The new oil wars

Oil palm plantation expansion and violence in Indonesia

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Abstract

What is the relationship between agricultural commodity production and violence? We answer this question by examining the patterns of violence associated with the growth of the oil palm sector in Indonesia. Using data on the expansion of plantation coverage derived from satellite imagery along with data on reported incidence of low-intensity con ict, we nd that the relationship between plantation expansion and con ict is increasing but non-linear over time. To understand the causal mechanisms, we conducted eldwork in six villages in palm producing areas of Indonesia. We nd that the violence associated with oil palm occurs in large part through the channel of organized crime, as oil palm production gives rise to multiple opportunities for theft and extortion by violent, if low-tech, armed groups.

Key words: Palm oil; political economy; violence; conflict

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1 Introduction

Research on the relationship between natural resources and violence is vast (Nillesen and Bulte, 2014; Ross, 2015; Le Billon, 2001). A large body of work demonstrates a positive, and likely causal, association between the presence of high value and capital intensive resources, most notably oil, and violent conflict (Ross, 2015; Dal Bó and Dal Bó, 2011; Bellows and Miguel, 2009; Weinstein, 2006; Fearon, 2005). In contrast, the theoretical and empirical relationship between the production of labor intensive agricultural commodities, such as coffee or rubber, and violence is more ambiguous (Dube and Vargas, 2013; Berman et al., 2017; Bazzi and Blattman, 2014; Brückner and Ciccone, 2010; McGuirk and Burke, 2017; Ciccone, 2018; Markowitz, 2017). An increase in the export value of a cash crop may, on the one hand, raise the returns to farming, thus keeping young men in gainful employment and away from violence (Collier, 2000; Dube and Vargas, 2013; McGuirk and Burke, 2017). Rising revenue in any sector could also increase state capacity, thus dampening the risk of conflict (Humphreys, 2005; Thies, 2010). On the other hand, however, rising returns to cash crop production could generate conflict among land users over the economic surplus produced by the trade. For instance, growing profits in a sector could generate increased pressure to expand the area under cultivation, leading to conflict between small holders, plantation owners, and indigenous peoples (Wolford, 2010; Sauer, 2018). What then is the relationship between agricultural commodity production and violence?

We answer this question by examining the patterns of violence associated with the growth of the oil palm sector in Indonesia. Fueled by a surge in global demand, Indonesia experienced a rapid expansion of oil palm production in the first two decades of 2000s. Although oil palm is a legally produced and traded commodity, its expansion has been associated with numerous social and environmental problems (Santika et al., 2019). This paper demonstrates that this expansion also led to increased levels of violence and predation.

We argue that the violence associated with oil palm occurs in large part through the thus far neglected channel of *organized crime*. Oil palm, as we show, has some of the features of a capital intensive industry, giving rise to multiple opportunities for theft and extortion by violent, if low-tech, armed groups. At the same time, unlike a geographically concentrated and high-value commodity like mineral oil or diamonds, it does not generate strong enough incentives for violent groups to contest control of the state (Bazzi and Blattman, 2014). Thus, the level of violence falls far below the threshold for civil war (Kalyvas, 2015), the focus of most recent writing in this area (Bazzi and Blattman, 2014). Rather, criminal gangs, or in Indonesian terms, *preman*, produce low-level violence both in competing for control the trade itself, and in exploiting their local dominance to extract income from farmers and producers through associated protection "services".

We first demonstrate the plausibility of our explanation compared to alternative accounts by drawing on several months of original fieldwork conducted in six randomly selected palm producing villages in two districts in the province of South Sumatra, one of the regions where the majority of recent palm oil plantation expansion has occurred. Our field research uncovered several patterns of violence, but the most significant were those associated with what local people described as the oil palm mafia (*mafia sawit*). These groups engaged in various forms of predation including the theft of oil palm fruits from plantation owners, extortion and intimidation of farmers, as well as generalized criminality in the communities and roads in the remnant spaces that remained outside of the plantations, sometimes spilling into the plantations themselves.

To empirically estimate the relationship between oil palm expansion and conflict, we make use of newly available panel data on the growth of palm oil plantation coverage from 1995 to 2015 derived from satellite imagery at the *desa* (village) and *kecamatan* (sub-district) levels. We combine this with violence and conflict data from the Village Potential Survey (PODES) 2014 for a cross-sectional analysis and from the National Violence Monitoring System (NVMS) from 2005 to 2014 to study trends in resource conflict. Our dataset covers xx provinces in Sumatra, Kalimantan, and Papua.[RS] Our unit of analysis is the village for the cross-sectional study and the subdistrict for the dynamic analysis. We classify each geographical unit (village or sub-district) into three groups – those without oil palm production by 2015, recent oil palm producers (those that began planting after 2005 but not before), and old oil palm producers (those that had begun before 2005), and econometrically compare the incidence and trajectory of violence and conflict across these groups.

The cross-sectional analysis shows that villages that are engaged in oil palm production report a greater incidence of conflict and theft. Relative to villages with no oil palm production, those with oil palm production have a 2 percentage point greater likelihood of conflict and 5 percentage point greater likelihood of the incidence of theft. Two supplementary analyses support our causal interpretation. First, we find that conflict is elevated when international prices for oil palm are high. The *kecamatan* level analysis, which allows us to use annual conflict data, shows an inverted U-shaped pattern of conflict in sub-districts that produce oil palm. Resource conflicts escalate after 2008, peak in 2012, and gradually decline thereafter. This escalation of conflict in palm producing areas is coincidental with an increase in oil palm prices. Second, we find that the pattern of conflict in 2014 is quite similar in villages that began oil palm production at different times, except for producers began only after 2010. Given the time lag between planting and harvesting, this indicates that violence is driven by competition over the rents produced by the commodity trade rather than by conflicts over land ownership per se. We deal with the potential endogeneity of plantation expansion by

using the suitability of an area for palm cultivation based on its soil type, topography, climate, and existing usage. Results remain robust.

This paper makes several contributions, both theoretical and empirical. First, this paper adds to a growing body of work on the microdynamics of violence associated with the primary commodity sector. Although commodity price shocks have been utilized to gain explanatory leverage on violence within the context of civil war and armed conflict (Berman et al., 2017; Bazzi and Blattman, 2014; McGuirk and Burke, 2017; Ciccone, 2018), we show that its effects may also be felt in peacetime. We capture these dynamics by focusing on levels of violence that are well-below the threshold of civil war, but where murders, beatings, and threats of violence constitute a daily reality.

Second, moreover, we also add theoretically to existing work on commodity price effects. While existing work has focused on income and state effects, we show also that its effects may also be felt through the intermediary level of organized crime. Like other lootable natural resources, but unlike many bulk commodities, oil palm production is associated with multiple choke points in the process of production over which producers, processors, and intermediaries compete (Dube and Vargas, 2013; Berman et al., 2017; Bazzi and Blattman, 2014; McGuirk and Burke, 2017; Ciccone, 2018). In other words, we find evidence that the *rapacity* mechanism previously only associated with high value goods such as mineral oil, may also be present in at least some agricultural commodity sectors.

Last, this case allows us to distinguish between the effects associated with the production of a commodity and of its expansion per se. Although qualitative research points to the issue of conflict over land rights associated with expansion (Li, 2017), utilizing subnational variation in the timing of plantation expansion and commodity price variation, we show instead that conflict over the spoils of production are instead more salient in explaining violence overall. First, we find little evidence of a difference in outcome between old and new palm plantations. Violence seems instead to be more closely associated with temporal variation in the surplus or rents produced by the industry. Second, we find that the association between violence and oil palm plantation expansion is evident only after palms have become productive, several years after any land expropriation would have taken place (c. 4–5 years after planting).

2 Background: oil palm expansion in Indonesia

Palm oil (*elaeis guineensis*) is an edible tropical oil, which grows only within a narrow band of ten degrees north and south of the equator. Demand for it has grown exponentially over the last two decades. Its

ubiquity in global consumer goods manufacturing is hard to overstate; palm oil contributes to about half of the packaged products sold in grocery stores in the United States. Imports to the United States alone rose from less than 200,000 metric tons in 2000 to 1 million metric tons by 2010, while global production is predicted to hit 84 million tons by 2020. Global palm oil production is concentrated overwhelmingly in Indonesia and Malaysia, which jointly produce about 85 percent of world exports. However, vast unexploited areas of West Africa and South America are also suitable for its cultivation.

The commodity price boom of the late 2000s and early 2010s provided a strong economic incentive for oil palm expansion. Figure 1 depicts the rapid rise in prices for processed palm oil. The spikes in prices were caused by sharp rise in demand from fast growing economies, especially China and India. Concurrently, Indonesian production and exports of palm oil increased rapidly in the 2000s. Figure 2a, which plots increases in aggregate area under cultivation over time, shows that expansion of the area under oil palm cultivation far outpaced any other estate crops. A large fraction of Indonesian oil palm is exported, as shown in Figure 2b, making this crop an important export of Indonesia.

Figure 1 here.

Figure 2 here.

Oil palm plantations generally "expand to take up all space" (Li, 2017, 5) in a given area, pushing out all other forms of agrarian production. In Indonesia, such plantations have rolled out over pre-existing hamlets, farms and forests, with villages often enclaved within vast expanses of palm trees. Palm production and harvesting is also relatively capital intensive, in part because oil palm fruits are heavy, and need to be taken for processing within 48 hours of being harvested (McCarthy and Cramb, 2009). As a result, palm oil production requires highly coordinated operation of mobile work gangs to harvest the fruits, transport them by truck, and move through the plots, spreading fertiliser and pesticide (unlike rubber, which can be harvested and cultivated by an individual smallholder).

Indonesia's plantation expansion in the 2000s was characterized by the involvement of large foreign investors who sought to work with existing small-holder farmers (as opposed to state-led development during the "New Order" regime in the early 1990s), spontaneous migration to frontier areas (as opposed to government-induced migration under the Transmigration program), and expansion in areas surrounding existing estates (Budidarsono et al., 2013). Data from Badan Pusat Statistik (BPS) – the Indoensian Statistics Bureau – show that the number of large plantation companies increased from 693 in 2000 to 1,600 in 2015 (Badan Pusat Statistic, n.d.). In the same period, the area of large plantations increased from under 3 million hectares to 6.7 million hectares, while those of smallholders remained constant at 3.5 million hectares.

