Land-use transformation and conflict: The effects of oil palm expansion in Indonesia*

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Abstract

Agricultural commodity booms can improve rural employment and livelihoods, but also accelerate land-use change in rural areas. Where land-use rights are unclear and economic institutions non-cohesive, such booms can trigger social conflict over land. We investigate this phenomenon in Indonesia, where rising global demand for palm oil caused a large expansion in production area over the past decades. Based on a yearly panel of 2,755 rural sub-districts from 2005 to 2014, we link highly detailed data on local outbreaks of conflict to variations in plantation expansion incentives. We show that local incentives to establish new plantations lead to violent disputes over land, resources and political representation, an effect that is distinct from the impact of income shocks in already established production areas. The adverse consequences increase with the importance of land rents as an income source, and are more pronounced in areas where land is more contestable and unequally distributed, as well as during local elections. Our findings underline the importance of Indonesia's ongoing land reform efforts and the necessity of rural land transformation to go hand in hand with conflict mitigation strategies.

JEL classification codes O13, Q15, Q33, Q34, R11

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1 Introduction

Under which conditions do agricultural commodity booms lead to social conflict? An extensive literature suggests that the economic gains resulting from such booms should generally reduce conflict by creating employment and raising incomes, thereby increasing the opportunity cost of violence (Becker, 1968; Grossman, 1991; Collier and Hoeffler, 1998; Dal Bó and Dal Bó, 2011). At the same time, incentives to contest the distribution of these additional rents may lead to a rising potential for conflict. This "rapacity effect" has been observed in the case of capital-intensive commodities like oil and minerals, but is less evident for agricultural windfalls (see Blair et al., 2021). In this paper, we identify one mechanism by which agricultural commodity booms can spark social conflict: by incentivizing land-use transformation. When land acquisition and agricultural expansion collide with ambiguous legal frameworks and non-inclusive economic institutions, it can lead to an unequal distribution of land benefits, fueling social unrest and conflict.[1] This can erode trust in institutions and exacerbate social tensions, as the lack of legal recourse for marginalized groups ultimately leads them to express their grievances or demand a fair share of resources through disruption or violence.

Strong economic pressures for land conversion are very prevalent in contemporary tropical countries, where vast tracts of predominantly forested land remain undeveloped for agricultural use (Balboni et al., 2023a). Despite this, the recent empirical literature in economics has largely neglected the role of social conflict arising from land-use changes,[2] especially as a unique catalyst – separate from the well-established impacts of commodity booms in existing production areas.

We address this gap by studying how intensifying competition over land can cause social conflicts in a setting where the cohesiveness of economic institutions is low, clientelism and patronage are widespread, and effective property rights are structurally skewed to favor certain groups. Our research focuses on the context of Indonesia's palm oil boom, one of the largest agricultural commodity booms in recent decades worldwide. Beginning in the 1990s, Indonesia responded to rapidly rising global demand by expanding its pro-

[1] Non-cohesive institutions are seen as a major determinant of distributional conflict also more generally (Besley and Persson, 2011; Fetzer and Kyburz, 2024). In this paper, we specifically refer to economic institutions determining who benefits from rising land rents.

[2] The topic has been on the periphery of the discourse surrounding land institutions and economic development for some time. North and Thomas (1973) already refer to a comparable situation in 16th-century England, where the rising demand for wool led to the privatization of communal lands through enclosures intended to avert overgrazing. As North and Thomas (1973) note, this transformation often favored elites and stripped small farmers or commoners of their land rights, leading to riots and even rebellions in areas where the redistribution of wealth was substantial enough.

duction of palm oil at an astonishing rate. Between 2001 and 2019, Indonesia more than doubled the area dedicated to oil palm cultivation, leading to the industry occupying 8.5% of the country's land area and contributing to 4.5% of its GDP (UNDP, 2019; Gaveau et al., 2022). Although this boom has contributed to a substantial improvement in livelihoods (Qaim et al., 2020), it is also increasingly associated with widespread social conflicts, particularly land disputes, that frequently turn violent or even deadly.[3] Such conflicts over land use are partly rooted in Indonesia's institutional framework for land governance. On nearly two-thirds of the national territory, private ownership is technically prohibited and exploitation rights are state-controlled, historically favoring a coalition of political, bureaucratic, and agribusiness interests (Cramb and McCarthy, 2016). With the democratization of the country and decentralization of land governance after 1998, the responsibility for land allocation fell to local politicians and bureaucrats, a situation which has given rise to widespread rent-seeking at the local level (Burgess et al., 2012; Aspinall and Berenschot, 2019; Cisneros et al., 2021; Afrizal and Berenschot, 2022). A series of flawed reforms resulted in a complicated and intransparent land rights situation that exacerbates most of these issues (Nurhidayah et al., 2020). In such a context, we argue that a rapid increase in expected land rents could trigger conflicts related to the distribution of economic benefits and to grievances over local representation.

