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

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Abstract

This study investigates how permanent shocks to legal sectors where specific criminal groups operate can affect the evolution and expansion of organized crime as a whole, both in the short and long run. The setting is Japanese organized crime, the yakuza, and the 1960s energy transition from domestic coal to imported oil. The transition reduced coal mining jobs, negatively impacting both coal miners and yakuza groups involved in the coal mining industry. Short-term effects indicate increased yakuza arrests for economic crimes in coal-rich areas, likely due to mining-associated yakuza members turning to illegal activities and joining non-mining yakuza groups rather than coal miners joining the yakuza. As mining-associated yakuza groups declined, other yakuza groups expanded their territories, intensifying conflicts in coal-rich areas, with yakuza groups in coal-rich areas becoming the targets of attacks rather than being attackers. Long-term effects on yakuza conflict persisted for over half a century. At a granular level, as coal mining declined, new business opportunities expanded in nearby non-mining municipalities over time, which yakuza groups exploited to expand their territories. Today, areas with greater mining job losses have more yakuza members and groups. However, yakuza exclusion ordinances enacted in the 2010s may help break this persistent cycle by reducing overall demand for yakuza services.

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1 Introduction

Organized crime presents global challenges, with millions of people living under criminal governance across global regions including Latin America, Asia, and Europe (Hill, 2003; Gambetta, 1993; Lessing, 2021; Varese, 2001). These criminal organizations are subject to structural economic changes, which impact their operations and diverse revenue streams ranging from drug trafficking and extortion of rents to taxes collected from citizens. The diverse nature of criminal income sources raises crucial questions about how economic shocks in crime-infiltrated sectors affect organized crime. On the one hand, negative economic shocks may weaken criminal organizations, potentially leading to their decline or dissolution (e.g., Fenizia and Saggio, 2024; Gavrilova et al., 2019; Sobrino, 2020). On the other hand, such shocks might trigger adaptation and diversification within these organizations, leading them to replace lost income with other economic opportunities (e.g., Battiston et al., 2022; De Haro Lopez, 2023). Yet, a critical gap remains in our understanding: how do permanent shocks to legal sectors where specific criminal groups are involved affect the evolution and expansion of organized crime as a whole in both the short and long run?

To answer this question, this study exploits a shift in demand from domestically available coal to imported oil to understand the consequences on organized crime in the short and long run. The setting is Japanese organized crime called the yakuza and the coal mining industry in the 1960s, where coal was the primary energy source in the postwar period. Despite the mining industry's small share of the labor force (about 1% between 1955 and 1961), coal production was the backbone of Japan's postwar economic recovery. However, as oil gained recognition as a more efficient and stable energy source, the coal industry faced increasing challenges. In response, the government formed the "Coal Mining Investigation Team" in 1962, which concluded that coal could not compete with heavy oil in price and efficiency. Furthermore, Japan's rapid economic growth pressured the government to fulfill its role in the global market economy, leading to the liberalization of crude oil imports in 1962 (Agency for Natural Resources and Energy, 2018). The combination of oil trade liberalization and the government's recognition of coal's uncompetitiveness constituted an energy transition that led to the decline of the coal mining industry.

Japanese organized crime, known as the yakuza, originated sectors including gambling, peddling, black markets, mining, dock labor, company ruffians, rogue journalism, and pimping. The

term "yakuza" is a generic term for hierarchically structured organized crime, not a specific group. Of particular interest is that some yakuza groups—those that had their origins in coal mining and as racketeers or armed hoodlums—were involved in the coal mining industry as labor brokers or protection racketeers (henceforth, mining-associated yakuza). The presence of these mining-associated yakuza groups is primarily determined by coal mining availability in specific areas (Appendix D). Fast-forward to 2024, under 1992 anti-yakuza laws, 25 large yakuza organizations (originating various sectors) are officially designated.[1] Smaller yakuza groups affiliate with one of these designated syndicates, which represent distinct clans. These organizations maintain potential rivalries, while some may form alliances.

This study hypothesizes that the 1960s energy transition from coal to oil shaped yakuza expansion in both short and long term. While the transition may have decreased mining-associated yakuza activities due to fewer rents, it may have increased overall yakuza activities through two channels: (i) coal miners finding crime more attractive (i.e., the opportunity cost channel), or (ii) mining-associated yakuza turning to illegal activities as income substitutes (e.g., the substitution channel). As small mining-associated yakuza groups likely weakened due to limited expansion capacity, former miners and mining-associated yakuza members might have joined non-mining groups, leading to the expansion of these groups in size and power.

The expansion of non-mining yakuza groups likely intensified competition and conflicts in coal-rich areas. This territorial expansion, and the resulting conflicts, were likely driven by both pre-existing economic opportunities beyond coal mining and new ones that emerged after the energy transition. These conflicts could have followed two patterns: either multiple groups operated in the same territory while competing over limited resources, or groups engaged in prolonged conflicts to drive out or absorb rivals.

At a granular level, however, in municipalities dependent on coal mining, the industry's decline might have led to broad economic and population contraction, making these once-thriving municipalities less attractive for yakuza expansion. By contrast, as the coal industry declined in mining municipalities, new businesses might have emerged in nearby non-mining municipalities, either through geographical displacement of economic opportunities or new businesses expanding. These

[1] I refer to large-scale designated yakuza organizations as "yakuza syndicates", while I refer to other yakuza organizations as "yakuza groups."

nearby non-mining municipalities, with their emerging businesses previously free from yakuza control, might have become new targets for territorial expansion. The energy transition thus initiated distinct trajectories and path dependencies for yakuza operations, which persisted over time.

To study the yakuza's consequences of the energy transition, I broadly conduct three sets of analyses using historical data on coal mining combined with unique data on the yakuza: prefecture-level panel analysis, cross-sectional analysis (with a Bartik-style instrument), and municipal-level analysis.[2] Using prefecture-level panel data, I compare yakuza activity in coal-rich prefectures to those in coal-scarce prefectures before and after the transition in an event-study design. I find that yakuza arrests for economic-motivated crimes increased more in coal-rich prefectures relative to coal-scarce ones, with this trend persisting for over a decade. This increase is likely not due to enforcement effects (Appendix H). Instead, two channels could have contributed: (i) coal miners transitioned into yakuza groups due to their lower opportunity cost of crime, and (ii) mining-associated yakuza members shifted to illegal economic activities. I exploit the historical presence of mining-associated yakuza groups. Using a triple-differences design, I find evidence that the increase in yakuza activities is likely due to mining-associated yakuza members shifting to economic-motivated crimes, including gambling (Appendix G), consistent with the substitution channel, rather than the opportunity cost channel, where coal miners would have sorted into the yakuza.

Looking at yakuza arrests in different sectors (e.g., mining sector, peddlers), 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. Furthermore, the Yamaguchi-gumi, the largest yakuza group with its roots in dock labor and originating from a coal-scarce prefecture, expanded its territory into coal-rich areas post-transition. These results provide evidence of a shift in yakuza group compositions and the expansion of yakuza groups.

One immediate implication of the shift in yakuza group compositions and group expansion is an increase in conflicts among different yakuza groups. Using yakuza conflict data from the 1920s to the 2010s, I show that, in the post-transition period, yakuza conflicts increased in coal-rich prefectures, and there was an increase in conflicts targeting yakuza groups that originated

[2] Prefectures form the first level of jurisdiction, and Japan consists of 47 prefectures. However, Okinawa is excluded from this study as it was part of U.S. territories until 1972.

in coal-rich prefectures, while there was little change in conflicts initiated by yakuza groups that originated in coal-rich prefectures. Heterogeneous analysis suggests increased yakuza conflicts in coal-rich prefectures where mining-associated yakuza groups' power declined but where alternative yakuza economic opportunities existed. Importantly, the effect of the energy transition on yakuza conflict persisted over half a century later.

While most analyses so far consider short-term effects up to 10 years, I extend this research by examining the medium- and long-term consequences of the energy transition on various yakuza measures. For this analysis with cross-sectional variation, I construct a Bartik-style instrumental variable that captures mining job losses due to the energy transition, following an approach similar to Duflo and Pande (2007); Sequeira et al. (2020). I show that prefectures that experienced greater mining job losses due to the energy transition in the 1960s have a higher number of yakuza members and of different yakuza groups in the medium (e.g., 1970s) and long term (e.g., 2000s and 2010s). The persistent effects of the energy transition on contemporary yakuza activities are pronounced in prefectures that had a historical presence of mining-associated yakuza groups and historically available alternative economic opportunities for yakuza involvement (Appendix I). One alternative explanation for this persistence is that the energy transition might have changed economic, demographic, and law enforcement conditions. With the caveat that they are likely bad controls (Angrist and Pischke, 2008), I include contemporary measures of these variables to see if the transition's effects are attenuated. I find little evidence that these channels explain the persistent effect (Appendix Q).

I provide micro-level evidence of yakuza and business expansion patterns in mining and nearby non-mining municipalities to better understand the long-term effects of the energy transition. Using data from Fukuoka prefecture, known for its historical coal mining and high yakuza activity, I examine how proximity and number of historical coal mining establishments affect present-day yakuza presence and non-mining sector establishments. Results indicate higher business establishment numbers in municipalities closer to historical coal mining areas, an effect persisting over the medium and long term. Present-day yakuza offices are also more numerous in these nearby municipalities. However, the number of historical coal mining establishments itself does not correlate with yakuza offices or business establishments. These findings support the hypothesis that as coal mining declined, new business opportunities expanded in nearby non-mining municipalities over

time, which yakuza groups exploited to expand their territories.

How can policies mitigate the persistent effects of the energy transition on the yakuza? Between 2010 and 2012, all prefectures enacted yakuza exclusion ordinances (YEOs), which attempt to break ties between the yakuza and non-yakuza businesses and citizens by imposing sanctions on non-yakuza citizens. The YEOs weaken financial flows funding the yakuza (Hoshino and Kamada, 2020). Notably, while the energy transition served as a negative labor demand shock for mining-associated yakuza groups, the YEOs served as a negative demand shock for the yakuza as a whole. I find suggestive evidence that the effects of the energy transition on the yakuza were weaker after the enactment of the YEOs. These results suggest that reducing the demand for yakuza services as a whole can partially break the cycle of persistent effects from the energy transition.

The energy transition offers a unique opportunity for the current investigation for the following reasons. First, it primarily affected coal mining areas, determined by geographical conditions, and specifically impacted the coal industry without increasing overall unemployment rates (see results in Appendix E). This suggests behavioral changes were limited to yakuza members in coal mining and coal miners, who were often low-skilled, young males with aggressive traits and tattoos (Seto, 2023; Iwai, 1963; Yamamoto, 2015) (Appendix J shows that the energy transition's effects are present only for yakuza-related arrests, not for non-yakuza arrests). Second, the energy transition, being a shock specific to mining-involved yakuza groups, allows for an examination of spillover effects on non-mining yakuza groups. Third, the transition from coal to oil is structural and irreversible, acting as a persistent shock for yakuza, given that joining the yakuza is an irreversible investment (e.g., once one joins a group, he finds difficult to resigns). Finally, the focus on historical contexts provides two important implications. (i) Given the growing interest in transitioning from oil to environmentally friendly energy sources, understanding the historical shift towards oil is crucial. (ii) From a contemporary policy perspective, it is important to consider how to mitigate the persistent effects of the energy transition on the supply of organized crime.

This study advances our understanding of the economics of crime literature in two key ways and contributes to the broader literature on historical persistence and development. This study builds on research investigating economic shocks in legal and illegal markets and their impact on organized crime. Previous studies have focused on transitions in crop legality and accessibility, as well as crackdowns on illegal drug markets (e.g., Angrist and Kugler, 2008; Castillo et al., 2020;

Chimeli and Soares, 2017). While some research finds that organized crime adapts and diversifies in response to decreased economic opportunities (Battiston et al., 2022; De Haro Lopez, 2023), others find a reduction in criminal activities following decreased opportunities (Gavrilova et al., 2019; Sobrino, 2020). A related but different research stream examines natural resources and organized crime/conflict (Bazzi and Blattman, 2014; Buonanno et al., 2015; Dimico et al., 2017; Dube et al., 2016; Gambetta, 1993; Berman et al., 2017; Lei and Michaels, 2014; Sánchez De La Sierra, 2020). While most research focuses on either temporary price shocks or permanent structural differences in natural resource economics, this study examines a permanent demand shift from domestic coal to imported oil in a setting where local yakuza groups had historical involvement in coal mining. In addition, while research on organized crime and illegal markets generally considers the effects of economic conditions on violence, this study shows that, in the short-run, incumbent criminal group members responded to economic shocks in crime-involved sectors by switching to alternative income-generating crime, similar to how economic conditions affect individual-level crime - contributing to property crime but not violent crime (Ludwig and Schnepel, 2024).

Second, this study contributes to research on the expansion of organized crime. While early work suggests organized crime activities are confined to original locations (Gambetta, 1993; Reuter, 1985), recent research highlights forcible movement of criminal group members to explain territorial expansion (Dipoppa, 2024; Varese, 2011; Paolo and Matteo, 2014; Sviatschi, 2022). This study provides a different channel of group expansion: as mining-associated yakuza groups weakened, other yakuza groups expanded. This aligns with Dell (2015), who shows that weakened Mexican drug trafficking organizations face territorial takeovers by rivals. Sobrino (2020) finds that increased U.S. heroin demand led to more Mexican drug trafficking organizations in opium poppy-suitable areas in Mexico. Other studies also highlights competition in illegal market structures (e.g., Bruhn, 2021; Brown et al., 2021). This research complements existing studies by showing how initial organized crime structures shaped long-term outcomes, including prolonged yakuza conflicts: as affected criminal groups decline, other criminal groups grow stronger, especially in areas with alternative economic opportunities for organized crime—leading to persistent effects.

Lastly, research examines the persistent effects of historical events and institutions on development (e.g., Acharya et al., 2024; Acemoglu et al., 2001; Nunn, 2020) and the role of geography in shaping development (Diamond, 1997; Kitamura and Lagerlöf, 2020). Importantly, understanding

historical roots provide an opportunity to design a better contemporary public policy (e.g., Lowes and Montero, 2021; Nunn, 2020). By combining the geographical distribution of coal mining and the energy transition in the 1960s, it sheds light on the long-lasting impact of past economic and industrial changes on the distribution of organized crime and suggests strategies for alleviating these enduring consequences.

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

2 Institutional Background

2.1 Yakuza

I provide background information about the yakuza to understand the institutional context for the current investigation.[3]

Origins of Yakuza Groups. While gamblers (*bakuto*), itinerant peddlers (*tekiya*), and black-market groups (*guren-tai*) as racketeers or armed hooligans account for a large proportion of yakuza groups (e.g., National Police Agency, 1978), they were also historically classified according to other sectors such as mining, dock labor, company ruffians (*kaisha goro*), rogue journalists (*shinbun goro*), and pimping.

Mining-associated Yakuza Groups. Of particular interest here is yakuza groups engaged in the mining sector. In mining areas, two yakuza groups were often prevalent: yakuza groups with their roots in the mining industry and racketeers (Iwai, 1963). In the mining sector, yakuza groups evolved from labor contractors and mining camp bosses. They also served as unofficial labor managers for mining companies by breaking strikes and suppressing union activities. In other words, yakuza groups, who were often informally hired by mining companies, engaged in both labor brokers and racketeering. In my analysis, I use information on arrests of mining-associated yakuzas and racketeers to identify areas with a presence of yakuza groups involved in the mining industry. The

[3]This review is not comprehensive (See Hill (2003, 2004) for a more comprehensive review).

presence of mining-associated yakuza groups were primarily driven by higher coal mining availability during the pre-transition period (Table A4 in the Appendix). Notably, when controlling for coal mining availability, other demographic and economic factors show little correlation with these groups' presence. This pattern suggests that the scale of coal mining operations drove demand for yakuza groups, who served either as labor brokers or protection racketeers, a finding consistent with the account that natural resources drives the demand for services from organized crime (Buonanno et al., 2015; Dimico et al., 2017; Gambetta, 1993).

Contemporary Yakuza Syndicates . Fast-forward to the contemporary period, under anti-yakuza laws enacted in 1992, the Public Safety Commission designates large yakuza organizations based on specific criteria. Unlike in other countries, forming or joining yakuza organizations is *not* illegal in Japan due to the Freedom of Association (Article 21 of the Japanese Constitution). However, their economic activities are strictly prohibited under the anti-yakuza laws. As of 2024, there are 25 designated yakuza syndicates in Japan.[4]

Activities of Yakuza. The yakuza's economic activities include both legal and illegal income sources. The demand for yakuza services has been present throughout Japan's history, adapting to prevailing social and economic conditions (Hill, 2003). During Japan's post-war economic boom, the yakuza engaged in protection racketeering, extortion, gambling, and entertainment businesses, while also operating in various industries such as mining, construction, and bars. Similar to the role of the yakuza in coal mining, the yakuza gained power in construction through labor dispatch and subcontracting, managing workers and providing materials. During this period, despite their diverse origins, yakuza groups expanded their economic activities beyond their original sectors, though the capacity for such expansion likely depended on the size of each group. In the 1970s, they expanded their illegal income sources to methamphetamine distribution; they also engaged in the creation of spurious organizations advocating for the outcaste group's (*burakumin*) emancipation. Specifically, the yakuza extort businesses by falsely claiming to represent outcaste communities and threatening to accuse companies of discrimination. In the 1980s and onward, the yakuza expanded into economic activities such as land sharking and illegal high-interest lending, leading

[4] About 96% of yakuza members belong to one of these designated yakuza organizations (National Police Agency, 2009, 2014)

to the label "economic yakuza" (Hill, 2003, 2004). However, yakuza exclusion ordinances enacted across prefectures from 2010 to 2012 prohibited non-yakuza citizens from assisting them, making it difficult for the yakuza to conduct businesses that relied on non-yakuza individuals and businesses (Hoshino and Kamada, 2020, 2022). I examine some of these yakuza's economic opportunities in relation to the energy transition, as a channel through which the energy transition has shaped the yakuza.

Yakuza Group Expansion. In the 1960s and 1970s, large-scale yakuza groups such as the Yamaguchi-gumi and the Inagawa-kai engaged in turf wars and expanded their influence by absorbing smaller yakuza groups (National Police Agency, 1989). Large-scale yakuza groups expanded to scale up their economic activities and establish a system of tribute payments from smaller affiliated groups (National Police Agency, 1989). Notably, this expansion occurred not through migration of organized crime members to different locations, but through the violent absorption of smaller groups to secure territorial control. While it is possible that consolidation may reduce violence, large yakuza groups actively used violence as a strategic tool to expand their territory and power. In my analysis, I consider the role of the target and attacker of conflicts, and I examine whether the Yamaguchi-gumi, the largest yakuza group with its origin in dock labor and coal-scarce area, expanded into coal-rich prefectures.

2.2 Energy Transition

This section outlines the energy transition from coal to oil in 1960s Japan, drawing on Agency for Natural Resources and Energy (2018). Post-World War II, Japan resumed oil imports but regulated them due to limited foreign currency. As the economy grew, pressure to liberalize trade increased. In June 1960, the government approved the Outline of the Trade and Foreign Exchange Liberalization Plan" in June 1960, leading to crude oil import liberalization in October 1962. Panel A in Figure 1 shows actual and counterfactual trends in crude oil import quantities.[5] Compared to the counterfactual trajectory, actual oil import quantities increased more rapidly after 1962.

Concurrently, during the post-war period, the coal industry attempted to streamline its operations to compete with oil in the international market, as oil was increasingly recognized as a more

[5]The counterfactual trends are obtained by fitting linear trends to pre-1962 data and then projecting values for all subsequent years based on these pre-1962 trends.

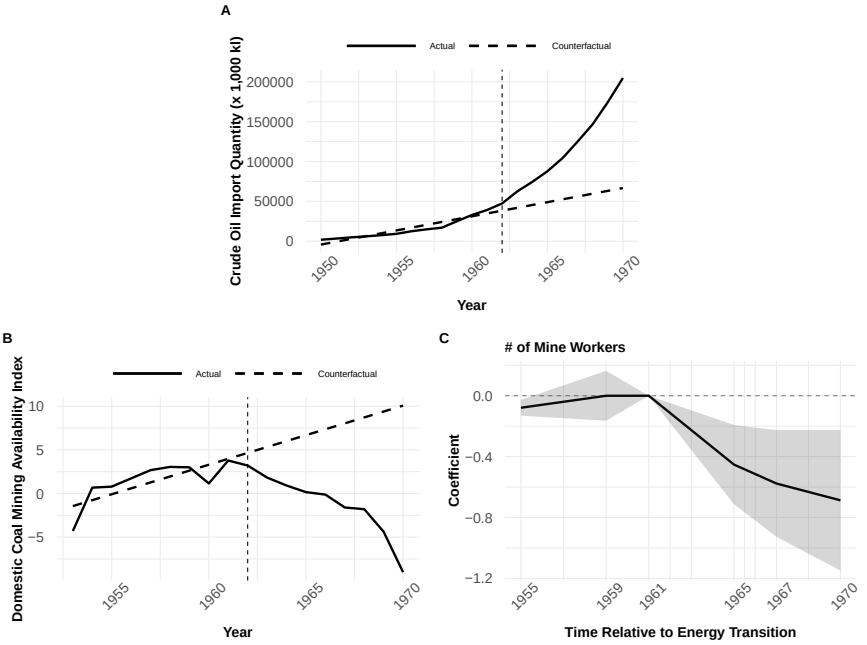
efficient and stable energy source. Despite these efforts, the coal mining industry deteriorated. In 1962, the government formed the "Coal Mining Investigation Team," and the team concluded that coal cannot compete with heavy oil. The goal of the coal mining policy then shifted from a policy aiming at competing with competitive energy sources in terms of price to a policy that acknowledges coal's inability to compete with heavy oil while focusing on avoiding social friction caused by the collapse of the coal mining industry.

These developments—trade liberalization of oil and a shift in coal mining policy acknowledging coal's inability to compete with heavy oil—constitute the energy transition that led to the coal mining industry's decline. Panel B in Figure 1 displays trends in domestic coal mining availability, showing a drastic decrease after 1962.[6] Panel C presents event-study estimates of the transition's effects on mine workers relative to total workers. A one standard deviation increase in coal mining availability leads to a decrease of about 0.57 mine workers per 100 total workers post-transition (a 53% decline relative to the baseline mean).

These findings confirm the energy transition as a large negative demand shock in the mining industry. For event-study and difference-in-differences designs, I use the years before and after the 1962 policy shock, exploiting prefecture-level variation in pre-transition coal mining availability. To construct a treatment variable capturing mining job losses, I use crude oil import quantities over time as a source of Bartik-type variation.

[6] This index is derived from coal mining areas, number of coal mining lots, and coal production within Japan (see Section 3.1 for details and Appendix B for individual trends).

Figure 1: Trends in Crude Oil Import Quantity, Domestic Coal Mining Availability Index, and the Number of Mine Workers

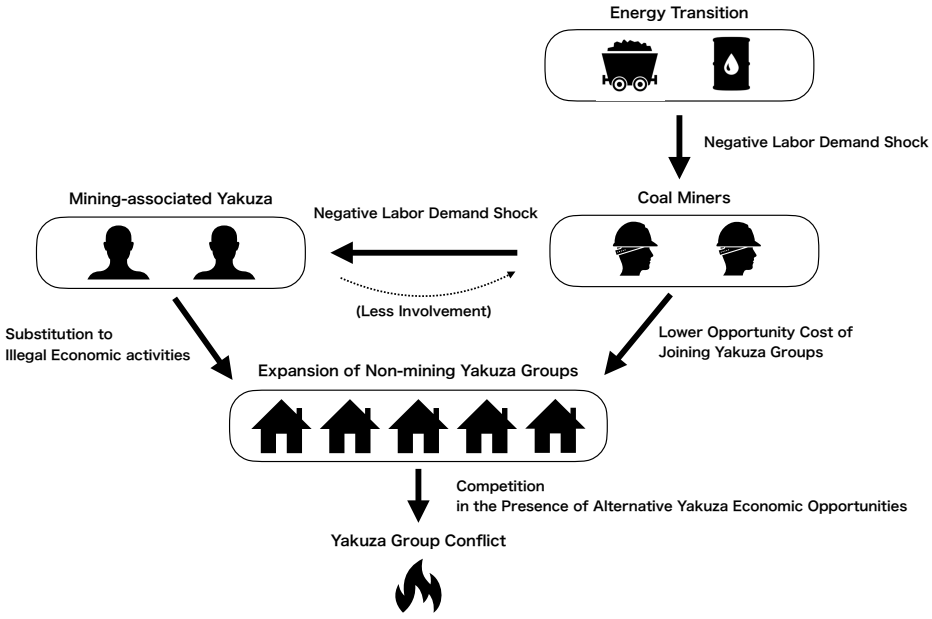


Data Source and Note: (Panel A) Crude oil import quantities (source: the Ministry of Economy, Trade and Industry). (Panel B) Coal mining availability index consists of coal mining areas, the number of coal mining lots, and the amount of coal production (source: the Japan Statistical Yearbook). (Panel C) **Outcome**: the number of mine workers relative to 100 total workers, where the total workers are fixed in the pre-transition period (source: the Japan Statistical Yearbook). **Mean of dep. var. in the pre-transition period**: 1.067.

2.3 Consequences of Energy Transition on Yakuza

This section lays out the links between the energy transition and the yakuza. To begin with, there are three key actors of interest: (i) mining-associated yakuza groups (i.e., yakuza groups with their origin in the mining industry and racketeers/armed hoodlum) operating either as labor brokers or protection racketeers, (ii) coal miners, and (iii) non-mining yakuza groups. The presence of mining-associated yakuza groups is primarily determined by coal mining availability in specific areas (Appendix D). Greater coal mining availability typically leads to increased demand for mining-associated yakuza as labor brokers or protection racketeers, consistent with Buonanno et al. (2015); Dimico et al. (2017); Gambetta (1993). Consequently, some coal mining areas have mining-associated yakuza groups, while others do not. Figure 2 illustrates these actors and the channels through which the energy transition has affected the yakuza.

Figure 2: Energy Transition and Yakuza: Actors of Interest and Channels



The energy transition reduced coal mining jobs. Through this decline in mining employment, the transition indirectly affected yakuza groups involved in the coal mining industry. These yakuza groups, who were often informally employed by mining companies, served two roles: as labor brokers to manage worker recruitment and as protection racketeers to handle labor disputes. This decline served as a negative labor demand shock for mining-associated yakuza members by reducing both their labor management and racketeering opportunities. Consequently, the energy transition likely increased yakuza activities through two primary channels: the opportunity cost channel, where displaced coal miners sorted into yakuza groups, and the substitution channel, where mining-associated yakuza members deprived of revenues sought alternative criminal activities.