The expansion was uneven during this time, as shown in Figure 3, which illustrates the additional plantation area added between between 1995 and 2015. In the period 1995-2000, oil palm planted area increased over threefold, from 0.9 to 3 million hectares in 2000. Growth between 2000-2005 was relatively modest, with an increase by 0.6 million hectares only. After the democratic transition in 1999, the central government lost its "fiscal, administrative, and coercive" capacity to expand plantations (McCarthy and Cramb, 2009). Credit at concessionary rates became less available. The state resumed its efforts to develop the sector by setting a target of expanding palm oil by 1.5 hectares with a credit scheme, continuing the partnership model of the earlier period. Another rapid increase took place between 2005 and 2010, with palm area increasing from 3.6 million hectares to 5.2 million hectares. The period of 2010-2015 also saw rapid growth, with the area under cultivation increasing from 5.2 million to 6.7 million hectares.

The production of palm oil is geographically concentrated in particular provinces. Riau, North Sumatra, and West and Central Kalimantan are the largest palm producing provinces in terms of planted area, each with over 1 million hectares in 2015 (see Table A1 and Figure 3). In 2016, 60% of Indonesian production area was located in provinces in Sumatra, where as 35% was located in Kalimantan.[RS] These provinces also saw double digit growth in the area under palm production between 2011 and 2016.

The expansion of oil palm has been a double-edged sword for Indoensia. On the one hand, it is a source of poverty reduction in many rural areas that have few economic alternatives (Edwards, 2018). However, it may have contributed to the slowdown in Indonesian manufacturing exports in the 2000s through the "Dutch disease" effect, and it is unclear whether it will lead to broad-based, sustainable development (Shrestha and Coxhead, 2018). Critics of the industry also point to its negative social and environmental impact (Euler et al., 2016). The extensive deforestation, in particular the massive burning of peat swamp forests, required for its production both damages biodiversity and unlocks enormous carbon sinks. At the same time, as we explain in the next section, its future expansion is also likely to be accompanied by increased violence.

3 Theoretical Considerations

3.1 Previous Research

The theoretical relationship between agricultural commodity production and violence is ambiguous. The most common channel through which agricultural commodity production is assumed to affect conflict in producing areas is through household *income*, the theory being that as incomes from farming rise, the opportunity cost of fighting and other predatory activity increases (Collier, 2000; McGuirk and Burke, 2017; Dube and

Vargas, 2013). Analogously, increased conflict in non-producing areas may be faciliated by a spillover effect of increased availability of financing (Berman et al., 2017; Weinstein, 2006). Dube and Vargas (2013) show that a fall (rise) in the export price of bulk agricultural commodities is associated with an increase (decrease) in the intensity of conflict. Yet evidence on other agricultural commodities, both legal and illegal, yields the opposite results (Angrist and Kugler, 2008; Brückner and Ciccone, 2010; MillaǹQuijano, forthcoming) or no relationship at all (Bazzi and Blattman, 2014; Fearon, 2005).

Bulky and low value agricultural commodities are not typically associated with a *rapacity* effect (Dube and Vargas, 2013) or *state* effect (Bazzi and Blattman, 2014; Thies, 2010). Where commodities generate substantial economic surpluses, or rents, it could be expected that groups will fight to control them(Collier, 2000). Thus far, these effects have been observed mostly in geographically concentrated, high value sectors, such as mineral oil and diamonds (Berman et al., 2017; Dube and Vargas, 2013; Bellows and Miguel, 2009). The presence of oil, for example, is associated with a greater likelihood of civil war onset (Ross, 2006). A related channel linking agricultural commodity production and violence is conflict over land rights. An increase in the value of a crop could drive expansion of the area under cultivation. Although qualitative research suggests that the expansion of cash crop production is associated with social conflict, whether between small and large land holders or migrant farmers and indigenous populations (Wolford, 2010; Sauer, 2018), thus far statistical evidence for this mechanism is lacking.

3.2 Causal Mechanisms

Violence in the shadow economy is often attributed to the absence of the state as a third party enforcer of property rights (Yashar, 2018; Andreas and Wallman, 2009; Gambetta, 1996; Reuter, 1983). Yet in some nominally legal sectors, such as construction, distinctive production technologies also allow for substantial criminal involvement. Where the rents associated with an industry can be monopolized through force, elevated levels of violence are often observed (Gambetta and Reuter, 1995; Catino, 2019; Reuter, 1987). Palm oil, like all cash crops and other non-renewable resources such as oil, diamonds, or precious metals, but unlike subsistence crops, naturally generates controllable rents (Murphy et al., 1993; Ross, 2001). The size and nature of these rents are, however, distinct from those produced by high value, geographically concentrated, and relatively low bulk commodities.

Oil palm cultivation requires vast amounts of territory. However, in the oil palm sector, as described above, there are multiple physical and temporal points in the supply chain where rents can be extracted, from the granting of licenses by government officials in return for bribes, to the monopolization of transportation

services between plantations and processing plants (Danzer, 2008, 27). We build on the idea that variation in the level of violence in the shadow economy is primarily driven by *competition between specialists in violence over control of the rents produced in a given economic sector* (Yashar, 2018; Lessing, 2012). At the most basic level, we thus anticipate that the incidence of violence and predation should be higher in rural areas in which oil palm is cultivated than in areas in which it is not cultivated, although we expect levels and types of violence to be quantitatively and qualitatively different to those observed in areas of high value commodities such as mineral oil.

3.3 Additional Predictions

To the degree that violence is associated with competition over rents, rather than some other process, we expect it to be associated with two additional processes. First, violence should vary with market prices. Previous research on civil wars has found that increases in the price of labor-intensive agricultural commodities may decrease conflict as workers prefer increased wages to the risk of predation–an *income* effect–while an increase in the price of capital-intenstive commodites such as oil may increase armed conflict as state and non-state entities compete to control the sector's higher rents–a *state* effect (Dube and Vargas, 2013; Berman et al., 2017; Bazzi and Blattman, 2014). Owing to the unusual characteristics of oil palm production, in many respects it is closer to a capital-intensive 'point' resource than a 'diffuse' agrigultural one (Auty et al., 2001).

While farm gate prices may vary to a degree with international market fluctuations, the income effect is likely to be small, with little impact on the opportunity cost of predation for individual farmers or laborers. The biggest price shock is likely to be felt at the intermediary levels of transit and processing, where profits and rents are concentrated. If the pool of rents increases sufficiently due to higher prices, the potential prize for those willing to violently contest control over the rents associated with the transportation and processing of oil palm excedes its costs. We can thus imagine a price threshold across which violent competition should intensify.

Second, we also anticipate a temporal effect. Our expectation is that violence should occur largely after oil palms have become productive, not before. Oil palm takes approximately four years to begin generating fruits, implying that we should begin to see violence approximately five years after palms have been first planted rather than during the land acquisition, forest clearance, or initial planting stages themselves. Evidence of higher levels of violence during the initial planting stage would suggest that violence could be driven more by competition over land rights and possible conflict between native and migrant labor. In spite

of the primacy that land conflict occupies in both academic and advocacy literature on oil palm, violence stemming directly from conflict over land was not the primary form of violence recorded in the villages we studied. Of our six case-study villages, only one had experienced this form of violence within the last dozen years.

4 Mechanisms

4.1 Fieldwork

To illustrate the causal mechanisms linking oil palm plantation expansion with elevated levels of violence, we conducted fieldwork in six randomly selected villages in two districts in the province of South Sumatra, the region where the majority of recent palm oil plantation expansion has occurred. Our two districts, Ogan Komering Ilir and Musi Rawas Utara, were first randomly selected from those sub-districts which had extensive palm plantation coverage according to our satellite data. We next identified villages in these sub-districts which, according to PODES, depended on plantations as the main source of income and which had experienced murders or group fights in the recent past.

Local researchers under the supervision of one of the authors visited each of these villages, as well as district capitals, neighboring towns, and the provincial capital, where they interviewed members of local communities, community leaders, plantation company staff, local police and government officials, as well as NGO activists and academics, in order to develop a picture of general industry dynamics and to reconstruct histories of violence in these villages and surrounding communities. While in the field, researchers found that the three selected villages in Musi Rawas Utara had relatively little direct engagement in palm oil cultivation (in one village only 6 of 291 households were involved, with most other households growing rubber; proportions in the other villages were similar). We therefore focused on the three villages in Ogan Komering Ilir in follow-up field research by one of the authors and the local researchers.

4.2 A Predatory Political Economy

In both field research locations, we encountered communities whose members were habituated with the occurrence of interpersonal violence, with villagers routinely carrying weapons for personal protection, being fearful of travelling alone or at night in some locations, and where the possession of firearms – mostly handmade and local in origin – was widespread (highly unusual in Indonesia). Eruptions of mass violence

– inter-village clashes, brawls between rival gangs, and fights between company security forces and local residents – were not everyday occurrences but were sufficiently regular for all persons we encountered to be familiar with numerous such events in their localities in recent times, in many cases able to provide vivid firsthand accounts of decapitations, shootings, and other forms of extreme bodily violence.

The most significant dynamic in the production of interpersonal violence was activity associated with what local people call the oil palm mafia, a term used to refer to groups engaged in theft of oil palm from company plantations. While some of this theft took place in day time and was conducted by individuals or small groups who filched harvested fruits that were awaiting collection on roadsides, there was also a highly organized version in which gangs using trucks would raid company estates at nights, harvest fruits (without the selectiveness and care that accompanies normal harvesting) and sell them to middlemen who would then transport them to processing factories (often located in rival plantations from where the theft occurred). The larger-scale theft was usually run by local gangs based in nearby villages inhabited by members of indigenous local ethnic groups, often those who had experienced land alienation as a result of plantation expansion. Padang Pasir (a pseudonym) village was reputedly a center of this activity in Ogan Komering Ilir district. Such larger-scale predation was also typically highly organized – for example, rival gangs would divide plantations into distinct blocks so as not to compete directly for fruits, and the thieves would typically make payoffs to company security, police and military officers. Even so, the operations of this mafia occasionally resulted in violent clashes and arrests when thieves encountered rival groups or company security on plantation roads.