Consistent with these expectations, we find that stronger economic pressure to expand oil palm plantations increases the incidence of violent conflicts, especially in the form of resource conflicts and conflicts involving popular justice, as well as violence around local elections. To show this, we connect yearly variations in the occurrence of social conflicts and oil palm expansion incentives within 2,755 rural Indonesian sub-districts over time. Our empirical models control both for sub-district-fixed effects capturing unobserved local heterogeneities, and for common time shocks through year fixed effects. Endogeneity bias could arise in this setting from reverse causality—several previous studies document that local conflict slows down agricultural investments and the process of land-use change (Burgess et al., 2015; Singh, 2013; Prem et al., 2020; de Roux and Martínez, 2021)—but also because of spillovers across space and time. Since land transformation takes time, related conflicts could break out already years before the actual land conversion takes place, or years later, if initial agreements between investors and locals are not maintained. To mitigate the scope for such a bias, our main explanatory variable captures national-

[3]In 2012, Indonesia's National Land Agency (BPN) acknowledged that there were at least 4000 cases of land conflicts directly related to palm oil (see Berenschot et al., 2021a). Although most land conflicts overall tend to be relatively peaceful (de Juan et al., 2022), this is not always the case—a recent survey of 150 oil-palm related conflicts across four provinces by Berenschot et al. (2021a) revealed that these conflicts alone had resulted in 243 injuries and 19 fatalities.

level variation in incentives for oil palm expansion, which we bring to the local level via a suitability-based exposure measure that reflects the relative size and potential profitability of the agricultural area that is not yet used for oil palm.

Our identification strategy relies on a one-dimensional shift-share measure, where one shift variable—capturing yearly variation in the economy-wide speed of land-use change—is combined with spatially varying predetermined shares in a large number of spatial units. The necessary identification assumption in this case relies on the conditional exogeneity of shares (Goldsmith-Pinkham et al., 2020): places with relatively more or less yet unconverted and highly suitable areas should have been on parallel development trends, once other sources of differential dynamics are controlled for. Areas suitable for oil palm lie especially in the lowland areas of Sumatra and Kalimantan, but the availability of (unconverted) land is larger in more remote and less developed sub-districts. In order to account for differential development and potentially also conflict dynamics due to these factors, we interact a measure for initial economic remoteness—average travel time to the nearest major city in 2000—with a full set of year effects. Further robustness checks expand the set of initial conditions that could lead to differential dynamics, and demonstrate the robustness of our results to various ways of building the shift-share measure, and to controlling for spatial spillover effects or correlation of standard errors across places with similar shares.

Importantly, the mechanism of land-use change highlighted in our study is also distinct from income shocks that affect current producer areas. To demonstrate this, we additionally control for income shocks on current production area in the form of positive or negative price shocks as well as shocks to local precipitation and droughts. While we find that social conflict increases with negative income shocks to the existing oil palm sector (negative price shocks or localized drought shocks), these controls do not change the effects of land-use change.

Estimates from our preferred specification show that incentives to convert 1 percent of the area of a given sub-district to oil palm plantations are associated with an increase in the likelihood of conflicts by about two thirds, on average. At the local level, these adverse impacts of expansion incentives are highly heterogeneous. We document three major sets of results that are in line with theoretical predictions and qualitative evidence: First, social conflict related to land expansion pressure is closely related to scarcity. Adverse impacts are stronger where less land is available, suggesting that competition over increasingly scarce resources is an important driver of violence (in line with the mechanism proposed by Acemoglu et al. (2020)). The conflict-inducing effects are mitigated in places with a lower share of agricultural households, or where other sources of income from natural resources are available. This provides suggestive evidence that alternative income sources mitigate competition for agricultural land by reducing its perceived scarcity.

