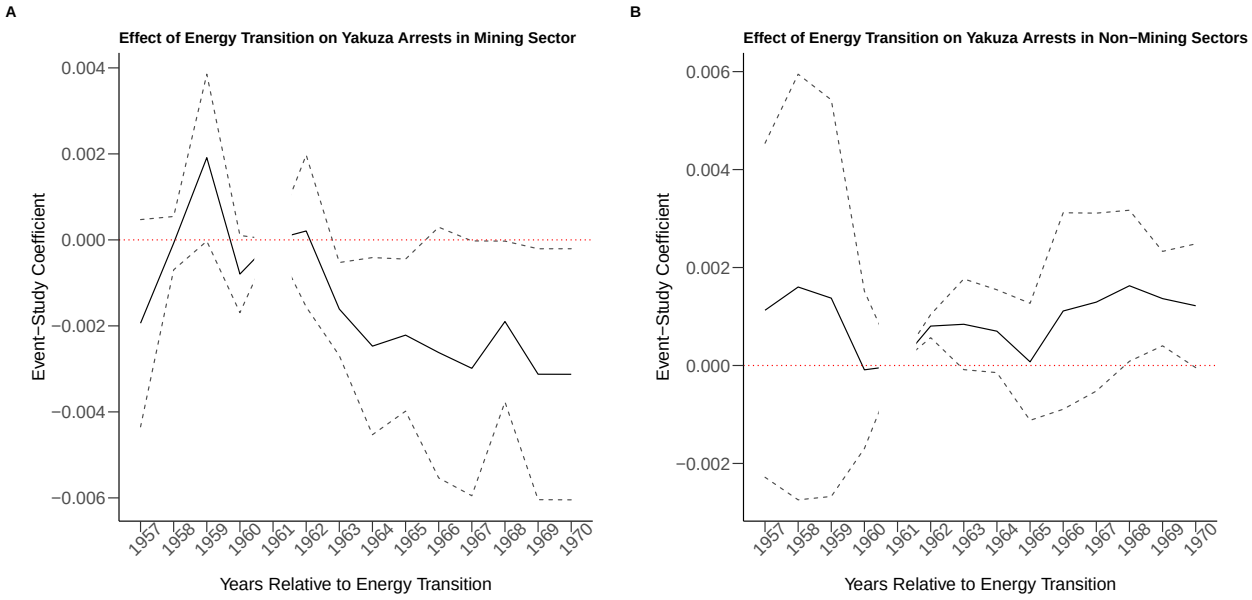
Table 2: Triple-Difference Estimates

	(1)	(2)	(3)	(4)
	Yakuza Arrest			
	Total Crime	Economic Crime	Violent Crime	Organized Crime
Coal Mining Availability × Post	0.090	0.060	0.087	
	(0.081)	(0.073)	(0.094)	
Coal Mining Availability × Post × Mining Yakuza	0.440***	0.720***	0.202	
	(0.158)	(0.120)	(0.162)	
Coal Mining Availability				-0.255***
				(0.078)
Coal Mining Availability × Mining Yakuza				0.373***
				(0.078)
Prefecture FE	x	x	x	–
Mining Yakuza × year FE	x	x	x	x
Coal Mining Availability × Post × Yakuza in Other Sectors	x	x	x	x
Region-by-year FE	x	x	x	x
Observations	644	644	644	368
Sample period	1957-1970	1957-1970	1957-1970	1963-1970
R-squared	0.764	0.656	0.795	0.792

Notes: Significance at the 1%, 5%, and 10% levels indicated by ***, **, and *, respectively. Two-way clustering standard errors are in parentheses.

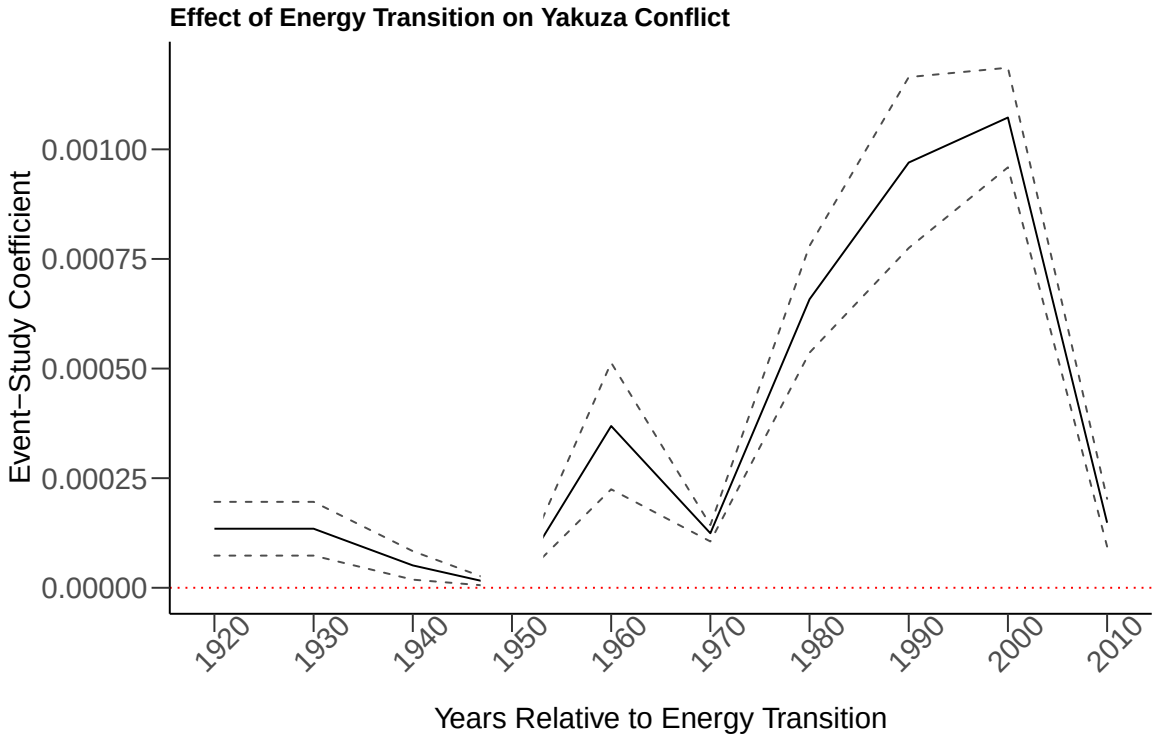
Result on Short-Run Effect of Energy Transition on Yakuza Arrest in Different Origin Sectors: Figure ?? examines the effect of the energy transition on yakuza arrests in different sectors. I use the specification 1 and replace the overall yakuza arrests with the number of yakuza arrests who were in the mining sector, or the number of yakuza arrests who were in non-mining sectors. Panel A provides the result on yakuza arrests in the mining sector (i.e., mining associated yakuza), while Panel B provides the result on yakuza arrests in non-mining sectors. The results provide suggestive evidence that while the number of yakuza arrests in the mining sector declines post-energy transition, while the number of yakuza arrests in non-mining sectors increases. This result is consistent with the idea that while the power of mining-associated yakuza was on the decline, the power of non-mining yakuza was on the rise following the energy transition.

Figure 3: Event-Study Analysis: Short-Run Effect on Yakuza Arrests in Different Origin Sectors



Result on Long-Run Effect of Energy Transition on Yakuza Conflict: Figure 4 provides event-study estimates and the 95% confidence intervals of the effects of the energy transition on yakuza conflicts over decades. It shows that prior to the 1960s, the likelihood of yakuza conflicts is similar across prefectures with varying degrees of mining job loss. This result provides suggestive evidence that the parallel trends assumption likely holds. The decades following the energy transition, the likelihood of yakuza conflicts increase more in prefectures with high coal mining availability than in prefectures with low availability. This effect persists over a half-century. In terms of the magnitude, comparing prefectures in the 90th percentile of the coal mining site distribution to comparing them in the 75th percentile of the distribution, I find, on average, a roughly a 14 percentage point increase in yakuza conflict in the energy transition period. This provides evidence of the long-term consequences of the energy transition on yakuza conflict. Note, however, in the 1970s and 2010s, there is a large drop in the likelihood of yakuza conflict. For the 1970s, this is likely because of an intensification of yakuza conflict in the decades before, and the police were cracking down on the yakuza in that period. For the 2010s, this can be two things. First, during this period, the use of violence has become less common, so it is far less likely to observe yakuza conflict. Second, the yakuza exclusion ordinances were enacted beginning in 2010, which may have reduced the likelihood of conflict among yakuza organizations.

Figure 4: Event-Study Analysis: Long-Run Effect on Yakuza Conflict



Note: **Outcome**: Yakuza conflict (baseline mean before the 1960s: 0.043). **Treatment**: # of mining sites. 50th percentile: 4. 75th percentile: 20. 90th percentile:282. 95th percentile: 450. **Coefficient**: $\alpha \times 10$. **Standard errors**: two-way clustered at the prefecture and decade levels. **Observations**: $460 = 46$ (prefecture) $\times$ 10 (decade).

3.2 Medium- and Long-term Analysis with Cross-sectional Data and Panel Data after 1970

Now, I investigate the medium- and long-term consequences on different yakzua measures using cross-sectional data. For this cross-sectional setting, in the spirit of Duflo and Pande (2007); Sequeira et al. (2020), I first construct a treatment variable that captures mining job loss induced by the energy transition using a difference-in-differences design.