A related form of violence was more generalized criminality in the communities and roads surrounding the plantations themselves. Both sub-districts were marked by high levels of violent predatory crime – robbery and hold-ups on highways and plantation roads, kidnapping for ransom, inter-gang warfare and the like – fostered by an extensive mafia-style political economy in which the same local gangs, sometimes described as petty-gangsters or toughs ran protection rackets around the oil palm plantations. Among our three case-study villages in Ogan Komering Ilir, Padang Pasir (mentioned above) was also a major location of such activity. A lucrative source of income for many of the young men in the village was the main inter-provincial highway that ran through the village. Village youths ran a racket on this road, in which they would provide "security" for oil palm and other goods trucks passing along the road – requiring them to display stickers produced by the group, and sometimes riding shotgun to accompany them along the road. They did so in exchange for fees, with the implicit or sometimes explicit threat that they would attack or rob drivers who did not pay. Another income source was the official government weigh station located in the village in which Ministry of Transport officials were supposed to weigh passing truicks to ensure they did not exceed

government-set weight limits, and to charge government taxes. Working in cahoots with the officials running the station, villagers collected payments from truck drivers in exchange for free passage. This business was so lucrative that some of the men in charge of it became very wealthy, building ostentatiously large houses near the station. Protection rackets like this are common in many parts of Indonesia (Tajima, 2014; Wilson, 2015), run by petty gangsters or *preman* and clustering around centers of economic activity such as public transportation terminals or nightlife districts in the cities or natural resource projects in rural areas. Participants in *preman* typically collaborate with police and other formal security actors, and this pattern was also observable in our field sites.

This mafia-style political economy gave rise to a local subculture of violence in both districts, in which many male residents – especially of villages which had lost their land to the oil palm companies and whose residents were not integrated into smallholder schemes – cultivated reputations for personal toughness and violence. This was certainly the case with Padang Pasir village. Referring to its violent reputation, the residents of many neighbouring villages labelled Padang Pasir a "hell village" (kampung neraka), while some of the villlage's residents themselves took pride in their reputation for "hardness." One such resident was disarmingly frank: "People call it a hell village because the indigenous people who live there don't care about the law, they live by the law of the jungle. ...In their everyday lives they carry knives, tucked into their waists. In [a neighbouring village] they produce lots of homemade guns. People around here buy them to rob people. .. In areas like this the women work each day tapping rubber, but the men gamble, drink and steal" (Confidential interview, 5 April 2018).

4.3 Alternative Mechanisms

We noted above that one possible mechanism linking violence with oil palm plantation expansion is conflict over land use rights between plantation companies, local residents, and other actors. There is an extensive qualitative literature on land-grabbing and land conflict in Indonesia and beyond, documenting the sometimes violent confrontations that can occur when local landowners resist attempts by companies to establish oil palm plantations (Acciaioli and Dewi, 2016; Levang et al., 2016; Potter, 2009). In both of our case-study districts, local land-rights advocates have compiled many reports of legal disputes, protests and occupations, as well as violent clashes between local landowners and plantation companies. However, despite the primacy that land conflict occupies in both academic and advocacy literature on oil palm, violence stemming directly from conflict over land was not the primary form of violence recorded in the villages we studied. Of our six case-study villages, only one, Padang Pasir village, had experienced this form of violence within the last 15 years and the violence recorded referred primarily to property damage. The most recent instance of this

violence occurred in around 2005 (local recollections varied on the precise date) when residents invaded the grounds of a plantation company, burning down the office building and destroying seven trucks (staff had been forewarned of the attack and had fled, so interpersonal violence was avoided). Even in this case, as we noted above, most recent violence resulted from the criminal political economy surrounding the industry.

Another possibility is that violence in palm producing areas is driven by inter-ethnic conflict. A large literature on ethnic conflict in Indonesia notes that large-scale inter-ethnic violence in the country has often been triggered by competition between rival ethnically-defined preman groups for territory or economic resources (Wilson, 2013; Varshney, 2008; Tajima, 2008; Van Klinken, 2007). This dynamic was also visible in one of our case-study districts, Ogan Komering Ilir where a large number of Javanese (as well as some Balinese and Sundanese) transmigrants were engaged in the oil palm industry (transmigrants were not present in the parts of Musi Rawas Utara where we conducted research so this form of violence was absent there). Once again, however, this violence was deeply embedded in the predatory criminal behaviour described above, with often vulnerable transmigrants being the targets of predation by local gangs. For example, Javanese migrant farmers reported being stopped and robbed or being forced to hand over some of their oil palm fruits by armed youths while travelling along plantation roads. Some violent clashes also occurred when locals claimed the smallholdings of Javanese migrant farmers as part of their ancestral lands. This background of widespread insecurity for transmigrants ultimately led to the formation of a Javanese martial arts group (the local branch of the Indonesia-wide group Persaudaraan Setia Hati Terate, PSHT) in Ogan Komering Ilir district in the mid-2000s. In effect, PSHT operated as an ethnic self-defence group to protect the local Javanese and retaliate when they experienced violence. However, by the time we conducted our research there were signs that at least some PSHT members were themselves leveraging their organizational muscle to themselves engage in the illicit economy – and in formal politics – in patterns reminiscent of preman organizations in other parts of the country.

5 Empirical Strategy

We next describe our strategies to examine the relationship between oil palm production and conflict quantitatively. The goal of our analyses is to determine whether conflict is systematically related to the prevalence and expansion of oil palm in a location. The gradual expansion of oil palm to new areas in the 2000s allows us to analyze which phase of expansion is prone to conflict. Based on satellite data on prevalence of oil palm in a location (described in detail below), we can categorize a location into three types based on how recently it engaged in oil palm production: (1) No oil palm production by 2015; Palm production in 2005 but not

earlier; and (3) Palm production since 1995 (possibly earlier).[RS1,2] We argue that by analyzing the trajectory of conflict in these different types of locations, we can determine the dynamic relationship between oil palm expansion and violence. Given that the timing of production matters for generating conflict, we should find statistically significant differences in pattern of conflict across the various types of locations.

However, there are possible problems with using palm oil expansion as a causal variable. First, it is possible that some unobservable factors may influence both incidence of conflict and oil palm production in a particular location. For example, local property rights regimes or the strength of local institutions may be related to both conflict and investments in oil palm production. These factors cannot be easily captured in the data and could lead to bias in our estimates. Relatedly, palm production may not expand in areas with very high risk of conflict. Given the long-term planning required to reap rewards from the commodity, investors may be hesitant to invest in areas that have pre-existing risk factors that are likely to exacerbate conflict. Due to this feedback effect from conflict to palm expansion, the statistical relationship between the two variables could be non-linear.

The effect of time-constant unobserved factors can be taken into account through fixed effects regression. Yet there may be other factors correlated with presence of oil palm that vary over time and affect trends in conflict. We account for this source of confounding by ensuring that our estimates are robust to the inclusion of appropriate control variables and to the use of instrumental variables estimation, with agro-climatic suitability for palm oil production instrumenting for actual output. Oil palm requires a certain climatic and geographic conditions for it to be viable. The ideal conditions are determined by the slope of the land, rainfall patterns, and soil type, which have all been well-documented in previous studies. We do not expect degree of palm oil suitability to be correlated with unobservable influencers of conflict, after controlling for observable characteristics of the location in the baseline.

Second, the presence of oil palm in certain location is highly correlated across time. Oil palm plantations are concentrated in a few areas of Indonesia that have conducive agro-climactic conditions. Such spatial and temporal correlation may lead our standard errors to be erroneously low.

Taking note of these issues, we perform three types of analysis:

[1] Our earliest satellite data is from 1995.

[2] Once a village is recorded as engaged in oil palm production in a given year, we classify it has continuously producing in all subsequent years. In the data, a small number of villages switch from production to non-production in subsequent years.

5.1 Village level analysis

For 2014, we are able to merge the information on oil palm production, palm suitability, and proxies for conflict at the village or *desa* level. Furthermore, we also have information on the timing of oil palm production at the location. Thus, we study how the length of oil palm production in a village effects occurrence of conflict. The regression model is

$$conflict_i = \beta_0 + \beta_1 palm_i + \beta_2 palm_i \times type_i + \alpha X_i + e_i \tag{1}$$

where $conflict_{it}$ is the conflict incidence in location i, $palm_i$ is share of village area under oil palm production and new_i is an indicator for new oil palm production. The variable $type_i$ is a categorical variable which indicates whether the village obtained oil palm before or in 1995, or in 2000, 2005, 2010, or 2015.

Using satellite data, we also calculate proximity to palm producing villages for those that never received oil palm. We study whether villages that are closer to oil palm producing villages also experience higher rate of conflict. For this analysis, we regress incidence of crime and conflict on quadratic distance to nearest village that produces oil palm.

5.2 Difference-in-differences

Since we have panel of sub-districts (*kecamantan*), we can study the relationship between level of conflict in a sub-district and the level of oil palm cultivation. Our model is

$$conflict_{it} = \alpha_0 + \delta palm_{it} + \sum_t \beta_t palm_{it} \times year_t + \sum_t X_{i0} \times year_t + fe_i + fe_t + e_{it} \tag{2}$$

where, $conflict_{it}$ is the conflict incidence in location i at time t, $palm_{it}$ is a measure of intensity of oil palm production at time t, X_{i0} is a vector of control variables measured during baseline year (2005), $year_t$ is an indicator variable for year t, fe_i represents the fixed-effects of location i, and e_{it} incorporates other unmeasurable factors that may affect conflict. The interaction between $palm_{it}$ and $year_t$ allows the oil palm production to have different impact on conflict over time.