First, a decrease in the value of resource endowments can increase organized crime by decreasing the opportunity cost of engaging in criminal activities (Bazzi and Blattman, 2014; Dube and Vargas, 2013; Dube et al., 2016). Following the energy transition, coal miners who lost their jobs experienced a decreased opportunity cost of crime, potentially leading them to join yakuza groups. This suggests an increase in the total amount of yakuza activities on the extensive margin. Consistent with this account, in a town in Fukuoka prefecture where 20,000 people relied on coal mining for their livelihood, miners who lost their jobs often joined yakuza groups out of desperation and personal connections, despite the absence of organized yakuza territories in the area (Social Affairs

Department of Mainichi Shimbun, 1958).

Second, a decrease in economic opportunities for organized crime leads to substitution into other criminal activities (Battiston et al., 2022; De Haro Lopez, 2023; Hoshino and Kamada, 2022). Following the energy transition, mining-associated yakuza members lost their primary income sources from the legitimate mining industry. Consequently, they likely shifted to illegal economic activities, increasing the total amount of yakuza criminal activities on the intensive margin. Additionally, if non-mining legitimate jobs yielded lower returns than coal mining, these yakuza members would need to expand their criminal activities to compensate for the loss. Anecdotal evidence supports this channel. In the 1950s, a coal miner who formed a yakuza group at a mining site changed his group's focus several times in the 1960s and 1970s, expanding into illegal cab services, clubs, bars, and entertainment (Yamahira, 2018).

The energy transition likely led to changes in yakuza group compositions and territorial control. The transition disrupted mining-associated yakuza groups' position as stationary bandits by eliminating their territorial base and stable revenue streams (Olson, 1993). Although *Taishu-kai*, a yakuza group with origins in coal mining, successfully expanded its economic activities and remains a designated yakuza organization today, most mining-associated yakuza groups were small, limiting their capacity for expansion. Consequently, instead of becoming roving bandits, members of mining-yakuza groups likely either joined existing non-mining yakuza groups or saw their groups absorbed by non-mining yakuza groups. Non-mining yakuza groups might have expanded in two ways: through the expansion of non-mining groups already present in coal-rich areas, and through the migration of yakuza groups from coal-scarce areas into coal-rich areas. Taken together, the size and power of mining-associated yakuza groups declined, while non-mining yakuza groups expanded post-transition.

The expansion of non-mining yakuza groups likely intensified competition and conflicts in coal-rich areas. This territorial expansion, and the resulting conflicts, were likely driven by two types of economic opportunities: first, pre-existing economic opportunities beyond coal mining (such as those discussed in Section 2.1), and second, new economic opportunities that emerged after the energy transition. As mining-associated yakuza's influence waned, non-mining yakuza groups attempted to seize these economic opportunities, leading to increased conflicts. These conflicts could follow two patterns: (i) multiple yakuza groups would continue to operate in the same

territory while competing over limited resources, each accepting smaller benefits; (ii) groups would engage in prolonged conflicts to either drive out or absorb rivals, with the ultimate goal of securing larger benefits. The energy transition thus initiated distinct trajectories and path dependencies for yakuza operations. Once established, these new patterns of yakuza activity tended to persist over time, shaping the long-term landscape of the yakuza in coal-rich areas.

Lastly, I consider economic opportunities and yakuza's expansion of territory at a more granular level. At the local level, the decline of the mining industry might have led to overall economic decline in mining municipalities. In these declining areas, yakuza groups had little incentive to expand their territories. However, as coal mining declined, new industries might have emerged in nearby non-mining municipalities, either through the geographical shift of economic activities or through new business entrants. These non-mining municipalities, with their emerging businesses previously untouched by yakuza influence, became attractive targets for yakuza territorial expansion. In other words, yakuza groups found it advantageous to extend their reach into nearby non-mining municipalities within coal-rich regions, where thriving new industries created demand for their services. The energy transition thus created distinct trajectories for yakuza operations.

3 Data, Research Design, and Result

This paper combines multiple datasets and empirical strategies to study the role of the energy transition in shaping the yakuza in short and long run. My empirical analyses broadly take three steps: prefecture-level panel analysis, cross-sectional analysis (with a Bartik-style instrumental variable), and municipal-level analysis.[7] First, using an event-study design and prefecture-level panel data, I exploit regional variation in coal mining availability in the pre-transition period and before and after the energy transition. With data on mine workers, the analysis verifies that the energy transition serves as a negative labor demand shock in the mining industry. Subsequently, I examine the short- and long-term effects of the energy transition on the yakuza, in terms of yakuza arrests for different offenses, in different sectors, as well as yakuza-related conflicts. In Appendix E

[7]Prefectures are Japan's main administrative divisions, similar to states in the United States or provinces in Canada, though generally much smaller in size. Japan consists of 47 prefectures, with most being roughly the size of Connecticut or Delaware. However, Hokkaido, the largest prefecture, is comparable to Maine or Indiana. Municipalities (cities, towns, and villages) are nested within each prefecture, much like how U.S. counties contain various cities and towns. In this study, I exclude Okinawa prefecture from the analysis as it was under U.S. administration until 1972.

and G, I complement these analyses using Bartik-variation in crude oil import quantities over time (Goldsmith-Pinkham et al., 2020). I refer these analyses to panel level analysis.

Second, I turn my attention to other yakuza measures in more recent periods. Some measures are based on panel data, while others are based on cross-sectional data. However, most of these measures are not available before the 1960s, which limit my ability to implement the event-study design for these yakuza outcomes. Instead, in the spirit of Duflo and Pande (2007); Sequeira et al. (2020), I construct a treatment variable that captures mining job losses induced by the energy transition using Bartik-type variation in crude oil import quantities over time. Using this predicted treatment variable, I examine the effects of the energy transition on a variety of yakuza measures in medium and long run. I refer this analysis to Bartik-style analysis. For both panel-level and Bartik-style analyses, the geographical unit is the prefecture level.

Lastly, while I focus on prefecture-level analysis due to data limitations on the yakuza, I also conduct a supplementary analysis using municipal-level data from Fukuoka Prefecture (the location highlighted in Figure 3). Fukuoka is historically known for its coal mining industry and yakuza activities, making it a suitable case study site. I exploit two measures: the minimum distance to a historical mining establishment and the number of historical coal mining establishments as of 1961. I examine these historical coal mining measures in relation to present-day yakuza office locations, crime statistics, and the number of business establishments in sectors where yakuza involvement is likely based on discussion in Section 2. I refer to this as a municipal-level analysis.

Throughout each analysis, I provide data and empirical designs in relevant sections. Table 1 presents, along with data sources, summary statistics of the variables used in the main text.

Table 1: Summary Statistics

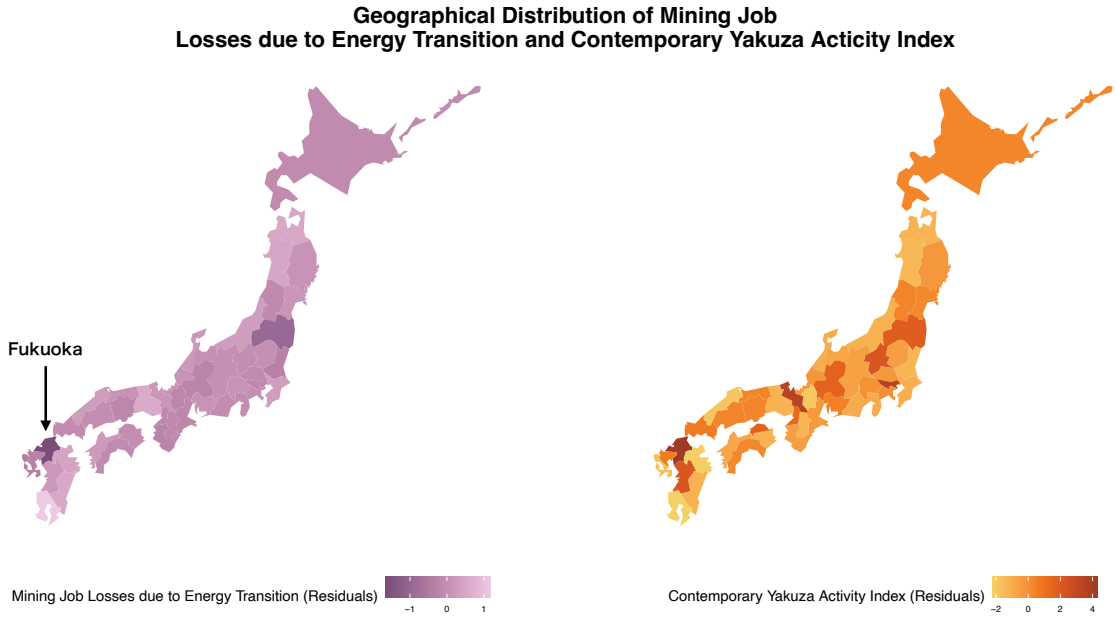
			Mean	Std.Dev.
Data Source	**Unit**	**Yakuza Data for Panel-level Analysi**		
Crime Statistics	Prefecture-by-Time	Yakuza Arrest Property Crime (1957-1970)	11.099	9.200
Crime Statistics	Prefecture-by-Time	Yakuza Arrest Violent Crime (1957-1970)	27.670	17.662
Crime Statistics	Prefecture-by-Time	Yakuza Arrest in Mining Sector (1957-1970)	0.177	0.805
Crime Statistics	Prefecture-by-Time	Yakuza Arrest among Racketeers (1957-1970)	13.846	13.007
Crime Statistics	Prefecture-by-Time	Yakuza Arrest in Other Sectors (1957-1970)	28.224	20.189
Yamaguchi-gumi Daikaibo	Prefecture-by-Time	Yamaguchi-gumi Expansion (1955-1970)	0.373	0.484
Wikipedia	Prefecture-by-Time	Yakuza Conflict (1920-2010)	0.078	0.268
Wikipedia	Prefecture-by-Time	Inter-prefecture Target (Pre-Post: 1920-1950, 1960-2010)	0.180	0.386
Wikipedia	Prefecture-by-Time	Inter-prefecture Attacker (Pre-Post: 1920-1950, 1960-2010)	0.095	0.295
Wikipedia	Prefecture-by-Time	Intra-prefecture Target (Pre-Post: 1920-1950, 1960-2010)	0.170	0.377
Wikipedia	Prefecture-by-Time	Intra-prefecture Attacker (Pre-Post: 1920-1950, 1960-2010)	0.117	0.323
		Yakuza Data for Cross-sectional Analysis		
Statistical Survey on Correction by the Ministry of Justice	Prefecture-by-Time	Yakuza Incarceration (Total) (2006-2019)	1.191	1.019
Statistical Survey on Correction by the Ministry of Justice	Prefecture-by-Time	Yakuza Incarceration (Top-ranking Yakuza Members) (2006-2019)	0.367	0.325
Statistical Survey on Correction by the Ministry of Justice	Prefecture-by-Time	Yakuza Incarceration (Regular Yakuza Members) (2006-2019)	0.648	0.618
Statistical Survey on Correction by the Ministry of Justice	Prefecture-by-Time	Yakuza Incarceration (Unknown Rank Yakuza Members) (2006-2019)	0.176	0.293
Prefectural Police Departments	Prefecture-by-Time	Yakuza Members (2008-2014)	43.089	20.656
White Paper on Crime	Prefecture	Yakuza Arrests (2013)	11.925	8.082
White Paper on Crime	Prefecture	Yakuza Arrests (1974)	311.956	191.044
White Paper on Crime	Prefecture	Yakuza Arrests (1974)	311.956	191.044
Matsumoto (1968)	City	Yakuza Members by City (1967)	13.653	6.480
Ninkyo-Dainyakka (1987)	Prefecture	Yakuza Members (1951, Placebo)	53.170	86.576
Boryokudan Josei/White Paper on Crime	Prefecture-by-Time	# of Desginated Yakuza Syndicates (1996, 2008)	2.989	1.706
	Prefecture-by-Time	Yakuza HHI (2008-2013)	0.427	0.297
Nihon Yakuza Map (2002)	Prefecture	# of Yamaguchi-gumi Affiliated Groups (2002)	2.326	6.225
Nihon Yakuza Map (2002)	Prefecture	# of Yakuza Syndicates' Headquarters (2002)	0.427	0.297
	Prefecture	Indicator for Yakuza Syndicate Formed After 1962	0.109	0.311
	Prefecture	Indicator for Yakuza Syndicate Formed Before 1962 (Placebo)	0.173	0.379
Ninkyo-Dainyakka (1987)	Prefecture	# of Yakuza Groups (1951, Placebo)	24.5	30.396
Yakuza Wiki	Prefecture	# of Hangure Groups	1.130	2.993
		Panel Data on Mining		
Japan Statistical Yearbook	Prefecture-by-Time	Mine Workers (1955, 1959, 1961, 1965, 1967, 1970)	0.929	1.380
		Cross-sectional Data on Mining		
Japan Statistical Yearbook	Prefecture	# of Coal Mining Lots	77.425	209.899
Japan Statistical Yearbook	Prefecture	Coal Mining Areas	16117.49	47812.72
Japan Statistical Yearbook	Prefecture	Coal Production (Ton)	1033493	3348076
		Time-series Data on Oil Import Price		
Ministry of Economy, Trade and Industry	Time	Crude Oil Price by Year (Dollar per Barrel)	2.233	0.242
		Data for Municipal-level Analysis in Fukuoka		
Yakuza Office Street View Search	Municipality	Presence of Yakuza Offices (2023) (Extensive Margin)	0.208	0.406
Yakuza Office Street View Search	Municipality	# of Yakuza Offices (2023) (Intensive Margin)	0.430	1.078
Fukuoka Prefectural Police Department	Municipality-by-Time	(Reported) violent Crime (2007-2019)	56.122	31.469
Fukuoka Prefectural Police Department	Municipality-by-Time	(Reported) property Crime (2007-2019)	867.55	465.466
Establishment and Enterprise Census	Municipality-by-Time	# of Business Establishments in Construction (1971, 1981, 1991, 2001, 2012)	271.452	275.4264
Establishment and Enterprise Census	Municipality-by-Time	# of Business Establishments in Restaurants (1971, 1981, 1991, 2001, 2012)	1000.411	1663.645
Establishment and Enterprise Census	Municipality-by-Time	# of Business Establishments in Real Estate (1971, 1981, 1991, 2001, 2012)	164.819	285.040
Establishment and Enterprise Census	Municipality-by-Time	# of Business Establishments in Infrastructure (1971, 1981, 1991, 2001, 2012)	5.0472	7.7198
Japan Mining Archive	Municipality	Minimum Distance to a Historical Mining Site	6172.848	6903.5
Japan Mining Archive	Municipality	# of Historical Mining Sites	1.1111	2.5262

Notes: Yakuza-related (arrest, incarceration, members) variables, and reported-crime variables: the number of the variable of interest per 100,000 people. For yakuza arrests in 1974, it is per 1,000,000 people. Yakuza Members by City (1967) is per 10,000 people and contains data for 82 large cities. **Worker-related variables:** the number of workers of interest per 100 total workers.

To motivate my analyses, Figure 3 maps two key variables at the prefecture level: historical mining job losses induced by the energy transition and contemporary yakuza activity. For mining job losses, I construct a Bartik-style instrumental variable following approaches similar to Duflo and Pande (2007) and Sequeira et al. (2020) (detailed in Section 3.2). For yakuza activity, I create a composite index using principal component analysis of all continuous yakuza-related variables measured after 2000 that are used in the cross-sectional analysis. Darker colors indicate either greater mining job losses or higher yakuza activities. The correlation coefficient of these two residualized variables (that is, each outcome is the residual of regressing each outcome on covariates and division fixed effects) is approximately 0.6, suggesting that prefectures that experienced greater

mining job losses historically tend to have higher yakuza activities today.[8]

Figure 3: Geographical Distribution of Mining Job Losses due to Energy Transition and Contemporary Yakuza Index



Note: Each outcome is the residual of regressing the outcome on geographic covariates and division fixed effects.

3.1 Panel-level Analysis

In this section, I use prefecture-level panel data to examine the effects of the energy transition on mining job losses, as well as yakuza arrests and conflicts over time.

Coal Mining Availability (Prefectural Level Data). To capture coal mining availability, I use three measures: (i) coal mining areas, (ii) the number of coal mining lots (e.g., land areas where excavation, mining, and production of coal are permitted by a mining right holder), and (iii) the amount of coal production. These three are highly correlated with one another ($\rho \approx 0.9$). For this reason and also to mitigate measurement error, I construct an index of coal mining availability

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

extracted from a principal components analysis.[9] I construct the index using data from the pre-transition period. To facilitate interpretation, I standardize the index to mean = 0 and standard deviation = 1. Appendix B provides the distribution of the coal mining availability index and its individual components. As a robustness check, instead of using the index, I use each variable (i.e., coal mining areas, the number of coal mining lots, and amount of coal production) as cross-sectional variation, and the results are provided in Appendix O.

Mine Workers (Panel-level Data). I use the Japan Statistical Yearbook to calculate the share of mine workers relative to 100 total workers, where the denominator is fixed at the population size as of 1961. There are two remarks regarding this data. First, although the Japan Statistical Yearbook provides annual statistics[10], the values for mine workers remain the same in some years. Between 1955 and 1970, unique values are observed in 1955, 1959, 1961, 1965, 1967, and 1970.

Yakuza Arrests (Panel-level Data). I use panel data on yakuza arrests based on Crime Statistics from 1957 to 1970. The end of the panel period is determined by data availability. Since yakuza membership is not illegal in Japan, the police can readily identify whether an arrested individual is a yakuza member. The outcome of interest is the number of yakuza arrest cases for an offense type per 100,000 people, where the denominator is fixed at the population size as of the 1960 census year. I examine both overall property (i.e., theft and fraud combined) and violent crime (i.e., robbery, murder, assault, threat, and extortion combined).

The data set also identifies the number of yakuza arrest persons in different sectors. As discussed in Section 2.1, the yakuza has diverse origins across various sectors, including coal mining. Here I focus on the number of mining-associated yakuza arrests, those among racketeers, and arrests in other sectors than those in the mining sector and of racketeers. This sector-specific yakuza arrest data is unique and allows me to examine the effects of the energy transition on changes in yakuza group composition over time. Police could determine yakuza members' sectoral affiliations. Yakuza members typically took great pride in their organizational history and were traditionally tolerated in Japanese society, with their offices openly displaying group symbols. When arrested, members

[9] Before running a principal components analysis, I standardize each measure to mean = 0 and standard deviation = 1.

[10] Data can be accessed here.

would rarely conceal their group affiliations, making it straightforward for authorities to trace their organizational origins.

To identify the channels through which the energy transition affected yakuza's criminal activities, I exploit the presence of yakuza groups in the mining industry. For the main analysis, I define prefectures as having a presence of mining-associated yakuza if a prefecture has any yakuza arrests in the mining sector before 1962 (i.e., between 1957 and 1961), and I create a binary indicator accordingly. This is given that the number of yakuza arrests in the mining sector is small (see Table 1). As a robustness check, I also create a binary indicator if the number of yakuza arrests in the mining sector is above the median, as well as a binary indicator if the number of yakuza arrests among racketeers is above the median in the pre-transition period. The list of prefectures with a presence of mining-associated yakuza, alternative definitions, and estimation results with alternative definitions are provided in Appendix M.

In Appendix G, I examine three crime categories that organized crime is more likely to be involved in: gambling, prostitution, and drug trade. However, for these three outcomes, the data is only available after 1963. Thus, I cannot implement the event-study design but can still use the Bartik design for these outcomes.

While arrest data reflects both yakuza and police behavior, I address this potential confound in two ways. First, I demonstrate robustness to the inclusion of enforcement measures in Appendix H. Second, I discuss in Appendix A how an enforcement-based explanation contradicts some of key findings.

Expansion of large-scale yakuza group (Panel-level Data). To capture the expansion of large-scale yakuza group expansion, I focus on the Yamaguchi-gumi, the largest yakuza group, and use a binary indicator of whether the Yamaguchi-gumi has a presence across prefectures and years. During the 1960s and 1970s, large-scale groups (i.e., the Yamaguchi-gumi, Sumiyoshi-kai, and Inagawa-kai) expanded their territories. Due to data limitations, the analysis focuses solely on the expansion of the Yamaguchi-gumi.

Yakuza Conflicts (Panel-level Data). I construct panel data on yakuza conflicts based on Wikipedia. The Wikipedia dataset covers from the 1920s to the 2010s. It documents major

conflicts between yakuza groups but excludes small-scale or minor conflicts associated with the major ones. I verified the relevant information based on yakuza-related books and websites, and coded information on the time, place of each yakuza conflict, yakuza groups involved in each conflict, as well as the places of headquarters of yakuza groups involved in each conflict. Due to 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 0 otherwise. Because the 1920s, 1930s, and 2010s each contain only one major yakuza conflict, I combine the 1920s and 1930s periods together and collapse the 2010s with the 2000s period. I merge the location of conflicts with data on coal mining availability.

Additionally, the conflict data identifies the attacking and targeted yakuza groups in each conflict. The data also allows me to determine whether the yakuza groups involved in a conflict originate from the same prefecture or different prefectures (i.e., locations of headquarters). From this information, I generate four indicators: (i) indicator for conflicts where a yakuza group was the target of an attack from a group originating in a different prefecture (i.e., inter-prefecture target), (ii) indicator for conflicts where a yakuza group was the attacker against a group originating in a different prefecture (i.e., inter-prefecture attacker), (iii) indicator for conflicts where a yakuza group was the target of an attack from a group originating in the same prefecture (i.e., intra-prefecture target), (iv) indicator for conflicts where a yakuza group was the attacker against a group originating in the same prefecture (i.e., intra-prefecture attacker). For these measures, instead of using the locations of conflict, I merge the locations of headquarters of attacking yakuza groups and targeted yakuza groups with data on coal mining availability. Due to the limited number of observations of conflicts for each category, I focus on the pre-(1920-1950) and post-(1960-2010) periods of the energy transition, resulting in a panel consisting of 92 observations (46 prefectures $\times$ 2 periods).

Empirical Design. To identify the effects of the energy transition on the outcomes of interest, I employ an event-study specification that exploits two sources of variation: (i) cross-sectional variation in coal mining availability in the pre-energy transition period and (ii) time variation leading up to and following the energy transition.

$$y_{i,r(i),t} = \sum_{\tau=k}^{l} \alpha_\tau mine_i \times \mathbb{1}(\tau = t - event,time) + \mu_i + \lambda_{r(i),t} + \epsilon_{i,r(i),t}, \tag{1}$$

where $y_{i,r(i),t}$ represents the outcome variable of interest (e.g., the number of yakuza arrest cases per 100,000 people, or a binary indicator for conflict between yakuza groups) in prefecture i, division r, and time t. The event-study dummies $\mathbb{1}(\tau = t - event,time)$ span from k to l, with the values of k and l varying depending on the dataset used (e.g., for yakuza arrest data: $k = 1957$ to $l = 1970$, for yakuza conflict data: $k = 1920$ to $l = 2010$). $mine_i$ is an index of coal mining availability in prefecture i before the energy transition period. α_τ are time-varying coefficients, capturing the effects of the energy transition, relative to a reference period. The choice of the reference period depends on the dataset: for mine workers and yakuza arrest data, the reference period is 1961, while for yakuza conflict data, it is 1950. The coefficients are interpreted as the difference in the outcome variable between prefectures with varying levels of coal mining availability, compared to the reference period.

μ_i is prefecture fixed effects, and $\lambda_{r(i),t}$ division-by-time fixed effects, which force me to compare coal-rich prefectures to coal-scarce prefectures within the division and time period, conditional on prefecture fixed effects. $\epsilon_{i,r(i),t}$ is the error term. I cluster standard errors at the prefecture level to account for the serial correlation in the error term. All the analyses use weighted least squares (WLS) with population in the 1960 census year as weights, thus giving more weight to prefectures with larger populations. As a robustness check, I provide estimates using ordinary least squares (OLS) in Appendix N.

An identifying assumption here is the parallel trends assumption, which states that in the absence of the energy transition, the outcome of interest 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.

However, note that because coal mining availability is a continuous measure, the parallel trends assumption is required in a strong form (Callaway et al., 2024). This means that the outcomes in coal-scarce prefectures serve as the counterfactual outcomes for those in coal-rich prefectures, and coal-rich prefectures would have had the same treatment effect as coal-scarce prefectures. The stronger version of the parallel trends assumption is not distinguishable from the usual parallel trends assumption in a binary DiD setting. To mitigate potential issues associated with a continuous

DiD setting, I perform several checks that are complementary to the main results. First, I run a binary form of event-study specifications, with the results presented in Appendix P. Second, for short-term effects, I conduct the Bartik reduced-form analysis using crude oil import quantities over time; the results are provided in Appendix E and G. Lastly, for the long-term consequences on yakuza conflict, I do not run the Bartik reduced-form analysis due to oil shocks in the 1970s. Instead, I complement the main event-study analysis with a predicted treatment variable (i.e., a Bartik-style instrument) that captures the mining job losses due to the energy transition between 1955 and 1970 (as explained in Section 3.2). I estimate the effect of mining job losses by the energy transition on yakuza conflict by decade; the results are presented in Appendix K. This approach can also mitigate the concern that the parallel trends assumption might not hold for an extended period.

Next, using yakuza arrest data, I attempt to provide insights into the channels through which the energy transition led to an increase in yakuza arrests. Two potential channels are: (i) incumbent yakuza members who lost their revenues from the mining industry and changed their economic activities, and (ii) coal miners who experienced a decreased opportunity cost of crime and sorted into yakuza groups. To explore these channels, I exploit the historical presence of mining-associated yakuza groups. In prefectures with mining-yakuza presence in the pre-transition period, both mining-associated yakuza members and coal miners would change their behavior. By contrast, in prefectures without mining-yakuza presence, only coal miners would change their behavior. Thus, taking the difference in the outcome of interest between prefectures with the presence of mining-associated yakuza groups and those without it provides suggestive evidence for the behavior of mining-associated yakuza. Using the historical presence of mining-associated yakuza groups, I estimate the following triple-differences specification:

$$y_{i,r(i),t} = \tilde{\alpha}\, mine'_i \times post_t + \tilde{\beta} mine'_i \times post_t \times yakuza^m_i + \tilde{\gamma}\, mine'_i \times post_t \times yakuza^o_i \qquad (2)$$
$$+ \tilde{\mu}_i + \tilde{\lambda}_{r(i),t} + \tilde{\delta}^m_t + \tilde{\delta}^o_t + \tilde{\epsilon}_{i,r(i),t},$$

where $yakuza^m_i$ 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 $mine'_i \times post_t$, where $post_t$ takes value one after 1962 and zero otherwise.