Thus, this section provides two analytical frameworks: (i) difference-in-differences analysis of the energy transition on mine workers with prefecture-by-census-year panel data, and then (ii) in combination with the predicted treatment variable, cross-sectional analysis of the effects of mining job loss induced by the energy transition on contemporary yakuza's outcomes.

Data on Mine Workers (Unit: Prefecture-by-Census-Year): I use historical census data to calculate the share of mine workers relative to total workers in census years of 1955, 1960, 1965, and 1970.

Construction of Mining Job Loss Induced by Energy Transition with Difference-in-Differences Design: To construct a treatment variable that captures a decline in the share of mine workers induced by the energy transition, I use an approach in the spirit of Duflo and Pande (2007); Sequeira et al. (2020). To do so, I run the following DiD specification with the 1955, 1960, 1960, 1965, and 1970 census years, which compare the share of mine workers in prefectures with high mining availability and prefectures with low mining availability across census years:

$$mine\,workers_{i,r(i),t} = \beta\, mine_i \times post_t + \tilde{\mu}_i + \tilde{\delta}_{r(i),d} + \tilde{\epsilon}_{i,r(i),t}. \tag{4}$$

$mine\,workers_{i,r(i),t}$ is the share of mine workers in prefecture i and census year t. Equation 4 is the same as the above event-study equation 1, except for $post_t$, which equals 1 after 1965 census years and 0 otherwise. After estimating equation 4, I construct a predicted treatment variable as follows:

$$\widehat{mine\,workers}_i = \frac{1}{T}\sum_{t=1}^{T} \widehat{\beta}\, mine_i \times post_t. \tag{5}$$

$\widehat{mine\,workers}_i$ captures a predicted change in the share of mine workers induced by the energy transition. Because prefectures with high mining availability should have greater damage with respect to a decline in mine workers than prefectures with low mining availability, $\widehat{\beta}$ is expected to be negative, and thus $\widehat{mine\,workers}_i$ is also negative.

In order to credibly estimate the causal effects of $\widehat{mine\,workers}_i$ on the outcomes, the key assumption is that $\widehat{mine\,workers}_i$ is exogenous. While I cannot directly test the exogeneity assumption, Figure A1 shows that $\widehat{mine\,workers}_i$ is conditionally uncorrelated with geographical characteristics as well as pre-existing measures of demographic and economic characteristics. This result provides suggestive evidence of the exogeneity of mining job loss induced by the energy transition. To further validate the parallel trends assumption for this analysis, I run an event-study specification and provide the result in Figure B.

Specifications: With $\widehat{mine\ workers}_i$, I examine reduced-form effects on yakuza and other crime measures. Yakuza variables for this analysis are cross-sectional, but other crime measures and socioeconomic development measures are readily available after the 1970s. For the latter case, I use panel data structure, and because I do not yet have these variables measured before the energy transition (currently under construction), I cannot use event-study designs and include prefecture fixed effects. Instead, I estimate the following specification 7

$$yakuza_{i,r(i)} = \pi_0 + \pi_1 \widehat{mine\ workers}_i + +\pi_2 X_i + \gamma_{r(i)} + \eta_{i,r(i)}, \tag{6}$$

$$y_{i,r(i),t} = \tilde{\pi}_0 + \sum_{t=1970}^{2010} \tilde{\pi}_t \widehat{mine\ workers}_i \times \mathbf{1}_t + +\tilde{\pi}_2 X_i + \tilde{\gamma}_{r(i),t} + \tilde{\eta}_{i,r(i),t}, \tag{7}$$

Because $\widehat{mine\ workers}_i$ is negative, the coefficients of interest, π_1 ($\tilde{\pi}_t$), are *negative* if mining job loss increases yakuza's activities or other crime measures. X_i is the vector of prefecture-level time-invariant geographical characteristics (i.e., latitude, longitude, land area, elevation, whether a prefecture is located on the coastline), and $\eta_{i,r(i)}$ ($\tilde{\eta}_{i,r(i),t}$) are the error term. I use robust standard errors for equation 6 and two-way clustering standard errors at the prefecture and decade for equation 7. In addition to reduced-formed estimates, I provide two-stage least-squares (2SLS) estimates in Section D.

Result on Effect of Energy Transition on Mining Job Loss: Table 3 provides the estimation result from equation 4. It shows that the coefficient is negative and statistically significant, indicating a greater decline in the share of mine workers in prefectures with high coal mining availability than prefectures with low coal mining availability after the energy transition. In terms of magnitude, from prefectures with the 75 percentile of coal mining availability to prefectures with the 90 percentile, the share of mine workers decrease by 0.9 per 100 workers. This translates into a 76% decrease in the share of mine workers relative to the baseline mean. This result confirms that the following analyses and corresponding results are reasonable in terms of long-term consequences. I use the predicted treatment variable from equation 5.

Table 3: DiD Estimate: Energy Transition and Mine Workers

	Share of Mine Workers
Coal Mining Availability × Post	−0.0036**
	(0.0016)
Mean of Dep. Var. in 1960	1.172
50th percentile of coal availability	4
75th percentile of coal availability	20
90th percentile of coal availability	282
95th percentile of coal availability	450
R-squared	0.869
Census Years	1955, 1960, 1965, 1970

Notes: Significance at the 1%, 5%, and 10% levels indicated by ***, **, and *, respectively. Standard errors clustered at the prefecture and census year levels.

Now, I turn my attention to cross-sectional measures of various yakuza's activities.

Data on Yakuza Members (Unit: Prefecture): I use three measures to capture yakuza members: (i) the number of yakuza members (average between 2008 and 2014, and as of 1977), (ii) the number of yakuza incarceration (average between 2006 and 2016). The years of the outcome variables are based on the availability of data, but similar measures in different points in time allow me to examine medium- and long-run effects.

First, I obtain data on the number of yakuza members (2008-2014) by requesting prefectural police departments. The dataset contains the number of yakuza members in 37 prefectures from 2008 to 2014.[2] According to the Organized Crime Division of the National Police Agency (NPA), the police draw on many sources to identify whether a yakuza member leaves his yakuza organization.[3]

[2]The reader may be curious whether those 37 prefectures that provided data may be different from the rest of the prefectures. Hoshino and Kamada (2020) indirectly probe into this possibility. They create a binary outcome that equals 1 if a prefecture reported the data and 0 otherwise. They then run a diagnostic test by regressing this binary outcome observed covariates, and the corresponding regression result provides suggestive evidence that there are no systematic differences in reporting the data.

[3]For example, the police judge based on expulsion letters and interviews with relevant members and arrested members. A yakuza organization sends an expulsion letter to other yakuza organizations when its member leaves. This letter prevents the defecting member from transferring to another yakuza organization. However, this notification may not be sufficient for the police to count the one as a yakuza dropout. The police need supporting evidence, which they can obtain by investigating yakuza offices and interviewing others. These processes allow the police to track the actual number of yakuza members, reducing the possibility of miscounting the number of yakuza members who hide their identities in the underground.

In addition, to assess medium-run effects, I use data on the number of yakuza members as of 1977, which I obtain from National Police Agency (1978). The outcome is measured as the number of yakuza members per 100,000 inhabitants.

Second, I obtain data on the number of yakuza incarceration from e-Stat, a portal site for Japanese government statistics. e-Stat provides prefecture-level data on the number of yakuza incarceration from 2006 to 2016, and the data is originally from Statistical Survey on Correction by the Ministry of Justice. The outcome is measured as the number of yakuza incarceration per 100,000 inhabitants.

I construct a yakuza member index, based on principal components analysis extracted from the average number of yakuza members (2008-2014), the average number of yakuza incarceration (2006-2014), and the number of yakuza members as of 1977. Before running principal components analysis, I standardize each variable to mean = 0 and standard deviation = 1.

Data on Yakuza Organizations (Unit: Prefecture): I use three measures to capture yakuza organizations: (i) the number of different yakuza organizations, (ii) yakuza fragmentation index, and (iii) indicators for the headquarter of a yakuza organization being formed after (resp. before) 1962.

First, I obtain data on the number of designated yakuza organizations, as of 2008, from (National Police Agency, 2009). To capture the number of yakuza organizations in the 1990s, I also obtain data from National Police Agency (1996), which allows me to examine the medium-run effects as of 1995.

Second, I define a prefecture-level fragmentation index of yakuza organizations in a manner similar to the Hirschman-Herfindahl index.[4] Let s_{pg} be the "share" of a (designated) yakuza organization g in prefecture p, which we will define. It would be desirable to know the number of members of each yakuza organization in each prefecture to calculate the share, but such data do not exist. I need to estimate these figures. I assume that the members of yakuza organization g are distributed over all the prefectures in which g operates, proportionally to the population of these prefectures. As the total number of members of each yakuza organization is known, I can calculate the share s_{pg} under this assumption. Let q_p be prefecture p's population for each p, and then the

[4]See Brown et al. (2021) for a similar construction of the HHI-based gang competition measure.

ratio of prefecture p's population among all prefectures where a yakuza organization g operates is equal to $q_p / \sum_{p'} q_{p'}$, where $\sum_{p'}$ runs over all prefectures where g operates. Hence, the number of g's members in p is estimated to be $N_{gp} = (g$'s total number of members$) \times (q_p / \sum_{p'} q_{p'})$. I then define the share $s_{pg} = N_{gp} / \sum_{g'} N_{g'p}$ if g operates in p and $s_{pg} = 0$ otherwise, where $\sum_{g'}$ runs over all yakuza organizations operating in p. By definition, $0 \leq s_{pg} \leq 1$ and $\sum_g s_{pg} = 1$ (since each prefecture has at least one yakuza organization). I define the yakuza fragmentation of prefecture p as $fragmentation_p = 1 - \sum_g s_{pg}^2$. Note that $fragmentation_p = 0$ if there is only one (monopoly) yakuza organization in p and YCI_p increases in the number of yakuza organizations in p.