5.3 Year interactions

To explore the timing effects around expansion, we also use an alternate model:

$$conflict_{it} = \alpha_0 + \delta palm_i + \sum_{t=2006}^{2014} \beta_t palm_i \times year_t + \sum_{t=2006}^{2014} \theta_t X_{i0} \times year_t + \sum_{t=2005}^{2014} \delta_t year_t + fe_i + e_{it} \quad (3)$$

Here, $conflict_{it}$ is the conflict incidence in location i at time t, $palm_i$ is a measure of intensity of oil palm production in the location, X_i is a vector of control variables measured during baseline year (2005), $year_t$ is an indicator variable for year t, fe_i represents fixed-effects of location i, and e_{it} incorporates other unmeasurable factors that may affect conflict. The estimates β_t - one for each sample year - shows the trends in conflict in areas with varying intensity of palm oil, thus providing an impact of palm on conflict. Conceptually, this model tracks the evolution of conflict in locations with varying degrees of oil palm production. Our specification mirrors the one used by Berman et al. (2017, pg. 1574), except that we use year dummies rather than prices of minerals in that year.[3]

For each analysis, we present results from different models that vary in how $palm_i$ is measured. In the baseline model, we use area under palm production in 2005. Alternatively, we also use area under palm production measured in 2015 (the time period remain the same as the baseline model). The latter model is used to account for the possibility that conflict incidence may preceed oil palm production. So, areas that eventually recieved oil palm (after 2005) still may experience incidence of conflict between 2006-2014. In the third variation of the model, we use area with high level of suitability for oil palm production as $palm_i$ since actual production might be endogenous.

For the sub-district analysis, the dependent variable is a count of the number of events in each location, with many locations reporting zero conflict, we use a negative binomial fixed-effects regression model. We also vary the estimation sample of sub-districts to test robustness of our results. The baseline model includes all the sub-districts for which relevant data is available, but also conduct estimation after excluding provinces in Java where no oil palm production ever took place. Our standard errors are corrected for potential correlation across sub-districts by clustering by province and time.

[3] We only deal with single commodity - oil palm - rather than multiple minerals in Berman et al. (2017).

6 Data description

6.1 Violence and conflict data

We quantify conflict and crime intensity in a sub-district by the occurrences of various types of conflict. The data source for conflict is the National Violence Monitoring System (NVMS) dataset (National Violence Monitoring System (NVMS) dataset, 2015). NVMS records incidence of violence and conflict that were reported in local newspapers. Detailed description of the data is available in Barron et al. (2014). This data only captures latent conflict that manifest as newsworthy incidents. The database defines violence as any deliberately committed actions that either (1) cause physical harm to people or property (injury, bruising, death, rape/sexual harassment, damage to buildings, broken windows, burned houses, etc) or (2) restrict physical freedom of people (abduction, kidnapping, etc). Events are classified as "resource conflict," "government programs," "electoral," "separatist," "identity-based," "popular justice," "criminal," or "law enforcement."

The coverage of provinces differ over time, so we focus on the 2005-2014 period, which covered 16 provinces containing 3737 of the 6771 sub-districts (based on 2011 boundaries).[4] Violent crime and popular justice are most common type of violence, comprising over 75% of reported events. A drawback of this dataset is the lack of coverage for all provinces and also possible errors in coding the location of conflict. Although the events are recorded at the village (*desa*) level, we aggregate the information at the sub-district (*kecamatan*) level. Thus, our estimation dataset comprises of a panel of sub-districts with information on the number of violent events occurring yearly from 2005 to 2014.

Figure 4 shows the average number of incidents by provinces, broken down between three periods: 1998-2004, 2005-2011, 2012-2014. The number of events for each period is divided by the number of sub-districts in the province (in 2011 - corresponding to the coding used by NVMS data) times the number of years in the period. So, the height of each bar represents the number of incidents per kecamaten per year in that province. We can clearly see that DKI Jakarta has the highest average incidence reported. We also find increasing number of incidents reported in Maluku Utara and Papua, which were among the provinces covered in each of the three periods.

Figure 4 about here

Another source is the Village Potential Survey (*Pontesi Desa Survei* - PODES) dataset, which is a census of all villages in Indonesia conducted at roughly 3-year intervals. We use data from PODES 2005,

[4] Coverage was expanded to 34 provinces from 2012.

2008, 2011, and 2014. PODES asks respondents (usually the village head) various questions about village demographics, economy, as well as major events that occurred over the past year. A module on village security includes questions about occurrence (as well as detailed information about parties involved) of any mass fights (*perkelahian massal*) and occurrence of varous types of crime.[5] In 2014, about 3.4% of the village heads reported mass fight in the community, a proportion which has remained constant since 2006.[6] Among villages that report any conflict, the average number of conflict is 1.67, meaning that more than conflicts are common. One caveat of PODES is that, given that this information is reported by the village head, there may be misreporting of violent episodes. The inconsistency between NVMS and PODES violence data for corresponding years has been documented by Barron et al. (2014). Their main concern, based on comparison of reported conflict-related deaths in PODES and NVMS, is underreporting of violence in calmer areas and overreporting in areas with more violence. Thus, using multiple sources of conflict data allows us to check the robustness of our findings to alternative data sources.

6.2 Oil palm production

The main variable we use to characterize the involvement of a sub-district in oil palm production is share of sub-district area under palm cultivation. This is computed using remote-sensed data that classifies pixels in satellite images into various land use categories, with oil palm cultivation being one of them (Austin et al., 2017). This information is available every five years from 1995 to 2015. Based on this information, we classify locations into the six categories mentioned above.

The summary statistics for oil palm production are shown in Tables 1-5, separately for oil palm-growing regions of Sumatra, Kalimantan, and Papua. First at the village level, we find that over time more and more villages are engaged in oil palm production. By 2015, eight provinces had over a quarter of the villages in oil palm production in 2015 (see Table 1). Likewise, Table 2 shows the average share of village area under oil palm cultivation by type of village. Villages in Kalimantan and Papua that already had oil palm in 1995 continued to expand oil palm production in the 2000s. At the same time, villages that recently obtained oil palm also continue to grow rapidly.

Table 1 about here.

Table 2 about here.

[5] While the question asking about the occurrence of conflict is same across time, there is variation in questions about intensity of conflict. In 2005 round, village head are asked to report the number of deaths, injuries, and value of damages from mass fights.

[6] The 2003 PODES reported higher incidence of violence at 7%, mostly due to separatist conflict in Aceh.

We observe similar patterns when aggregating at the sub-district level. Table 3 shows that the proportion of sub-distircts producing palm increased between 2000 and 2015 in all the producing provinces. The fastest growth is observed in Kalimantan, where the share increased from 29% in 2000 to 63% in 2015. Table 4 shows that the coverage of palm oil also increased between 2000 and 2015. In 2000, 30% of sub-districts in Sumatra, 29% in Kalimantan and 8% in Papua had some oil palm plantation. Over the next 15 years, as new areas came under production, the percentage had grown to 43%, 64%, and 15% respectively, highlighting the rapid growth especially in the Eastern parts of Indonesia. The fastest growth came between 2005 and 2010 in Kalimantan, where the share of sub-districts with any oil palm increased from 36% to over 53%.[7] On average, 5.6% of sub-district area in Sumatra, 1.9% in Kalimantan, and 0.2% in Papua were covered by oil palm plantation. This grew rapidly in the next 15 years, to 8.6%, 9.7%, and almost 1% in the three regions respectively. In Table 5, we just focus on those sub-districts which had some plantation in 2015 (thus ignoring sub-districts that never received any oil plam plantation). As expected, the coverage percentages are higher.[8]

Table 3-Table 5 here.

6.3 Control variables

We construct control variables from *Pendataan Potensi Desa* (PODES) and Census data. PODES is a census of all villages conducted every 3 years. The controls include those related to social characteristics (percentage of Christian, percent migrants), economic characteristics (presence of plantation business), political situation (voting patterns), and security apparatus (distance to nearest police station). Except the social characteristics, the controls are derived from PODES 2005, which collects information at the village level. To convert a village-level characteristic into those of the sub-district, we calculate the share of households living in village with that characteristic. For example, with distance to police station, we calculate the share of families living in villages where police station is within 5 kilometers (km). A summary of all the variables used in the empirical analysis is presented in Table A2.

[7] To account for the administrative subdivisions that Indonesia went through, all sub-districts are reverted to their 2000 boundaries.

[8] In the Appendix, we also utilize other sources to document the expansion of oil palm plantation. Table **??** shows change in plantation employment share in major oil palm region. Table **??** shows that, in Sumatera and Kalimantan, the number of kecamatans where share of population employed in plantation sector is above 10 percent rose significantly in the first decade of 2000s.

7 Results

7.1 Oil palm and violence: Descriptive analysis

The data shows that incidence of violence is quite different across different types of locations. To visualize the pattern of conflict by type of location during 2005-2014 period, we run a baseline model specified in Equation 3 without any controls and plot the coefficients on interactions between sub-district type and year. We use incidence of four types of violence: resource, governance, criminal, and domestic. The coefficients are derived from fitting a fixed-effects negative binomial distribution model on the conflict data and displayed in Figure 5. Resource conflict and criminality show increasing trend in both recent and old oil palm producing regions. The incidence is much higher in the 2010–2011 period than before 2006 relative to sub-districts with no oil palm production. We do not see a similar pattern in the incidence of government conflict or domestic violence, which gives us confidence that the trend is not spurious due to greater newspaper coverage of oil palm producing areas after the boom in prices.

7.2 Econometric results

In this section, we present our findings from regression analysis of the impact of oil palm production on crime and conflict. We begin by reporting results from our village-level analysis, which shows increased rates of conflict and crime among villages that received oil palm before 2010. This indicates that much of the conflict takes place during the production phase, when oil palm fruits need to be cultivated, harvested, and transported to the facility for processing.

7.2.1 Village level analysis

Table 8 reports the results of village level estimation of equation 1 . Columns 1-4 report results with conflict as dependent variable, and Columns 5-8 use theft has dependent variable. Columns 1 and 5 only use basic explanatory variables; the rest of the columns control for additional village characteristics. In columns 3 and 7, we exclude villages that were engaged in oil palm production but did not increase their oil palm area between 2010 and 2015. In columns 4 and 8, we include interactions between palm area in 2015 and village type.

We find that the incidence of conflict is more likely in villages that have oil palm production. Compared to villages without any oil palm, villages that received oil palm before 2010 are almost 2 percentage

points more likely to report conflict, except for those villages that received oil palm between 1995 and 2000. But the likelihood of conflict is not statistically different for villages that received oil palm recently. The coefficients do not change much when we exclude palm producing villages that did not see any additional growth between 2010 and 2015, except for those villages that received oil palm between 1995 and 2010, in whose case the coefficient more than doubles. Interaction between village type and area under palm production yield statistically insignificant results. This is probably because our dependent variable is occurrence rather than intensity. So, size of oil palm area does not have explanatory power conditional on having oil palm production. We do not find any impact of size of oil palm production in the village, most likely because of dependent variable cannot capture intensity of conflict in the village.