Second, we find that initial land distribution plays an important role. Locations with a higher ex-ante share of communally-owned land experience a stronger increase in conflicts due to expansion pressure. This finding is in line with qualitative and descriptive research arguing that local elite control over village lands had very adverse effects on social cohesion during the oil palm boom, and that resource conflicts over communal lands are frequent due to the unclear ownership (Barron et al., 2009; Cramb and McCarthy, 2016; Afrizal and Berenschot, 2022).

Finally, we find that expansion pressure is closely linked to election conflicts. Whenever incentives for land conversion are stronger, local elections and official appointments are surrounded by more outbreaks of violence. This is driven by elections at the village and district level, where most decisions about land-use are made in Indonesia. As the majority of election violence in Indonesia targets candidates rather than voters (Harish and Toha, 2017), this finding could capture two mechanisms: Either, that public display of discontent with decision-makers becomes more likely when palm oil-related issues are more salient, or that elections turn more competitive and violent as the gains from winning office (and being at least partly in charge of land allocation decisions) increase.

Overall, our findings align with assessments by various qualitative and anecdotal sources stating that the rise in reported land disputes in Indonesia is primarily driven by imbalanced ownership and disputes over the economic potential of these lands, rather than cultural, social, or environmental factors (e.g., Cramb and McCarthy, 2016; Nurhidayah et al., 2020; Afrizal and Berenschot, 2022). We also test some of these competing explanations and do not find evidence for environmental, ethnic, or population-related disputes in our context.

This paper contributes to several strands of the literature. First, we contribute to the wider literature on the economic causes of conflict. The concept of a "resource curse", characterized by negative externalities, rent-seeking, and violent competition over economic gains at various levels of society, has been extensively researched in the context of windfalls from natural resources (for reviews see Nillesen and Bulte, 2014; Ross, 2015; Blair et al., 2021; Vesco et al., 2020), and its relevance has been often documented for extractive industries (Ross, 2015; Blair et al., 2021; Berman et al., 2017). However, the conflict-inducing rapacity effects of agricultural commodity price booms are often found to be dominated by an opportunity cost mechanism that reduces the likelihood of conflict, especially for labor-intensive farming (Dal Bó and Dal Bó, 2011; Bazzi and Blattman, 2014; Gehring et al., 2023; McGuirk and Burke, 2020). In line with this, many studies document the conflict-inducing effects of negative agricultural income shocks, be it in form of negative price shocks (Dube and Vargas, 2013; Berman and Couttenier, 2015; Fjelde, 2015; Dube et al., 2016), or weather-shock-induced crop loss (Harari and La Ferrara, 2018). By contrast, cases where the rapacity effect dominates and conflict increases due to an agricultural commodity boom are often contingent on the prior presence of insurgents who capture resources and fight for the control of land (Crost and Felter, 2020; Ubilava et al., 2022; Millán-Quijano and Pulgarín, 2023). Our contribution to this literature is to show that even in a relatively stable democracy without the presence of armed groups, agricultural commodity booms can incite social conflict by triggering disputes related to land use changes. More specifically, our case study also contributes to the literature on small-scale social conflicts, which do not always evolve into armed insurgencies, and have been understudied (Bazzi and Gudgeon, 2021). Even beyond their direct negative impacts on affected populations, it is crucial to understand these conflicts, as they can erode trust and exacerbate existing social divides (Rohner et al., 2013). Furthermore, economic grievances and resentments associated with land distribution and increasing land scarcity may contribute to mass violence and even civil wars (Cederman et al., 2011; Dercon and Gutiérrez-Romero, 2012).

Second, our research is more closely linked to a growing micro literature exploring the role of institutions in shaping social and resource conflicts (Besley and Persson, 2011), linking land-use related conflicts to land contestability and tenure insecurity (Fetzer and Marden, 2017; Castañeda Dower and Pfutze, 2020), and showing that resource revenue windfalls are less likely to cause conflict if institutions are more cohesive (Fetzer and Kyburz, 2024). We contribute to this literature by documenting similar mechanisms at play during an agricultural commodity boom. We study a setting where unclear allocation of land-use rights becomes a decisive factor in the outbreak of distributional conflicts. By focusing on land disputes, we also contribute to a body of literature that explores conflict in relation to various dimensions of resource scarcity. Other studies have explored conflicts induced by factors such as water shortage, population pressure, or even decreases in cocaine supply (Almer et al., 2017; Castillo et al., 2020; Acemoglu et al., 2020; Unfried et al., 2022).