I construct a yakuza organization index, based on principal components analysis extracted from the number of yakuza organizations in 1995 and 2008, and the yakuza fragmentation index as of 2008. As before, I standardize each variable mean = 0 and standard deviation = 1 before principal components analysis.

Lastly, I create two indicators for yakuza organizations. The first indicator equals one if a prefecture has the headquarter of a designated yakuza organization formed after 1962 or otherwise zero. In a similar vein, the second indicator equals one if a prefecture has the headquarter of a designated yakuza organization formed before 1962 or otherwise zero.

Result on Effect of Mining Job Loss by Energy Transition on Various Yakuza's Activities Decades Later: Table 4 provides reduced-form estimates, and it examines the yakuza member index and yakuza organization index. Both outcomes are standardized to mean = 0 and standard deviation = 1. For each outcome, there are three specifications: (i) a specification without any covariates, (ii) a specification with geographic covariates, and (iii) a specification with the geographic covariates and region fixed effects. The results are consistent across specifications (except for Column (1)), and the size of the coefficients increases when covariates are added. Column (3) finds that from prefectures with the 25 percentile of mining job loss by the energy transition to prefectures with the 10 percentile, both yakuza member and organization indices are higher by a 1.5 standard deviation.

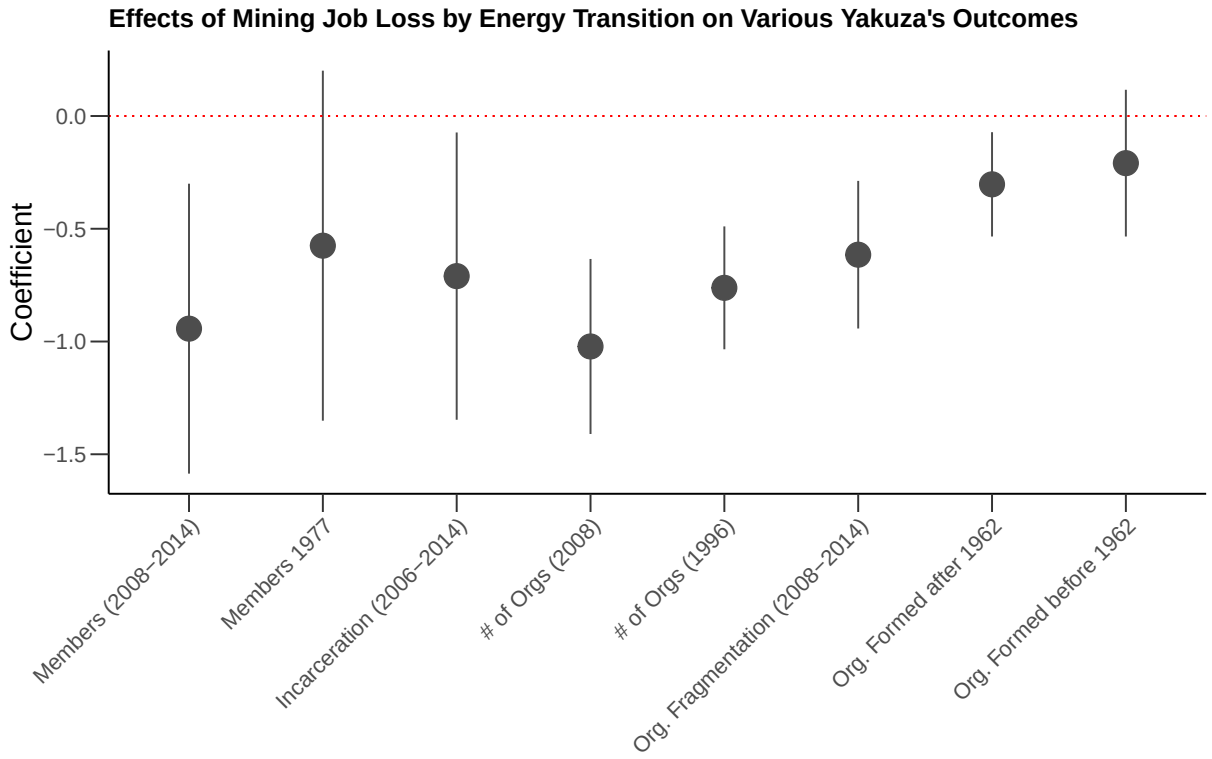
Table 4: Mining Job Loss by Energy Transition and Yakuza Members and Organizations

	(1)	(2)	(3)	(4)	(5)	(6)
	Yakuza Member Index			Yakuza Org. Index		
Mining Job Loss by Energy Transition	−0.054	−1.627**	−1.397***	−0.569***	−1.777***	−1.386***
	(0.244)	(0.655)	(0.434)	(0.127)	(0.249)	(0.256)
Geographic Controls		x	x		x	x
Region Fixed Effects			x			x
5th percentile of mining job loss				−1.646		
10th percentile of mining job loss				−1.032		
25th percentile of mining job loss				−0.071		
50th percentile of mining job loss				−0.011		
Observations	36	36	36	46	46	46
R−squared	0.062	0.436	0.582	0.144	0.444	0.587

Notes: Yakuza member index: (mean=0, st.dev.=1): based on principal components analysis extracted from the average number of yakuza members (2008-2014), the average number of yakuza incarceration (2006-2014), the number of yakuza members as of 1997. **Yakuza organization index:** (mean=0, st.dev.=1): based on principal components analysis extracted from the number of yakuza organizations in 2008 and 1995, and the yakuza fragmentation index. **Geographical controls:** i.e., latitude, longitude, land area, elevation, whether a prefecture is located on the coastline. Significance at the 1%, 5%, and 10% levels indicated by ***, **, and *, respectively. Robust standard errors are in parentheses.

Figure 5 provides reduced-form estimates and the 95% confidence intervals for disaggregated outcomes to assess medium- and long-run effects. To facilitate interpretations with ease, I standardize all continuous measures to mean = 0 and standard deviation = 1. Across all relevant measures, I find higher activities of the yakuza in the 1970s, 1990s, and 2000s-2010s in prefectures with greater mining job loss.

Figure 5: Reduced-Formed Estimates and 95% Confidence Intervals: Various Yakuza's Activities



Note: **Members (2008-2014)** = # of yakuza member per 100,000 (avg. of 2008-2014). **Members (1977)** = # of yakuza member per 100,000 in 1977. **Incarceration (2006-2016)** = # of yakuza incarceration per 100,000 (avg. of 2006-2016). **Arrests (1974)** = Yakuza arrests (2008-2014): (1) 0-200, (2) 201-300, (3) 301-400, (4) 401-500, (5) 501-600, (6) 601-800, and (7) more than 801 yakuza arrests. **# of Orgs. (2008)** = # of yakuza organizations in 2008. **# of Orgs. (1995)** = # of yakuza organizations in 1995. **Orgs. Fragmentation (2008-2014)** = Yakuza fragmentation index (avg. of of 2008-2014). **Org. Formed after 1962** = Indicator that equals 1 if the headquarter of a yakuza organization formed after 1962 and otherwise 0. **Org. Formed before 1962** = Indicator that equals 1 if the headquarter of a yakuza organization formed before 1962 and otherwise 0. **Treatment**: Mining job loss by energy transition. 5th percentile of mining job loss by energy transition: -1.646. 10th percentile of mining job loss by energy transition: -1.032. 25th percentile of mining job loss by energy transition: -0.071. 50th percentile of mining job loss by energy transition: -0.011. Specification includes geographical controls and region fixed effects.

In terms of yakuza members, in comparison to prefectures with the 25th percentile, prefectures with the 10th percentile of mining job loss have a greater number of yakuza members by a 1 standard deviation in between 2008 and 2014, yakuza members by 0.6 as of 1977 (though showing large confidence intervals and the coefficient is not statistically significant), yakuza incarceration by a 0.72 standard deviation in between 2006 and 2014. In terms of yakuza organizations, prefectures with greater mining job loss have a greater number of yakuza organization by a 1 stadard deviation in

2008, by a 0.7 standard deviation in 1996, and more fragmentation of rival yakuza organizations by a 0.56 standard deviation. Lastly, prefectures with greater mining job loss have a higher likelihood of having the headquarter of a yakuza organization formed *after* 1962. As a placebo test, the likelihood of having the headquarter of a yakuza organization formed *before* 1962 is not statistically correlated with mining job loss by the energy transition, although the size of the coefficients for *before* and for *after* are similar, suggesting that these results perhaps remain tentative.

Result on Effect of Mining Job Loss by Energy Transition on Delinquency and Other Crime Measures in the Medium- and Long-run: I examine one channel for the persistent effect—Intergenerational Transmission of Crime and Criminal Trajectories. I indirectly test this channel, drawing on data from e-Stat, which provides crime measures from 1975 and onward. Because they do not provide data prior to 1975, event-study analysis is not possible. Instead, I provide reduced-form estimates for outcomes measured in each decade from the 1970s to 2010s. All the outcomes are standarized to mean = 0 and standard deviation 1.