In addition, villages that received oil palm earlier are three times more likely to report theft than those recently began producing. The coefficients suggest that villages that already had oil palm in 1995 are 10 percentage points more likely to report theft. On the other end, recent oil palm producers are 3 percentage points more likely to report theft than villages without oil palm. The coefficient on share of village area under oil palm does is small and statistically insignificant at conventional levels. This could be because we do not have information on intensity of conflict and crime in PODES.

Table 8 here.

For villages that do not produce oil palm, proximity to producing villages fuels conflict and crime. The results of this analysis is shown in Table 9. We find no impact on conflict, however villages that are closer to oil palm producing areas report greater incidence of theft. This may be due to the fact that a large part of crime associated with oil palm production takes place while transporting the fruit for processing.

Table 9 here.

7.2.2 Panel data estimation

Table 10 presents results of estimating equation 2. Most of the individual coefficients are not statistically different from zero. The coefficient on the level of palm production is small, negative, and statistically insignificant from zero. On the other hand, the interaction between palm production and year dummies are positive, providing suggestive evidence that the effect of palm production on conflict increased over time. For example, in column (2) the impact of one unit of palm production on conflict occurrence is 0.02 times higher in 2014 compared to 2005. The average palm production in the sample is 2.7, which translates into a marginal effect of 0.05 ($0.02\times$ 2.7) higher conflict or 5% (the average resource conflict incidence is 0.95 in the sample). Part of the reason for seeminly small effects is that we only focus on contemparenous effect in this

model. However, as discussed above, conflict could arise during the preparation phase due to land conflict, or during production due to theft or labor issues. Thus, we need to understand how the conflict evovles over time.

Table 10 here.

7.2.3 Results using NVMS data 2005 - 2014, palm production as regressor

The results from estimating model represented by equation 3 are presented in Table 11. In column (1), we report the results of running a negative binomial fixed-effects regression with resource-related violence as the dependent variable and an indicator for oil palm presence as the main regressor of interest. Also, shown are coefficients on interaction between oil palm presence and year indicators, which can be interpreted as time-varying effect of the presence of oil palm in the sub-district. The coefficients are small and statistically insignificant upto 2008, but become significant after 2008 and are increasing upto 2012, after which we see a slight decline. This indicates that in sub-districts with oil palm production, resource-related violence were increasing between 2008 and 2012, before declining in 2013 and 2014. The incidence of conflict coincide with the boom period for palm oil, implying that economic value of the resource is the main driver of conflict. In this sense, the results are similar in spirit to those found by Berman et al. (2017).

Table 11 here.

In column (2)-(5) of Table 11, we present results after inclusion of control variables. The results are similar when we use additional control variables, each of which is interacted with year dummies. In Column 2, we control for social characteristics of sub-disrict by including share of Christian population and share of migrant population in 2000, derived from Census data. These variables account for other factors that may lead to increased conflict over time. In Column 3, we alternatively control for importance of plantation in 2005 by including share of families living in villages with plantation business and shar of families living in villages where plantation is the main income source. The coefficients for years 2013 and 2014 fall sightly upon adding these controls, which indicate that conflict may have increased in those areas where plantation is an important economic activity. In Column 4, we control for density of police stations in the sub-district by controlling for share of families living in villages that are within 5km of the nearest police station. The coefficients are again similar to the baseline model. In Column 5, we control for voting pattern in the 2004 election by controlling for share of families living in villages where Golkar and PDP were the most voted parties, as reported in 2005 PODES. The set of controls used is indicated at the bottom of the table. The

results are qualitatively similar even though the value of the coefficients are slightly changed. We can conclude that sub-districts with any palm presence saw an increasing incidence of resource conflict between 2008-2012.

Figure 6 visualizes the effect of oil palm production on resource-related conflict over time by plotting coefficients on the interaction terms. The two lines correspond to two models: one uses presence of palm oil in 2005 as the indicator for palm presence, the other uses oil palm in 2015 (estimation results are available in the Appendix for this specification). In both models, the coefficients get larger for subsequent years, indicating that incidence of resource conflict grew in sub-districts which had palm oil.

Figure 6 here.

To ensure that the above results are not confounded by endogeneity of palm expansion, we reestimate the model by including palm suitability as the regressor. The models otherwise remain the same. This result is presented in Table 12. The structure of this table is similar to Table 11. The results qualitatively are similar: sub-districts where larger share of area are suitable for palm oil production see a growing intensity of resource conflict between 2009 and 2013, relative to the baseline of 2005. The results are similar when adding additional control variables.

Table 12 here.

Since expansion of oil palm may have broader impacts than just resource conflict, we use total conflict events recorded by NVMS as the dependent variable. The results are presented in Table 13. We observe a similar pattern but less pronounced trend. This could be because other types of conflict are also prevalent in other locations without oil palm, thus attenuating the impact of oil palm proliferation.

8 Conclusion

In this paper, we study the evolution in conflict and crime in oil palm producing areas of Indonesia. Our quantitative analysis finds that oil palm production, and in particular expansion, is associated with increased incidence of conflict and crime. This result runs counter to some recent research, which shows that increased agricultural commodity prices are associated with a lower incidence of conflict due to the increased opportunity cost of engaging in conflict rather than farming (Dube and Vargas, 2013; McGuirk and Burke, 2017). In these theories, conflict and production are separable activities. However, in some cases, production and conflict may be intimately linked without possibility of separation. Anytime there is production, there is possibility of conflict.

We argue that in the case of oil palm specifically, conflict is directly associated with specific aspects of production process; namely, the expansive and lightly administered nature of the territory in which oil palm is produced, and the presence of choke points in the supply chain, especially in the areas of harvesting and transportation. Our qualitative analysis supports this view, which reveals the operation of gangs engaged in both in the theft of oil palm fruit from plantations and in racketeering activities in the transportation and processing of harvested oil palms.

Last, our empirical methodology extends the work of recent reseach in economics that has attempted to estimate causal effect of resources on conflict using subnational data on location of natural resources and conflict (Berman et al., 2017; McGuirk and Burke, 2017). The granularity of our data, however, allows us to go beyond this research in at least two crucial respects. First, by utilizing satellite data on the expansion of the commodity in question, we are able to address temporal dynamics in a way that previous research has not. Second, because oil palm requires very specific growing conditions, we are able to employ an instrumental variables strategy to deal with possible confounding in the location of expansion.

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Tables

Table 1: Proportion of villages with palm coverage in Sumatra, Kalimantan and Papua by province and year

	1995	2000	2005	2010	2015
Aceh	0.03	0.05	0.05	0.08	0.09
Sumatera Utara	0.18	0.21	0.22	0.25	0.25
Sumatera Barat	0.03	0.08	0.09	0.10	0.09
Riau	0.33	0.37	0.42	0.47	0.46
Jambi	0.05	0.11	0.17	0.25	0.29
Sumatera Selatan	0.08	0.12	0.15	0.20	0.24
Bengkulu	0.02	0.05	0.07	0.10	0.14
Lampung	0.02	0.04	0.05	0.07	0.07
Kepulauan Bangka Belitung	0.07	0.22	0.25	0.30	0.35
Kalimantan Barat	0.06	0.09	0.12	0.25	0.40
Kalimantan Tengah	0.11	0.13	0.19	0.28	0.34
Kalimantan Selatan	0.05	0.06	0.09	0.14	0.17
Kalimantan Timur	0.06	0.11	0.20	0.30	0.38
Kalimantan Utara	0.01	0.05	0.06	0.12	0.16
Papua Barat	0.01	0.03	0.04	0.05	0.06
Papua	0.01	0.01	0.01	0.01	0.02
Total	0.08	0.11	0.13	0.17	0.19
Observations	36794				

Source: Authors' calculation from PODES 2014 and GIS data.
Administrative boundaries pertain to 2014 definitions. (Back to Section 6.2.)

Table 2: Average share of village area under oil palm in Sumatra, Kalimantan and Papua by province and year

	No palm	2015	2010	2005	2000	1995
Sumatra						
Palm area in 1995	0.00	0.00	0.00	0.00	0.00	0.22
Palm area in 2000	0.00	0.00	0.00	0.00	0.13	0.38
Palm area in 2005	0.00	0.00	0.00	0.09	0.18	0.43
Palm area in 2010	0.00	0.00	0.10	0.20	0.25	0.52
Palm area in 2015	0.00	0.08	0.17	0.26	0.25	0.44
Observations	24795					
Kalimantan and Papua						
Palm area in 1995	0.00	0.00	0.00	0.00	0.00	0.11
Palm area in 2000	0.00	0.00	0.00	0.00	0.05	0.21
Palm area in 2005	0.00	0.00	0.00	0.09	0.08	0.31
Palm area in 2010	0.00	0.00	0.09	0.27	0.16	0.44
Palm area in 2015	0.00	0.10	0.21	0.37	0.19	0.46
Observations	13307					

Source: Authors' calculation from PODES 2014 and GIS data.
The table shows fraction of village area under oil palm cultivation by type of the village. The columns titles indicate the first year in which the village was recorded as having palm. (Back to Section 6.2.)

Table 3: Proportion of sub-districts with palm production by region and year

	Sumatra	Kalimantan	Papua
Percent subdist. with palm in 2000	0.31	0.29	0.08
Percent subdist. with palm in 2005	0.35	0.36	0.10
Percent subdist. with palm in 2010	0.41	0.53	0.10
Percent subdist. with palm in 2015	0.43	0.64	0.15

Source: Authors' calculation from GIS data.
(Back to Section 6.2.)