Third, our work also contributes to the literature investigating the political economy of social conflict and decentralized decision-making in Indonesia. More specifically, it is related to studies on the causes of social violence (Bazzi and Gudgeon, 2021; Barron et al., 2009, 2016), as well as to work on the broader political economy of natural resource use (Burgess et al., 2012; Cisneros et al., 2021; Balboni et al., 2021, 2023b).

Finally, our research extends upon existing literature examining the link between palm oil production and conflict. Prior work has focused on the link between oil palm plantations and forced displacement during Colombia's civil war (Tellez, 2022; Millán-Quijano and Pulgarín, 2023) as well as on the long-term relationship between conflict and palm oil production in Indonesia (Grasse, 2022; Kenny et al., 2022). Kenny et al. (2022) emphasize the role of intensifying predation and the rise of criminality with rising palm oil prices. Grasse (2022) explores the relevance of land-use change as a correlate of social conflict in Indonesia, but only in a long-difference setting. In contrast to these studies, we study the short-term fluctuations in conflict and demonstrate in a unified framework how the same palm oil boom drives social conflict on existing production area through the opportunity cost channel—via negative income shocks on existing plantations—and induces social conflict through pressure towards land-use change in suitable but not yet converted areas at the same time. By using rich policy and administrative information on the local institutional setting, we highlight the role of land rights distribution and local political incentives in moderating the conflict-inducing effects of the commodity boom.

The remainder of our paper is structured as follows: The subsequent section provides background information on Indonesia's palm oil boom and the institutional framework. Section 3 describes our data sources and introduces our main variables. Section 4 establishes the empirical link between the local pressure to expand oil palm area and social conflict, presenting the empirical strategy, main results and discussing identification and alternative explanations. Section 5 discusses underlying mechanisms, whereas section 6 concludes.

2 Background and hypotheses

2.1 Palm oil and land competition in Indonesia

Palm oil is an agricultural commodity extracted from the fruit of oil palms, a high-yielding tree crop originating from West Africa (Corley and Tinker, 2015). Commercial production in Indonesia dates back over 100 years, but it gained significant economic importance in the 1980s (Cramb and McCarthy, 2016). Over the last four decades, the global use of palm oil expanded not only for food production, but also in industrial applications and biofuels (Qaim et al., 2020). The global commodity boom created strong incentives for oil palm cultivation, transforming land use in rural regions of Indonesia, where suitable area was abundant.[4] Between 2001 and 2019, more than 4% of Indonesia's land area was converted for oil palm cultivation, with the total plantation area in the country now reaching over 16 Mha (Gaveau et al., 2022). Given its lower labor requirements, oil palm presents a more profitable alternative to other conventional land uses, such as rubber plantations. This has led to a widespread adoption among Indonesian smallholder farmers, resulting in large improvements in rural livelihoods (Kubitza et al., 2018b; Qaim et al., 2020). However, despite its significance for many smallholders, about two thirds of the oil palm area in Indonesia today is dominated by large industrial estates (Gaveau et al., 2022).[5]

While earlier decades had seen several state-led agrarian development initiatives, the state became notably absent in the oil palm sector from the late 1990s onward (Cramb and McCarthy, 2016). Decentralization policies and a withdrawal of most direct funding opportunities for smallholders in the wake of the Asian financial crisis caused a poorly regulated and highly unbalanced growth of the sector (Pramudya et al., 2017). According to case studies, wealthier farmers, rural entrepreneurs and local businessmen with better industry knowledge and access to capital expanded their land holdings significantly as palm oil prices increased (Cramb and McCarthy, 2016). Conversely, villagers lacking such resources often sold their land in response to rising prices, frequently through informal markets at undervalued rates due to a widespread lack of formal titles (Rist et al., 2010; Krishna et al., 2017). This process caused a significant concentration of land ownership. The resulting land scarcity in more densely populated rural regions made farmers unable to acquire new land through common traditional methods of converting fallows or clearing forests (Rist et al., 2010; Krishna et al., 2017; Kubitza et al., 2018a). Influential villagers in some areas even started to claim and sell parts of formerly common lands (Cramb and McCarthy, 2016), disrupting traditional subsistence farming practices and potentially causing considerable grievances in rural communities.