Column (1) reports the result for delinquency arrest rates to provide suggestive evidence for the intergenerational transmission of crime channel. Those who grew up in areas where the yakuza are around may internalize values conducive to the yakuza, which may reduce the cost of joining a yakuza organization. A typical scenario of this kind is that juvenile delinquents in a motorcycle gang are recruited by yakuza members. To be consistent with the intergenerational transmission channel, delinquency arrest rates are higher in prefectures with greater mining job loss from the 1970s and 2010s, and the effect attenuates over time.

Second, given that joining a yakuza organization is an irreversible investment, mine workers who joined a yakuza organization upon the energy transition have likely remained in their yakuza organizations decades later. In line of this perspective, I find that the number of reported felony crime (both violent, property, and social disorder) is higher in prefectures with greater mining job loss. I also look at methamphetamine arrests. Methamphetamine is an illegal drug that is most frequently abused in Japan. Yakuza organizations are largely involved in smuggling and distributing it, earning a considerable amount of money. Although the data does not differentiate the use and sale of methamphetamine, it still helps us hint at the involvement of the yakuza. Estimates indicate that the effects generally attenuate over time.

Table 5: Medium- and Long-run Effects on Delinquency and Other Crimes

	(1) Arrest Delinquency	(2) Reported Violent Crime	(3) Reported Property Crime	(4) Reported Social Disorder	(5) Arrest Methamphetamine
Mining Job Loss by Energy Transition × 1970	−0.666***	−1.142***	−0.776***	−0.763**	−1.108***
	(0.102)	(0.156)	(0.146)	(0.177)	(0.156)
Mining Job Loss by Energy Transition × 1980	−0.576***	−0.932***	−0.835***	−0.480*	−0.985***
	(0.108)	(0.158)	(0.152)	(0.191)	(0.175)
Mining Job Loss by Energy Transition × 1990	−0.376**	−0.843***	−0.872***	−0.422*	−0.663**
	(0.110)	(0.161)	(0.183)	(0.186)	(0.168)
Mining Job Loss by Energy Transition × 2000	−0.458**	−0.800***	−0.740**	−0.632**	−0.637**
	(0.108)	(0.162)	(0.184)	(0.185)	(0.166)
Mining Job Loss by Energy Transition × 2010	−0.440**	−0.783***	−0.567**	−1.299***	−0.576**
	(0.099)	(0.152)	(0.149)	(0.171)	(0.165)
Geographic Controls	x	x	x	x	x
Region Fixed Effects × Decade Fixed Effects	x	x	x	x	x
Observations	230	230	230	230	230
R−squared	0.873	0.647	0.745	0.579	0.702

Notes: Delinquency arrests: delinquency arrests per 100,000 residents aged under 18. **Reported violent, property, and social disorder:** # of reported crime category per 100,000 residents. **Methamphetamine arrests:** # of methamphetamine arrests per 100,000 residents . Significance at the 1%, 5%, and 10% levels indicated by ***, **, and *, respectively. Two-way clustered standard errors are in parentheses.

3.3 Supplementary Analyses

Mining Job Loss and Territory Expansion of Yakuza Organizations: I examine territory expansion of yakuza organizations. To do so, I rely on yakuza organizational-level data, instead of prefecture level data. I focus on the period before the largest yakuza organization—*Yamaguchi-gumi* split in 2015. At that time, there are 21 designated yakuza organizations, but one of which was located in Okinawa prefecture. Thus observations are 20 in this analysis. Specifically, I estimae the following specification:

$$yakuza_{g,i,r(g,i)} = \kappa_0 + \kappa_1 \widehat{mine\,workers}_i + \phi_{r(g,i)} + \nu_{g,r(g,i)}. \tag{8}$$

Here, $yakuza_{g,i,r(g,i)}$ is the indicator for territory expansion for yakuza organization g that originates in prefecture i. I consider the following types of territory expansion: (i) whether or not a yakuza organization expands its territory, (2) it expands its territory to coal mining prefectures (based on coal mining availability above median), or (iii) it expands its territory to non-coal mining prefectures.

Result on Territory Expansion: Table 6 provides the estimation results. Columns (1 - 3) focus on yakuza organizations that originate in coal mining prefectures, and examine whether they expand their territory to other prefectures, and if so, where they expand their territory to: other coal mining prefectures than their origin prefecture, or non-coal mining prefectures. Columns (4 - 6) focus on yakuza organizations that originate in non-coal mining areas, and examine whether they expand their territory to other prefectures, and if so, where they expand their territory to: coal mining prefectures, or non-coal mining prefectures than their origin prefecture.

The results indicate that yakuza organizations that originate in coal mining prefectures are more likely to expand their territory if their headquarters are located in prefectures with greater mining job loss. They are more likely to expand their territory to other coal mining areas, but no more likely to do so to non-coal mining areas. I find no such patterns for yakuza organizations that originate in non-coal mining areas.

Table 6: Yakuza Organization-Level Analysis: Coal Mining Job Loss and Territory Expansion

	(1)	(2)	(3)	(4)	(5)	(6)
Origin:	Coal Mining Pref.			Non-Coal Mining Pref.		
Expand to:	Anywhere	Coal Mining Area	Non-Coal Mining Pref.	Anywhere	Coal Mining Pref.	Non-Coal Mining Pref.
Mining Job Loss by Energy Transition	−0.380***	−0.404***	0.024	0.038	−0.002	0.039
	(0.104)	(0.123)	(0.043)	(0.061)	(0.002)	(0.062)
Region Fixed Effects	x	x	x	x	x	x
Observations	20	20	20	20	20	20
R-squared	0.697	0.734	0.208	0.754	0.728	0.127

Notes: Delinquency arrests: delinquency arrests per 100,000 residents aged under 18. **Reported violent, property, and social disorder:** # of reported crime category per 100,000 residents. **Methamphetamine arrests:** # of methamphetamine arrests per 100,000 residents . Significance at the 1%, 5%, and 10% levels indicated by ***, **, and *, respectively. Two-way clustered standard errors are in parentheses.

Micro Evidence from Fukuoka Prefecture Lastly, I use municipality level data on the presence of a yakuza office, as of 2021, and other crime measures, as of 2007 (still data collection process), in the Fukuoka prefecture, which is known for high yakuza's activities. The former data comes from "yakuza news dot com" and the latter data comes from the Fukuoka prefectural police department. I measure the minimum distance from a municipality to a historical mining site as of 1961. I estimate the following estimation equation:

$$y_{i,r} = \beta_0 + \beta_1 \ln dist_i + \beta' X_i' + \delta_r + \epsilon_{i,r}, \tag{9}$$

where y_i is either an indicator of the yakuza office presence, or the number of crime measures. I use OLS for the former outcome and Poisson-pseudo maximum likelihood estimator (PPML) for the latter outcome. For PPML estimation, I also include the exposure term with the municipality population size, where the parameter is constrained to 1. $\ln dist_i$ is the log of the minimum distance between a coal mining site (as of 1961) and municipality i. X_i' includes latitude and longitude. δ_r: region fixed effects, where Fukuoka is divided by 14 unique areas. I use robust standard errors to account for heteroskedasticity.

Result on Effect of Distance to Historical Mining Site on Yakuza Office and Crime Measures: Table ?? provides the estimation results, showing that municipalities closer to a historical mining site as of 1961 are more likely to have a yakuza office and high crime rates as of today.

Table 7: Effects of Distance to Historical Mining Site on Yakuza Office and Crime Rates

	(1) Yakuza Office	(2) Total Crime	(3) Economic Crime	(4) Violent Crime
Log of Distance to a Historical Mining Site	-0.345**	-0.194**	-0.181**	-0.288**
	(0.146)	(0.093)	(0.089)	(0.119)
Latitude and Longitude	x	x	x	x
Region FE	x	x	x	x
Observations	72	72	72	72
Exposure Term		x	x	x

3.4 Other Results

Substitution of Industries and Unemployment Rates: The results thus far indicate that coal mining job loss induced by the energy transition leads to higher yakuza activities. But an alternative possibility is that if mine workers could substitute their job with an alternative industry, participating in a yakuza organization was not necessary. To test this possibility, I estimate the DiD specification with the outcome being the share of workers in a relevant low-skilled industry: (i) construction, (ii) manufacturing, (iii) infrastructure, as well as unemployment rates.

Table 8 provides DiD estimates. It is shown that the positive and significant effect on the share of construction workers, but not manufacturing infrastructure workers, or unemployment rates. From prefectures with the 75th percentile of the coal availability distribution to prefectures with

the 90th percentile, the share of mine workers increases by 0.25 per 100 workers. This translates into a 4% increase in construction workers relative to the baseline mean. Given a 67% increase in mine workers in Table 3, this substitution effect is not strong enough to drive away the effects on the yakuza.

Table 8: DiD Estimate: Energy Transition and Substitution of Industries

	(1)	(2)	(3)	(4)
	Share of			
	Construction	Manufacturing	Infrastructure	Unemployment
Coal Mining Availability × Post	0.00095***	-0.00055	0.00014	0.00008
	(0.00027)	(0.00034)	(0.00016)	(0.000)
Mean of Dep. Var. in 1960	5.951	17.852	0.622	0.691
50th percentile of coal availability			4	
75th percentile of coal availability			20	
90th percentile of coal availability			282	
95th percentile of coal availability			450	
Adjusted R-squared	0.082	0.014	0.020	0.017

Notes: Significance at the 1%, 5%, and 10% levels indicated by ***, **, and *, respectively. Robust standard errors in parentheses.