The coefficients of interest are $\tilde{\alpha}$ and $\tilde{\beta}$; the former captures the effects for coal miners, while the latter captures the effects for mining-associated yakuza members. $yakuza_i^o$ takes the value one if a prefecture has above the median value of yakuza arrests in sectors other than mining and racketeers in the pre-energy transition period (1957-1961). $\tilde{\gamma}$ on $mine_i' \times post_t \times yakuza_i^o$ captures the differential effect of the energy transition among prefectures with a high presence of yakuza groups in other sectors. $\tilde{\delta}_t^m$ (resp. $\tilde{\delta}_t^0$) represents the mining-yakuza-by-year fixed effects (resp. the other-sector-yakuza-by-year fixed effects). As a robustness check, I use alternative definitions of the presence of mining-yakuza groups and estimation results are provided in Appendix M. Bartik reduced-form estimates are presented in Appendix G.

This specification allows me to control for shocks other than the energy transition that are specific to mining-associated yakuza groups, as well as non-mining yakuza groups. For instance, from 1964 to 1970, enforcement against the yakuza increased due to prolonged conflicts. While division-by-year fixed effects account for these changes, it is still possible that the police targeted specific yakuza groups. The included fixed effects absorb these group-specific shocks.

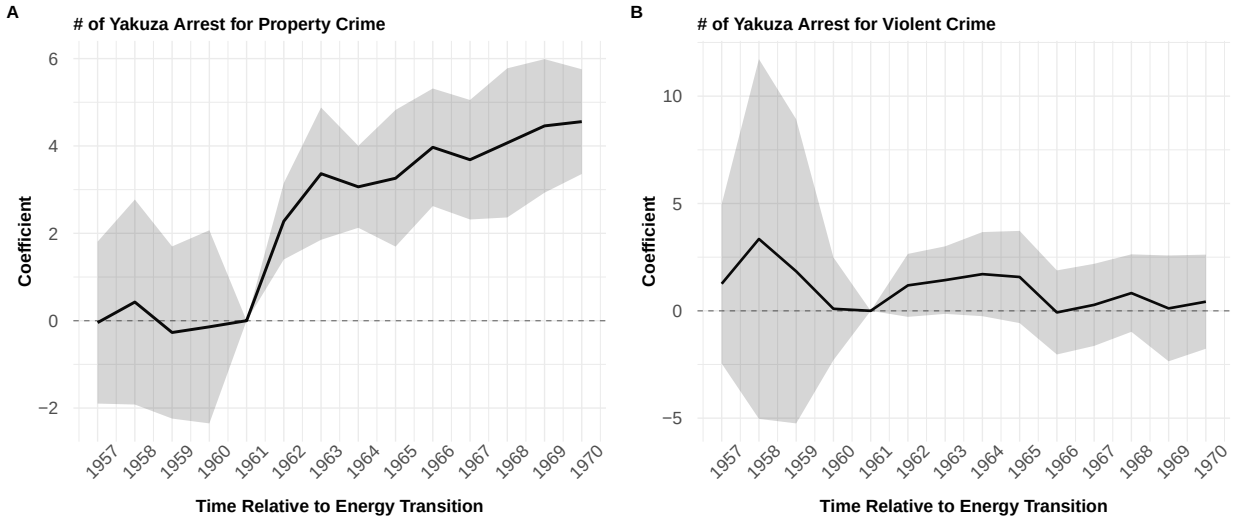
The presence of mining-associated yakuza groups is strongly correlated with high coal mining availability, as demonstrated in Table A4. This correlation makes prefectures with and without historical mining-associated yakuza presence not directly comparable. To address this issue, I standardize the index of coal mining availability separately for prefectures with and without the presence of mining-associated yakuza groups, setting the mean to 0 and the standard deviation to 1 within each group. The standardized variable , $mine_i'$, corrects for the difference in the value of the mining variable between prefectures with and without the presence of mining-associated yakuza groups.

Result on Short-term Effect of Energy Transition on Yakuza Arrest. Figure 4 shows event-study estimates and the 95% confidence intervals of the short-term effect of the energy transition on the number of yakuza arrests (property crime shown in Panel A and violent crime shown in Panel B) per 100,000 people. First, before 1962, there are little differential trends in yakuza arrest rates between coal-rich prefectures and coal-scarce prefectures. Second, in the years after 1962, yakuza arrest rates for property crime increased more in coal-rich prefectures relative to coal-scarce prefectures, and the effect of the energy transition on yakuza arrests for property crime persists

over the subsequent 10 years. A one standard deviation increase in coal mining availability leads to an increase of about 3.6 yakuza arrests for property crime per 100,000 people. This translates into a 30% increase relative to the baseline mean. This pattern is not observed for violent crime. These results are consistent with the idea that, at least in the short term, crime increased due to deprived economic opportunities following the energy transition.

Note, however, that this result may reflect a change in enforcement, although in such a case, we should also observe an increase in violent crime. To indirectly eliminate this possibility, Appendix H provides tentative results, indicating that the energy transition does not change the enforcement level during this time period. Additionally, as a robustness check, Appendix H includes the interaction term of the number of police officers per 1,000 people measured in the pre-energy transition period and year fixed effects. The coefficient of interest remains statistically and economically significant. Thus, I interpret this result as evidence indicating that the energy transition increases yakuza activities.

Figure 4: Short-term Effect on Yakuza Arrest



Unit of analysis: prefecture-by-year. **Time period:** 1957-1970 (annually). **Observations:** 644. **Outcome:** # of yakuza arrests for property crime and violent crime per 100,000 people, where the size of population is fixed as of the 1960 census year. Property crime includes theft and fraud; violent crime includes robbery, murder, assault, threat, and extortion. **Mean of dep. var. (property crime) in the pre-transition period**: 11.098. **Mean of dep. var. (violent crime) in the pre-transition period**: 27.670. **Standard errors:** clustered at the prefecture level.

Result on Channel: Mining-associated Yakuza Members or Coal Miners. To provide suggestive evidence for the channel of the increase in crime, Table 2 presents triple-difference estimates, where I exploit additional variation: the presence of mining-associated yakuza groups in the pre-transition period. It examines two outcomes. Columns (1-2) show yakuza arrests for property crime; Columns (3-4) show yakuza arrests for violent crime. For each outcome, the first column shows the results without including the interaction terms of coal mining availability, post, and the indicator for a high presence of non-mining yakuza groups, while the second column shows the results with the interaction term. In Column (1), the coefficient on the triple interaction term with the mining-associated yakuza presence is positive for property crime, while the coefficients on the treatment variable without the the mining-associated yakuza presence dummy (i.e., coal mining availability and post) are not statistically significant. In Column (2), when I add the additional triple-interaction term with the dummy variable for a high presence of yakuza groups in other sectors, the coefficient on the triple-interaction term with the presence of mining-yakuza groups remains positive and significant without much change in the size of the coefficient. However, the coefficient on coal mining availability and post becomes marginally significant.

For violent crime, the coefficients on the triple interaction terms with the mining-associated yakuza presence dummy are not statistically significant, and the sign of the coefficients is negative. In Column (4), when I add the additional term with the dummy variable for a high presence of yakuza groups in other sectors, the coefficient on the interaction term of coal mining availability and post is positive and significant. Appendix G presents additional results using a Bartik reduced-form design for property crime, violent crime, gambling, prostitution, and drug trade. These findings provide further evidence of the involvement of former mining industry yakuza members in economically motivated crimes, specifically property crime and gambling. This suggests that the observed increase in yakuza activities is likely attributable to these mining-associated yakuza members transitioning to economically motivated criminal activities. Appendix L presents event-study estimates, indicating that pre-trends in the outcomes are less of a concern.

Table 2: Triple-Difference Estimates

	(1)	(2)	(3)	(4)
	Yakuza Arrests			
Dep.Var.:	Property Crime		Violent Crime	
Coal Mining Availability × Post	1.1462	1.7499*	1.1562	3.5769**
	(0.8214)	(0.9389)	(1.9624)	(1.7443)
Coal Mining Availability × Post × Mining Yakuza	3.7451***	3.7787***	-1.3722	-1.2435
	(1.3862)	(1.2879)	(3.1012)	(2.6573)
Coal Mining Availability × Post × Yakuza in Other Sectors		-1.9098		-7.6182*
		(1.5790)		(4.2245)
Mining Yakuza × Post	x	x	x	x
Non-Mining Yakuza × Post		x		x
Prefecture FE	x	x	x	x
Division-by-Time FE	x	x	x	x
Observations	644	644	644	644
R-squared	0.6556	0.6591	0.7813	0.7936

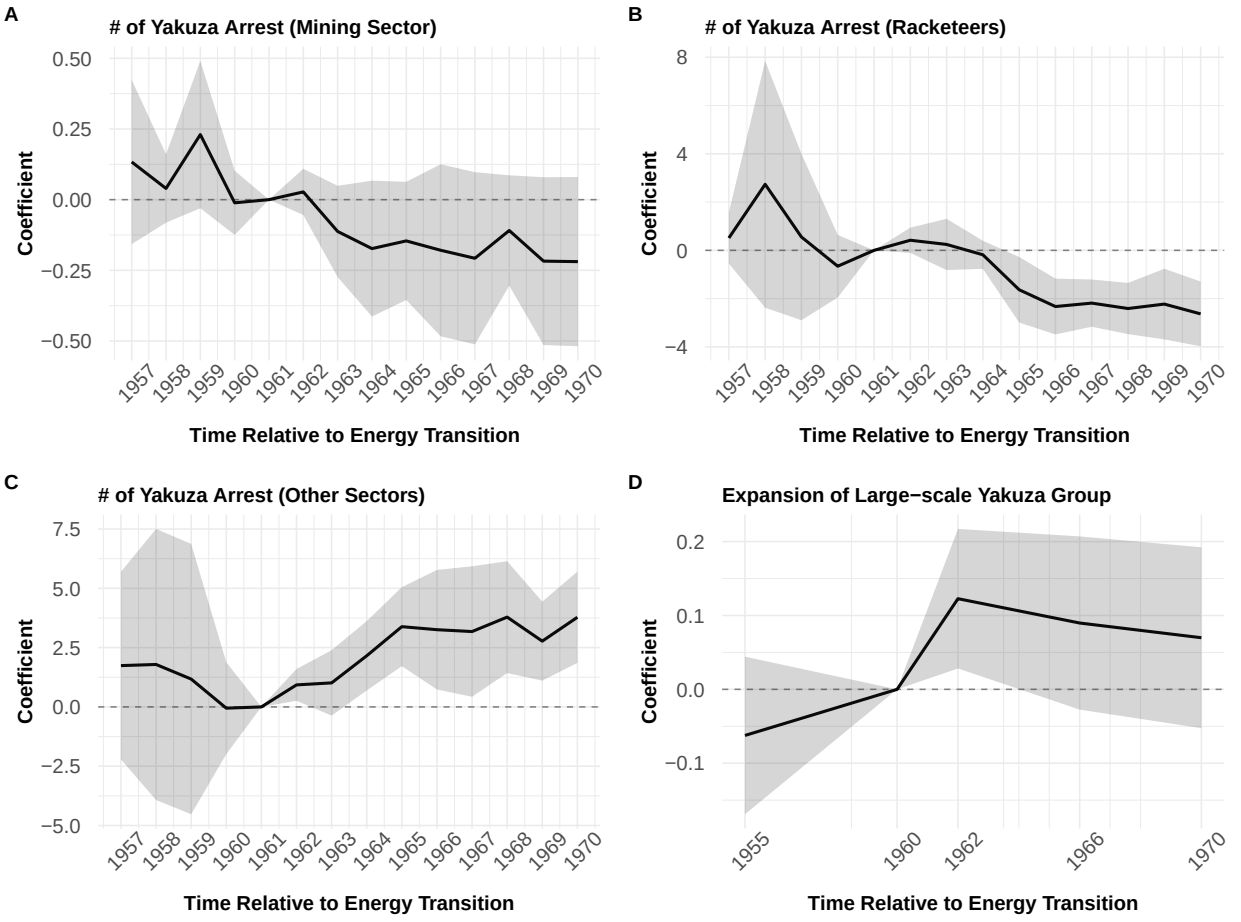
Notes: Significance at the 1%, 5%, and 10% levels indicated by ***, **, and *, respectively. Standard errors clustered at the prefecture level in parentheses. **Unit of analysis:** prefecture-by-year. **Time period:** 1957-1970 (annually). **Outcome:** # of yakuza arrests for property crime and violent crime per 100,000 people, where the size of population is fixed as of the 1960 census year. Property crime includes theft and fraud; violent crime includes robbery, murder, assault, threat, and extortion. **Mean of dep. var. (property crime) in the pre-transition period**: 11.098. **Mean of dep. var. (violent crime) in the pre-transition period**: 27.670.

Short-term Effects of Energy Transition on Yakuza Group Composition and Expansion. An immediate implication from the previous analysis is that former mining-associated yakuza members and racketeers, when transitioning to illegal economic activities post-energy transition, might have joined yakuza groups in other sectors. Small mining-associated yakuza groups likely declined due to limited expansion capacity, while non-mining yakuza groups probably grew in size. I now examine this possibility.

Figure 5 presents event-study estimates with 95% confidence intervals showing how the energy transition affected yakuza arrests across sectors and the expansion of a major yakuza group. Based on equation 1, I examine three outcomes of yakuza arrests in different sectors: (i) the number of yakuza arrests in the mining sector (Panel A), (ii) the number of yakuza arrests of racketeers (Panel B), and (iii) the number of yakuza arrests in other sectors (that is, non-mining and non-racketeers) (Panel C). The results reveal contrasting patterns: arrests in mining and of racketeers declined post-transition (though mining sector estimates are imprecise), while arrests in other sectors increased. Panel D examines the expansion of the Yamaguchi-gumi, the largest yakuza group, originating from dock labor in a coal-scarce region. While showing an upward pre-transition trend, their expansion

in coal-rich prefectures accelerated after the transition. Taken together, the results are consistent with the idea of a shift in yakuza group composition following the energy transition. While the power of mining-associated yakuza was on the decline, two parallel developments occurred following the energy transition: the power of non-mining yakuza was on the rise, and yakuza groups expanded into coal-rich areas through migration.

Figure 5: Yakuza Group Composition and Expansion

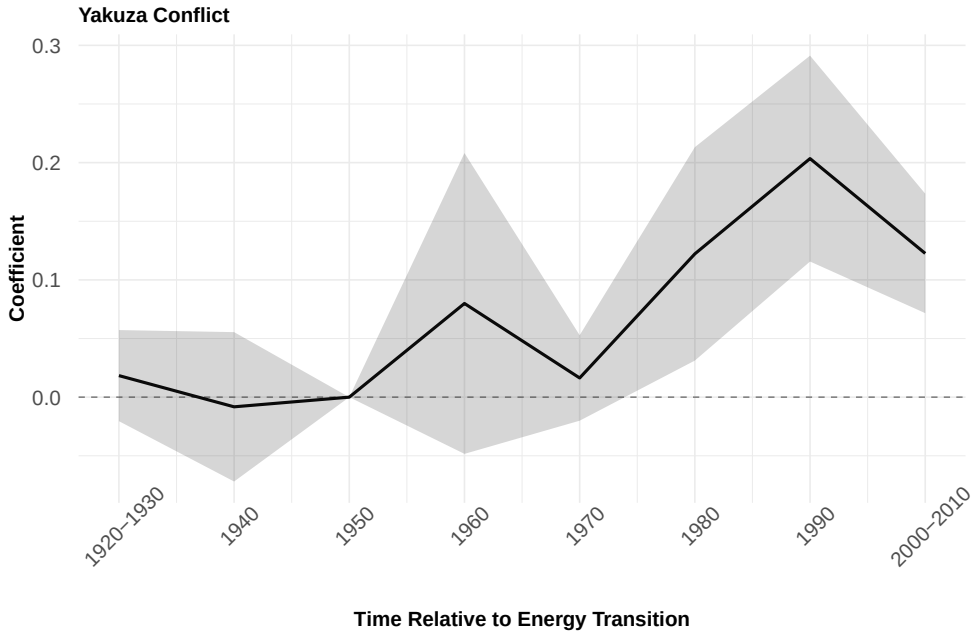


Unit of analysis: prefecture-by-year. **Time period: Panel A-C**: 1957-1970 (annually). **Panel D**: 1955, 1960, 1962, 1966, 1970. **Observations: Panel A-C**: 644. **Panel D:** 230. **Outcome: Panel A-C**: # of yakuza arrests in the mining sector, racketeers, and in other sectors per 100,000 people, where the size of population is fixed as of the 1960 census year. **Panel D**: a binary indicator for the presence of the yamaguchi-gumi. **Mean of dep. var. (mining sector) in the pre-transition period**: 0.296. **Mean of dep. var. (racketeers) in the pre-transition period**: 20.403. **Mean of dep. var. (other sectors) in the pre-transition period**: 48.036. **Mean of dep. var. (expansion of large-scale yakuza group) in the pre-transition period**: 0.148. **Standard errors:** clustered at the prefecture level.

Result on Long-term Effect of Energy Transition on Yakuza Conflict. One immediate implication of the previous results is an escalation of yakuza-related conflicts. To examine this, I now look at the effect of the energy transition on yakuza-related conflicts. Figure 6 provides event-study estimates and the 95% confidence intervals of the effects of the energy transition on yakuza conflicts over decades.[11] It shows that in the decades following the energy transition, the likelihood of yakuza conflicts increased more in coal-rich prefectures than coal-scarce prefectures. This effect persists over half a century, providing evidence of the long-term consequences of the energy transition on yakuza conflict. On average, a one standard deviation increase in coal mining availability increases the likelihood of yakuza conflicts increased by 10 percentage points in the post-transition period. Note, however, that in the 1970s, there is a large drop in the likelihood of yakuza conflict. One potential interpretation of this is that yakuza conflicts in the previous decades led to crackdowns on the yakuza, which might have led to a decrease in conflicts either through deterrence or incapacitation in that period. In the latter case, after their release from prison, these yakuza members may have had shorter time horizons and faced lower opportunity costs of engaging in conflicts. Appendix H examines the robustness of this result conrolling for enforcement measures.

[11] Note that unlike the previous yearly analyses, this analysis uses decade-level data, with the 1950s serving as the reference period. That is, all conflicts are grouped by decade (e.g., a conflict occurring in 1965 is categorized in the 1960s).

Figure 6: Long-term Effect on Yakuza Conflict



Unit of analysis: prefecture-by-decade. **Time period/data points:** 1920-2010 (decade). The 1920s and 1930s are combined due to scarcity of data, and the 2010s is merged with the 2000s. **Observations:** 460. **Outcome:** a binary indicator for yakuza conflict. **Mean of dep. var. in the pre-transition period**: 0.043. **Standard errors:** clustered at the prefecture level.

Channels for Conflict. I examine two complementary channels for the increase in yakuza conflicts: (i) Yakuza groups that originated from coal-rich prefectures would be more likely to be targeted by groups that originated from other prefectures, rather than they initiating conflicts themselves. (ii) The effects on yakuza conflict are depended on the availability of demand for yakuza services beyond coal mining.

Results on Channel: Targets or Attackers I disaggregate the conflict outcome into four categories: (i) indicator for conflicts where a yakuza group was the target of an attack from a group originating in a different prefecture (i.e., inter-prefecture target), (ii) indicator for conflicts where a yakuza group was the attacker against a group originating in a different prefecture (i.e., inter-prefecture attacker), (iii) indicator for conflicts where a yakuza group was the target of an attack from a group originating in the same prefecture (i.e., intra-prefecture target), (iv) indicator for conflicts where a yakuza group was the attacker against a group originating in the same prefecture

(i.e., intra-prefecture attacker).[12]

Table 3 presents the results. Column (1) shows the result for conflicts of inter-prefecture target; Column (2) shows the result for inter-prefecture attacker; Column (3) shows the result for intra-prefecture target; and Column (4) shows the result for intra-prefecture attacker. The coefficient of interest is statistically and economically significant for conflicts where a yakuza group was the target of an attack from a group originating in a different prefecture. This indicates that yakuza groups in coal-rich prefectures became targets of conflicts. Specifically, a one standard deviation increase in coal mining availability leads to an increase in the likelihood of conflicts targeting these groups by approximately 13 percentage points.[13] This pattern is not observed for conflicts where a yakuza group was the attacker against a group originating in a different prefecture. This means that yakuza groups in coal-rich prefectures did not initiate an conflict against another group in another prefecture. In other words, during the post-transition period, there was an increase in conflicts targeting yakuza groups in coal-rich prefectures, while there was little change in conflicts initiated by yakuza groups in coal-rich prefectures. Similarly, there is no systematic patterns for conflicts where both groups originate in the same prefecture.

[12] Because the conflict data is already scarce, the disaggregated categories have even fewer observations, limiting the ability to run an event-study specification.

[13] In the previous version of the manuscript (as of 2024/07/18), the standard error in Column (1) was incorrectly reported as 0.0637. The correct standard error is 0.0361.

Table 3: Channel for Yakuza Conflicts: Targets or Attackers of Conflicts

	(1)	(2)	(3)	(4)
Dep.Var.:	Conflict			
Origin:	Different Prefecture		Same Prefecture	
Role:	Target	Attacker	Target	Attacker
Coal Mining Availability × Post	0.1277***	0.0611	0.0152	0.0655
	(0.0361)	(0.0538)	(0.0184)	(0.0545)
Prefecture Fixed Effects	x	x	x	x
Division × Time Fixed Effects	x	x	x	x
Observations	92			
R-squared	0.6697	0.864	0.825	0.892

Notes: Significance at the 1%, 5%, and 10% levels indicated by ***, **, and *, respectively. Standard errors clustered at the prefecture level in parentheses. **Unit of analysis:** prefecture-by-prepost. **Time period:** 1920-1950 (pre) and 1960-2010 (post). **Outcome:** Column (1): Inter-prefecture target. Column (2): Inter-prefecture attacker. Column (3): Intra-prefecture target. Column (4): Intra-prefecture attacker **Mean of dep. var. (inter-prefecture target) in the pre-transition period**: 0.0638. **Mean of dep. var. (inter-prefecture attacker) in the pre-transition period**: 0.0425. **Mean of dep. var. (intra-prefecture target) in the pre-transition period**: 0.127. **Mean of dep. var. (intra-prefecture attacker) in the pre-transition period**: 0.0638.

Result on Channel: Conflicts Depending on Initial Characteristics. Now, I examine the heterogeneous effects of the energy transition on the overall conflict by pre-existing characteristics that likely capture the presence of mining-associated yakuza groups, as well as economic opportunities for yakuza involvement. Based on the discussion in 2, I examine the following characteristics: (i) presence of mining-associated yakuza groups, (ii) proportion of construction workers, (iii) number of construction establishments, (iv) proportion of outcaste group, (v) the number of public gambling sites, and (vi) proportion of methamphetamine arrests. All the variables are divided into above median (high) or below median (low) (except for the presence of mining-associated yakuza groups, see Yakuza Arrests (Panel-level Data) in Section 3). I estimate the effects of the energy transition among coal-rich prefectures with high moderator and among coal-rich prefectures with low moderator, and I provide the p-value of joint significance test of two coefficients.

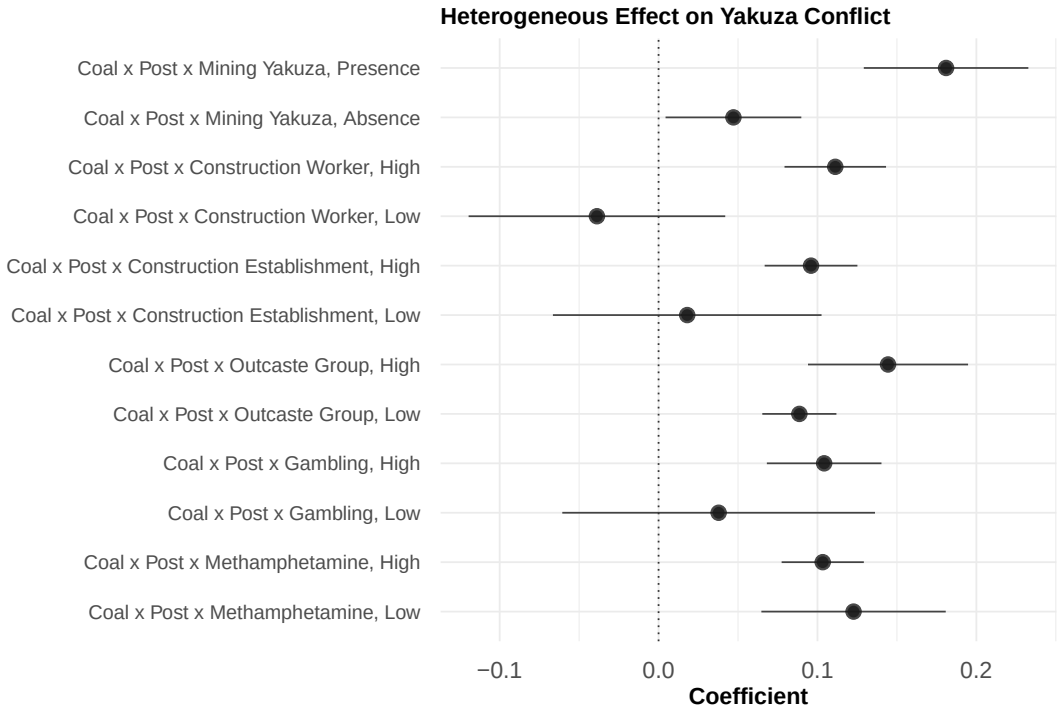
Table 7 shows the point estimates with 95% confidence intervals. First, while the energy transition increased yakuza conflicts in coal-rich prefectures without mining-associated yakuza groups, the effect is much larger in areas where these groups were present (the difference is the coefficients

is statistically significant). This pattern is consistent with yakuza conflicts emerging in coal-rich prefectures where mining-associated yakuza groups' power declined.