Table 4: Average percentage sub-district area covered by palm production by region and year

	Sumatra	Kalimantan	Papua
Palm percent 2000	5.60	1.88	0.22
Palm percent 2005	6.53	3.12	0.29
Palm percent 2010	8.31	6.28	0.52
Palm percent 2015	8.64	9.70	0.96

Table 5: Average percentage sub-district area covered by palm production (sub-districts with non-zero palm area in 2015)

	Sumatra	Kalimantan	Papua
Palm percent 2000	12.00	2.89	1.43
Palm percent 2005	14.00	4.79	1.88
Palm percent 2010	17.82	9.67	3.43
Palm percent 2015	18.52	14.94	6.33
Observations	623		

Table 6: Incidence of various type of conflict by status of oil palm production

	(1)		(2)		(3)	
	All villages		Has palm 2005		New palm	
	Mean	SD	Mean	SD	Mean	SD
Conflict						
Fights	0.02	0.14	0.03	0.17	0.03	0.16
Theft	0.38	0.48	0.52	0.50	0.41	0.49
Burning	0.01	0.11	0.02	0.15	0.01	0.11
Harm	0.02	0.15	0.03	0.16	0.02	0.15
Others	0.23	0.42	0.33	0.47	0.24	0.43
Other characteristics						
Number of families	530.07	907.65	720.79	955.08	508.17	624.92
Distance (km) to district mayor's office	56.44	84.48	66.35	59.89	72.20	78.17
Infra: electricity	83.50	28.97	92.99	15.71	85.81	22.99
Infrastr: Police post within 5km	0.49	0.50	0.42	0.49	0.36	0.48
Economy: Main inc source plantation	0.38	0.49	0.71	0.45	0.58	0.49
Presence of several ethnic groups	0.76	0.43	0.95	0.22	0.89	0.31
Observations	37209		4648		2834	

Source: Authors' calculation from PODES 2014 data. Only villages in provinces of Sumatra, Kalimantan, and Papua that were part of the NVMS sample are included in the calculations.
(Back to Section 7.1.)

Table 7: Incidence of various type of conflict by status of oil palm production

	(1)		(2)		(3)	
	All sub-districts		Has palm 2005		New palm after 2005	
	Mean	SD	Mean	SD	Mean	SD
Other conflicts	0.05	0.21	0.05	0.21	0.03	0.17
Resource Conflict	0.13	0.33	0.19	0.39	0.11	0.31
Governance Conflict	0.07	0.26	0.06	0.24	0.07	0.26
Election and Position	0.06	0.25	0.04	0.21	0.06	0.25
Conflict of Identity	0.03	0.18	0.03	0.16	0.03	0.16
Popular justice	0.25	0.43	0.30	0.46	0.19	0.40
Violence in Law Enforcement	0.18	0.38	0.21	0.41	0.20	0.40
Criminality	0.59	0.49	0.70	0.46	0.56	0.50
Domestic Violence	0.21	0.41	0.27	0.44	0.20	0.40
Separatism	0.02	0.15	0.01	0.09	0.02	0.15
Any conflict	0.69	0.46	0.78	0.41	0.66	0.47
N	7580		2280		1080	

Source: Authors' calculation from NVMS data. Only subdistricts in provinces of Sumatra, Kalimantan, and Papua that were part of the NVMS sample are included in the calculations. Detailed defintion of conflict types is available in Appendix Table A3.
(Back to Section 7.1.)

Table 8: Probability of conflict and crime by village type

	(1) Fights	(2) Fights	(3) Theft	(4) Theft
New palm vill	0.0153***	0.0165***	0.0190	0.0300**
	(0.00477)	(0.00478)	(0.0141)	(0.0138)
Old palm vill	0.0117**	0.0125***	0.0802***	0.0863***
	(0.00494)	(0.00482)	(0.0198)	(0.0176)
Palm area 2015, new palm	-0.0231**	-0.0234**	0.0316	0.0231
	(0.00963)	(0.00968)	(0.0395)	(0.0391)
Palm area 2015, old palm	-0.00124	-0.000355	-0.0151	-0.0184
	(0.00936)	(0.00937)	(0.0273)	(0.0262)
Vill controls:				
Dist.(km) to mayor's office		-0.00568***		-0.0330***
		(0.00170)		(0.00544)
Infrastr: Police post within 5km		0.00307		0.0545***
		(0.00200)		(0.00723)
Presence of several ethnic groups		0.0121***		0.0955***
		(0.00287)		(0.0138)
_cons	0.0192***	0.0294***	0.366***	0.283***
	(0.000584)	(0.00905)	(0.00293)	(0.0282)
Controls	No	Yes	No	Yes
Observations	37209	37119	37209	37119

Source: Authors' calculation from PODES 2014.
The table shows results from regressing incidence of fights and theft on village type. All regressions include district fixed-effects, and columns 2 and 4 include additional control variables. Village boundaries are based on 2014 definitions. Sample comprises of villages in Sumatra, Kalimantan, and Papua. Standard errors clustered at the district level in parenthesis. * < .1 ** < .05 *** < .01.
(Back to Section 7.2.1.)

Table 9: Probability of conflict and crime by distance to nearest palm producing village

	(1) Fights	(2) Fights	(3) Theft	(4) Theft
Dist to nearest palm vill.	0.0000861	0.000890	-0.0964*	-0.0886*
	(0.0151)	(0.0150)	(0.0495)	(0.0487)
Squared distance	-0.00131	-0.00142	0.00872	0.00769
	(0.00218)	(0.00216)	(0.00555)	(0.00539)
Controls	No	Yes	No	Yes
N	47646	47646	47646	47646

Source: Authors' calculation from PODES 2014.
The table shows results from regressing incidence of fights and theft on distance to nearest oil palm producing village. All regressions include district fixed-effects, and columns 2, 3, 5 and 6 include additional control variables. "New area" means growth in oil palm coverage by more than 5 percentage points between 2010 and 2015. Village boundaries are based on 2014 definitions, and villages in Java are excluded. Standard errors clustered at the village level in parenthesis.
* < .1 ** < .05 *** < .01. (Back to Section 7.2.1.)

Table 10: Estimation results on the impact of palm oil on resource conflict - panel data

	(1) Baseline	(2) Control 1	(3) Control 2	(4) Control 3	(5) Control 4
Palm production	-0.0146	-0.0118	-0.0190	-0.0161	-0.0140
	(0.0140)	(0.0118)	(0.0153)	(0.0135)	(0.0160)
Palm prodn x 2010	0.0133	0.0136	0.0151	0.0146*	0.0133
	(0.00923)	(0.00955)	(0.0127)	(0.00889)	(0.00855)
Palm prodn x 2014	0.0190	0.0205**	0.0180	0.0193	0.0186*
	(0.0119)	(0.0103)	(0.0152)	(0.0136)	(0.0108)
Social	No	Yes	No	No	No
Plantation	No	No	Yes	No	No
Security	No	No	No	Yes	No
Election	No	No	No	No	Yes
N	1906	1825	1861	1861	1861

Standard errors in parentheses
* p¡.1, ** p¡.05, *** p¡.01

Source: Authors' calculation. The table show results from negative binomial fixed-effects regression with resource conflict as dependent variable and palm production interacted with year indicator as regressor of interest. Column 1 is the baseline model. Column 2 includes the following control variables: sub-district's share of Christians, and share of migrants. Column 3 includes controls for share of families living in villages with plantation business. Column 4 includes controls for share of families living in villages within 5km of a police station. Each controls are also interacted with year dummies. Column 5 includes controls for share of families living in villages that voted for Golkar and PDP. Sub-districts are defined based on their 2000 boundaries. (Back to Section 7.2.2

Table 11: Estimation results on the impact of palm oil on resource conflict

	(1) Baseline	(2) Control 1	(3) Control 2	(4) Control 3	(5) Control 4
Palm presence	-0.485**	-0.571***	-0.552**	-0.373*	-0.436**
	(0.210)	(0.212)	(0.246)	(0.214)	(0.220)
Palm presence x 2006	0.178	0.192	0.154	0.222	0.212
	(0.223)	(0.228)	(0.250)	(0.230)	(0.232)
Palm presence x 2007	0.103	0.117	0.148	0.147	0.148
	(0.228)	(0.234)	(0.256)	(0.235)	(0.237)
Palm presence x 2008	0.522**	0.587***	0.586**	0.573***	0.597***
	(0.204)	(0.207)	(0.230)	(0.210)	(0.211)
Palm presence x 2009	0.498**	0.526**	0.421*	0.522**	0.546**
	(0.214)	(0.219)	(0.244)	(0.222)	(0.224)
Palm presence x 2010	0.497**	0.566***	0.570**	0.580***	0.560**
	(0.216)	(0.219)	(0.246)	(0.223)	(0.225)
Palm presence x 2011	0.769***	0.849***	0.776***	0.782***	0.836***
	(0.206)	(0.209)	(0.233)	(0.212)	(0.213)
Palm presence x 2012	0.813***	0.892***	0.895***	0.795***	0.835***
	(0.202)	(0.207)	(0.231)	(0.210)	(0.211)
Palm presence x 2013	0.619***	0.736***	0.670***	0.629***	0.666***
	(0.211)	(0.213)	(0.237)	(0.218)	(0.218)
Palm presence x 2014	0.475**	0.591***	0.429*	0.485**	0.516**
	(0.216)	(0.221)	(0.245)	(0.225)	(0.225)
Social	No	Yes	No	No	No
Plantation	No	No	Yes	No	No
Security	No	No	No	Yes	No
Election	No	No	No	No	Yes
N	12780	12270	12260	12260	12260

Standard errors in parentheses
* p¡.1, ** p¡.05, *** p¡.01

Source: Authors' calculation. The table show results from negative binomial fixed-effects regression with resource conflict as dependent variable and palm presence in 2015 interacted with year indicator as regressor of interest. Column 1 is the baseline model. Column 2 includes the following control variables: sub-district's share of Christians, and share of migrants. Column 3 includes controls for share of families living in villages with plantation business. Column 4 includes controls for share of families living in villages within 5km of a police station. Each controls are also interacted with year dummies. Column 5 includes controls for share of families living in villages that voted for Golkar and PDP. Sub-districts are defined based on their 2000 boundaries. (Back to Section 7.2.3.)