Evaluating Enforcement Channel: The observe in increased yakuza arrests may be explained by a change in enforcement level before and after the energy transition. To test this possibility, I run the same DiD specification as before and use two outcomes: (i) the number of police officers per capita and (ii) community enforcement against the yakuza. Community enforcement can be either local government ordinances to crackdown on the yakuza or local civil-associations' effort to flight against the yakuza. I find null effects of the energy transition on both outcomes. However, it is important to note that variable on the number of police officers I use is based on only a very short-period (still under construction), so this result should be read with a grain of salt.

	(1)	(2)
	# of Police Officers	Community Enforcement
Coal Mining Availability × Post	0.0000915	-0.0001545
	(0.0000807)	(0.0002394)
Observations	184	644
R-squared	0.720	0.854
Period	1955-1960, 1962-1963	1957-1970

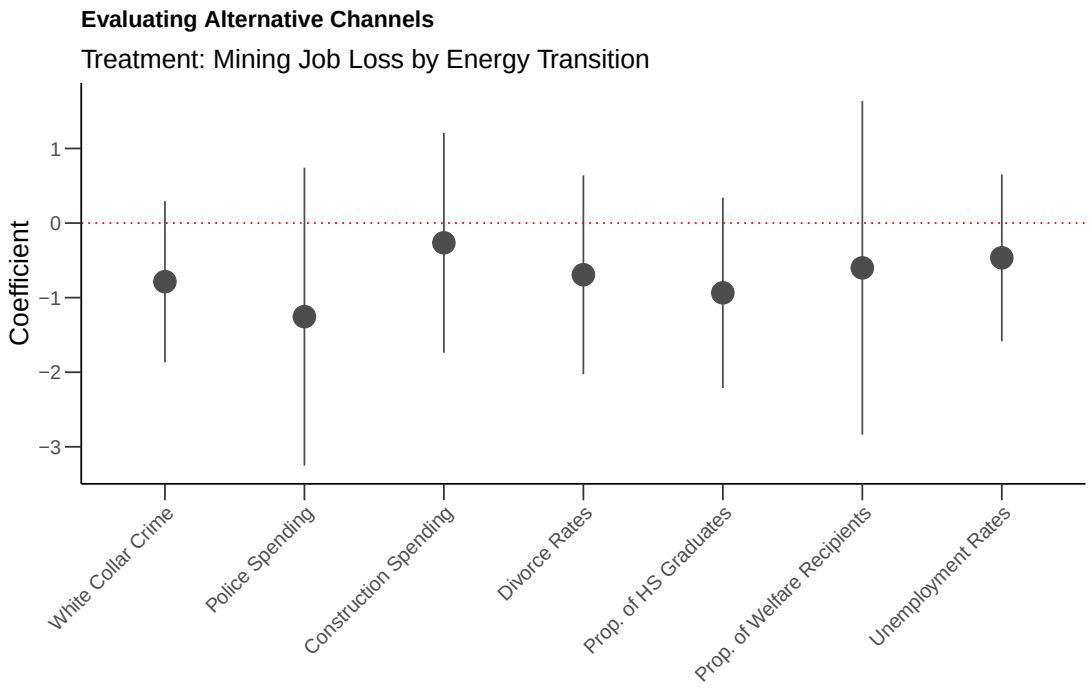
Evaluating Weak Institution Channel: If the persistent effect of mining job loss on the yakuza is due to the quality of institutions (e.g., weak institutions), then we should observe the effect on the

yakuza should be weaker in prefectures with higher government expenditures. I test this possibility using government expenditures as of 1961 and focus on total expenditures, expenditures on property rights, and expenditures on the police force. Table 9 shows that the effects of mining job loss on yakuza member and organization indices do not vary by these types of expenditures.

Table 9: Evaluating the Weak Institution Channel

	(1)	(2)	(3)	(4)	(5)	(6)
	Yakuza Member Index			Yakuza Org. Index		
Mining Job Loss by Energy Transition	-0.665	-1.517***	-0.788	-1.174***	-1.390***	-1.102***
	(0.548)	(0.528)	(0.494)	(0.316)	(0.262)	(0.332)
Mining Job Loss by Energy Transition × Total Expenditure	0.377			0.114		
	(0.315)			(0.189)		
Mining Job Loss by Energy Transition × Expenditure on Property Rights		-1.37			-0.014	
		(0.807)			(0.517)	
Mining Job Loss by Energy Transition × Expenditure on Police			0.363			0.089
			(0.253)			(0.160)
Total Expenditure	1.362***			0.481***		
	(0.304)			(0.139)		
Expenditure on Property Rights		0.689*			0.095	
		(0.362)			(0.118)	
Expenditures on Police			1.176***			0.422***
			(0.289)			(0.111)
Geographic Controls	x	x	x	x	x	x
Region Fixed Effects	x	x	x	x	x	x
Observations	36	46	36	46	36	46
R-squared	0.809	0.818	0.659	0.734	0.795	0.828

Evaluating Socioeconomic Development Channels: Lastly, I examine whether the persistent effects of the energy transition on the yakuza are due to a change in socioeconomic development. For instance, the current yakuza activities could be due to areas being poor after the energy transition. I consider the following outcomes: (i) white collar crime, which should be a crime type that the yakuza are less likely to engage, (ii) police spending, which can be used for a institutional quality measure, (iii) construction spending, which can be used for another institutional quality measure, (iv) divorce rates, which can be used to indicate the role of family structures in generating crime rates, (v) proportions of high school graduates, proportions of welfare recipients, and unemployment rates, all of which should be good proxies for local socioeconomic development. I find that none of these variables are correlated with the treatment variable, partially eliminating the alternative channels.



Note: 1970-2010: Police spending; Construction spending; Divorce; Welfare recipients; Unemployment rates. 1980-2010: High school graduates. I standardize each variable to mean = 0 and standard deviation = 1.

4 Conclusion

Exploiting the energy transition from coal to oil in the 1960s as a negative labor demand shock, I document that in prefectures with greater loss of coal mine workers induced by the energy transition, the yakuza are more active today: a greater number of yakuza members, arrests and incarceration, yakuza organizations, and more conflicts among rival yakuza organizations. Consistent with intergenerational transmission of crime, I show that those areas have higher arrest rates of juvenile delinquency. In addition, I observe a change in the composition of yakuza organization due to coal mining job loss: a decrease in yakuza arrests in the mining sector and an increase in yakuza arrests in non-mining sectors. I also show that prefectures with greater mining job loss experienced the territory expansion of yakuza organizations. Taken together, this study reveals that a labor demand shock can have long-lasting effects on organized crime.

APPENDIX

A Exogeneity Test

I regress the predicted treatment variable on a number of prefecture-level characteristics, including geographical characteristics as well as historical measures on demographic and economic characteristics measured before the energy transition, conditional on region fixed effects. Figure A1 indicates that the covariates are not associated with the decline in mine workers induced by the energy transition. This result provides indirect evidence that mining job loss induced by the energy transition is plausibly exogeneous.