2.2 The institutional framework of land-use change

Even in democratic societies where political power theoretically resides with the populace, economic institutions controlling resource distribution may disproportionately favor

[4] The expansion of palm oil production was primarily achieved by extending existing plantations and establishing new ones, rather than intensifying production on existing land, despite actual yields in Indonesia being notably below their potential levels (Euler et al., 2016).

[5] The plantation industry in Indonesia is characterized by various forms of joint-ventures between companies and locals, and definitions of smallholders vary widely (Cramb and McCarthy, 2016). The most common form of joint-venture are nucleus estate and smallholder schemes, or "plasma" schemes, where the company develops individual or community lands to plantations, and lets locals either retain a small share of these plantations in exchange, or pays them regular fees.

elites (Acemoglu and Robinson, 2008). Elites may have an incentive to preserve weak and intransparent land rights despite the high efficiency costs of doing so (North et al., 2009), since this enables them to capture land rents while bypassing legal institutions. In Indonesia, such a dynamic has played out in the context of oil palm expansion, where resource governance has in many cases favored elites and led to the concentration of land in their hands.

Most economic institutions determining the distribution of land rents in Indonesia go back to colonial times. During the late 19th century, the Dutch colonial administration introduced an extensive system of land rights based on the principle of *domein verklaring* (free state domain), stating that land not under private ownership belonged to the colonial state. This resulted in vast expanses of lands, predominantly forested areas, becoming state property (Colchester et al., 2006). After Indonesia's independence in 1945, the new government intended to democratize the control of land through the Basic Agrarian Law of 1960. Nonetheless, the law also confirmed state control over much of the forested land. Under president Suharto's authoritarian New Order regime (1966–1998), the state further expanded its control over land and natural resources. The Forestry Law of 1967 classified roughly 70% of the country's total land area as "Forest Estate" (*Kawasan hutan*), falling under state control. Under the pretext of using this land to 'achieve the utmost prosperity' and foster inclusive economic development, as envisioned by the Basic Agrarian Law of 1960 and by Indonesia's 1945 constitution, Suharto's regime promoted intensive logging and large-scale plantation agriculture in these areas. This led to a considerable concentration of land in the hands of large agribusinesses and a group of elites well-connected with the regime (Lucas and Warren, 2013).

While the political reforms and decentralization policies after 1998 promoted local autonomy and attempted to increase political accountability at the regional level, the historical legacy of centralized control over land persists (Cramb and McCarthy, 2016). The reforms delegated land-use allocation authority to district governments but did not address the highly unequal land ownership structures. The shift of authority created new local forms of crony capitalism and rent-seeking rather than eliminating them (Burgess et al., 2012; Nurhidayah et al., 2020). Oil palm investors and local elites are reported to regularly finance local political campaigns, in exchange for plantation permits and the suppression of community protests (Aspinall and Berenschot, 2019; Cisneros et al., 2021).

The various interest groups profit from an intransparent land rights regime in rural areas. During the past decades, numerous (often competing) revisions to the boundaries of the Forest Estate, together with jurisdictional disputes between different levels of government over the management of land allocation, have resulted in a complex and intransparent land rights situation. This legal ambiguity is often exploited by local political elites to justify private acquisition and control of land resources (Nurhidayah et al., 2020).[6] Since individual ownership is technically forbidden in the Forest Estate, customary land uses in these areas are rarely recognized in courts (Afrizal and Berenschot, 2020).

As a result of these issues, rural communities face a weak legal foundation for resolving land disputes, both among themselves and with incoming companies, and instead are reported to rely on "rightless" forms of collective action (Berenschot et al., 2022). With no legal recourse, communities impacted by agricultural expansion frequently seek assistance from local civil servants and politicians if direct negotiations with companies or investors fail. Often, instead of facilitating dialogue or acting as neutral mediators, these officials assume the role of judges, at times favoring the companies (Afrizal and Berenschot, 2020). This approach can leave conflicts unresolved, prompting protests and breeding mistrust.[7]

Land-use related conflicts are also likely to be triggered by weak community representation (Cramb and McCarthy, 2016; Berenschot et al., 2021a). Village heads and traditional leaders are often part of local elites with a high degree of influence over village lands (Aspinall and Rohman, 2017; Berenschot et al., 2021b). Plantation companies usually limit their consent-obtaining efforts to village heads, assuming that these leaders act with community support. This is often not the case, leading to resentment and conflict within the communities (Nurhidayah et al., 2020; Afrizal and Berenschot, 2020, 2022). The failure of community leaders to represent their communities is further exacerbated by government procedures, which establish "land acquisition task forces" at various levels. Community leaders and local elites are encouraged to join these committees and are often asked to convince locals to give up their lands, leading to conflicts as these leaders side against their own communities (Afrizal and Berenschot, 2020).