Second, the heterogeneous effects across other initial characteristics is consistent with the following interpretation: the impact of the energy transition on yakuza conflicts is larger in coal-rich prefectures with either high demand for yakuza services or greater opportunities for yakuza economic activities. Coal-rich prefectures with high levels of construction workers, construction establishments, and outcaste group populations exhibit a higher likelihood of conflict compared to those with low levels. The difference in the coefficients is statistically significant; for construction establishments, the difference is only marginally significant. For public gambling sites, the coefficient for coal-rich prefectures with a high level of public gambling sites is significant and large in magnitude (0.104) while the coefficient for those with a low level of public gambling sites is not significant and small in magnitude (0.037). But the difference in the coefficients is not statistically significant at conventional levels (0.172). Regarding methamphetamine arrests, coal-rich prefectures show similar trends in yakuza conflict regardless of whether the arrest levels are high or low.

Taken together, the results are consistent with the following perspective: following the energy transition, yakuza groups from other areas entered and attacked local yakuza groups in coal-rich prefectures where mining-associated yakuza groups' power declined but where alternative yakuza economic opportunities existed.

Figure 7: Heterogeneous Effects on Yakuza Conflict



Unit of analysis: prefecture-by-decade. **Time period/data points:** 1920-2010 (decade). The 1920s and 1930s are combined due to scarcity of data, and the 2010s is merged with the 2000s. **Observations:** 460. **Outcome:** a binary indicator for yakuza conflict. **Mean of dep. var. in the pre-transition period**: 0.043. **Standard errors:** clustered at the prefecture level. **Moderator Z of interest**: divided by above median or below median (except for the presence of mining-associated yakuza groups, see Yakuza Arrests (Panel-level Data) in Section 3). $y_{i,r(i),t} = \alpha_0 mine_i \times post_t \times Z_i^{high} + \alpha_1 mine_i \times post_t \times Z_i^{low} + \alpha_2 Z_i^{high} \times post_t + \mu_i + \lambda_{r(i),t} + \epsilon_{i,r(i),t},$. **P-value of Joint Significance Test of Two Coefficients**: 0.000 (Mining Yakuza), 0.0009 (Construction Worker), 0.098 (Construction Establishment), 0.044 (outcaste Group), 0.172 (Gambling), 0.200 (Methamphetamine).

3.2 Bartik-style Analysis

Now, I investigate the medium- and long-term consequences of the energy transition on different yakzua measures. This analysis uses cross-sectional variation in the treatment variable.

Bartik-style Instrument: Construction of Variable on Mining Job Losses due to Energy Transition. For this analysis, in the spirit of Duflo and Pande (2007); Sequeira et al. (2020), I construct a treatment variable that captures mining job losses induced by the energy transition using a Bartik-type variation in crude oil import quantities over time. The idea is that crude oil import quantities were on the rise during this period, which serves as a negative demand

shifter in coal-rich prefectures, and thus demand for the coal mining industry decreased in those prefectures. To capture this, I include the interaction term of time-varying coal mining availability index $mine_{i,t}$, and crude oil import quantities over time $oil\,import_t$: $mine\,workers_{i,r(i),t} = \ddot{\beta}_1\, mine_{i,t} \times oil\,import_t + \ddot{\beta}_2\, mine_{i,t} + \ddot{\mu}_i + \ddot{\delta}_{r(i),d} + \ddot{\epsilon}_{i,r(i),t}$. The key component of this equation is the interaction term $mine_{i,t} \times oil\,import_t$, which captures the differential effects of oil import quantities on mining employment by the local availability of coal mining. I then construct a predicted treatment variable: $\widehat{mine\,workers}_i = \frac{1}{T}\sum_{t=1}^{T} \widehat{\beta}_1\, mine_{i,t} \times oil\,import_t$. This variable represents the average predicted change in the share of mine workers for each prefecture over the study period, induced by the energy transition as proxied by changes in oil import quantities. Note that this approach differs slightly from the standard Bartik-type design that exploit the interaction of time-invariant cross-sectional variation with time variation (see Appendix C for an explanation). Table A2 presents the estimation result.

To credibly estimate the effects of $\widehat{mine\,workers}_i$ on yakuza-related outcomes, the key assumption is that $\widehat{mine\,workers}_i$ is exogenous. Although the exogeneity assumption cannot be directly tested, Table A3 provides an indirect test. Conditional on geographical characteristics, most pre-existing measures of demographic and economic characteristics are not correlated with the constructed treatment variable. This result lends credence to the exogeneity of mining job losses induced by the energy transition. Furthermore, the validity of this treatment variable relies on the exclusion restriction assumption. In the current context, the energy transition—the interaction of coal mining availability and oil import quantities—would affect yakuza-related outcomes only through a decline in mine workers. A potential concern might arise if the energy transition increases the share of construction workers, as shown in Appendix E. However, an increase in construction workers should be interpreted as a consequence of the decline in mine workers induced by the energy transition, rather than the energy transition directly affecting the increase in construction workers.

Yakuza Measures (Panel/Cross-Sectional Data). Now, with the predicted treatment variable, I turn my attention to measures of various yakuza's activities. For the main analysis in this section, I focus on measures on yakuza members as well as yakuza syndicates. First, for yakuza members, I use the number of incarcerated yakuza members per 100,000 people, which include incarceration of high-ranking members, regular members, and unknown ranks. The dataset covers

from 2006 to 2019. Yakuza incarceration data encompass members from the 25 designated yakuza syndicates, including their affiliated groups. The effects on unknown rank yakuza incarceration may be ambiguous. According to my interview with the Ministry of Justice, unknown rank incarceration includes several categories: (i) peripheral yakuza members, (ii) yakuza members potentially affiliated with other criminal organizations, such as hangure (described below), (iii) those in transition between different ranks. For the first two categories, the energy transition is not expected to impact incarceration among this group. This is because for a persistent effect to be salient, it should be most concentrated among committed members. Furthermore, as explained below, hangure and yakuza are distinct groups, so the energy transition would not impact hangure. However, for the third category, if incarcerated individuals were in a transition phase at the time of apprehension, the effect might still be present.

Second, for yakuza syndicates, I use the number of designated yakuza syndicates in 1996 and 2008, and (iv) yakuza Herfindahl-Hirschman Index (HHI) from 2008 to 2013 (See Brown et al. (2021) for a similar construction of the HHI-based gang competition measure). The construction of the yakuza HHI is provided in Appendix V. For this yakuza HHI, a higher value indicates higher fragmentation.

For supplementary outcomes, I use both panel and cross-sectional data on the yakuza. I use the number of yakuza members per 100,000 people from 2008 to 2014. Note that this is an unbalanced panel dataset, consisting of 37 prefectures (see Appendix V for the variable description). Due to this limitation, I use this dataset for a supplementary purpose. Other yakuza measures are based on cross-sectional data, including arrested yakuza members in 2013 (i.e., the number of yakuza arrests per 100,000 people) and arrested yakuza members in 1974 (i.e., the number of arrests per 1,000,000 people, albeit crudely divided)[14], yakuza members across 82 large cities in 1967 (i.e., the number of yakuza members per 10,000 people, where the number is crudely divided)[15], the number of yakuza syndicates' headquarters in 2002, and the number of Yamaguchi-gumi affiliated yakuza groups in 2002. In addition, I create an indicator that equals one if a prefecture has the headquarters of a designated yakuza syndicate formed after 1962 and zero otherwise.

Lastly, I have four placebo outcomes: (i) the number of yakuza members per 100,000 people in

[14]The divisions are 0-200, 201-300, 301-400, 401-500, 501-600, 601-800, and 800 and above. I take the midpoint number for each range.

[15]The divisions are 1.25, 3.75, 6.25, 8.25, 8.75, 12.5, 17.5, and 20.

1951, (ii) the number of yakuza groups in 1951, (iii) an indicator that equals one if a prefecture has the headquarters of a designated yakuza syndicate formed before 1962, and zero otherwise[16], and (iv) the number of hangure groups. The first three outcomes are placebo outcomes related to time. If the energy transition, which took place in the 1960s, had causal effects, these outcomes should not be correlated with the treatment variable. The fourth outcome relates to hangure groups, which are an emergent type of criminal organization distinct from the yakuza. Hangure groups are loosely organized, less hierarchical, and not subject to anti-yakuza laws. As they represent a different type of criminal organization, the energy transition should not be correlated with their presence. Data sources and summary statistics are provided in Table 1.

Empirical Design. With $\widehat{mine\,workers}_i$, I examine the effects of mining job losses induced by the energy transition on yakuza measures. I estimate specification 3 for yakuza measures available in panel data and specification 4 for yakuza measures only available in cross-sectional data:

$$yakuza_{i,r(i),t} = \tilde{\pi}_0 + \tilde{\pi}_1 \widehat{mine\,workers}_i + +\tilde{\pi}_2 X_i + \tilde{\gamma}_{r(i),t} + \tilde{\eta}_{i,r(i),t}, \tag{3}$$

$$yakuza_{i,r(i)} = \pi_0 + \pi_1 \widehat{mine\,workers}_i + +\pi_2 X_i + \gamma_{r(i)} + \eta_{i,r(i)} \tag{4}$$

The coefficients of interest are $\tilde{\pi}_1$ and π_1. $\widehat{mine\,workers}_i$ represents the predicted change in mine workers' share per prefecture due to the energy transition. Lower values indicate greater job losses. If mining job losses increase yakuza activities, $\tilde{\pi}_1$ and π_1 should be negative, indicating that as $\widehat{mine\,workers}_i$ decreases, yakuza measures increase. $\gamma_{r(i)}$ (resp. $\tilde{\gamma}_{r(i),t}$) represents division fixed effects (resp. division-by-time fixed effects). X_i is a vector of prefecture-level time-invariant geographical characteristics. I include latitude, longitude, total land area, elevation, and the areas of mountains, as they are likely correlated with the availability of coal mining areas. Furthermore, I include whether a prefecture is located on the Sea of Japan, as these locations are closer to neighboring countries and might be better suited for illegal smuggling, and the number of ports established prior to 1962, because (i) they might be used for smuggling illegal goods and (ii) coal was transported via ports. $\eta_{i,r(i)}$ ($\tilde{\eta}_{i,r(i),t}$) is the error term. I use cluster standard errors at the prefecture level for equation 3 and robust standard errors for equation 4.

[16] For the this outcome, one caveat is that if a prefecture has both types of syndicates (formed before and after 1962), that prefecture is double-counted.

For yakuza measures in panel data, I then estimate the heterogeneous effects of the energy transition by the yakuza exclusion ordinances (YEOs):

$$yakuza_{i,r(i),t} = \ddot{\pi}_0 + \ddot{\pi}_1 \widehat{mine\,workers}_i + \ddot{\pi}_2 \widehat{mine\,workers}_i \times yeo_{i,t} + \ddot{\pi}_3 yeo_{i,t} + \ddot{\pi}_4 X_i + \ddot{\gamma}_{r(i),t} + \ddot{\eta}_{i,r(i),t}. \quad (5)$$

The coefficients of interest are $\ddot{\pi}_1$ and $\ddot{\pi}_2$. The former is expected to be negative, and the latter is expected to be positive. In other words, before the enactment of the YEOs, the effect of mining job losses due to the energy transition should be large (more negative), but after the YEOs, the effects should be smaller (less negative). The enactment dates of the YEOs are provided in Appendix V

Result on Effect of Mining Job Losses due to Energy Transition on Various Yakuza Activities in the Medium and Long Term. Table 4 presents estimates of the impact of mining job losses due to the energy transition on various yakuza activities. Panels A-E display different outcomes, each with four specifications: Column (1) a bivariate relationship; Column (2) adds division-by-time fixed effects; Column (3) further adds geographic control variables, and Column (4) incorporates the interaction term of mining job losses and the YEOs variable. For panel F with the number of designated yakuza syndicates, the heterogeneous effect by the YEOs is not presented because the sample period is limited to 1996 and 2008.

For yakuza incarceration (total, high-ranking, and regular members), the coefficients of interest are negative and statistically significant across different specifications, except for the bivariate relationship between mining job losses and high-ranking yakuza member incarceration. Recall that because lower values of the treatment variable indicate greater job losses, a negative coefficient means higher yakuza criminal activities. Based on the preferred specification (third column for each outcome), a one standard deviation increase in mining job losses due to the energy transition is associated with an increase in yakuza incarceration by 0.5 per 100,000 people for total (26% relative to the sample mean), 0.2 for high-ranking members (54%), and 0.24 for regular members (30%). By contrast, none of the coefficients are significant for unknown ranks, indicating that the energy transition had little impact on peripheral yakuza members. For yakuza syndicates, a one standard deviation increase in mining job losses due to the energy transition is associated with a

0.189 higher yakuza HHI (42%) and an additional 1.5 yakuza syndicates (50%).

Moreover, the effects of mining job losses on yakuza activities are attenuated following the enactment of the yakuza exclusion ordinances (YEOs), highlighting the importance of reducing the demand for yakuza services as a whole. There are two exceptions to this heterogeneous effect. First, the energy transition shows persistent effects on high-ranking yakuza incarceration, but the YEOs do not mitigate this persistent effect for this group. High-ranking yakuza members are typically deeply committed to the yakuza. This result suggests that the YEOs had little impact on those already established in higher ranks within the yakuza. Second, throughout all specifications, the coefficients are not significant for unknown rank yakuza incarceration, possibly reflecting peripheral yakuza members. However, when heterogeneous effects are considered, a positive effect emerges. This positive coefficient might indicate that after the YEOs, some yakuza members resigned from their syndicates. If apprehended during this transition phase, they would be classified under unknown rank incarceration.

The second is a positive effect observed for unknown rank yakuza incarceration. For one, throughout all specifications, the coefficients are not significant for this group, which might reflect peripheral yakuza members. But when heterogeneous effects are considered, it is positive. The positive coefficient might reflect that after the YEOs, yakuza members resigned their syndicates, and if they were apprehended they would be in transition phase.

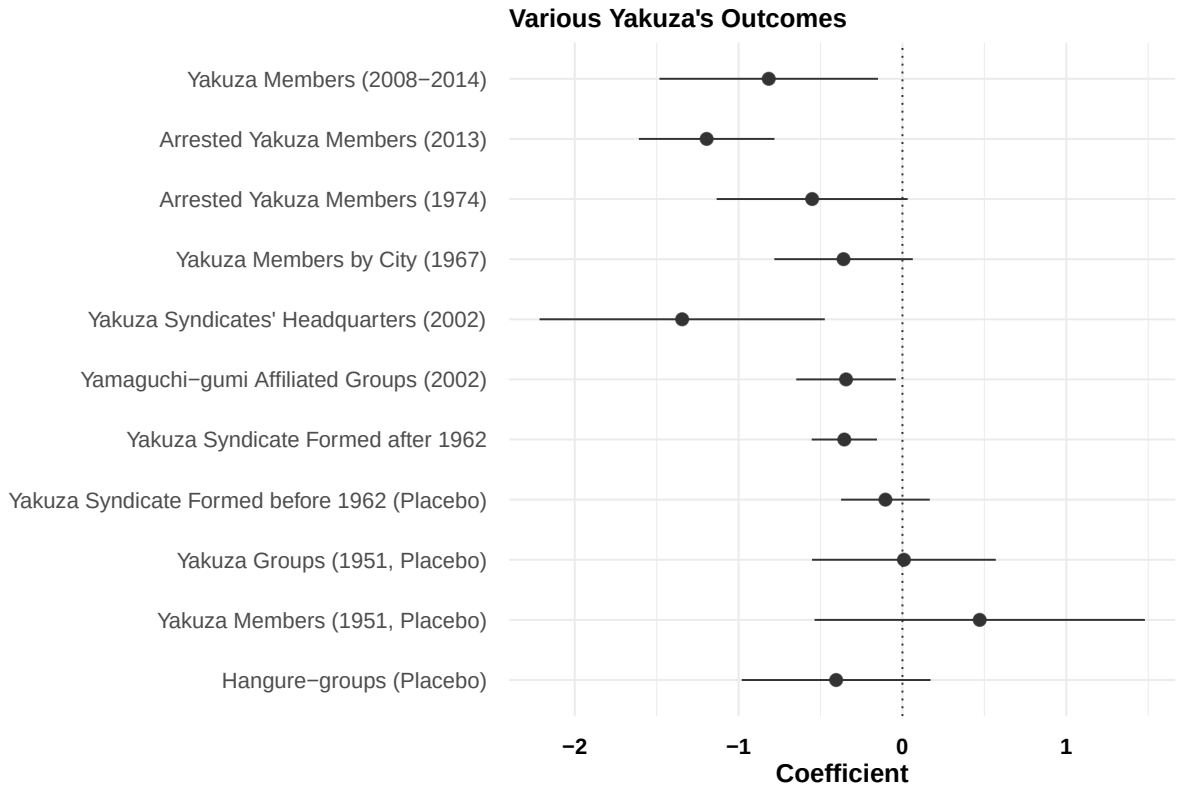
Table 4: Mining Job Losses due to Energy Transition and Contemporary Yakuza Members and Syndicates

	(1)	(2)	(3)	(4)
Panel A: Total Yakuza incarceration (2006-2019)				
Mining Job Losses due to Energy Transition	-0.1172*	-0.2391***	-0.5190***	-0.6492***
	(0.0597)	(0.0515)	(0.0774)	(0.0918)
Mining Job Losses due to Energy Transition × YEO				0.1865***
				(0.0435)
YEO				-0.0200
				(0.3853)
Observations	644	644	644	644
R-squared	0.0293	0.6310	0.6858	0.6969
Panel B: High-ranking Yakuza Incarceration (2006-2019)				
Mining Job Losses due to Energy Transition	-0.0201	-0.0568*	-0.2668***	-0.2680***
	(0.0414)	(0.0313)	(0.0334)	(0.0355)
Mining Job Losses due to Energy Transition × YEO				0.0008
				(0.0103)
YEO				-0.0800
				(0.1534)
Observations	644	644	644	644
R-squared	0.0076	0.5894	0.7177	0.7179
Panel C: Regular Yakuza Member Incarceration (2006-2019)				
Mining Job Losses due to Energy Transition	-0.1122***	-0.1786***	-0.2460***	-0.3887***
	(0.0217)	(0.0232)	(0.0451)	(0.0592)
Mining Job Losses due to Energy Transition × YEO				0.2039***
				(0.0359)
YEO				-0.0497
				(0.2567)
Observations	644	644	644	644
R-squared	0.0666	0.6371	0.6667	0.6997
Panel D: Unknown Rank Yakuza Incarceration (2006-2019)				
Mining Job Losses due to Energy Transition	0.0150**	-0.0037	-0.0062	0.0074
	(0.0056)	(0.0040)	(0.0298)	(0.0313)
YEO				0.1097*
				(0.0603)
Mining Job Losses due to Energy Transition × YEO				-0.0182***
				(0.0066)
Observations	644	644	644	644
R-squared	0.0087	0.3298	0.3791	0.3819
Panel E: Yakuza HHI (2008-2013)				
Mining Job Losses due to Energy Transition	-0.0610***	-0.0451**	-0.1891***	-0.1919***
	(0.0173)	(0.0205)	(0.0464)	(0.0462)
Mining Job Losses due to Energy Transition × YEO				0.0038**
				(0.0018)
YEO				-0.0216
				(0.0879)
Observations	276	276	276	276
R-squared	0.1124	0.4902	0.6947	0.6948
Panel F: # of Designated Yakuza Syndicates (1996,2008)				
Mining Job Losses due to Energy Transition	-0.4684***	-0.4950***	-1.5344***	
	(0.0994)	(0.1270)	(0.1991)	
Observations	92	92	92	
R-squared	0.1447	0.6150	0.7889	
Geographic Controls	-	-	x	x
Division-time FE	-	x	x	x

Notes: Total Yakuza incarceration Incarceration: the number of yakuza incarceration per 100,000 people. **High-ranking Yakuza Incarceration**: the number of incarcerated high-ranking yakuza members per 100,000 people. **Regular Yakuza Member Incarceration:** the number of incarcerated regular yakuza members per 100,000 people. **Unknown Rank Yakuza Incarceration**: the number of incarcerated yakuza members with unknown rank per 100,000 people. **Yakuza HHI:** defined as $1 - HHI$ indicating a higher value = more fragmentation among different yakuza syndicates. **Geographic controls:** i.e., latitude, longitude, land area, elevation, the amount of mountains, whether a prefecture is located on the Sea of Japan, the number ports established before 1962. Significance at the 1%, 5%, and 10% levels indicated by ***, **, and *, respectively. Standard errors are clustered at the prefecture level.

Figure 8 presents estimates and 95% confidence intervals for disaggregated outcomes, assessing medium- and long-term effects. To facilitate interpretation, all continuous measures are standardized to have a mean of 0 and a standard deviation of 1. Across all relevant measures, prefectures experiencing greater mining job losses exhibit higher yakuza activities in the 1970s, 1990s, and 2000s-2010s, although some estimates are less precise. Notably, the number of yakuza groups affiliated with the Yamaguchi-gumi, the largest yakuza syndicate, is higher in prefectures with greater mining job losses, suggesting group expansion in these areas. Null effects or an opposite-signed coefficient for placebo outcome measured before the energy transition or unrelated to the yakuza further strengthens the credibility of the results.

Figure 8: Estimates and 95% Confidence Intervals: Various Yakuza's Activities



Note: All continuous variables are standardized to mean = 0 and standard deviation = 1. **Observations**: 46 for all outcomes except for **Yakuza Members by City (1967)** and **Yamaguchi-gumi Affiliated Groups**. **Yakuza Members by City (1967)**: based on 82 cities. **Yamaguchi-gumi Affiliated Groups**: 45 with Hyogo prefecture excluded, where the headquarter of the Yamaguchi-gumi is located. **Yakuza syndicate formed after (resp. before) 1962**: binary outcome. **Specification:** division fixed effects, and geographic controls (i.e., latitude, longitude, land area, elevation, the amount of mountains, whether a prefecture is located on the Sea of Japan, the number ports established before 1962)

3.3 Municipal-level Analysis

Lastly, I provide micro-level evidence of yakuza and business expansion patterns in mining and nearby non-mining municipalities, using municipal-level data from Fukuoka prefecture. Fukuoka is historically known for both its coal mining industry and high yakuza activity. Specifically, I examine the minimum distance from a historical coal mining establishment and the number of historical coal mining establishments in relation to the current number of yakuza offices and other crime measures, as well as the number of establishments in non-mining sectors that the yakuza are likely involved in, both in the medium and long run.

To test the hypothesis that as the coal mining industry declined in mining municipalities, yakuza groups expanded their territories into nearby non-mining municipalities where new business opportunities emerged, the following should be observed. First, non-mining municipalities closer to those with historical coal mining establishments should have higher yakuza presence, higher crime rates, and more business establishments. Therefore, the distance from mining municipalities should be negatively correlated with these outcomes. Second, municipalities with a higher number of historical coal mining establishments should have lower or similar levels of yakuza presence, crime rates, and fewer or a similar number of business establishments compared to municipalities with fewer mining establishments. Thus, the number of mining establishments should be either negatively correlated or uncorrelated with these outcomes.

I use the number of yakuza offices sourced from the "Yakuza Office Street View Search (Yakuza Jimusho Street View Kensaku)" (see Appendix V for the description of the website), the number of violent and property crimes from 2007 to 2019, obtained from the Fukuoka Prefectural Police Department, as well as the number of business establishments for different sectors in 1972, 1981, 1991, 2001, and 2012, obtained from the official homepage of the Fukuoka Prefecture. The number of historical mining establishments as of 1961 is sourced from the Japan Mining Archive, and I calculate the minimum distance from a municipality to municipality with a historical mining establishment as of 1961.[17] Summary statistics are provided in Table 1. Using WLS with municipality

[17]For municipalities that changed their borders due to municipal mergers during this period, I use the current municipality.

population from the 1960 census year as the weights, I estimate the following equations:

$$yakuza_{i,r} = \alpha_0 + \alpha_1 \ln dist_i + \alpha_2 \#mining\, est_i + \alpha' X_i' + \delta_r^b + \epsilon_{i,r}, \tag{6}$$

$$crime_{i,r,t} = \tilde{\alpha}_0 + \tilde{\alpha}_1 \ln dist_i + \tilde{\alpha}_2 \#mining\, est_i + \beta' X_i' + \tilde{\delta}_r^b + \tilde{\delta}_t^b + \tilde{\epsilon}_{i,r,t}, \tag{7}$$

$$establishment_{i,r,t} = \ddot{\alpha}_0 + \sum_{t=1971}^{2012} \ddot{\alpha}_t^{dist} \ln dist_i \times \mathbb{1}_t + \sum_{t=1971}^{2012} \ddot{\alpha}_t^{est} \#mining\, est_i \times \mathbb{1}_t + \beta' X_i' + \tilde{\delta}_r^b + \tilde{\delta}_t^b + \tilde{\epsilon}_{i,r,t}, \tag{8}$$

In equation 6, $yakuza_{i,r}$ is either the presence of yakuza offices (extensive margin) or the number of yakuza offices (intensive margin) in municipality i; in equation 7, $crime_{i,r,t}$ is either the number of violent or property crimes per 100,000 residents; in equation 8, $establishment_{i,r,t}$ is the number of establishments for a particular sector, such as construction, in municipality i and year t. $\ln dist_i$ is the log of the minimum distance from a municipality with a historical mining establishment to municipality i, while $\#mining\, est_i$ is the number of historical coal mining establishments.[18] X_i includes latitude, longitude, and land area. δ_r^b ($\tilde{\delta}_r^b$) and $\tilde{\delta}_t^b$ represent region-by-mining-presence fixed effects and year-by-mining-presence fixed effects, respectively, where Fukuoka prefecture is divided into three regions r (i.e., Fukuoka, Kitakyushu, Chikuho-Chikugo).[19][20] Region-by-mining-presence fixed effects allow for comparing varying distances among non-mining municipalities, and varying numbers of mining establishments among mining municipalities within each region.

α_1 (resp. $\tilde{\alpha_1}$) is expected to be negative and captures the distance effect on the outcome of interest among municipalities without a coal mining establishment within a region (resp. within a region and time), while α_2 (resp. $\tilde{\alpha_2}$) is expected to be null or negative and captures the effect of the number of historical mining establishments on the outcome of interest among municipalities with a coal mining establishment within a region (resp. within a region and time).[21] For equation

[18] For municipalities with at least one coal mining establishment, taking the log of the distance variable generates missing values. I replace those missing values with zero after the logarithm transformation.