Figure A1: Exogeneity Test

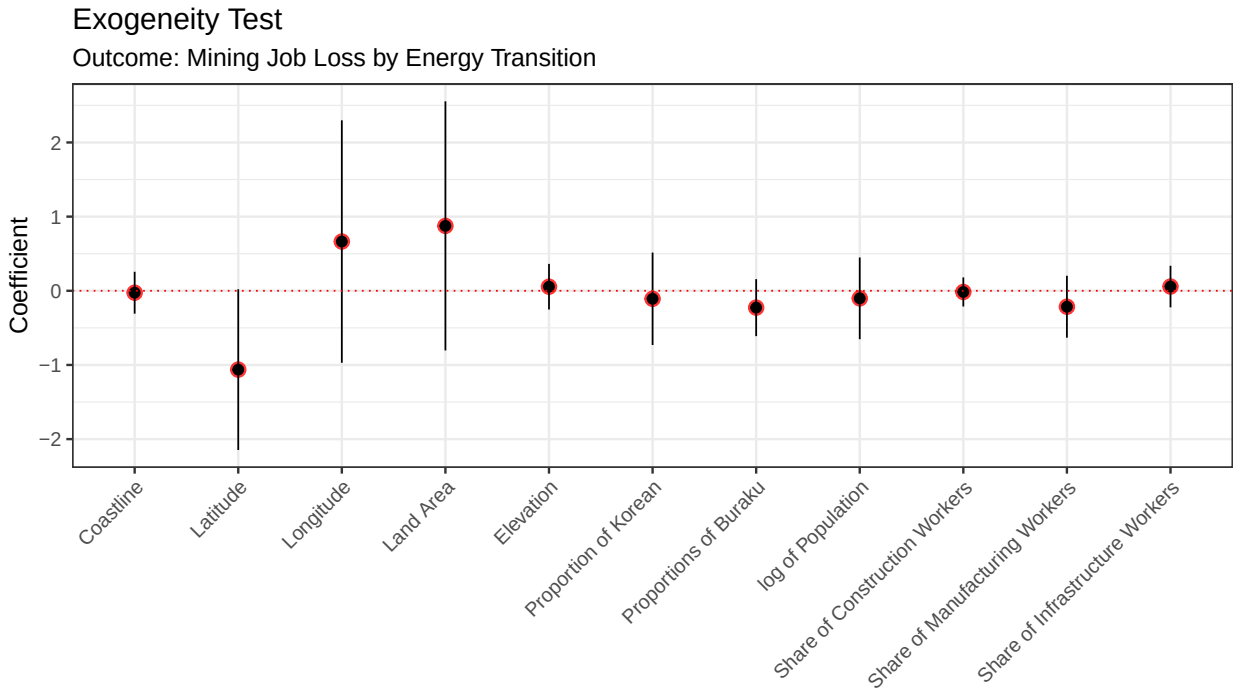
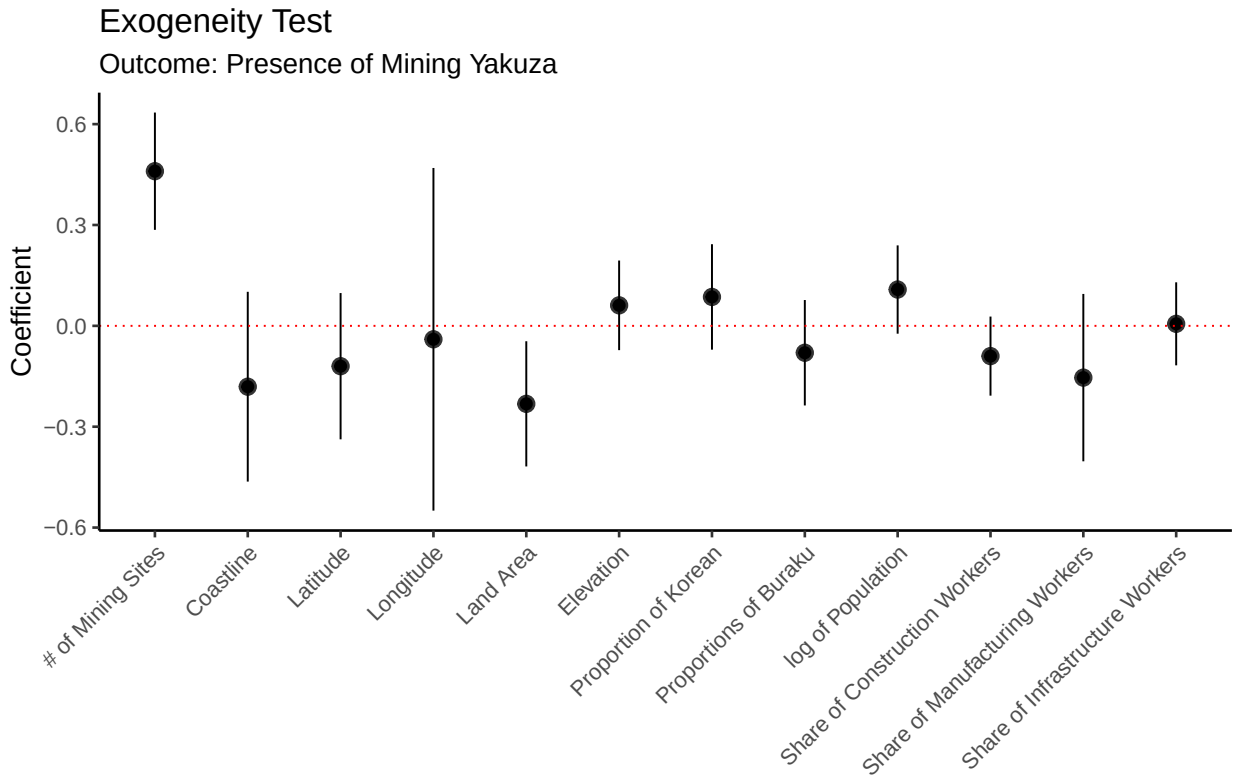


Figure A2 indicates that the covariates are not generally associated with the historical presence of mining yakuza organizations, except for the number of mining sites. That is, mining yakuza organizations are far more likely to be present in prefectures with a greater number of mining sites.

Figure A2: Exogeneity Test of Mining Yakuza Presence

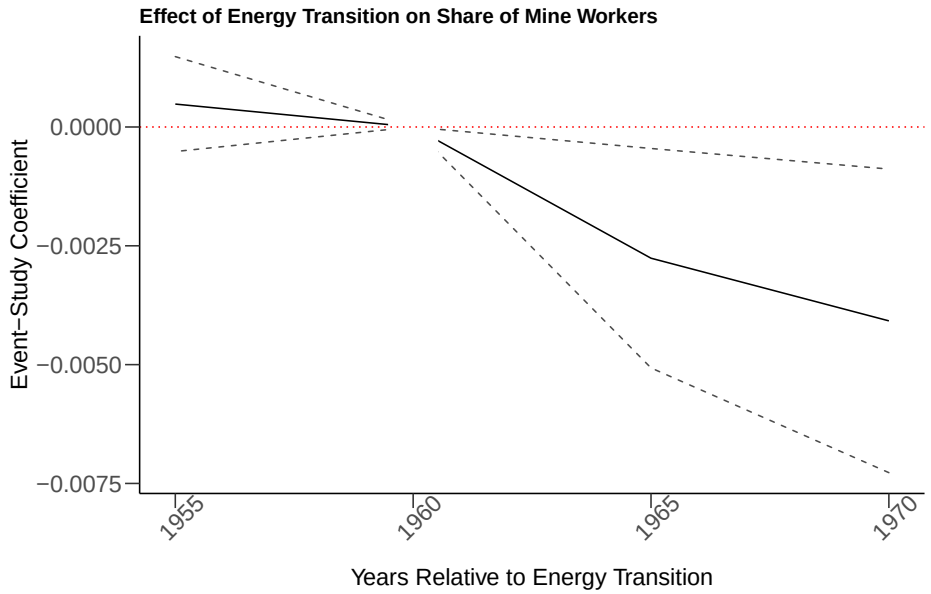


B Event-Study Analysis: Energy Transition and Mine Workers

To further validate the identifying assumption in the difference-in-differences identification strategy in equation 4, I run the following event-study specification:

$$mine_{i,t} = \sum_{-2}^{1} \beta_t availability_i \times census\, year_t + \mu_i + \omega_t + \epsilon_{i,t}. \tag{10}$$

Figure ?? provides the result, indicating negligible differences in coal mine workers across prefectures with varying degrees of coal mining availability in the census years before the energy transition, but coal mine workers declined more in prefectures with high availability than it did in prefectures with low availability after the energy transition.

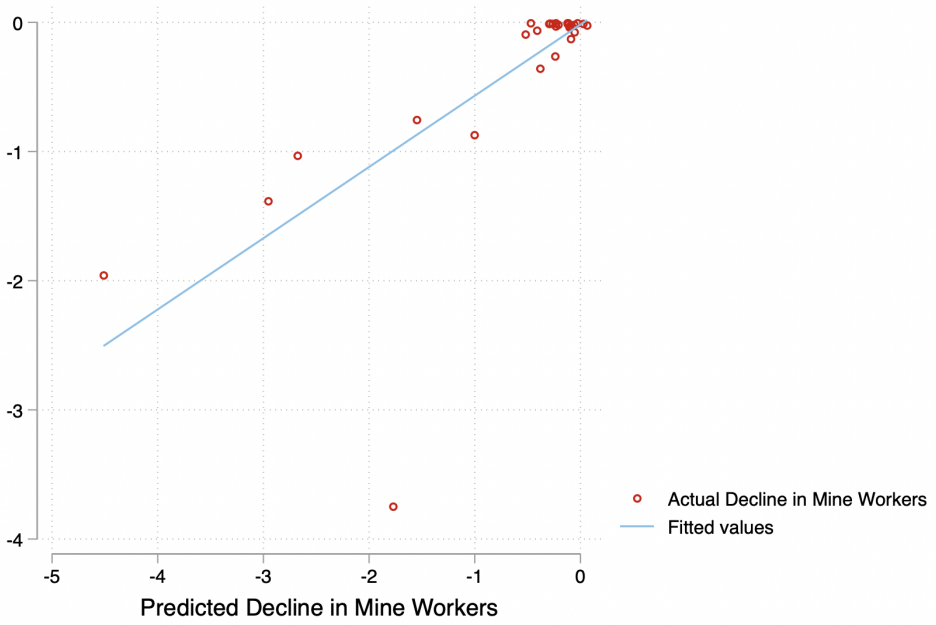


- **Outcome**: share of mine workers per 100 total workers (baseline mean before 1962: 1.1780).
- **Treatment**: # of mining sites. 50th percentile: 4. 75th percentile: 20. 90th percentile:282. 95th percentile: 450.
- **Standard errors**: two-way clustered at the prefecture and year levels.
- **Observations**: 184 = 46 (prefecture) × 4 (1955, 1960, 1965, 1970 census year).

C Actual Decline in Mine Workers and Predicted Decline in Mine Workers

Figure A3 shows the relationship between predicted decline in mine workers and actual decline in mine workers. The correlation coefficient is 0.75.