2.3 Prior evidence and main hypotheses

Qualitative research suggests that the increasing land disputes in Indonesia are predominantly motivated by economic interests rather than cultural, social, or environmental concerns (e.g., Rist et al., 2010; Cramb and McCarthy, 2016; Nurhidayah et al., 2020; Afrizal

[6]Only in 2011 did the Indonesian government announce an initiative to consolidate land use and zoning maps under the One Map Policy. At the time of writing, this process is still ongoing.

[7]Grasse (2022) suggests that alternative conflict resolution mechanisms, such as those set up by the Roundtable On Sustainable Palm Oil (RSPO), can mediate such conflicts. Other sources argue that the effect of these alternative mechanisms is limited, since they are reported to favor companies disproportionately (Afrizal and Berenschot, 2020; Afrizal et al., 2023).

and Berenschot, 2022). Contrary to common views of resistance against capitalism or environmental activism, rural communities are reported to often welcome oil palm company presence and economic development, pragmatically prioritizing advantageous land deals and profit-sharing over ideological opposition to land development (Afrizal and Berenschot, 2022). This economic focus, however, also sets the stage for conflict: disputes often arise when initial agreements are broken or not fulfilled. Consistent with these notions, we expect that economic incentives for land conversion and the associated competition for economic gains are a fundamental driver of social conflicts during the oil palm boom in Indonesia.

From a theoretical perspective, the expected economic rents from oil palm determine local demand for land. Areas with high potential oil palm yield face increased conversion pressure when the marginal returns of agricultural expansion are higher. Thus, greater pressure for land-use change should arise wherever there is still land of high agricultural suitability that is not yet used for growing oil palm, and whenever temporal factors, such as high world market prices and favorable political and macroeconomic conditions, encourage production expansion. Together, these factors result in fluctuating economic pressure for land-use change across space and time. Previous literature shows that the intensity of land conversion to oil palm in Indonesia is indeed cyclical and follows political incentives and global prices (Cisneros et al., 2021; Gaveau et al., 2022). Investors often secure land use concessions without immediate intent for conversion, instead holding the land in anticipation of favorable opportunities or an increase in land value (McCarthy et al., 2012). Such repeated cycles of land expansion pressure could in turn cause additional conflicts arising from intensifying competition and increasing scarcity of land.

We expect this land expansion pressure to induce conflicts independently from crop-specific income shocks tied to existing plantations. There, rising prices might benefit producers, land owners, and potentially workers, thus increasing the opportunity cost of conflict. At the same time, they could also cause increase incentives to contest the distribution of these windfall rents. Conversely, price drops may trigger or alleviate local social conflicts through similar mechanisms. In both scenarios, the combined impact of these factors is uncertain. Since oil palm plantations take several years to become economically productive, we expect the local conflict-inducing effects of land-use change not to be fully synchronised with the effects of income shocks. Moreover, expansion pressure could spark conflicts also in areas not yet involved in palm oil production, while already producing regions may face income-related conflicts but no land-use disputes anymore. This setting offers a unique opportunity to distinguish between the conflict effects of land-use change and the income effects of the commodity boom in producing regions.

3 Data

3.1 Measuring local conflict

Our primary outcome of interest captures the local presence of violent conflict as recorded by Indonesia's *National Violence Monitoring System* (NVMS, or *Sistem Nasional Pemantauan Kekerasan, SNPK*). Initially funded by the World Bank, the NVMS assembles information on local violence incidents from newspaper reports, resulting in a comprehensive database of violent events. These incidents are geo-referenced and consistently recorded from 2005 to 2014 for a sub-sample of 16 provinces in Indonesia, out of which we focus on 14 provinces that also collect further socio-economic data (see Figure A1 a for a spatial distribution).[8] Our sample of predominantly rural regions records 16,511 individual conflict incidents.[9] Despite its limited regional and temporal coverage, the NVMS exhibits significantly higher precision and frequency compared to other conflict data sources in Indonesia, such as the periodic village census PODES, which are more likely to suffer from reporting biases (Barron et al., 2016). Additionally, unlike widely-used conflict databases (e.g., UCDP or ACLED), the NVMS captures small-scale incidents of violence, including disputes between neighbors and cases of popular justice. The NVMS is considered one of the most comprehensive data sources available on local conflicts in developing countries (Bazzi et al., 2022). However, it is not without limitations. Under-reporting in remote areas is likely, given its dependence on newspaper accounts. To address this potential reporting bias, we only compare rural areas and control for remoteness in our empirical specifications.