Table 12: Estimation results on the impact of palm oil on resource conflict

	(1) Baseline	(2) Control 1	(3) Control 2	(4) Control 3	(5) Control 4
Palm suitable	-0.00272	-0.00430*	-0.00114	-0.00176	-0.00256
	(0.00233)	(0.00237)	(0.00246)	(0.00237)	(0.00238)
Palm suitable x 2006	0.00167	0.00192	0.00107	0.00183	0.00199
	(0.00234)	(0.00237)	(0.00245)	(0.00235)	(0.00240)
Palm suitable x 2007	0.00303	0.00337	0.00283	0.00302	0.00310
	(0.00234)	(0.00239)	(0.00242)	(0.00234)	(0.00238)
Palm suitable x 2008	0.00338	0.00350	0.00233	0.00325	0.00346
	(0.00222)	(0.00226)	(0.00232)	(0.00223)	(0.00227)
Palm suitable x 2009	0.00590***	0.00678***	0.00464*	0.00570**	0.00577**
	(0.00229)	(0.00234)	(0.00238)	(0.00229)	(0.00234)
Palm suitable x 2010	0.00151	0.00130	0.000922	0.00194	0.00165
	(0.00241)	(0.00245)	(0.00251)	(0.00241)	(0.00245)
Palm suitable x 2011	0.00576**	0.00615***	0.00429*	0.00537**	0.00569**
	(0.00225)	(0.00230)	(0.00236)	(0.00227)	(0.00230)
Palm suitable x 2012	0.00648***	0.00696***	0.00501**	0.00580***	0.00543**
	(0.00221)	(0.00227)	(0.00232)	(0.00224)	(0.00227)
Palm suitable x 2013	0.00364	0.00387*	0.00271	0.00338	0.00298
	(0.00231)	(0.00234)	(0.00241)	(0.00233)	(0.00235)
Palm suitable x 2014	0.00510**	0.00582**	0.00316	0.00433*	0.00415*
	(0.00229)	(0.00236)	(0.00242)	(0.00234)	(0.00236)
Social	No	Yes	No	No	No
Plantation	No	No	Yes	No	No
Security	No	No	No	Yes	No
Election	No	No	No	No	Yes
N	12370	11860	12100	12100	12100

Standard errors in parentheses
* p¡.1, ** p¡.05, *** p¡.01

Source: Authors' calculation. The table show results from negative binomial fixed-effects regression with resource conflict as dependent variable and percent subdistrict area with high suitability as regressor of interest. Column 1 is the baseline model. Column 2 includes the following control variables: sub-district's share of Christians, and share of migrants. Column 3 includes controls for share of families living in villages with plantation business. Column 4 includes controls for share of families living in villages within 5km of a police station. Each controls are also interacted with year dummies. Column 5 includes controls for share of families living in villages that voted for Golkar and PDP. Sub-districts are defined based on their 2000 boundaries. (Back to Section 7.2.3.)

Table 13: Estimation results on the impact of palm oil on total conflict

	(1) Baseline	(2) Control 1	(3) Control 2	(4) Control 3	(5) Control 4
Palm presence	0.0391	0.00394	-0.0424	0.168*	0.129
	(0.0861)	(0.0884)	(0.100)	(0.0876)	(0.0909)
Palm presence x 2006	-0.0579	-0.0574	-0.112	-0.0851	-0.0836
	(0.0767)	(0.0774)	(0.0876)	(0.0783)	(0.0791)
Palm presence x 2007	0.0309	0.0578	0.0240	0.0145	0.00590
	(0.0774)	(0.0780)	(0.0886)	(0.0789)	(0.0796)
Palm presence x 2008	0.175**	0.200***	0.231***	0.150**	0.162**
	(0.0748)	(0.0753)	(0.0856)	(0.0765)	(0.0773)
Palm presence x 2009	0.163**	0.195***	0.186**	0.118	0.128*
	(0.0748)	(0.0754)	(0.0860)	(0.0765)	(0.0773)
Palm presence x 2010	0.184**	0.219***	0.271***	0.143*	0.163**
	(0.0766)	(0.0773)	(0.0878)	(0.0786)	(0.0793)
Palm presence x 2011	0.231***	0.272***	0.319***	0.192**	0.216***
	(0.0749)	(0.0753)	(0.0853)	(0.0765)	(0.0774)
Palm presence x 2012	0.172**	0.233***	0.325***	0.125	0.189**
	(0.0751)	(0.0754)	(0.0855)	(0.0767)	(0.0775)
Palm presence x 2013	0.305***	0.353***	0.393***	0.237***	0.251***
	(0.0745)	(0.0749)	(0.0851)	(0.0764)	(0.0772)
Palm presence x 2014	0.139*	0.190**	0.232***	0.0935	0.0777
	(0.0765)	(0.0769)	(0.0873)	(0.0785)	(0.0791)
Social	No	Yes	No	No	No
Plantation	No	No	Yes	No	No
Security	No	No	No	Yes	No
Election	No	No	No	No	Yes
N	12780	12270	12260	12260	12260

Standard errors in parentheses
* p¡.1, ** p¡.05, *** p¡.01

Source: Authors' calculation. The table show results from negative binomial fixed-effects regression with total conflict as dependent variable and percent subdistrict area with high suitability as regressor of interest. Column 1 is the baseline model. Column 2 includes the following control variables: sub-district's share of Christians, and share of migrants. Column 3 includes controls for share of families living in villages with plantation business. Column 4 includes controls for share of families living in villages within 5km of a police station. Each controls are also interacted with year dummies. Column 5 includes controls for share of families living in villages that voted for Golkar and PDP. Sub-districts are defined based on their 2000 boundaries. (Back to Section 7.2.3.)

Figures

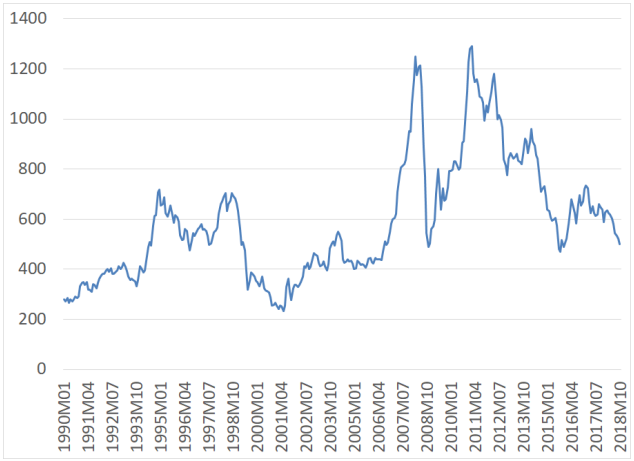
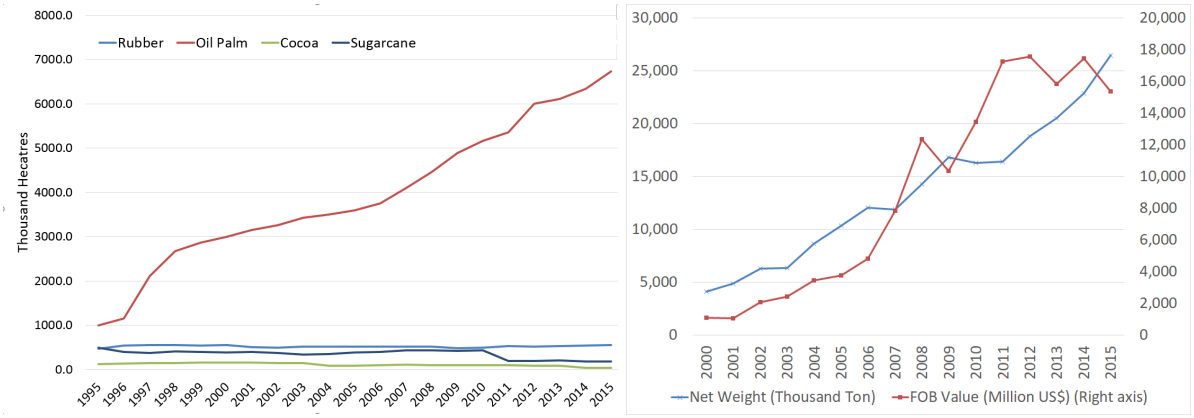


Figure 1: Monthly price of palm oil (USD per metric ton)
Source: World Bank commodity price data. The price series is for palm oil (Malaysia), f.o.b. spot beginning January 2015; previously Malaysia 5%, c.i.f. N.W. Europe, bulk, nearest forward.
(Back to Section 2).



(a) Area under major estate crops (b) Indonesian exports of palm oil, volume and value

Figure 2: Area under palm cultivation and growth of Indonesian exports
Source: Badan Pusat Statistik. The figure shows, in thousand hectares, estate areas by major crops over time. (Back to Section 2.)

Figure 3: Growth of Palm Oil Plantation Area, 2000-2015
(Back to Section 2.)