[19] According to government statistics, Fukuoka is divided into four regions: Fukuoka, Kitakyushu, Chikuho, and Chikugo. However, because 14 out of 15 municipalities in the Chikuho region have historical coal mining establishments, there is little variation in the region. Thus, I combine the Chikuho and Chikugo regions, which are adjacent to one another, to have more variation for estimation.

[20] Region-by-mining-presence fixed effects and time-by-mining-presence fixed effects are interaction terms of region and time (year) fixed effects, respectively, and a dummy variable, $mining\, est_i$, that indicates whether a municipality has a historical mining establishment. To be sure, $mining\, est_i$ is the extensive margin, and $\#mining\, est_i$ is the intensive margin of historical mining establishments.

[21] By construction, note that α_1 (resp. $\tilde{\alpha_1}$) is not estimable if $mining, est_i \neq 0$, and α_2 (resp. $\tilde{\alpha_2}$) is not estimable if $mining, est_i = 0$.

8, to better understand the medium and long run effects, I allow for the effects ($\ddot{\alpha}_t^{dist}$, $\ddot{\alpha}_t^{est}$) to vary across specific periods: 1971, 1981, 1991, 2001, and 2012.

Due to the proximity of municipalities to historical coal mining establishments, spatial correlation likely exists between observations. To account for this spatial correlation, I use Conley spatial standard errors with a 28 km window (Conley, 1999). The 28 km cutoff is determined by the maximum value of the minimum distance between a municipality and a municipality with a historical coal mining establishment. This ensures that all municipalities within the specified distance from a mining municipality are considered in the spatial correlation calculation. Furthermore, I apply a Bartlett kernel of distance to allow for distance decay within the error term between municipalities within the cutoff.

Result on Effect of Distance to Historical Coal Mining Establishments on Yakuza Offices, Crime Measures, and Potential Channels. Table 5 provides the estimation results. Panel A shows the results for contemporary yakuza offices and crime measures. Specifically, Columns (1) show the result for the presence of yakuza offices (extensive margin); Columns (2) shows the results for the number of yakuza offices (intensive margin); Columns (3-4) show the results for violent and property crime outcomes, respectively. Panel B shows the results for potential channels; Columns (1-4) show the results for # of establishments for construction, restaurants, real estate, and infrastructure, respectively.

Panel A reveals that the coefficients on the log of distance to a municipality with historical coal mining establishments are negative for both the extensive and intensive margins of yakuza offices, as well as violent crime rates. This indicates that the closer a municipality is to a municipality with historical mining establishments, the more yakuza offices it has. Specifically, for the extensive margin of yakuza offices, municipalities that are one percent closer have a 0.512 percentage point higher likelihood of the presence of yakuza offices. For the intensive margin, municipalities that are one percent closer have approximately 0.015 more yakuza offices. Regarding crime measures, being one percent closer is associated with about 0.2 more violent crimes and roughly 1.7 more property crimes per 100,000 residents. However, the coefficients for the number of coal mining establishments are not statistically significant for all outcomes, with only marginal significance observed for the intensive margin of yakuza offices.

Table 5: Effect of Distance to Historical Coal Mining Establishments on Yakuza Offices, Crime Measures, and Potential Channels

PANEL A	(1)	(3)	(1)	(2)
Dep.Var.:	Yakuza Office		Violent Crime	Property Crime
	Extensive Margin	Intensive Margin		
log of Distance to a Coal Mining Establishment	-0.5142***	-1.5417***	-27.5426***	-168.6246**
	(0.1304)	(0.4057)	(6.6238)	(84.7584)
# of Coal Mining Establishments	-0.0161	-0.0604*	0.3065	10.3443
	(0.0098)	(0.0330)	(0.7318)	(9.4984)
Region x Mining-Presence Fixed Effects	x	x	x	x
Covariate	x	x	x	x
Observations	72	72	936	936
R-squared	0.2485	0.1672	0.118	0.0700
Sample Period	As of 2023		2007-2019	
PANEL B	(1)	(3)	(1)	(2)
Dep.Var.:	# of Establishments			
	Construction	Restaurants	Real Estate	Infrastructure
log of Distance to a Coal Mining Establishment × 1971	-151.7474**	-1,028.0475***	-272.5330***	-2.0947
	(72.8872)	(383.4713)	(67.3316)	(2.8744)
log of Distance to a Coal Mining Establishment × 1981	-267.5601***	-1,171.2689***	-222.9883***	-4.5193***
	(87.8223)	(402.4294)	(75.7512)	(1.0041)
log of Distance to a Coal Mining Establishment × 1991	-350.6493***	-2,909.9056***	-236.0296***	-4.2389***
	(106.4057)	(1,003.5030)	(79.5416)	(1.3640)
log of Distance to a Coal Mining Establishment × 2001	-309.0986***	-2,681.4960***	-125.6823*	-10.8191***
	(113.3589)	(915.8410)	(75.4602)	(3.0827)
log of Distance to a Coal Mining Establishment × 2012	-346.7691***	-1,333.0610***	-210.0195**	-6.6509***
	(97.7807)	(471.0122)	(93.6973)	(2.0866)
# of Coal Mining Establishments × 1971	-2.2513	19.5740	-2.3442	0.5657***
	(8.5963)	(44.1757)	(6.9774)	(0.1449)
# of Coal Mining Establishments × 1981	1.5426	3.3293	-7.1495	0.6669***
	(9.4854)	(43.2001)	(8.0943)	(0.1716)
# of Coal Mining Establishments × 1991	3.1085	2.2794	-3.7061	0.5370***
	(9.8260)	(80.1627)	(8.2759)	(0.1533)
# of Coal Mining Establishments × 2001	4.9928	9.4239	-0.9379	0.2997**
	(9.7624)	(61.7406)	(6.7009)	(0.1222)
# of Coal Mining Establishments × 2012	0.7961	-1.5371	-0.2703	-0.2761**
	(9.2427)	(43.2384)	(7.4993)	(0.1238)
Region x Mining-Presence Fixed Effects	x	x	x	x
Year x Mining-Presence Fixed Effects	x	x	x	x
Covariate	x	x	x	x
Observations	360	360	360	360
R-squared	0.2079	0.1112	0.0571	0.2426
Sample Period	1971, 1981, 1991, 2001, 2012			

Notes: Yakuza Office (Extensive Margin): the presence of yakuza offices (a binary outcome). **Yakuza Office (Intensive Margin):** # of yakuza offices. **Violent Crime Rates:** # of violent crime per 100,000 residents. **Property Crime Rates:** # of property crime per 100,000 residents. **# of Construction Establishments:** # of establishments in the construction sector. **# of Restaurants:** # of establishments in the accommodations, eating and drinking service sector. **# of Real Estate:** # of establishments in the real estate activity sector. **# of Infrastructure:** # of establishments in the electricity, gas, heat supply and water sector. Significance at the 1%, 5%, and 10% levels indicated by ***, **, and *, respectively. Conley standard errors in parentheses.

Panel B reveals that municipalities in closer proximity to a municipality with a historical mining establishment have a higher number of business establishments in the construction, restaurant, real estate, and infrastructure sectors in the medium and long run. The time-varying coefficients on the log of distance are statistically significant across the examined periods, indicating a expansion of these business establishments near municipalities with historical coal mining presence. However,

with the exception of infrastructure, the time-varying coefficients on the number of historical coal mining establishments are not statistically significant.

The findings support the idea that business establishments have expanded in municipalities closer to those with a historical coal mining presence, and this effect persists over the medium and long term. Consequently, yakuza groups extend their territorial influence.

4 Conclusion

This study examines the nexus of natural resources and organized crime by addressing three key gaps in the literature: (i) demand shifts between natural resources, (ii) the long-term effects of negative demand shocks, and (iii) the impact of natural resource demand shifts on existing organized crime groups already involved in the legal resource sector. The study focuses on the energy transition from coal to oil in the 1960s and Japanese organized crime, the yakuza.

Following the energy transition, mining-associated yakuza members shifted to illegal economic activities, joining yakuza groups in other sectors. Non-mining yakuza groups exploited the weakened mining-associated yakuza groups in coal-rich prefectures with high demand for their services, leading to conflicts that persisted for over 50 years. In the medium to long term, prefectures with greater mining job losses due to the transition have more yakuza members and groups. However, the implementation of yakuza exclusion ordinances that discourage association with the yakuza and reduce demand for their services as a whole partially breaks the cycle of persistent effects.

Despite the fact that high demand for organized crime typically occurs when institutions are underdeveloped, this study indicates an increase in yakuza's activities during Japan's economic boom from the mid-1950s to the 1970s. While the specific case of the yakuza may have limitations in terms of its external validity, the results of this study nonetheless provide important lessons for understanding the connection between natural resources and organized crime more broadly.

First, when criminal groups that had been involved in a legitimate sector face a demand shift from one resource to another, they may find their income sources from the legitimate sector diminished. This loss of income can push these groups to transition to illegal economic activities and join other criminal organizations. The resulting changes in criminal group composition and the expansion of criminal groups in areas affected by the transition can create competition, leading to

increased conflict in these regions, which may persist in the long run.

Second, because the energy transition is a structural and irreversible change, and joining a criminal organization is an irreversible investment, the transition acts as a persistent shock for members of organized crime. One important implication of this study is its relevance to the current debate about energy transitions, which focuses not on the transition to oil, but rather on the transition away from oil. For instance, research has identified the involvement of Mexican drug trafficking organizations in oil theft (Battiston et al., 2022). As a result, we might observe long-term changes in criminal activities when there is a shift from oil to other energy sources.

Third, despite the adverse, long-term effects of the energy transition, if demand for organized crime is effectively reduced, the effects can be mitigated. Nunn (2020) highlights the importance of designing policies that take into account historical elements. To echo this, the present study considers what policies might be effective in mitigating the long-term effects of a historical event. However, it is crucial to note that while the yakuza exclusion ordinances were successful in reducing the number of yakuza members (Hoshino and Kamada, 2020), the ordinances unintentionally created another source of illegal market activity engaged by former and current yakuza members who likely struggle with their economic opportunities (Hoshino and Kamada, 2022). Therefore, additional rehabilitation programs may be necessary to provide further support to both current and former yakuza members, and this might be more effective at mitigating the persistent effects of the energy transition.

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APPENDIX

A Alternative Explanations

Additional Evidence for the Energy Transition as a Negative Labor Demand Shock for Mining-associated Yakuza: To bolster the interpretation that the energy transition deprived mining-associated yakuza of income sources from the mining industry, Appendix F shows that labor disputes decreased in coal-rich prefectures post-transition. This result is consistent with accounts of mining-associated yakuza groups intervening in the mining industry to settle labor disputes, such as their involvement in the 1959-1960 Miike coal mine labor dispute (Hyodo, 1981).

Enforcement Explanations for Yakuza Arrests: An increase in yakuza arrest following the energy transition could be due to an increase in enforcement. I partially eliminate this channel by regressing enforcement measures on the treatment in a DiD regression (Appendix H). I also include the number of police officers in the pre-energy transition period interacted with year fixed effects in some of my specifications as a robustness check. I also assess the robustness of the findings on contemporary yakuza outcomes by controlling for contemporary police force size in the regression model, although this may introduce potential bad control concerns.

Another potential explanation for the short-term increase in yakuza arrests could be that as mining-associated yakuza groups lost power, they were less able to bribe police officers, leading to more arrests. However, if this were the case, we would expect to see an increase specifically in arrests of mining-associated yakuza members (both those directly involved in mining and those among racketeers). Moreover, mining-yakuza groups typically operated on a small scale, making it unlikely they could influence police behavior at the prefecture level.

Alternative Explanations for the Persistent Effect: The persistent effects of the energy transition on contemporary yakuza outcomes might be explained by the resulting long-term economic decline. In the Bartik-style analysis, I include contemporary economic and demographic variables to test whether they attenuate the transition's effects, although these likely constitute bad controls (Angrist and Pischke, 2008). However, I find little evidence that these economic channels explain the persistent effect (Appendix Q).

Energy Transition Affecting Specific Populations: 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. I examine this possibility in two ways. First, I use total and non-yakuza arrests for property crime, instead of yakuza arrests for property crime, and show that the effects are entirely driven by yakuza-specific arrests, not non-yakuza arrests (Appendix J). Second, I regress unemployment rates on the treatment variable and show that the energy transition did not change overall unemployment rates at the prefecture level (Appendix E). Instead, the result in Appendix E is consistent with

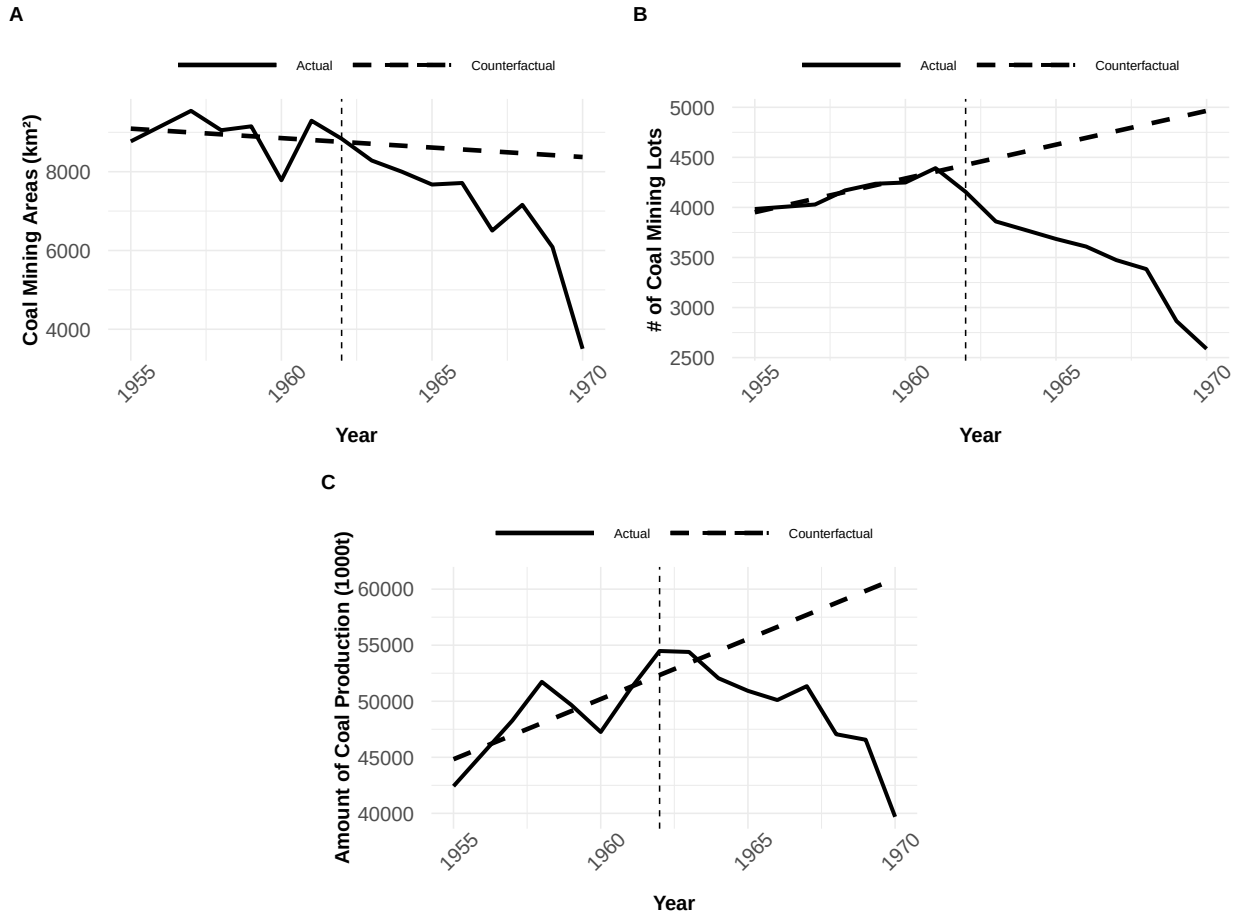
the interpretation that some mine workers transitioned into the construction industry following the energy transition. This can explain why coal miners did not transit into yakuza groups, or non-yakuza arrests for property crime did not increase following the energy transition.

B Coal Mining Measures: Trends and Regional Distribution

Overall Trends of Individual Coal Mining Measures

In the main text, I present the overall trends of the coal mining availability index. This subsection examines the specific trends for each coal mining measure: coal mining areas (Panel A), mining lots (Panel B), and coal production volume (Panel C). During the pre-transition period, an upward trend in coal production is observed, potentially due to the industry's efforts to streamline operations. However, the post-transition period exhibits a significant decline in coal production despite these earlier efforts.

Figure A1: Overall Trends of Each Coal Mining Measure



Geographic Distribution of Coal Mining Measures across Prefectures

This subsection presents the distribution of the coal mining availability index and its individual components, including coal mining areas, mining lots, and coal production volume.

Table A1: Distribution of Coal Mining Measures across Prefectures

Prefecture	Coal Mining Availability Index	Coal Mining Areas	Coal Mining Lots	Amount of Coal Production
Aichi	-0.3477806	0	0	0
Akita	-0.2215352	7005	41	79750
Aomori	-0.3393403	577	3	0
Chiba	-0.3477806	0	0	0
Ehime	-0.3377817	599	3	64
Fukui	-0.3093768	2173	13	4638
Fukuoka	3.177384	106487	641	17000000
Fukushima	0.6347933	41036	267	2446227
Gifu	-0.3431514	137	2	354
Gunma	-0.3477767	0	0	40
Hiroshima	-0.3477806	0	0	0
Hokkaido	5.147648	284664	1177	14900000
Hyogo	-0.3477806	0	0	0
Ibaraki	0.010899	11432	78	1472606
Ishikawa	-0.3427659	254	2	16
Iwate	-0.2916332	3188	18	35714
Kagawa	-0.3477806	0	0	0
Kagoshima	-0.3477806	0	0	0
Kanagawa	-0.3477806	0	0	0
Kochi	-0.3469971	51	0	0
Kumamoto	0.0183611	22706	106	259998
Kyoto	-0.3363683	720	4	0
Mie	-0.3354733	371	5	11763
Miyagi	-0.3400671	579	2	867
Miyazaki	-0.3424993	388	2	0
Nagano	-0.2880401	2413	24	21676
Nagasaki	1.526483	98832	387	5207535
Nara	-0.3420453	406	2	473
Niigata	-0.3247187	1082	9	3050
Oita	-0.3384218	666	3	0
Okayama	-0.318819	1454	10	14579
Osaka	-0.3477806	0	0	0
Saga	1.403955	105345	437	2689889
Saitama	-0.3477806	0	0	0
Shiga	-0.3477806	0	0	0
Shimane	-0.3200659	1800	9	2217
Shizuoka	-0.3477806	0	0	0
Tochigi	-0.3477628	0	0	179
Tokushima	-0.3286597	1225	6	2017
Tokyo	-0.3477806	0	0	0
Tottori	-0.3413099	414	2	275
Toyama	-0.3247399	2278	4	319
Wakayama	-0.3297983	651	7	19337
Yamagata	-0.235437	6300	33	123311
Yamaguchi	0.6642115	35350	261	3242808
Yamanashi	-0.3357835	820	4	51

C Explanation for Construction of Mining Job Losses due to Energy Transition with Bartik-type Design and Estimation Result

Explanation

To capture mining job losses due to energy transition, I exploit Bartik-type variation with crude oil import quantities over time, that interacts with time-varying coal mining availability across prefectures and time. That is, I include the interaction term of time-varying coal mining availability index $mine_{i,t}$, and crude oil import quantities over time $oil\,import_t$:

$$mine\,workers_{i,r(i),t} = \ddot{\beta}_1\, mine_{i,t} \times oil\,import_t + \ddot{\beta}_2\, mine_{i,t} + \ddot{\mu}_i + \ddot{\delta}_{r(i),d} + \ddot{\epsilon}_{i,r(i),t}. \tag{9}$$

The key component of this equation is the interaction term $mine_{i,t} \times oil\,import_t$, which captures the differential effects of oil import quantities on mining employment by the local availability of coal mining. I then construct a predicted treatment variable: $\widehat{mine\,workers}_i = \frac{1}{T}\sum_{t=1}^{T} \widehat{\beta}_1\, mine_{i,t} \times oil\,import_t$ This variable represents the average predicted change in the share of mine workers for each prefecture over the study period, induced by the energy transition as proxied by changes in oil import quantities.

This approach differs slightly from the standard Bartik-type design. Typically, such designs exploit the interaction of time-invariant cross-sectional variation with time variation. However, in this case, using a time-invariant measure of coal mining availability ($mine_i$) would lead to a problem. Because $\widehat{mine\,workers}_{i,t} = \widehat{\beta}_1\, mine_i \times oil\,import_t$ is the product of constant terms ($\widehat{\beta}_1$ and $mine_i$) and a time-varying term ($oil\,import_t$), $\widehat{mine\,workers}_{i,t}$ is just a constant multiple of $oil, import_t$. Thus, when $\widehat{mine\,workers}_{i,t}$ is averaged across time for the Bartik-style analysis, the resulting treatment variable, $\widehat{mine\,workers}_i$, would result in perfect collinearity with $mine_i$. To avoid this issue, I use $mine_{i,t}$, which varies both across prefectures and over time.

This approach follows Sequeira et al. (2020), who study the effects of historical immigration on contemporary economic development. They construct a time-invariant cross-sectional instrumental variable using panel data: they exploit immigration flows that change over time and time-varying railroad expansion across counties.

Estimation Result

Table A2 represents the estimation result from equation 9. The coefficient is negative and statistically significant, indicating that during this period, when crude oil import quantities were rising, coal-rich prefectures experienced a greater decrease in the share of mine workers compared to coal-scarce prefectures. From 1955 to 1970, oil import quantities increased from 9 ML to 204 ML. This indicates that a one standard deviation increase in coal mining availability leads to a decrease of approximately 0.85 mine workers per 100 total workers when oil import quantities increase by 195 ML. This translates to a 78% decrease relative to the baseline mean of the outcome in 1955 (1.0189 mine workers per 100 total workers).

Table A2: Bartik Reduced-form Estimate

Dep.Var.:	Mine Workers
Coal Mining Availability × Oil Import Quantity	-0.0044***
	(0.0011)
Coal Mining Availability (Time-Varing)	x
Prefecture Fixed Effects	x
Division-by-Time Fixed Effects	x
R-squared	0.9874
Observations	276
Sample Years	1955, 1959, 1961, 1965, 1967 ,1970

Notes: Data on import quantity is originally measured in thousands of kiloliters (kL). For improved readability, I divided this value by 1000, converting the unit to millions of kiloliters (ML). Significance at the 1%, 5%, and 10% levels indicated by ***, **, and *, respectively. Standard errors clustered at the prefecture level.

D Balance Test

I regress the predicted treatment variable on a number of prefecture-level characteristics, including geographic characteristics as well as historical measures on demographic and economic characteristics measured before the energy transition, conditional on division fixed effects. Table A3 indicates that the covariates are not associated with the decline in mine workers induced by the energy transition conditional on division fixed effects and geographic covariates. One exception is the coefficient on total number of public gambling sites, which is marginally significant. This result lends credence to the exogeneity of mining job losses induced by the energy transition.

Table A4 indicates that the covariates are not generally associated with the historical presence of mining-associated yakuza groups (exception is proportions of aged 15-19 population), conditional on coal mining availability. Instead, mining-associated yakuza groups are far more likely to be present in prefectures with greater coal mining availability in the pre-transition period. This is consistent with the idea that greater coal mining availability increases the demand for mining-associated yakuza, either as labor brokers or protection racketeers, consistent with Buonanno et al. (2015); Dimico et al. (2017); Gambetta (1993).

Table A3: Balance Test for Mining Job Losses due to Energy Transition

Variable	Coefficient	Standard Error	R-squared
Prop. of Male Population	-0.1141	(0.0923)	0.8446
Prop. of Korean Population	-0.1465	(0.1434)	0.8449
Prop. of Urban Population	-0.0577	(0.0873)	0.8401
Prop. of Population Aged 15-29	-0.1139	(0.0879)	0.8469
Prop. of Households on Welfare	-0.0292	(0.2257)	0.8386
Prop. of Outcaste Population	-0.1429	(0.1619)	0.8443
# of Total Gambling Sites	-0.2668*	(0.1493)	0.8818
Methamphetamine Arrest Rates	0.0226	(0.0956)	0.8385
Prop. of Construction Workers	-0.2286	(0.1544)	0.8628
Manufacturing total rate	-0.0206	(0.0150)	0.8495
Observations		46	
Geographic Covariates		x	
Division FE		x	

Notes: Significance at the 1%, 5%, and 10% levels indicated by ***, **, and *, respectively. Robust standard errors in parentheses. All covariates are measured in the pre-transition period and standardized to mean = 0 and standard deviation = 1. Each row represents a regression result of $\widehat{mine, workers}_i = \beta_0 + \beta_1 Z_i + \beta_2 X_i + \gamma_{r(i)} + \epsilon_i$, where $\widehat{mine, workers}_i$ is mining job losses due to the energy transition, Z_i is the variable of interest, X_i is geographic controls, and $\gamma_{r(i)}$ is division fixed effects.

Table A4: Balance Test for Presence of Mining-associated Yakuza

Variable	Coefficient	Standard Error	R-squared
Prop. of Male Population	0.1145	(0.0941)	0.4595
Coal Mining Availability	0.3411**	(0.1305)	
Prop. of Korean Population	0.0517	(0.0911)	0.4352
Coal Mining Availability	0.3597***	(0.1303)	
Prop. of Urban Population	0.0208	(0.1011)	0.4326
Coal Mining Availability	0.3687***	(0.1335)	
Prop. of Population Aged 15-29	0.1570**	(0.0728)	0.5020
Coal Mining Availability	0.3070**	(0.1369)	
Prop. of Households on Welfare	0.0266	(0.0898)	0.4327
Coal Mining Availability	0.3698**	(0.1377)	
Prop. of Outcaste Population	-0.0863	(0.0946)	0.4410
Coal Mining Availability	0.3925***	(0.1250)	
# of Total Gambling Sites	0.1747	(0.1236)	0.4925
Coal Mining Availability	0.2170	(0.1885)	
Methamphetamine Arrests Rates	-0.0348	(0.0788)	0.4343
Coal Mining Availability	0.3691**	(0.1346)	
Prop. of Construction Workers	-0.1690	(0.1104)	0.4830
Coal Mining Availability	0.4689***	(0.1279)	
Prop. of Manufacturing Workers	0.0022	(0.0153)	0.4321
Coal Mining Availability	0.3656**	(0.1426)	
Observations		46	
Geographic Covariates		x	
Division FE		x	

Notes: Significance at the 1%, 5%, and 10% levels indicated by ***, **, and *, respectively. Robust standard errors in parentheses. All covariates are measured in the pre-transition period and standardized to mean = 0 and standard deviation = 1. Each row represents a regression result of $yakuza_i^m = \beta_0 + \beta_1 Z_i + \beta_2 mine_i + \beta_3 X_i + \gamma_{r(i)} + \epsilon_i$, where $yakuza_i^m$ is an indicator for the presence of mining-associated yakuza groups, Z_i is the variable of interest, $mine_i$ is coal mining availability, X_i is geographic controls, and $\gamma_{r(i)}$ is division fixed effects.