Figure A3: Actual Decline in Mine Workers and Predicted Decline in Mine Workers



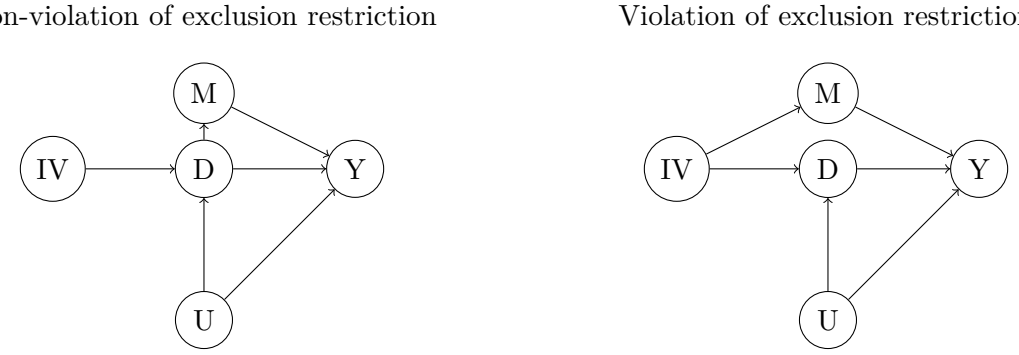
D 2SLS Estimates

The results so far are based on reduced-form estimation, where I regress the outcome of interest on mining job loss by the energy transition. This section provides 2SLS estimates. I provide the following remarks. First, note that the predicted treatment variable—coal mining job loss induced by the energy transition—serves as an instrumental variable (IV). In this sense, equation **??** is a "zero-stage" regression to construct an IV (Duflo and Pande, 2007; Sequeira et al., 2020). Second, the endogeneous variable of interest here is an actual decline in mine workers. Third, Appendix A1 provides suggestive evidence that the IV is plausibly exogeneous. In addition, most importantly, the IV needs to satisfy the exclusion restriction assumption, which states that the IV affects the outcome only through the channel of an actual decline in mine workers. One concern is that, as shown in Table 8, there is substitution to construction workers as a result of the energy transition. The reader may be concerned that this substitution effect may violate the exclusion restriction assumption.

Figure A4 illustrates the exclusion restriction with Directed Acyclic Graphs (DAG). The left figure indicates the non-violation of the exclusion restriction assumption, while the right figure

indicates the violation of the assumption. Let IV be the predicted coal mining job loss by the energy transition, D the actual decline in mine workers, M workers in other industries, Y yakuza's activities, and U unobserved confounders. In the left panel, the substitution to other industries occurs because of the actual decline in mine workers, which is induced by the predicted mining job loss by the energy transition. In the right panel, by contrast, the substitution occurs as a direct effect of the predicted mining job loss by the energy transition (i.e., not through the actual decline in mine workers). Because workers would change jobs from one sector to another, the substitution would not occur unless an actual change in workers in one sector. This argument implies that the DAG in the left panel is more plausible than in the right panel.

Figure A4: Illustration of Exclusion Restriction with Directed Acyclic Graphs



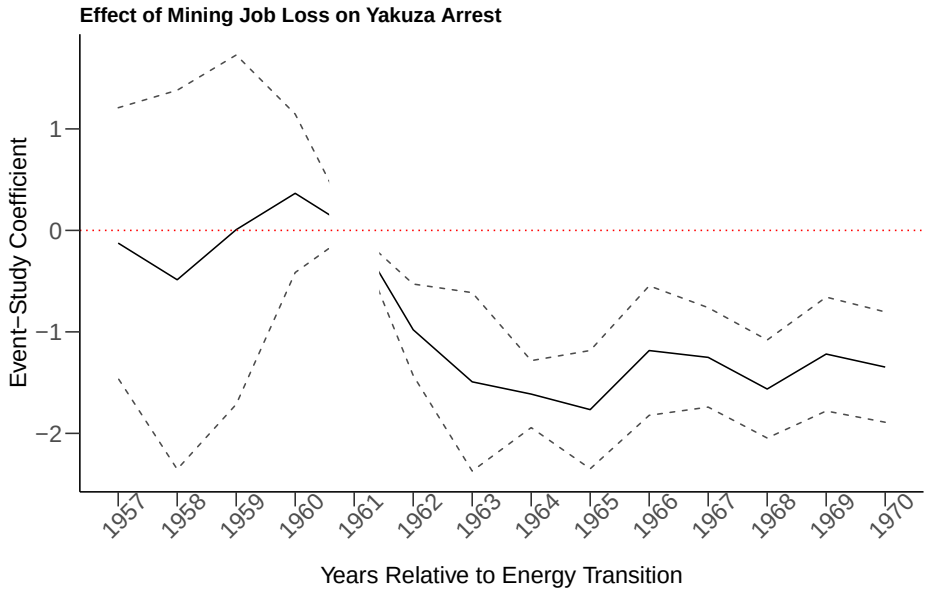
With this in mind, Table A1 provides 2SLS estimates. 2SLS estimates are qualitatively and quantitatively similar to reduced-form estimates in Table **??** and Figure 5. The only exception here is that the coefficients are no longer statistically significant for the number of yakuza members in 1977 and yakuza arrests in 1974, although the trends and patterns remain the same.

Table A1: 2SLS Estimates

	(1) Member Index	(2) Members 2008-2014	(3) Members 1977	(4) Incarceration 2006-2016	(5) Arrests 1974	(6) Org.Index	(7) Org. 2008	(8) Org. 1995	(9) Fragmentation 2008-2014	(10) Formed after 1962	(11) Formed before 1962
2nd Stage Estimate:											
Actual Decline in Mine Workers	-0.813***	-0.516**	-0.149	-0.738***	-0.361	-0.530***	-0.666***	-0.409***	-0.422***	-0.128***	0.093
	(0.281)	(0.210)	(0.128)	(0.174)	(0.235)	(0.092)	(0.082)	(0.146)	(0.082)	(0.036)	(0.060)
1st Stage Estimate:											
Predicted Decline in Mine Workers	1.115***	1.120***	1.115***	1.120***	1.120***	1.120***	1.120***	1.120***	1.120***	1.135***	0.868***
	(0.358)	(0.328)	(0.358)	(0.328)	(0.328)	(0.328)	(0.328)	(0.328)	(0.328)	(0.309)	(0.253)
F-Stat	10.33	11.60	10.33	11.60	11.60	11.60	11.60	11.60	11.60	13.51	11.77
Geographical Controls	x	x	x	x	x	x	x	x	x	x	x
Region Fixed Effects	x	x	x	x	x	x	x	x	x	x	x

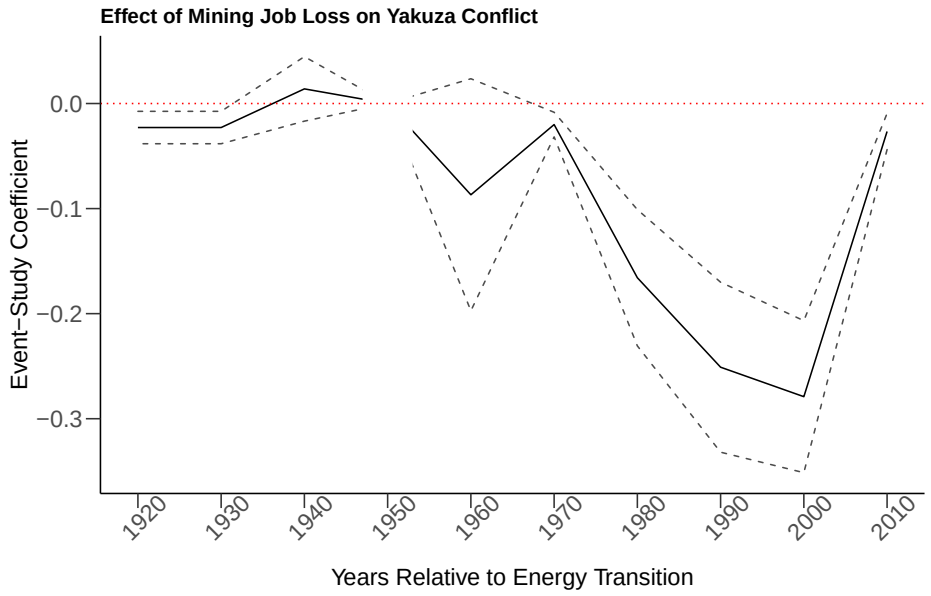
Notes: Note: **Members (2008-2014)** = # of yakuza member per 100,000 (avg. of 2008-2014). **Members (1977)** = # of yakuza member per 100,000 in 1977. **Incarceration (2006-2016)** = # of yakuza incarceration per 100,000 (avg. of 2006-2016). **Arrests (1974)** = Yakuza arrests (2008-2014): (1) 0-200, (2) 201-300, (3) 301-400, (4) 401-500, (5) 501-600, (6) 601-800, and (7) more than 801 yakuza arrests. **# of Orgs. (2008)** = # of yakuza organizations in 2008. **# of Orgs. (1995)** = # of yakuza organizations in 1995. **Orgs. Fragmentation (2008-2014)** = Yakuza fragmentation index (avg. of of 2008-2014). **Org. Formed after 1962** = Indicator that equals 1 if the headquarter of a yakuza organization formed after 1962 and otherwise 0. **Org. Formed before 1962** = Indicator that equals 1 if the headquarter of a yakuza organization formed before 1962 and otherwise 0. **Endogeneous Variable**: Actual decline in mine workers. 5 percentile of actual decline in mine workers: -2.677. 10 percentile of mining job loss by energy transition: -1.549. 25 percentile of mining job loss by energy transition: -0.297. **Instrumental Variable**: Predicted decline in mine workers (i.e., coal mining job loss by energy transition). 5th percentile of mining job loss by energy transition: -1.646. 10th percentile of mining job loss by energy transition: -1.032. 25th percentile of mining job loss by energy transition: -0.071. 50th percentile of mining job loss by energy transition: -0.011. Specification includes geographical controls and region fixed effects. **Geographical controls:** i.e., latitude, longitude, land area, elevation, whether a prefecture is located on the coastline. Significance at the 1%, 5%, and 10% levels indicated by ***, **, and *, respectively.