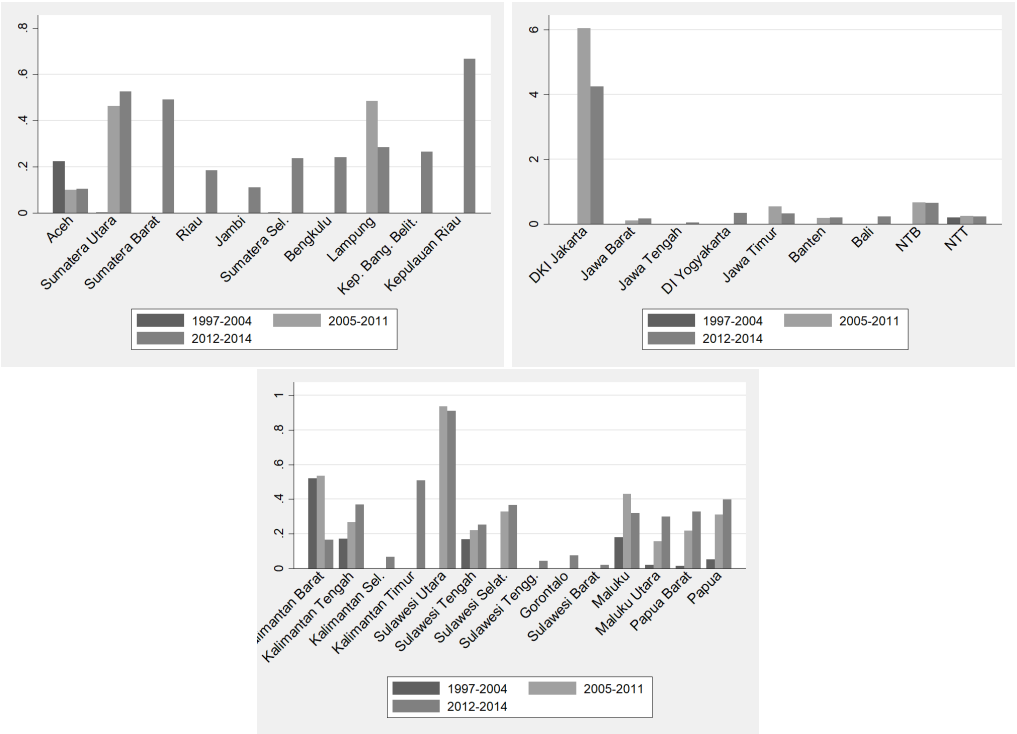
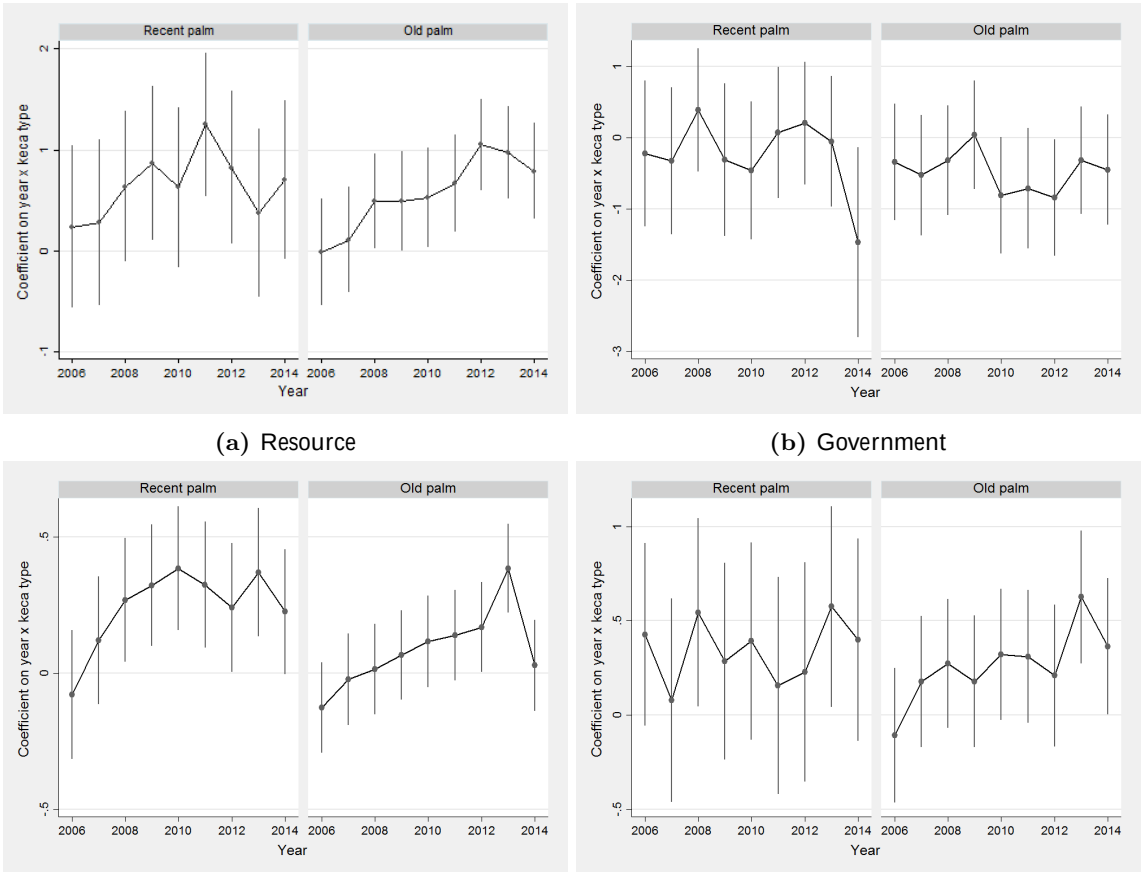


Figure 4: Average incidents reported in NVMS by province
Source: Authors' calculation. The figure shows number of entries in NVMS database by provinces per kecamaten-year.
Back to Section 6.



(a) Resource

(b) Government

(c) Criminality

(d) Domestic violence

Figure 5: Trend in four types of violence

Source: Authors' calculation from NVMS dataset. The figure plots coefficients on interaction between year dummies and indicator for type of sub-district given by fitting a fixed-effects zero-inflated negative binomial distribution model with incidence of each violence as dependent variable.

Back to Section 7.1.

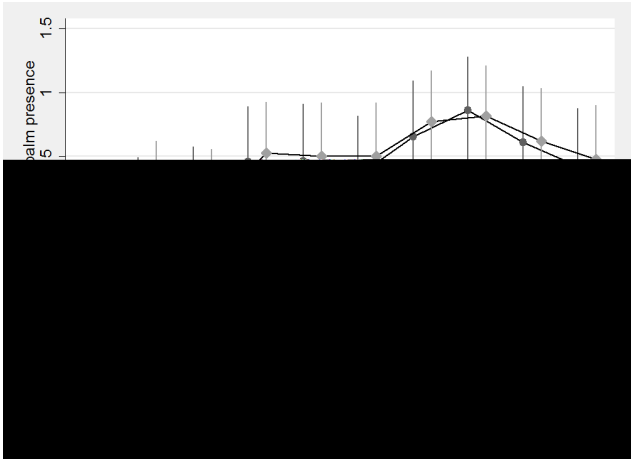


Figure 6: Trend in resource conflict by palm presence
Source: Authors' calculation. The figure shows coefficients on indicator for palm presence and year generated by a panel negative binomial regression with incidence of resource conflict as dependent variable. The lines show results from two models. In the first model, presence of palm oil in 2005 is used as the indicator of palm presence, where as in the second model, presence of palm oi in 2015 is used. The comparison is made against a baseline in 2005. (Back to Section 7.2.3.)

Appendix Tables

Table A1: Palm production area (thousand hectares) by provinces, 2011 – 2016

	2011	2014	2016	% Change 2011 to 2014	Province share 2016(%)
Aceh	360.2	420.2	441.3	16.7	3.7
Sumatera Utara	1164	1396.3	1445.7	20	12.13
Sumatera Barat	370.7	376.5	399.7	1.6	3.35
Riau	1919	2290.7	2430.5	19.4	20.4
Jambi	647	693	736.1	7.1	6.18
Sumatera Selatan	873.8	923	988.4	5.6	8.3
Bengkulu	308.1	293.8	298.2	-4.6	2.5
Lampung	123.4	184.9	213.6	49.8	1.79
Kep. Bangka Belitung	186.1	206.2	218	10.8	1.83
Kep. Riau	8.7	19	20.2	118.4	0.17
Dki Jakarta	0	0	0	0	0
Jawa Barat	14.1	13.6	14.3	-3.5	0.12
Jawa Tengah	0	0	0	0	0
Di Yogyakarta	0	0	0	0	0
Jawa Timur	0	0	0	0	0
Banten	14.8	19.7	21.4	33.1	0.18
Bali	0	0	0	0	0
Nusa Tenggara Barat	0	0	0	0	0
Nusa Tenggara Timur	0	0	0	0	0
Kalimantan Barat	700.5	936.4	1455.2	33.7	12.21
Kalimantan Tengah	1008.4	1115.9	1183.7	10.7	9.93
Kalimantan Selatan	424.8	512.9	437.6	20.7	3.67
Kalimantan Timur	657.3	733.4	933.9	11.6	7.84
Kalimantan Utara	0	153.3	168.7	0	1.42
Sulawesi Utara	0	0	0	0	0
Sulawesi Tengah	93.8	147.9	157.8	57.7	1.32
Sulawesi Selatan	27.9	50.9	56.4	82.4	0.47
Sulawesi Tenggara	44.8	45.2	49.4	0.9	0.41
Gorontalo	0	4.3	12.3	0	0.1
Sulawesi Barat	95.2	106.4	111.8	11.8	0.94
Maluku	0	10.3	10.6	0	0.09
Maluku Utara	0	0	0	0	0
Papua Barat	20.1	49.6	55.5	146.8	0.47
Papua	39.5	51.4	54.2	30.1	0.45
Indonesia	9102.3	10754.8	11914.5	18.2	100

Source: Badan Pusat Statistic

(Back to Section 2.)

Table A2: Summary of key variables and data sources

Variables	Description	Data Source
Dependent variables		
Conflict occurrence	Number of reported conflict during 2012-2014	National Violence Monitoring System (NVMS) dataset
Conflict intensity	Number of deaths and injuries during 2012-2014	National Violence Monitoring System (NVMS) dataset
Explanatory variables		
Palm area	Percent area under palm production in 2005 and 2015	GIS data
Instrumental variable		
Suitability	Share of sub-district area with high suitability	GIS data
Control variables		
ethnic	Ethnic fragmentation index	Census 2000
religion	Share of Christian population	Census 2000
votes_golkar, votes_pdip	Share of votes to the Golkar and PDI-P in 2004 election	PODES 2005
electricity	Percent households with electricity	PODES 2003
roads	Length of roads in km	PODES 2003
urban	Share of urban population	PODES 2003
density	Population density	
immigration	Share of migrants	Census 2000
police	Share of families living in village where police station is within 5km	PODES 2005

Table A3: Classification of conflict in NVMS data

Variables	Description
Other conflicts	Violence triggered by other issues
Resource Conflict	Violence triggered by resource disputes (land, mining, access to employment, salary, pollution, etc.)
Governance Conflict	Violence is triggered by government policies or programs (public services, corruption, subsidy, region splitting, etc.)
Conflict of Election and Position	Violence triggered by electoral competition or bureaucratic appointments.
Conflict of Identity	Violence triggered by group identity (religion, ethnicity, tribe, etc).
Popular justice	Violence perpetrated to respond to/punish actual or perceived wrong (group violence only)
Violence in Law Enforcement	Violent action taken by members of formal security forces to perform law-enforcement functions (includes use of violence mandated by law as well as violence that exceeds mandate for example torture or extra-judicial shooting).
Criminality	Criminal violence not triggered by prior dispute or directed towards specific targets.
Domestic Violence	Domestic violence comprises of acts of violence committed by a family member against other family member(s), where the family members live under one roof/same household.
Separatism	Violence triggered by efforts to secede from the Unitary State of the Republic of Indonesia (NKRI).

Source: NVMS Coding Manual.