E Substitution Effects

E.1 Substitution to Other Industries and Unemployment Rates

Table A5 provides summary statistics for variables used in Appendices E and F.

Table A5: Summary Statistics for Variables Used in Appendix E and F

		Mean	Std.Dev.
Japan Statistical Yearbook	Construction Workers (1955, 1959, 1961, 1965, 1967, 1970)	4.885	2.025
Japan Statistical Yearbook	Manufacturing Workers (1955, 1959, 1961, 1965, 1967, 1970)	17.761	9.991
Census	Unemployment Rates (1955, 1960, 1965, 1970)	0.027	0.022
Japan Statistical Yearbook	Labor Disputes(1966-1970)	0.011	0.009
Japan Statistical Yearbook	Union Members (1956-1969)	16.802	6.500

Notes: Worker-related variables: the number of workers of interest, labor disputes, union members per 100 total workers.

The results in the main text indicate that the energy transition led to higher yakuza activities. The short-term results are consistent with the idea that mining-yakuza members switched to illegal economic activities following the energy transition. The results also suggest that coal miners who lost their jobs did not sort into the yakuza (see Table 2). To further bolster the latter possibility, I test the substitution of legitimate industries. That is, if mine workers could substitute their jobs with alternative industries, participating in a yakuza group might not have been necessary. To test this, I estimate the DiD and Bartik specifications with the outcomes being the share of workers in relevant low-skilled industries: (i) construction, (ii) manufacturing, (iii) infrastructure, as well as unemployment rates. For Bartik specifications, because crude oil import quantities were increasing during this period, which serves as a negative demand shifter in coal-rich areas, a negative coefficient implies a decrease in the outcome of interest. For Bartik specification, I estimate the following specification: $y_{i,r(i),t} = \ddot{\beta}_1 \, mine_i \times oil\, import_t + \ddot{\mu}_i + \ddot{\delta}_{r(i),d} + \ddot{\epsilon}_{i,r(i),t}$. Unlike equation 3.2, I do not use time-varying $mine_{i,t}$, but time-invariant $mine_i$, where I fix the value in the pre-energy transition period.

Table A6 provides DiD (Panel A) and Bartik reduced-form (Panel B) estimates. Column (1) shows the result for mine workers; Column (2) for construction workers; Column (3) for manufacturing workers; Column (4) for unemployment rates. All the results are consistent across Panels. That is, mine workers decreased in the post-transition period, decreased when oil import quantities were increasing. This is partially offset by an increase of construction workers, but no change in manufacturing workers or unemployment rates. For instance, a one standard deviation increase in coal mining availability leads to a 0.546 decrease in mine workers per 100 total workers post-transition (i.e., a 46.7% reduction relative to the baseline mean), and an increase of 0.263 construction workers per 100 total workers, which translates into about an 8% increase relative to the baseline mean. These results are consistent with the idea that some mine workers transitioned into the construction industry following the energy transition.

Table A6: Substitution to Construction, Manufacturing Industries, and Unemployment Rates

PANEL A Dep.Var.:	(1) Mine Workers	(2) Construction Workers	(3) Manufacturing Workers	(4) Unemployment Rates
Coal Mining Availability × Post	-0.5456** (0.2145)	0.2627*** (0.1477)	0.1931 (0.3584)	-0.0168 (0.0210)
R-squared	0.9491	0.9368	0.9678	0.9330
PANEL B Dep.Var.:	(1) Mine Workers	(2) Construction Workers	(3) Manufacturing Workers	(4) Unemployment Rates
Coal Mining Availability × Oil Import Quantity	-0.0039** (0.0016)	0.014** (0.0004)	0.0006 (0.0015)	-0.0444 (0.0362)
R-squared	0.9461	0.9349	0.9678	0.9450
Observations	276	276	276	184
Sample Periods		1955,1959, 1961, 1965, 1967, 1970		1955,1960, 1965, 1970

Notes: Notes: Data on import quantity is originally measured in thousands of kiloliters (kL). For improved readability, I divided this value by 1000, converting the unit to millions of kiloliters (ML).

E.2 Substitution to Natural Gas / Oil Sectors

In addition to substitution to other industries, substitution within the mining industry might be possible. Upon the energy transition, oil became the primary source of energy. It is possible that prefectures that relied on coal mining became those that processed oil. While crude oil is extremely rare to extract in Japan, processing oil can be done via synthetic or imported oil. If this was the case, mine workers may have transitioned into these sectors, and thus the current estimate of mining job losses would be a lower bound (i.e., more negative). To address this concern, I include an additional interaction term between the number of oil/natural gas areas and year dummies in the DiD regression. Table A7 shows the result, indicating that no substitution to the natural gas/oil sector occurred.

Table A7: Substitution to Natural Gas / Oil Sectors

Dep.Var.:	Mine Workers
Coal Mining Availability × Post	-0.5462**
	(0.214)
Natural Gas/ Petroleum × Post	0.0115
	(0.0190)
Observations	276
R-squared	0.9617

F Labor Disputes and Union Members

The results in the main text, as well as in Appendix G indicate that mining-associated yakuza switched to illegal economic activities because the energy transition deprived them of income sources from the mining industry. Furthermore, yakuza conflicts intensified in coal-rich prefectures with high demand for yakuza services other than coal mining. To bolster the interpretation that the energy transition deprived mining-associated yakuza of their income sources and that yakuza groups relied on the demand for yakuza services beyond coal mining, this section examines whether labor disputes and union members decreased in coal-rich areas. While the data does not identify whether labor disputes and union members are specific to the coal mining industry, a decrease in these outcomes specific to coal-rich prefectures should be indicative of changes of these outcomes in the coal mining industry, especially when considered in combination with other evidence, such as the substitution effect in the construction industry in Appendix E.

Table A8 shows difference-in-differences (DiD) and Bartik reduced-form estimates. Note that for labor disputes, data is only available after 1966; therefore, I can only provide results based on the Bartik reduced-form estimation. For labor disputes, from 1966 to 1970, import quantities increased from 104ML to 204ML (millions of kiloliters). This indicates that a one standard deviation increase in coal mining availability leads to a decrease of approximately 0.01 labor dispute cases per 100 total workers when oil import quantities increase by 100 ML. This translates to a nearly 10% decrease relative to the baseline mean of the outcome in 1966 (0.013). Union membership indicates a decreasing trend in coal-rich areas but the coefficient is not statistically significant. A decrease in labor disputes is consistent with the idea that the energy transition deprived mining-associated yakuza of a possible income source, which in turn incentivized them to switch to other illegal economic activities.

Table A8: Labor Disputes and Union Members

PANEL A Dep.Var.:	(1) Dispute Rate	(2) Union Membership
Coal Mining Availability × Post		-0.0514 (0.1215)
R-squared		0.9330
PANEL B Dep.Var.:	(1) Dispute Rate	(2) Union Membership
Coal Mining Availability × Oil Import Quantity	-0.0001*** (0.0000)	-0.0003 (0.0011)
R-squared	0.6339	0.9329
PANEL C Dep.Var.:	(1) Dispute Rate	(2) Union Membership
Coal Mining Availability × Oil Import Price	0.0252*** (0.0075)	0.0203 (0.1139)
R-squared	0.5218	0.9450
Observations	276	644
Sample Period	1966-1970	1956-1969

Notes: Data on import quantity is originally measured in thousands of kiloliters (kL). For improved readability, I divided this value by 1000, converting the unit to millions of kiloliters (ML).

G Short-term Effects on Yakuza: Bartik Reduced-form Estimates

This section provides further evidence of the involvement of yakuza members who previously engaged in the mining industry in economically motivated crime. In the main text, I examine overall property crime (i.e., fraud and theft) and violent crime. I first replicate the DiD results using the Bartik specification, and then I examine economic crimes that organized crime is more likely to engage in: gambling, prostitution, and drug trade (Table A9 provides summary statistics). However, for these outcomes, data is only available after 1963.

Table A9: Summary Statistics for Variables on "Organized Crime" G

			Mean	Std.Dev.
Data Source	**Unit**	**Panel Level Analysis Data on Yakuza**		
Crime Statistics	Prefecture-by-Time	Yakuza Arrest Gambling (1963-1970)	1.987	2.010
Crime Statistics	Prefecture-by-Time	Yakuza Arrest Prostitution (1963-1970)	.491	1.514
Crime Statistics	Prefecture-by-Time	Yakuza Arrest Drug Trade (1963-1970)	0.103	0.381

Notes: Yakuza variables: the number of yakuza arrests of interest per 100,000 people.

Table A10 shows the Bartik reduced-form estimates for yakuza arrests for property and violent crime. Column (1) shows the baseline results. As before, because crude oil import quantities were increasing during this period, a positive coefficient implies higher yakuza activities. Column (2) considers the heterogeneous effects by the presence of mining-associated yakuza groups, and Column (3) further includes the interaction term of the treatment and the presence of non-mining yakuza groups. The results are consistent with Table 2 in that yakuza's engagement, especially members of mining-yakuza groups, in property crime increased more in coal-rich prefectures when oil import quantities were increasing.

Table A10: Bartik Reduced-form Estimates: Yakuza's Engagement in Property and Violent Crime

	(1)	(3)	(3)	(4)	(5)	(6)
Dep.Var.:	Property Crime			Violent Crime		
Coal Mining Availability × Oil Import Quantity	0.0273***	0.0078	0.0128*	-0.0076	0.0145	0.0287*
	(0.0029)	(0.0066)	(0.0075)	(0.0121)	(0.0159)	(0.0145)
Coal Mining Availability × Oil Import Quantity × Mining Yakuza		0.0308**	0.0311**		-0.0177	-0.0169
		(0.0123)	(0.0117)		(0.0219)	(0.0196)
Coal Mining Availability × Oil Import Quantity × Non Mining Yakuza			-0.0154			-0.0453
			(0.0149)			(0.0353)
Observations	644	644	644	644	644	644
R-squared	0.6476	0.6503	0.6523	0.7814	0.7826	0.7912

Table A11 provides estimation results for gambling, prostitution, and drug trade, which are economic crimes that organized crime is more likely to engage in. The results indicate the yakuza's engagement in gambling, but not in prostitution or drug trade. More specifically, in Column (1), the coefficient is not statistically significant. When adding the interaction terms with the presence of mining-associated yakuza groups, the coefficient of interest is significant in both panels. The results provide further evidence that mining-associated yakuza members switched to illegal economic activities that organized crime likely involves.

Table A11: Bartik Reduced-form Estimates: Yakuza's Engagement in "Organized" Economic Crime

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Dep.Var.:		Gambling			Prostitution			Drug Trade	
Coal Mining Availability × Oil Import Quantity	0.0012	-0.0038**	-0.0049***	0.0002	0.0011	0.0009	-0.0004	0.0004	0.0000
	(0.0008)	(0.0015)	(0.0016)	(0.0002)	(0.0008)	(0.0009)	(0.0003)	(0.0007)	(0.0005)
Coal Mining Availability × Oil Import Quantity × Mining Yakuza		0.0055***	0.0055***		-0.0012	-0.0012		0.0001	0.0001
		(0.0017)	(0.0016)		(0.0017)	(0.0017)		(0.0009)	(0.0008)
Coal Mining Availability × Oil Import Quantity × Non Mining Yakuza			0.0033			0.0004			0.0009
			(0.0022)			(0.0016)			(0.0014)
Observations	368	368	368	368	368	368	368	368	368
R-squared	0.6271	0.6313	0.6352	0.8716	0.8724	0.8736	0.6350	0.6519	0.6694

H Evaluating Enforcement Channel

An increased in yakuza arrests may be explained by a change in enforcement level. In fact, from 1964 to 1970, enforcement against the yakuza increased in response to the escalation of yakuza-related conflicts (Hill, 2003). To address this possibility, I conduct two sets of analyses. First, I regress enforcement measures on the treatment variable. The results suggest that the treatment variable is not correlated with those enforcement measures. Second, I include an enforcement variable as a regressor when examining yakuza-related arrests and conflicts.

First, 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.

Table A12 shows the results. The coefficients in both columns are not statistically significant, indicating that enforcement likely took place irrespective of areas with varying degrees of coal mining availability.

Table A12: Enforcement Measures

	(1) # of Police Officers	(2) Community Enforcement
Coal Mining Availability × Post	-96.371	-0.0235
	(60.592)	(0.0283)
Observations	184	644
R-squared	0.783	0.818
Period	1955,1960, 1965,1970	1957-1970

Second, I explicitly account for enforcement measures in regressions of yakuza outcomes. First, for yakuza arrests and conflicts in panel-level analysis, I control for the interaction term between the number of police officers per capita measured in the pre-transition period and year fixed effects. Second, for contemporary yakuza outcomes in Bartik-style analysis, I control for the number of police officers per capita measured in the pre-transition period. However, the enforcement level in contemporary periods might differ across prefectures with varying degrees of coal mining availability. The contemporary enforcement level is a "bad control" in the sense that it is affected by the energy transition, and one should not condition on it in a regression model (Angrist and Pischke, 2008). With this caveat in mind, I examine how the results are robust to its inclusion. I measure contemporary enforcement as the number of police officers per capita between 1975-1990, as one of my outcomes, data on the number of designated yakuza syndicates, begins in 1996. Table A13 presents the results. The results are robust to the inclusion of both historical and contemporary enforcement level. For Bartik-style analysis, the size of the coefficients is almost the same with and without the contemporary enforcement level. One exception is that for yakuza members, the size of the coefficients drops by half with the inclusion of contemporary enforcement.

Table A13: Effects of the Energy Transition on Yakuza Outcomes Conditional on Enforcement Measures

Dep.Var.:	(1) Yakuza Arrest Property Crime	(2) Yakuza Arrest Violent Crime	(3) Yakuza Conflict	(4) Yamaguchi-gumi Expansion	(5) Yakuza Incarceration Total	(6) Yakuza Incarceration Total	(7) Yakuza Incarceration High-ranking	(8) Yakuza Incarceration High-ranking	(9) Yakuza Incarceration Regular	(10) Yakuza Incarceration Regular	(11) Yakuza Incarceration Unknown	(12) Yakuza Incarceration Unknown	(13) Yakuza HHI	(14) Yakuza HHI	(15) # of Designated Yakuza Syndicates	(16) # of Designated Yakuza Syndicates
Coal Mining Availability × Post	3.4332***	-0.5434	0.1040***	0.1288***												
	(0.4242)	(1.6812)	(0.0151)	(0.0302)												
Mining Job Losses due to Energy Transition					-0.5207***	-0.4566***	-0.2672***	-0.2396***	-0.2476***	-0.2116***	-0.0059	-0.0054	-0.1891***	-0.1817***	-1.5325***	-1.3942***
					(0.0778)	(0.0825)	(0.0330)	(0.0353)	(0.0464)	(0.0470)	(0.0295)	(0.0312)	(0.0463)	(0.0467)	(0.1997)	(0.1799)
Observations	644	644	460	230	644	644	644	644	644	644	644	644	276	276	92	92
R-squared	0.6573	0.7841	0.4218	0.7792	0.6871	0.7084	0.7185	0.7531	0.6692	0.6858	0.3795	0.3796	0.6947	0.6986	0.7893	0.8200
Historical Police per Capita	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Contemporary Police per Capita						x		x		x		x		x		x

I Long-term Effects by Initial Characteristics: Bartik-style Analysis

This section examines how initial characteristics moderate the long-term effects of energy transition on contemporary yakuza outcomes. This analysis complements previous findings and helps understand underlying mechanisms for the persistent effects. I examine the same characteristics as in the heterogeneous effects analysis of yakuza conflict: (i) presence of mining-associated yakuza groups, (ii) construction workers, (iii) construction establishments, (iv) outcaste group, (v) public gambling sites, and (vi) methamphetamine arrests. All variables are dichotomized at their median into high and low categories, except for the presence of mining-associated yakuza groups (see Yakuza Arrests (Panel-level Data) in Section 3). For each moderator, I estimate the energy transition's effects separately for coal-rich prefectures with high and low values, and report the p-value for the joint significance test of these coefficients.

Table A14 presents the results. Panels A-E show different contemporary outcomes, ranging from total yakuza incarceration to the number of designated yakuza syndicates. Each column represents a different moderator. Each result section contains two coefficients - for example, Column (1) shows: mining job losses due to energy transition $\times$ mining yakuza (presence) and mining job losses due to energy transition $\times$ mining yakuza (absence). The results are broadly consistent with the heterogeneous effects observed in yakuza conflict (Figure 7). The heterogeneous effects are particularly robust for three characteristics: the presence of mining-associated yakuza groups, construction workers, and construction establishments. Methamphetamine stands as a notable exception to these patterns.

Table A14: Long-term Effects by Initial Characteristics: Bartik-style Analysis

Z:	(1) Mining Yakuza	(2) Construction Workers	(3) Construction Establishments	(4) Outcaste Group	(5) Gambling	(6) Methamphetamine
Panel A: Total Yakuza incarceration (2006-2019)						
Mining Job Losses due to Energy Transition × Z High	-0.650***	-0.561***	-0.579***	-0.551***	-0.474***	-0.086
	(0.185)	(0.087)	(0.094)	(0.124)	(0.124)	(0.244)
Mining Job Losses due to Energy Transition × Z Low	0.144**	0.068	-0.006	-0.424**	-0.589**	-0.481***
	(0.057)	(0.206)	(0.302)	(0.196)	(0.283)	(0.086)
P-value of Joint Significance Test:	0.0001	0.0031	0.0679	0.5882	0.7238	0.0862
Observations	644	644	644	644	644	644
Panel B: High-ranking Yakuza Incarceration (2006-2019)						
Mining Job Losses due to Energy Transition × Z High	-0.365***	-0.267***	-0.287***	-0.311***	-0.266***	-0.055
	(0.066)	(0.024)	(0.023)	(0.037)	(0.036)	(0.083)
Mining Job Losses due to Energy Transition × Z Low	-0.003	-0.015	-0.006	-0.159***	-0.177**	-0.253***
	(0.021)	(0.064)	(0.091)	(0.057)	(0.076)	(0.021)
P-value of Joint Significance Test:	0.0000	0.0002	0.0027	0.0212	0.3024	0.0147
Observations	644	644	644	644	644	644
Panel C: Regular Yakuza Member Incarceration (2006-2019)						
Mining Job Losses due to Energy Transition × Z High	-0.239**	-0.278***	-0.268***	-0.244***	-0.172***	-0.076
	(0.093)	(0.057)	(0.054)	(0.071)	(0.063)	(0.150)
Mining Job Losses due to Energy Transition × Z Low	0.112***	0.041	-0.076	-0.241**	-0.441***	-0.222***
	(0.038)	(0.118)	(0.188)	(0.116)	(0.157)	(0.052)
P-value of Joint Significance Test:	0.0002	0.0096	0.3228	0.9804	0.1372	0.3095
Observations	644	644	644	644	644	644
Panel D: Unknown Rank Yakuza Incarceration (2006-2019)						
Mining Job Losses due to Energy Transition × Z High	-0.045	-0.017	-0.024	0.004	-0.037	0.046
	(0.061)	(0.030)	(0.040)	(0.036)	(0.044)	(0.074)
Mining Job Losses due to Energy Transition × Z Low	0.034**	0.042	0.076	-0.024	0.029	-0.007
	(0.016)	(0.057)	(0.065)	(0.056)	(0.080)	(0.034)
P-value of Joint Significance Test:	0.1812	0.1929	0.0890	0.5829	0.5172	0.3513
Observations	644	644	644	644	644	644
Panel E: Yakuza HHI (2008-2013)						
Mining Job Losses due to Energy Transition × Z High	-0.283***	-0.236***	-0.184***	-0.242***	-0.158**	-0.315***
	(0.086)	(0.046)	(0.056)	(0.064)	(0.064)	(0.104)
Mining Job Losses due to Energy Transition × Z Low	-0.041**	-0.223***	-0.380***	-0.208***	-0.313***	-0.178***
	(0.019)	(0.078)	(0.115)	(0.054)	(0.102)	(0.048)
P-value of Joint Significance Test:	0.0037	0.8333	0.0561	0.6172	0.2048	0.1000
Observations	276	276	276	276	276	276
Panel F: # of Designated Yakuza Syndicates (1996,2008)						
Mining Job Losses due to Energy Transition × Z High	-2.178***	-1.578***	-1.474***	-1.876***	-1.342***	-1.561***
	(0.361)	(0.226)	(0.241)	(0.277)	(0.299)	(0.518)
Mining Job Losses due to Energy Transition × Z Low	-0.291**	-1.465***	-2.002***	-1.406***	-1.551***	-1.474***
	(0.116)	(0.425)	(0.514)	(0.277)	(0.482)	(0.192)
P-value of Joint Significance Test:	0.0000	0.7787	0.2866	0.1309	0.7380	0.8431
Observations	92	92	92	92	92	92
Geographic Controls	x	x	x	x	x	x
Division-time FE	x	x	x	x	x	x
Z	x	x	x	x	x	x

J Placebo Exercise: Non-yakuza Arrest for Property Crime

In the short-run, we observe that economic-motivated crime increases, and the channel is likely mining-associated yakuza members switching to illicit economic activities, rather than coal miners sorting into the yakuza due to lower opportunity costs of crime. Additionally, the result in Appendix E suggests that the energy transition substituted workers from mining to construction without generating significant unemployment. These pieces of evidence suggest that the energy transition-generated crime is yakuza-specific. I bolster this interpretation by looking at non-yakuza arrests for property crime as a placebo outcome.

Table A15 presents the results. Column (2) shows total arrests for property crime (i.e., theft and fraud), and Column (1) shows yakuza arrests. The results indicate that the effects are driven by yakuza arrests, not non-yakuza arrests. The point estimates appear larger for non-yakuza arrests than for yakuza arrests due to differences in baseline outcome means. The baseline outcome mean for total arrests is 564.190, for yakuza arrests is 11.204, and for non-yakuza arrests is 552.986. Thus, a one standard deviation increase in coal mining availability leads to an increase of about 1.9789 yakuza arrests for property crime per 100,000, which translates into 17.6% relative to the baseline mean. But for non-yakuza arrests, 4.2258 indicates only 0.76% relative to the baseline mean.

Table A15: Placebo Exercise: Non-yakuza Arrests for Property Crime

PANEL A	(1)	(2)	(3)
Dep.Var.:	Total Arrests	Yakuza Arrests	Non-Yakuza Arrests
		Property Crime	
Coal Mining Availability × Post	6.2048	1.9789***	4.2258
	(6.2729)	(0.2084)	(6.1908)
R-squared	0.8324	0.6988	0.8276
PANEL B	(1)	(2)	(3)
Dep.Var.:	Total Arrests	Yakuza Arrests	Non-Yakuza Arrests
		Property Crime	
Coal Mining Availability × Post	-27.6081	1.2705	-28.8786
	(28.1651)	(0.9014)	(28.1096)
Coal Mining Availability × Post × Mining Yakuza	53.1364*	3.6756***	49.4608
	(30.3911)	(1.1725)	(30.4152)
R-squared	0.8376	0.7013	0.8335
Observations	552	552	552
Sample Period		1959-1970	

Notes: Mean of dep. var. (total arrests for property crime) in the pre-transition period: 564.190. Mean of dep. var. (yakuza arrests for property crime) in the pre-transition period: 11.2043. Mean of dep. var. (non-yakuza arrests for property crime) in the pre-transition period: 552.986. **Sample period:** 1959-1970. For 1957 and 1958, I am still in the process of data collection.

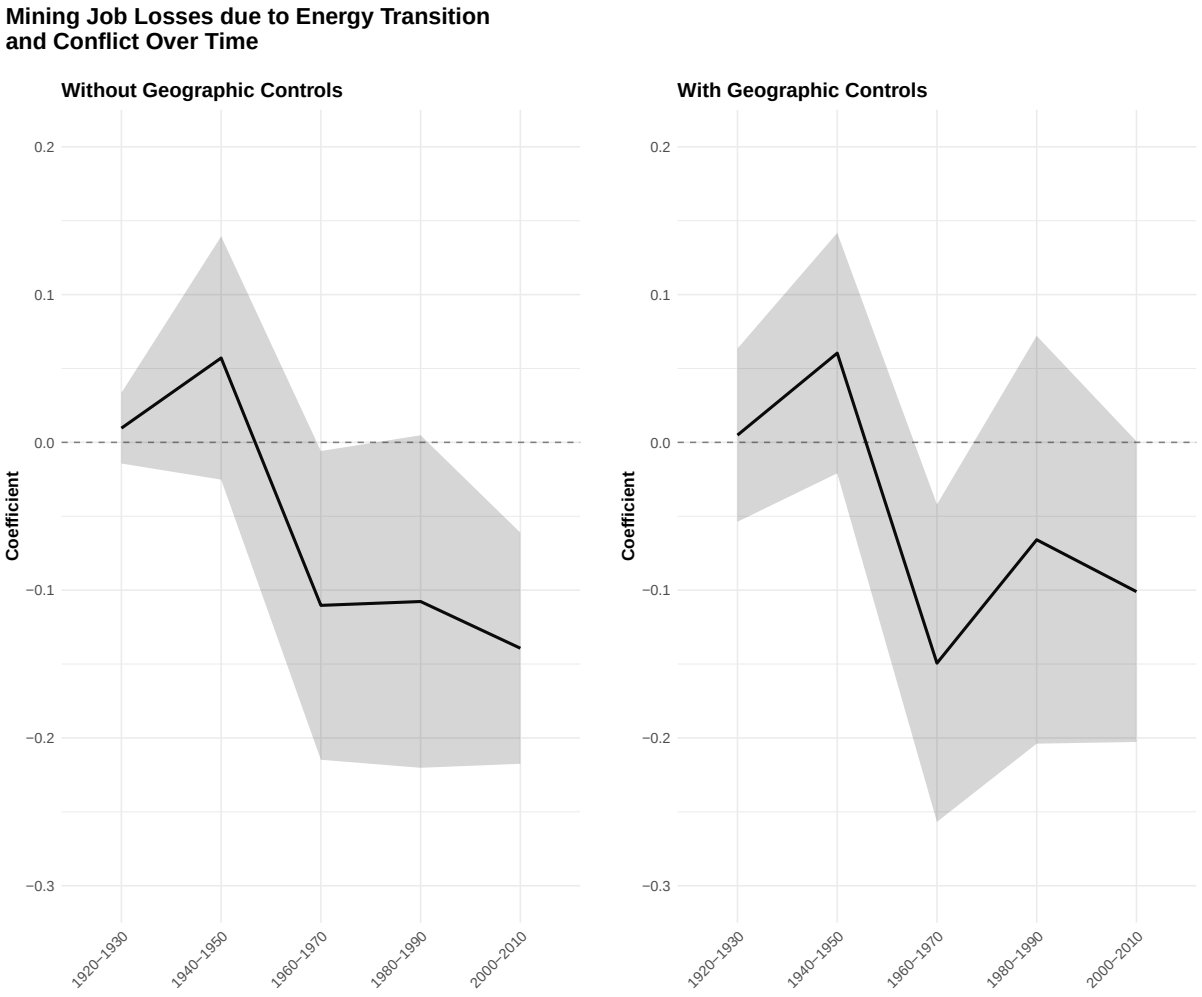
K Long-term Effects on Yakuza Conflict: Alternative Approach using Variable on Mining Job Losses due to Energy Transition

This section explores the long-term effects on yakuza conflict using an alternative approach. The extended timespan of conflict data presents two challenges: (i) conducting Bartik analysis is problematic due to oil shocks in the 1970s. This complicates the interpretation of estimated coefficients when using oil import data over a longer period. (ii) The parallel trends assumption may not hold over an extended timeframe.