E Event-Study: Mining Job Loss and Yakuza Arrest



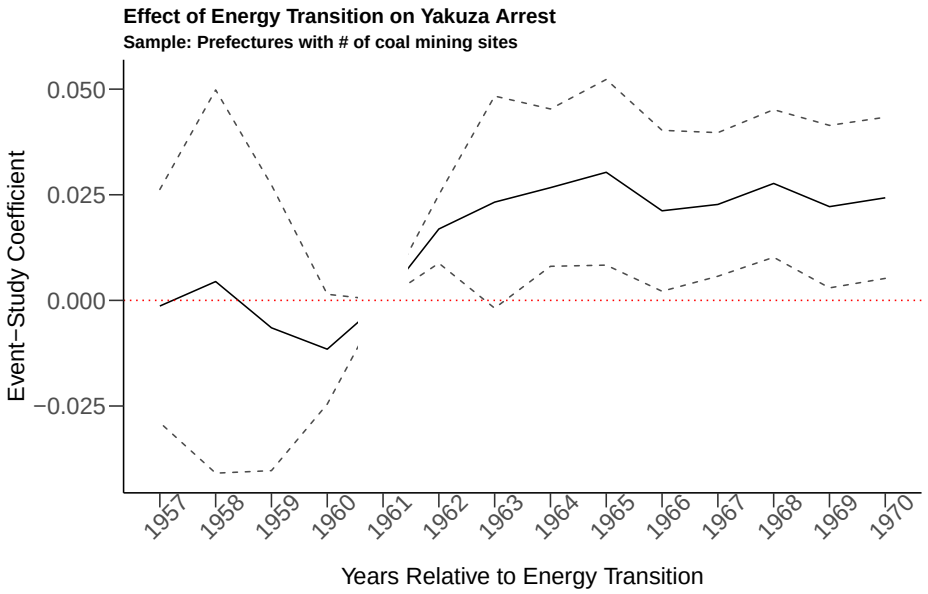
- Treatment: Predicted mine workers.

F Event-Study: Mining Job Loss and Yakuza Conflict



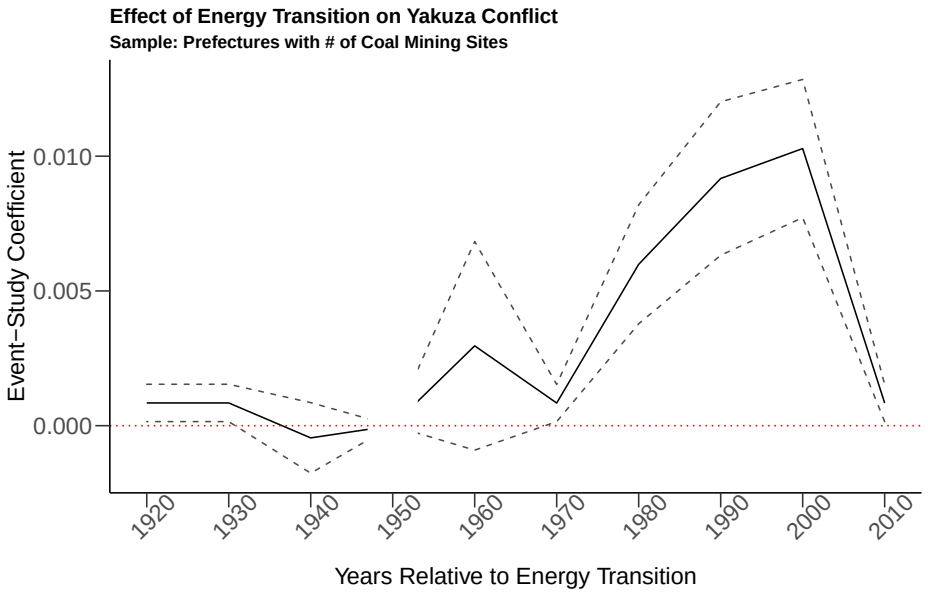
- Treatment: Predicted mine workers.

G Effect of Energy Transition on Yakuza Arrest with Alternative Sample



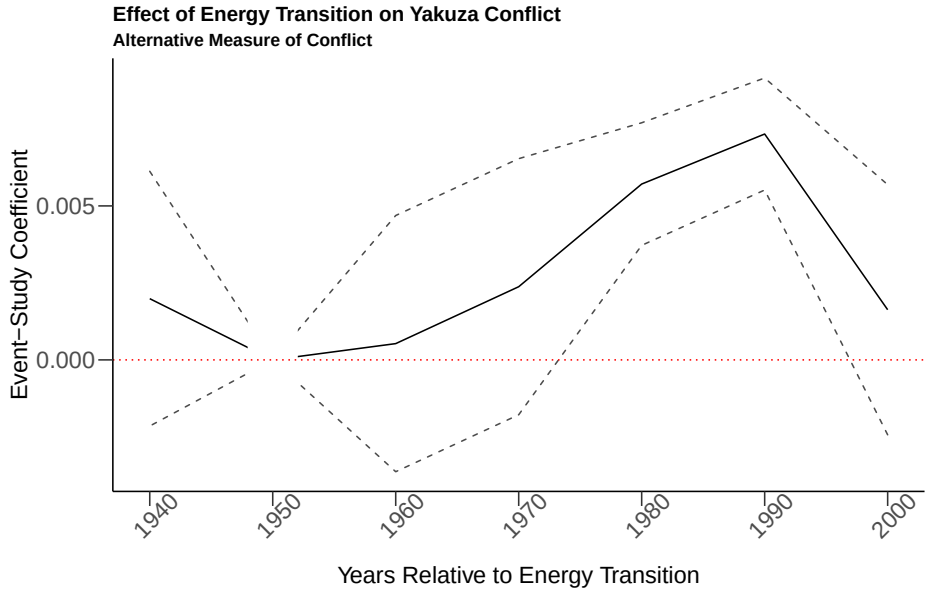
- Sample: Prefectures with Only Coal Mining Availability.

H Effect of Energy Transition on Yakuza Conflict with Alternative Sample



- Sample: Prefectures with Only Coal Mining Availability.

I Effect of Energy Transition on Yakuza Conflict with Alternative Measure



- Alternative Measure of Conflict.

J Robustness to Alternative Specification: Yakuza Arrest and Conflict

	(1)	(2)	(3)	(4)	(5)	(6)
Panel A			Yakuza Arrest			
Coal Mining Availability × Post	0.022**	0.020	0.022*	0.024**	-0.0301	0.033***
	(0.011)	(0.014)	(0.012)	(0.011)	(0.025)	(0.005)
	(1)	(2)	(3)	(4)	(5)	(6)
Panel B			Yakuza Conflict			
Coal Mining Availability × Post	0.00047***	0.00043***	0.00047***	0.00047***	0.00064**	0.00040***
	(0.00014)	(0.00012)	(0.00007)	(0.00007)	(0.00024)	(0.00012)

All specifications include prefecture FE and time FE

1. Baseline.

2. OLS.

3. Clustering SE at the prefecture level.

4. Sample limited to availability>0.

5. Exclude Hokkaido.

6. Exclude Fukuoka.

K Robustness to Alternative Specifications

This section examines the robustness of the main findings for the yakuza member index and yakuza organization index. Table A2 provides the results. The results are generally robust, but the result for the yakuza organization index is more robust than for the yakuza member index.

1. I exclude Fukuoka prefecture from the sample. Fukuoka is known for very high activities for the yakuza, and it is also historically known for its coal mining industry.

2. I exclude Hokkaido prefecture from the sample. Hokkaido is historically known for its coal mining industry.

3. Instead of region fixed effects, I include geographical fixed effects by the k-means clustering algorithm (with latitude and longitude). Figure **??** indicates the distribution of prefecture-pair based on the k-means clustering algorithm.

4. In addition to geographical controls, I include socioeconomic variables: log of population, prop. of Korean, prop. of Buraku, share of construction, share of manufacturing, share of infrastructure, unemployment rates.

5. I limit the sample to prefectures with availability>0

6. I use Conley standard errors, instead of robust standard errors.

7. I use bootstrap standard errors (only worked with geographic covariates) with 1,000 iteration.

Table A2: Preliminary Robustness Checks

Panel A	(1)	(2)	(3)	(4)	(6)	(7)	(8)
	Yakuza Member Index						
Mining Job Loss by Energy Transition	-0.875***	-0.552*	-1.009***	-0.177	-0.999***	-0.919***	-1.055
	(0.198)	(0.305)	(0.302)	(0.267)	(0.208)	(0.250)	(0.784)
Observations	35	35	36	36	23	36	36
R-squared	0.505	0.503	0.689	0.761	0.607	0.519	0.436
Panel B	(1)	(2)	(3)	(4)	(6)	(7)	(8)
	Yakuza Org. Index						
Mining Job Loss by Energy Transition	-0.579***	-0.978***	-1.174***	-0.309**	-0.514***	-0.673***	-0.768*
	(0.091)	(0.153)	(0.170)	(0.142)	(0.144)	(0.164)	(0.460)
Observations	44	44	45	45	30	45	45
R-squared	0.695	0.692	0.728	0.916	0.745	0.697	0.444

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