To address these issues, I supplement the main event-study analysis with a predicted treatment variable. This variable captures mining job losses resulting from the energy transition, using oil import quantities from 1955 to 1970 (see Section 3.2). Using this variable, I estimate the effects of mining job losses on yakuza conflict separately for five two-decade periods: 1920-1930, 1940-1950, 1960-1970, 1980-1990, and 2000-2010. I include division-by-time fixed effects and estimate the model both with and without geographic controls.

Note that since lower values of the variable indicate greater job losses, a negative coefficient indicates a higher likelihood of yakuza conflict. The findings generally support the main event study results. From the 1920s to the 1950s, the coefficients are small and sometimes in the opposite direction. However, from the 1960s onward, the coefficients become negative (indicating a higher likelihood of yakuza conflict) and larger in magnitude. When geographic controls are included, the estimates become less precise but maintain the overall trend.

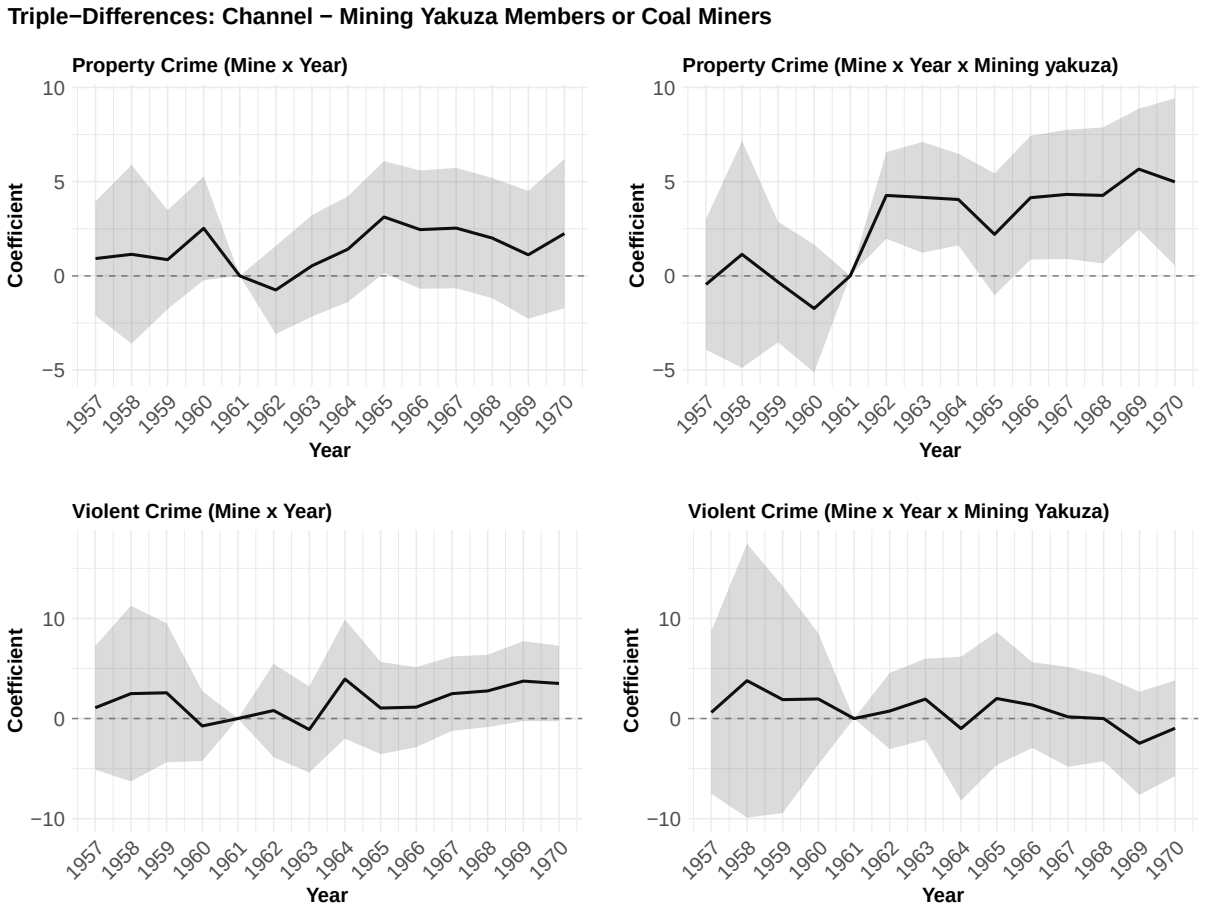
Figure A2: Estimates using Variable on Mining Job Losses due to Energy Transition



L Coal Miners or Mining Yakuza Members: Event-study Estimates

Table 2 provides triple-difference estimates to understand the channel through which the effect of the energy transition increased yakuza arrests in the short term: coal miners (the opportunity cost channel) or mining yakuza members (the substitution channel). The results are consistent with the substitution channel. This appendix provides event-study estimates, corroborating the main result.

Figure A3: Coal Miners or Mining Yakuza Members: Event-study Estimates



M Robustness to Alternative Definitions of Presence of Mining-associated Yakuza

This section examines the robustness of the results to alternative definitions of mining-associated yakuza. In the main text, I define the presence of mining-associated yakuza if a prefecture observed any yakuza arrests in the mining sector. As a robustness check, I create two additional indicators: (1) a binary indicator that takes the value of 1 if the number of yakuza arrests in the mining sector is above the median, and (2) a binary indicator that takes the value of 1 if the number of yakuza arrests among racketeers is above the median in the pre-transition period. Table A16 provides the list of prefectures according to each definition of mining-associated yakuza. Table A17 estimation results, showing the results are robust to alternative definitions.

Table A16: Presence of Mining-associated Yakuza

Pref with Mining Yakuza (at least observed in data)	Pref with Mining Yakuza (above the median)	Pref with Racketeers (above the median)
Aichi	Fukuoka	Chiba
Fukuoka	Fukushima	Fukuoka
Fukushima	Hokkaido	Gunma
Gifu	Ibaraki	Hiroshima
Gunma	Kumamoto	Hokkaido
Hokkaido	Nagasaki	Ibaraki
Hyogo	Saga	Kanagawa
Ibaraki		Kumamoto
Kumamoto		Miyagi
Mie		Miyazaki
Nagasaki		Nagano
Saga		Nagasaki
Shimane		Niigata
Tokyo		Oita
Yamaguchi		Okayama
		Osaka
		Saga
		Saitama
		Shizuoka
		Tochigi
		Tokyo
		Toyama
		Yamanashi

Table A17: Robustness to Alternative Definitions of Mining-associated Yakuza

	(1)	(2)	(3)	(4)
Dep.Var.:	Property Crime		Violent Crime	
Coal Mining Availability × Post	1.1336***		1.1562	
	(0.2462)		(0.7315)	
Coal Mining Availability × Post × Mining Yakuza (Median)	6.2014***		2.9901	
	(0.9942)		(3.5542)	
Coal Mining Availability × Post		0.7146		0.0809
		(0.6365)		(1.3229)
Coal Mining Availability × Post × Racketeers (Median)		4.1968***		-0.3914
		(1.0306)		(2.4316)
Mining Yakuza (resp. Racketeers) × Post	x	x	x	x
Prefecture FE	x	x	x	x
Division-by-Time FE	x	x	x	x
Observations	644	644	644	644
R-squared	0.6549	0.6529	0.7891	0.7812

N Robustness to Alternative Estimator

In the main text, throughout the analyses, I use weighted least squares (WLS) with population in the 1960 census year as weights. I use ordinary least squares (OLS) as an alternative estimator in this section. Figure A4 (for panel-level analysis) and Table A22 (for Bartik-style analysis) provide the results, indicating that they are not sensitive to this alternative estimator.

Figure A4: Alternative Estimator: OLS

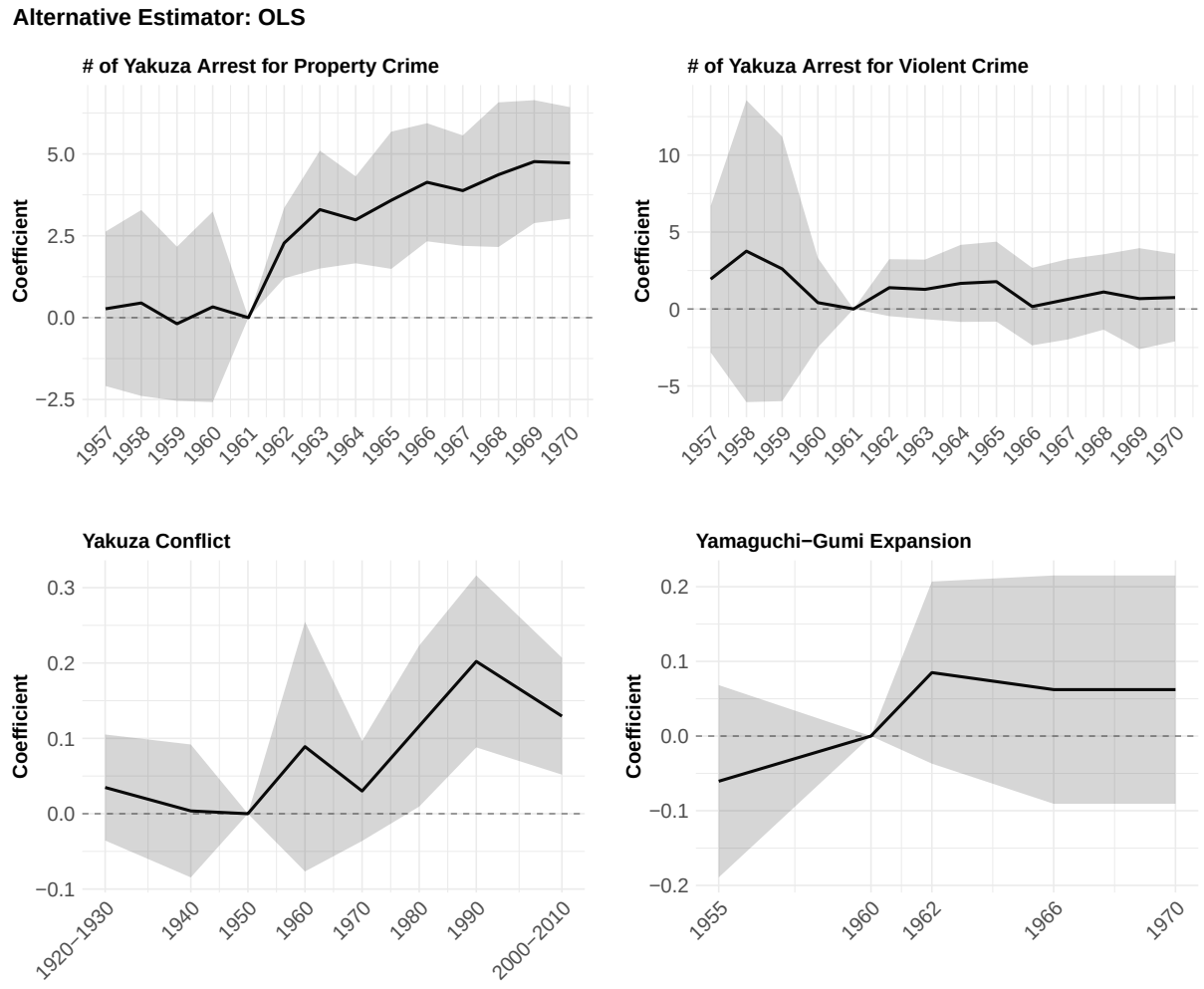


Table A18: Alternative Estimator: OLS

Dep.Var.:	Yakuza Incarceration				Yakuza Syndicates	
	Total	High-ranking	Regular	Unknown	HHI	# of Designated
Mining Job Losses due to Energy Transition	-0.4829***	-0.2350***	-0.2518***	0.0039	-0.2060***	-1.5344***
	(0.1051)	(0.0509)	(0.0563)	(0.0395)	(0.0527)	(0.1991)
Observations	644	644	644	644	92	276

O Robustness to Alternative Measures of Coal Mining Availability

This section examines robustness to alternative measurements of coal mining availability. Up to this point, I have used a composite index of cross-sectional variation in coal mining availability, which comprises three measurements: (i) coal mining areas, (ii) the number of coal mining lots, and (iii) the production of coal in the pre-transition period. I use this composite index because (i) these three measures are highly correlated with one another ($\rho \approx 0.9$) and (ii) the composite index can mitigate some measurement error. Figure A5 (for panel-level analysis) and Table A19 (for Bartik-style analysis) examine each of these measures separately to show that the observed results are not driven by a specific component of the index. For the Bartik-style analysis, the variable representing coal mining job losses due to the energy transition is constructed using each of these measures individually.

Figure A5: Alternative Measures of Coal Mining Availability

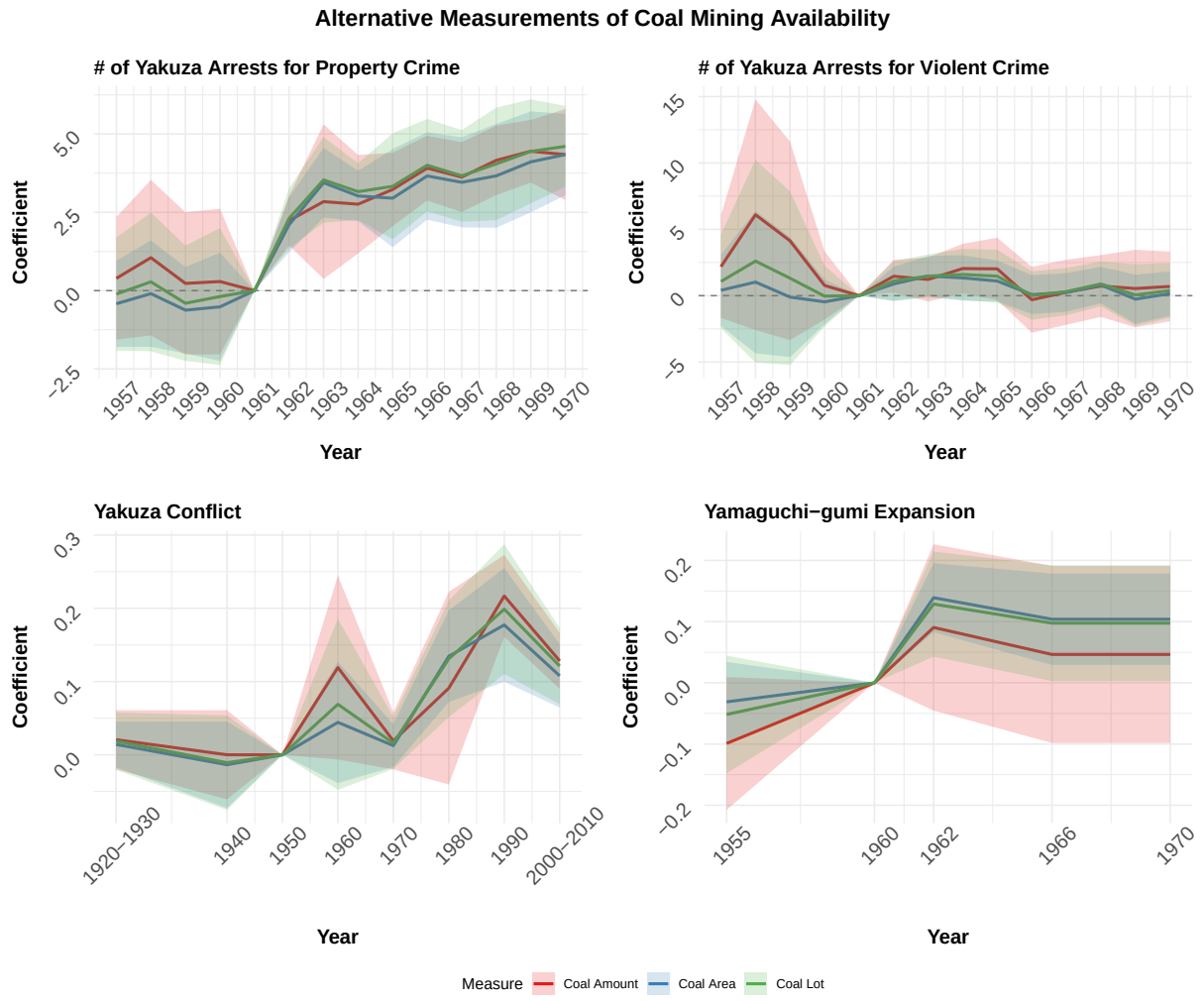


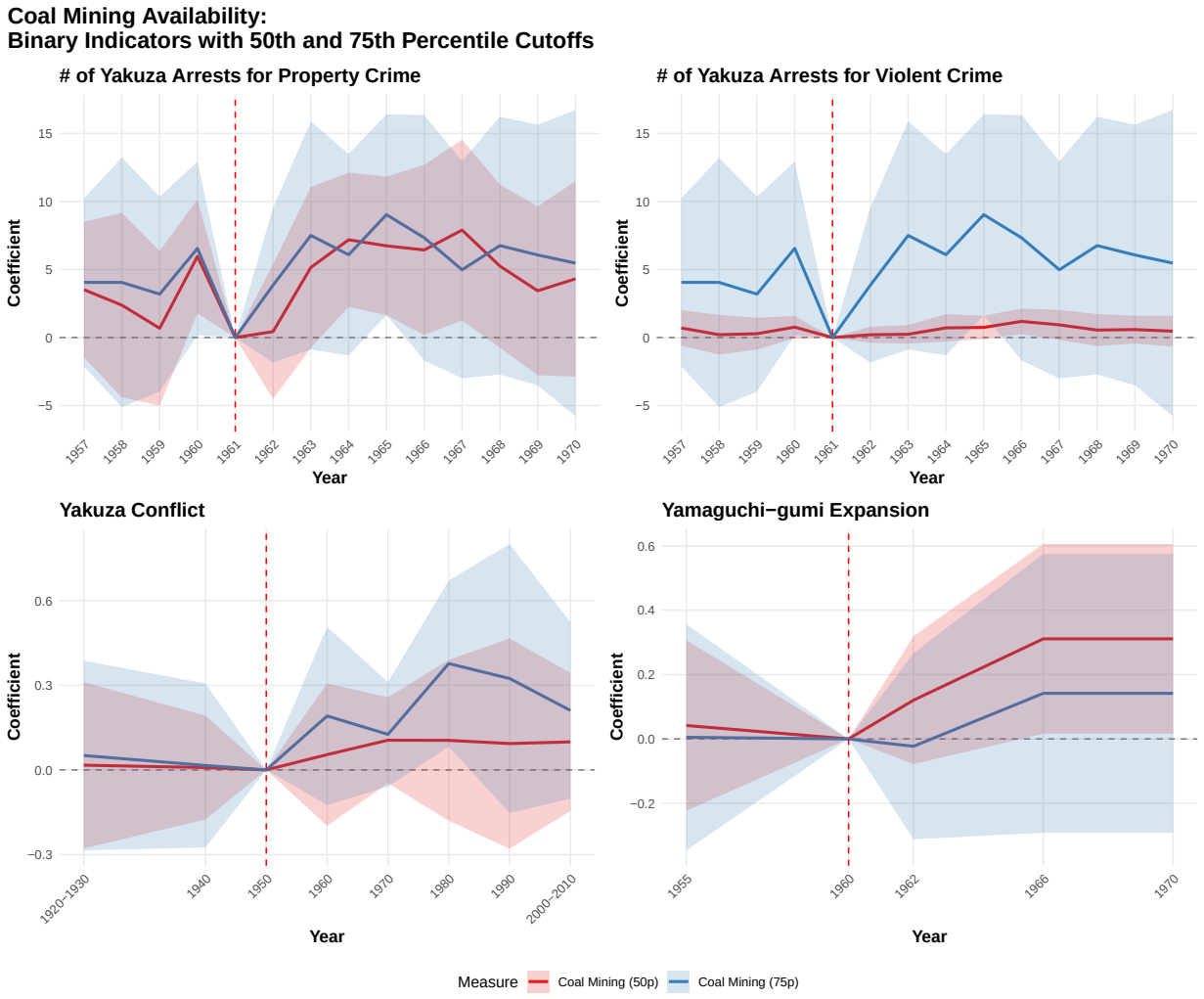
Table A19: Alternative Measures of Coal Mining Availability

Dep.Var.:	Yakuza Incarceration				Yakuza Syndicae	
	Total	High-ranking	Regular	Unknown	# of Designated	HHI
PANEL A						
Mining Job Losses due to Energy Transition	-0.4731***	-0.2171***	-0.2575***	0.0015	-1.5121***	-0.2039***
(Constructed with Coal Lot)	(0.1038)	(0.0565)	(0.0500)	(0.0413)	(0.2150)	(0.0515)
PANEL B						
Mining Job Losses due to Energy Transition	-0.5561***	-0.2403***	-0.3095***	-0.0063	-1.9598***	-0.2569***
(Constructed with Coal Area)	(0.1948)	(0.0876)	(0.0988)	(0.0556)	(0.3556)	(0.0742)
PANEL C						
Mining Job Losses due to Energy Transition	-0.3561***	-0.1950***	-0.1700***	0.0089	-1.1158***	-0.1423***
(Constructed with Coal Amount)	(0.0820)	(0.0260)	(0.0484)	(0.0263)	(0.1866)	(0.0425)
Observations	644	644	644	644	92	276

P Robustness to Binary Indicators of Coal Mining Availability

This section examines the robustness of the main results using binary indicators of coal mining availability. These indicators are created using 50th and 75th percentile cutoffs of the coal mining availability index.

Figure A6: Binary Indicators of Coal Mining Availability



Q Robustness to Observed Covariates

This section examines robustness to the inclusion of other covariates. In the main text, I focus on a parsimonious specification with prefecture fixed effects and division-by-time fixed effects for panel-level analysis, and geographic controls and division fixed effects for Bartik-style analysis. For the latter, this practice is partly justified by a balance test where the constructed treatment variable is not correlated with pre-transition demographic and economic covariates.

In addition to the inclusion of enforcement measurements, this section examines the inclusion of two other types of covariates: (i) population compositions and (ii) economic conditions. For Bartik-style analysis, I also include contemporary covariates. As noted before, the caveat of this approach is the presence of bad controls (Angrist and Pischke, 2008).

Table A20: Robustness to Historical Covariates × Year FE in Panel-level Analysis

	Male Pop	Korean Pop	Urban Pop	Pop 15-29	Welfare	Outcaste Pop	Gambling
Panel A: Property Crime							
Coal Mining Availability × Post	3.4156***	3.1522***	3.2407***	3.3210***	3.4878***	2.3733***	2.3007***
	(0.4661)	(0.5436)	(0.4878)	(0.5688)	(0.3889)	(0.8392)	(0.7157)
Panel B: Violent Crime							
Coal Mining Availability × Post	-0.5002	-0.9359	-0.5400	-0.3619	-0.2187	-1.5239	-1.6045
	(1.6667)	(1.8530)	(1.6895)	(1.4559)	(1.4015)	(2.0417)	(1.9115)
Panel C: Yamaguchi-gumi Expansion							
Coal Mining Availability × Post	0.1287***	0.1383***	0.1289***	0.1262***	0.1198***	0.1482***	0.1701***
	(0.0300)	(0.0293)	(0.0307)	(0.0332)	(0.0362)	(0.0399)	(0.0378)
Panel D: Conflict							
Coal Mining Availability × Post	0.1180***	0.1044***	0.1058***	0.1071***	0.1049***	0.1038***	0.1130***
	(0.0163)	(0.0157)	(0.0158)	(0.0166)	(0.0155)	(0.0148)	(0.0186)

Table A21: Robustness to Past Covariates in Bartik-style Analysis

	Male Pop	Korean Pop	Urban Pop	Pop 15-29	Welfare	Outcaste Pop	Gambling
Panel A: Total Yakuza Incarceration							
Mining Job Losses	-0.4714***	-0.5004***	-0.4373***	-0.4143***	-0.4921***	-0.5420***	-0.3768***
	(0.0912)	(0.0910)	(0.0887)	(0.1056)	(0.0757)	(0.0846)	(0.1333)
Panel B: High-ranking Yakuza Incarceration							
Mining Job Losses	-0.2407***	-0.2659***	-0.2350***	-0.2272***	-0.2500***	-0.2633***	-0.1948***
	(0.0379)	(0.0351)	(0.0330)	(0.0368)	(0.0199)	(0.0329)	(0.0416)
Panel C: Regular Yakuza Member Incarceration							
Mining Job Losses	-0.2148***	-0.2396***	-0.1965***	-0.1870***	-0.2377***	-0.2645***	-0.1491**
	(0.0516)	(0.0496)	(0.0502)	(0.0616)	(0.0494)	(0.0491)	(0.0621)
Panel D: Unknown Rank Yakuza Incarceration							
Mining Job Losses	-0.0159	0.0051	-0.0057	0.0000	-0.0044	-0.0142	-0.0329
	(0.0324)	(0.0282)	(0.0340)	(0.0325)	(0.0299)	(0.0312)	(0.0443)
Panel E: Yakuza HHI							
Mining Job Losses	-0.1801***	-0.1897***	-0.1767***	-0.1859***	-0.1906***	-0.2309***	-0.1867***
	(0.0470)	(0.0473)	(0.0496)	(0.0493)	(0.0444)	(0.0445)	(0.0566)
Panel F: # of Designated Yakuza Syndicates							
Mining Job Losses	-1.3506***	-1.5584***	-1.3876***	-1.4721***	-1.5314***	-1.7452***	-1.2997***
	(0.1755)	(0.1987)	(0.1854)	(0.2125)	(0.1892)	(0.2285)	(0.2668)

Table A22: Robustness to Contemporary Covariates in Bartik-style Analysis

	Welfare	Unemployment	Divorce Rates	HS Graduates	Population
Panel A: Total Yakuza Incarceration					
Mining Job Losses due to Energy Transition	-0.3853***	-0.4778***	-0.4585***	-0.4511***	-0.4512***
	(0.1251)	(0.0969)	(0.0952)	(0.1315)	(0.0889)
Panel B: High-ranking Yakuza Incarceration					
Mining Job Losses due to Energy Transition	-0.1899***	-0.2200***	-0.2237***	-0.2547***	-0.2298***
	(0.0275)	(0.0288)	(0.0328)	(0.0455)	(0.0327)
Panel C: Regular Yakuza Incarceration					
Mining Job Losses due to Energy Transition	-0.1945**	-0.2272***	-0.2196***	-0.1970**	-0.2034***
	(0.0778)	(0.0583)	(0.0559)	(0.0751)	(0.0481)
Panel D: Unknown Rank Yakuza Incarceration					
Mining Job Losses due to Energy Transition	-0.0009	-0.0307	-0.0152	0.0006	-0.0179
	(0.0398)	(0.0366)	(0.0347)	(0.0414)	(0.0351)
Panel E: Yakuza HHI					
Mining Job Losses due to Energy Transition	-0.1914***	-0.1986***	-0.1957***	-0.1686**	-0.1724***
	(0.0528)	(0.0493)	(0.0502)	(0.0729)	(0.0491)
Panel F: # of Designated Yakuza Syndicates					
Mining Job Losses due to Energy Transition	-1.3787***	-1.3884***	-1.3706***	-1.3737***	-1.2975***
	(0.2156)	(0.2116)	(0.2184)	(0.3091)	(0.1712)

R Robustness to Selection on Unboservables for Bartik-style Analysis

The panel-level analysis addresses endogeneity concerns through Difference-in-Differences (DiD), event-study, and Bartik designs. For the Bartik-style analysis, I attempt to mitigate these concerns by constructing a predicted treatment variable that leverages Bartik variation. This predicted treatment variable shows minimal correlation with observed covariates measured in the pre-transition period, enhancing the validity of the research design. However, some readers might still harbor concerns about unobserved confounders. To address this issue, I employ Oster (2019)'s coefficient stability approach. This method estimates the relative selection on unobservables, denoted as δ, which is a function of: (i) the estimate from regressing the outcome on the treatment variable alone, (ii) the estimate from regressing the outcome on both the treatment variable and observables, and (iii) the estimate from regressing the treatment variable on observables (i.e., selection on observables) The method compares the potential explanatory power of a theoretical model that includes unobservable factors (R^2_{max}) to the explanatory power of the most comprehensive model using only observable variables ($\bar{R}^2$). Specifically, it considers the ratio of R^2_{max} (which represents the unknown model fit if we could include all unobservable factors) to $\bar{R}^2$ (the R-squared from a fully specified regression using all available observable variables). The resulting δ value indicates how strong the influence of unobservables would need to be to nullify the observed treatment effect. The results indicate that unobservable factors would need to be approximately 3 to 14 times larger than the observable factors to drive away the observed effects. This holds true for most outcomes, with two exceptions: incarceration rates for unknown members, which consistently show a null effect, and incarceration rates for top-level members, which indicate negative values.

Panel-level analysis deals with endogeneity concerns via DiD, event-study, and Bartik designs. For Bartik-style analysis, I attempt to deal with them by constructing a predicted treatment variable that exploits Bartik variation; this predicted treatment variable is hardly correlated with observed covariates measured in the pre-transition period. This increases the validity of this research design, yet some readers might still be concerned about unobserved confounders.

Table A23: Oster's Coefficient Stability

Dep.Var.:	Yakuza Incarceration				Yakuza Syndicate	
	Total	High-ranking	Regular	Unknown	# of Designated	HHI
δ with $R^2_{max} = 1.3 \times \bar{R}^2$	14.31619	-3.90401	2.75528	-0.22502	3.56810	2.73841

S Robustness to an Excluded Division

This section examines the robustness of the main results to the exclusion of a specific division in Japan, where the country is divided into 7 division. I analyze the outcome variables used in the main results for each section using prefecture-level data. I run a variant of the leave-one-out analysis, where I perform the main DiD regression while excluding one divisionat a time. Table A24 indicates that the results for each outcome are robust to the exclusion of any specific division. This provides suggestive evidence that the results are not sensitive to outliers.

Table A24: Robustness to an Excluded Division

Excluded Region:	Hokkaido-Tohoku	Kanto	Tokai	Kinki	Chugoku	Shikoku	Kyushu
Dep.Var.:				Property Crime			
Coal Mining Availability × Post	2.3089**	3.4760***	3.4265***	3.4279***	3.3924***	3.4285***	3.7903***
	(0.9811)	(0.4114)	(0.4168)	(0.4165)	(0.4257)	(0.4144)	(0.1985)
Observations	546	490	560	560	574	588	546
Dep.Var.:				Violent Crime			
Coal Mining Availability × Post	-6.4635***	-0.3586	-0.5060	-0.5017	-0.5826	-0.5014	1.3722***
	(2.1320)	(1.6418)	(1.6570)	(1.6560)	(1.6872)	(1.6479)	(0.4240)
Observations	546	490	560	560	574	588	546
Dep.Var.:				Conflict			
Coal Mining Availability × Post	0.1382***	0.1043***	0.1041***	0.1041***	0.1045***	0.1040***	0.092***
	(0.0293)	(0.0155)	(0.0152)	(0.0152)	(0.0154)	(0.0152)	(0.0115)
Observations	390	350	400	400	410	420	390
Dep.Var.:				Yamaguchi-gumi Expansion			
Coal Mining Availability × Post	-0.0004	0.1309***	0.1285***	0.1286***	0.1352***	0.1287***	0.1599***
	(0.0848)	(0.0298)	(0.0301)	(0.0301)	(0.0277)	(0.0299)	(0.0174)
Observations	195	175	200	200	205	210	195
Dep.Var.:				Total Yakuza Incarceration			
Mining Job Losses due to Energy Transition	-0.4033***	-0.5305***	-0.5129***	-0.5725***	-0.5175***	-0.5154***	-0.9375***
	(0.1469)	(0.0745)	(0.0810)	(0.0746)	(0.0812)	(0.0762)	(0.2791)
Observations	546	490	560	560	574	588	546
Dep.Var.:				High-ranking Yakuza Incarceration			
Mining Job Losses due to Energy Transition	-0.2873***	-0.2615***	-0.2635***	-0.2818***	-0.2653***	-0.2664***	-0.3028***
	(0.0499)	(0.0347)	(0.0318)	(0.0344)	(0.0350)	(0.0331)	(0.0954)
Observations	546	490	560	560	574	588	546
Dep.Var.:				Regular Yakuza Member Incarceration			
Mining Job Losses due to Energy Transition	-0.1585*	-0.2550***	-0.2395***	-0.3034***	-0.2447***	-0.2429***	-0.4299**
	(0.0789)	(0.0401)	(0.0504)	(0.0457)	(0.0460)	(0.0440)	(0.1807)
Observations	546	490	560	560	574	588	546
Dep.Var.:				Unknown Rank Yakuza Incarceration			
Mining Job Losses due to Energy Transition	0.0425	-0.0140	-0.0098	0.0126	-0.0075	-0.0061	-0.2048*
	(0.0418)	(0.0353)	(0.0270)	(0.0189)	(0.0304)	(0.0287)	(0.1013)
Observations	546	490	560	560	574	588	546
Dep.Var.:				Yakuza HHI			
Mining Job Losses due to Energy Transition	-0.1967**	-0.1975***	-0.1837***	-0.1878***	-0.1880***	-0.1845***	-0.2401**
	(0.0746)	(0.0533)	(0.0404)	(0.0417)	(0.0470)	(0.0457)	(0.1023)
Observations	234	210	240	240	246	252	234
Dep.Var.:				# of Designated Yakuza Syndicates			
Mining Job Losses due to Energy Transition	-1.5847***	-1.5183***	-1.4682***	-1.5546***	-1.5458***	-1.5210***	-1.9296**
	(0.3233)	(0.2104)	(0.1691)	(0.2091)	(0.2080)	(0.2012)	(0.7404)
Observations	78	70	80	80	82	84	78

T Robustness to Alternative Sample

This section examines robustness to an alternative sample. I exclude prefectures without any coal mining availability; thus, it forces me to exploit purely the intensive margin of coal mining availability across prefectures. Table A25 presents the results, which are generally consistent except for total incarceration rates and those for regular members.

Table A25: Alternative Sample

	Property Crime	Violent Crime	Yakuza Conflict	Yamaguchi-gumi Expansion	Incarceration				Yakuza Syndicate	
					Total	High-ranking	Regular	Unknown	HHI	# of Designated
Coal Mining Availability × Post	3.4921***	0.5447	0.0887***	0.1315***						
	(0.2462)	(0.9706)	(0.0109)	(0.0361)						
Mining Job Losses due to Energy Transition					-0.4154	-0.2869***	-0.1703	0.0418	-0.1093**	-1.1868***
					(0.2781)	(0.0978)	(0.1343)	(0.0563)	(0.0445)	(0.3342)
Observations	406	406	290	145	406	406	406	406	174	58
R-squared	0.7787	0.7891	0.4900	0.7785	0.7377	0.7573	0.7179	0.4437	0.8337	0.8851

U Additional Results and Robustness Checks: Municipal-level Analysis

This section presents additional empirical results for municipal-level analysis. While the main text focuses on business establishments near mining municipalities, Table A26 shows employment rates in these areas, indicating increases in construction, restaurants/bars, and real estate sectors. These findings provide further evidence of growth in industries commonly associated with yakuza involvement.

Table A26: Effect of Distance to Historical Coal Mining Establishments on Employment Rates in Other Industries

Dep.Var.:	(1)	(2)	(3)	(4)
	Employment Rates			
	Construction	Restaurants/Bars	Real Estate	Infrastructure
log of Distance to a Coal Mining Establishment × 1971	-2.3283	-2.5205	-0.0811	0.0554
	(1.4177)	(4.0216)	(0.2669)	(0.0938)
log of Distance to a Coal Mining Establishment × 1981	-2.4444*	-4.1889	-0.3887	0.0088
	(1.3364)	(4.0845)	(0.2559)	(0.0746)
log of Distance to a Coal Mining Establishment × 1991	-2.6585**	-16.7004**	-0.6970**	0.0113
	(1.3403)	(8.3146)	(0.3313)	(0.0738)
log of Distance to a Coal Mining Establishment × 2001	-2.5171**	-14.9805**	-0.4856	-0.0176
	(1.2598)	(7.4943)	(0.3110)	(0.0742)
log of Distance to a Coal Mining Establishment × 2012	-2.5473**	-4.2815	-1.3070**	-0.0581
	(1.2487)	(4.3734)	(0.5884)	(0.0875)
# of Coal Mining Establishments × 1971	0.0186	0.1342	-0.0159	0.0074
	(0.0685)	(0.1884)	(0.0292)	(0.0054)
# of Coal Mining Establishments × 1981	-0.0184	-0.0537	0.0013	-0.0020
	(0.0652)	(0.1909)	(0.0179)	(0.0075)
# of Coal Mining Establishments × 1991	-0.0663	-0.3519	0.0053	0.0013
	(0.0649)	(0.2970)	(0.0179)	(0.0060)
# of Coal Mining Establishments × 2001	-0.0777	-0.4104	0.0049	-0.0063
	(0.0719)	(0.2784)	(0.0173)	(0.0058)
# of Coal Mining Establishments × 2012	-0.0468	0.1477	-0.0320	-0.0016
	(0.0628)	(0.1943)	(0.0248)	(0.0056)
Observations	360	360	360	360
R-squared	0.0474	0.0616	0.0436	0.0074

Tables A27, A28, A29 examine the robustness of the municipal-level analysis results. For yakuza offices, I also examine the robustness using alternative measures from Yakuza Wiki. The robustness checks include:(1) Alternative Conley standard errors with a 15km cutoff, (2) Alternative Conley standard errors with a 50km cutoff, (3) Analysis without geographic covariates, (4) Weighted Least Squares (WLS) with contemporary population, (5) Ordinary Least Squares (OLS), (6) Clustered standard errors, (7) Poisson-pseudo maximum likelihood (PPML) estimator for count outcomes and logit for binary outcomes, and (8) A binary measure for the distance variable, equaling one if the distance is below the median.

For the clustered standard errors (6), each municipality was assigned the identifier of the nearest coal mining establishment, with clustering by that ID. However, this approach resulted in only 22 clusters, so these results should be interpreted cautiously. Generally, the results from these robustness checks are consistent with the main findings, although some effects did not survive

across all specifications.

Table A27: Robustness Checks: Effect of Distance to Historical Coal Mining Establishments on Yakuza Offices

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Var.	Yakuza Office (Yakuza Office Street View Search)							
	Extensive Margin							
log of Distance to a Coal Mining Establishment	-0.5142***	-0.5142***	-0.5392***	-0.5648***	-0.2609**	-0.5142**	-3.7139**	
	(0.1527)	(0.1137)	(0.1728)	(0.1311)	(0.1160)	(0.2341)	(1.7886)	
# of Coal Mining Establishments	-0.0161	-0.0161**	-0.0298**	-0.0194*	0.0002	-0.0161	-0.1457	-0.0146
	(0.0112)	(0.0072)	(0.0146)	(0.0104)	(0.0060)	(0.0117)	(0.0903)	(0.0091)
Distance (Below Median)								0.5610***
								(0.1044)
Observations	72	72	72	72	72	1,224	62	72
R-squared	0.2485	0.2485	0.1885	0.2212	0.1034	0.3475		0.2966
PANEL B	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Var.	Yakuza Office (Yakuza Office Street View Search)							
	Intensive Margin							
log of Distance to a Coal Mining Establishment	-1.5417***	-1.5417***	-1.2567*	-1.7028***	-0.7085**	-1.5417*	-1.2618***	
	(0.5262)	(0.3377)	(0.7628)	(0.4434)	(0.2847)	(0.8505)	(0.3945)	
# of Coal Mining Establishments	-0.0604*	-0.0604**	-0.0848*	-0.0890**	-0.0263*	-0.0604**	-0.2290***	-0.0539*
	(0.0358)	(0.0237)	(0.0488)	(0.0450)	(0.0152)	(0.0282)	(0.0715)	(0.0314)
Distance (Below Median)								1.0930***
								(0.2973)
Observations	72	72	72	72	72	1,224	62	72
R-squared	0.1672	0.1672	0.1088	0.1625	0.0778	0.3256		0.1287
PANEL C	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Var.	Yakuza Office (Yakuza Wiki)							
	Extensive Margin							
log of Distance to a Coal Mining Establishment	-0.3332**	-0.3332***	-0.2914**	-0.3563**	-0.1527	-0.3332**	-1.7314*	
	(0.1442)	(0.1182)	(0.1208)	(0.1421)	(0.1560)	(0.1516)	(0.9353)	
# of Coal Mining Establishments	-0.0035	-0.0035	-0.0033	0.0020	0.0036	-0.0035	-0.0165	-0.0023
	(0.0259)	(0.0129)	(0.0151)	(0.0147)	(0.0139)	(0.0187)	(0.1343)	(0.0149)
Distance (Below Median)								0.3045*
								(0.1650)
Observations	72	72	72	72	72	1,224	72	72
R-squared	0.0505	0.0505	0.0462	0.0634	0.0197	0.0924		0.0507
PANEL D	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Var.	Yakuza Office (Yakuza Wiki)							
	Intensive Margin							
log of Distance to a Coal Mining Establishment	-2.6999	-2.6999***	-1.5330	-3.3253***	-1.5490**	-2.6999	-0.7092*	
	(1.7334)	(0.9593)	(2.6510)	(1.2660)	(0.6319)	(2.7886)	(0.3749)	
# of Coal Mining Establishments	0.0121	0.0121	-0.0125	-0.0519	0.0609	0.0121	-0.0048	0.0228
	(0.2063)	(0.1161)	(0.1844)	(0.2065)	(0.1076)	(0.1025)	(0.0433)	(0.1537)
Distance (Below Median)								2.1583*
								(1.1086)
Observations	72	72	72	72	72	1,224	72	72
R-squared	0.0551	0.0551	0.0109	0.0589	0.0525	0.2359		0.0489
Robustness to:	Conley 15km	Conley 50km	No Covariate	WLS with pop 2005	OLS	Clustered at Mining	PPML/logit	Binary Distance

Table A28: Robustness Checks: Effect of Distance to Historical Coal Mining Establishments on Crime Measures

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep.Var.:					Violent Crime			
log of Distance to a Coal Mining Establishments	-28.5143***	-28.5143***	-25.2041**	-25.9271***	-7.4259	-28.5143**	-0.5465***	
	(10.5225)	(6.0485)	(12.6521)	(9.6821)	(6.2062)	(10.8250)	(0.1893)	
# of Coal Mining Establishments	0.0687	0.0687	0.4759	0.1469	0.4308	0.0687	-0.0128	0.1828
	(0.7820)	(0.4858)	(0.6050)	(0.7602)	(0.6000)	(0.4799)	(0.0205)	(0.6472)
Distance (Below Median)								22.3997***
								(6.3357)
Observations	1,224	1,224	1,224	1,224	1,224	1,224	1,224	1,224
R-squared	0.1211	0.1211	0.0865	0.1001	0.0336	0.3646		0.0991
PANEL B	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep.Var.:					Property Crime			
log of Distance to a Coal Mining Establishment	-160.0154***	-160.0154	-160.3879	-152.1389	-62.3859	-160.0154	-0.3188*	
	(116.5486)	(61.1932)	(124.5631)	(100.1195)	(39.5189)	(107.5519)	(0.1787)	
# of Coal Mining Establishments	7.7168	7.7168	11.5681	10.9505	8.3739	7.7168	-0.0018	8.1599
	(11.0098)	(6.2351)	(7.7426)	(8.8901)	(8.0160)	(5.2125)	(0.0206)	(7.6496)
Distance (Below Median)								188.0513***
								(69.2191)
Observations	1,224	1,224	1,224	1,224	1,224	1,224	1,224	1,224
R-squared	0.0643	0.0643	0.0401	0.0549	0.0474	0.6622		0.0794
Robustness to:	Conley 15km	Conley 50km	No Covariate	WLS with pop 2005	OLS	Clustered at Mining	PPML	Binary Distance

Table A29: Robustness Checks: Effect of Distance to Historical Coal Mining Establishments on Business Establishments

PANEL A	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Var.	Construction Establishments							
log of Distance to a Coal Mining Establishment	-285.1649**	-285.1649***	-185.2608	-310.1470***	-113.4411*	-285.1649	-0.4625***	
	(131.9853)	(75.1601)	(199.9871)	(92.6697)	(63.4011)	(197.0631)	(0.1381)	
# of Coal Mining Establishments	1.6377	1.6377	13.3343	-3.0117	5.5755	1.6377	2.7141	-0.0093
	(10.3752)	(6.4912)	(9.3748)	(12.0660)	(5.0238)	(6.6817)	(8.8990)	(0.0114)
Distance (Below Median)								244.3777***
								(84.1213)
Observations	360	360	360	360	360	360	360	360
R-squared	0.2008	0.2008	0.0548	0.2058	0.2311	0.3407		0.1898
PANEL B	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Var.	Restaurants/Bars Establishments							
log of Distance to a Coal Mining Establishment	-1,824.7558**	-1,824.7558***	-1,439.5166	-1,956.6691***	-748.8496**	-1,824.7558	-0.6236***	
	(798.0752)	(437.5793)	(1,117.5818)	(632.3339)	(374.3556)	(1,105.3176)	(0.2303)	
# of Coal Mining Establishments	6.6139	6.6139	35.1206	-18.2554	22.7543	6.6139	14.0872	-0.0158
	(55.1620)	(34.9803)	(45.9923)	(69.7098)	(27.9218)	(32.1802)	(46.3310)	(0.0191)
Distance (Below Median)								1,378.3494**
								(567.6399)
Observations	360	360	360	360	360	360	360	360
R-squared	0.0835	0.0835	0.0571	0.0949	0.0781	0.3909		0.0602
PANEL C	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Var.	Real Estate Establishments							
log of Distance to a Coal Mining Establishment	-213.4505**	-213.4505***	-206.3759*	-214.0221***	-94.6096*	-213.4505	-0.2795	
	(94.1191)	(55.5857)	(113.7577)	(62.3178)	(54.0980)	(134.5735)	(0.2287)	
# of Coal Mining Establishments	-2.8816	-2.8816	0.3805	-6.6329	-2.4030	-2.8816	-2.5789	-0.0216
	(7.3791)	(5.7998)	(3.9466)	(12.8788)	(4.0802)	(6.2725)	(7.1470)	(0.0332)
Distance (Below Median)								342.0712***
								(102.1267)
Observations	360	360	360	360	360	360	360	360
R-squared	0.0523	0.0523	0.0475	0.0596	0.0632	0.3735		0.1274
PANEL D	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dep. Var.	Infrastructure Establishments							
log of Distance to a Coal Mining Establishment	-5.6646***	-5.6646***	-4.0535	-5.8580***	-0.7613	-5.6646*	-0.5415**	
	(2.1386)	(1.4881)	(2.8287)	(1.9585)	(1.7615)	(2.8114)	(0.2310)	
# of Coal Mining Establishments	0.3586**	0.3586***	0.4124**	0.2485	0.4184***	0.3586***	0.3857***	0.0059
	(0.1706)	(0.0980)	(0.1944)	(0.2100)	(0.1066)	(0.0759)	(0.1303)	(0.0172)
Distance (Below Median)								3.0523**
								(1.3933)
Observations	360	360	360	360	360	360	360	360
R-squared	0.1803	0.1803	0.0996	0.1498	0.0562	0.2658		0.1049
Robustness to:	Conley 15km	Conley 50km	No Covariate	WLS with pop 2005	OLS	Clustered at Mining	PPML	Binary Distance

V Measurements and Variable Construction

This section provides the description of variable construction as well as data acquisition.

Contemporary Yakuza Members: Data on the number of yakuza members from 2008 to 2014 was obtained by requesting information from prefectural police departments. The police use various ways to verify whether a yakuza member has left their organization, according to the Organized Crime Division of the National Police Agency (NPA). These include examining expulsion letters, interviewing relevant members and arrested individuals, and conducting investigations at yakuza offices. This thorough process helps the police track the actual number of yakuza members and reduces the likelihood of miscounting members who may be hiding their identities (for a more detailed description, see (Hoshino and Kamada, 2020)).

Number of Designated Yakuza Syndicates: 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 1996.

Yakuza Hirschman-Herfindahl Index: I use a prefecture-level yakuza Hirschman-Herfindahl index from 2008 to 2014 (also see Hoshino and Kamada, 2020, 2022). To calculate this index, I estimate the number of members of each yakuza organization in each prefecture, as such data is not directly available. The estimation assumes that members of a yakuza syndicate are distributed across all prefectures where the organization operates, proportionally to the population of these prefectures. Using these estimates, I calculate the share of each yakuza organization in each prefecture and then compute the yakuza HHI for each prefecture. The index of prefecture i is defined as $yakuza\,HHI_p = 1 - \sum_g s_{i,g}^2$, where $s_{i,g} = N_{gi} / \sum_{g'} N_{g'i}$ if g operates in i and $s_{i,g} = 0$ otherwise, where $\sum_{g'}$ runs over all yakuza syndicates operating in p. The number of g's members in p is estimated to be $N_{gp} = (g\text{'s total number of members}) \times (q_p / \sum_{p'} q_{p'})$. The index ranges from 0 to 1, with 0 indicating a monopoly (only one yakuza syndicate in the prefecture) and higher values suggesting a greater number of yakuza organizations operating in the prefecture.

Description of the Yakuza Office Street View Search (Yakuza Jimusho Street View Kensaku): The website on the Yakuza Office Street View Search (Yakuza Jimusho Street View Kensaku) provides the location and address of each yakuza group—both designated and affiliated ones—based on Google Street View, as well as the date when a yakuza office was added to the website in each prefecture (access the website by clicking here). I extracted information on the yakuza offices as of August 3rd, 2023. Since yakuza organizations are not illegal in Japan, the addresses are least likely subject to measurement error. However, it is important to note that the website does not specify how the sample is selected, so it might not be representative.

Enactment Dates of the Yakuza Exclusion Ordinances: The yakuza exclusion ordinances were enacted across different prefectures in Japan between 2011 and 2012.

Table A30: YEOs Enactment dates

Group	Enactment	#Prefecture	Prefecture
1	Apr. 2011	3	Fukuoka, Nagasaki, Kagoshima
2	Aug. 2011	1	Ehime
3	Apr. 2011	24	All the other prefectures
4	Jul. 2011	6	Aomori, Iwate, Akita, Fukushima, Nara, Wakayama
5	Aug. 2011	8	Yamagata, Saitama, Niigata, Shizuoka, Toyama, Ishikawa, Shiga, Miyazaki
6	Sep. 2011	2	Chiba, Nagano
7	Oct. 2011	2	Tokyo, Okinawa
8	Jan. 2012	1	Saga