We combine this information on violent conflict to a yearly panel for 2005 to 2014 that records the presence of any conflict at the level of Indonesian sub-districts (*kecamatan*), the third-tier administrative unit beneath provinces and districts and the lowest administrative level consistently referenced in the NVMS data. Our main sample includes a total of 2,755 rural sub-districts, amounting to about half of all Indonesian sub-districts in

[8] Though the NVMS sporadically covers all 34 provinces, full and consistent data coverage is only assured for Aceh, Maluku, North Maluku, Central and West Kalimantan, Central Sulawesi, Papua, West Papua, East and West Nusa Tenggara, Lampung, Greater Jakarta, North and South Sulawesi, North Sumatra, and East Java provinces. Due to data availability issues in other variables, we exclude Papua and West Papua.

[9] Three more types of violent incidents, crime, domestic violence, and law enforcement-related violence, are also included in the NVMS dataset, but are not used in our analysis. The aggregate trends are illustrated in Figure A10 in the appendix.

2005. The time period of 2005 to 2014 allows us to observe several years before and after the 2009 peak of Indonesia's palm oil boom. Moreover, the starting year of 2005 allows us to focus on small-scale community conflicts, as separatist conflicts that accompanied the fall of Suharto's regime had subsided by that time. We employ the 2014 sub-district boundary definitions to ensure temporal consistency across our data sources and time. We exclude sub-districts that cannot be accurately matched across time or have missing values in important variables, as well as all cities (*kotamadiya*); this latter restriction is due to a negligible importance of oil palm plantations in cities, and structurally different drivers of urban conflict. This results in an exclusion of 311 sub-districts from the provinces in our sample, leaving us with a total of 2,755 remaining in the final sample.

3.2 Measuring the pressure to expand oil palm area

To quantify the location-specific incentives for expanding the area dedicated to oil palm in each year, we construct a time-varying *shift-share* measure of the economic pressure for land-use change. Our primary measure for time-varying economic incentives—the *shift variable*—captures annual nationwide changes in oil palm plantation area. We obtain the yearly expansion of oil palm area at the national as well as at the local level from remotely sensed oil palm plantation maps that are derived from satellite imagery and other sources through a mix of automated and manual classification of plantation areas (Gaveau et al., 2022).[10] Our *share variable* captures location-specific exposure to these aggregate yearly dynamics, measuring the relative size of locally available area that is suitable for oil palm cultivation. We derive the local suitability to grow oil palm (and other crops) from maps provided by the *Global Agro-Ecological Zones* (GAEZ) project of the FAO/IIASA (2012), which take into account climatic conditions and terrain characteristics like slope, altitude and soil types.[11] We normalize the local oil palm suitability index by the area that is theoretically still available within each sub-district, including all area that has not yet been converted to oil palm by 2005 (Gaveau et al., 2022) and is not covered by settlements (Marconcini et al., 2021), water bodies (Pekel et al., 2016), or protected areas (UNEP-WCMC and IUCN, 2022). This normalization takes into account that the scope for land conversion is lower in regions that are already dominated by plantations and rests on the implicit

[10] We also consider alternative data sources, such as Danylo et al. (2021) and Du et al. (2022), for robustness checks. From these three sources, the accuracy of the data by Gaveau et al. (2022) appears to be the highest both with regard to the location of plantations, but also in terms of the exact year when plantations are created, making it our preferred data source to capture actual oil palm expansion.

[11] Sub-district-level oil palm suitability is calculated as the weighted mean of intersecting pixel values of FAO/GAEZ's raster maps and accounting for partial pixel coverage.

assumption that all available and suitable land that has not yet been converted to oil palm represents potential expansion area. We fix the shares to an initial period, the year 2005, such that shares are pre-determined and do not vary in response to the dynamics of the ongoing land-use change.

Our resulting measure of the expansion pressure EP_{it} in district i and year t can be described as follows:

$$EP_{it} = \left(\frac{s_i \gamma_i A_i}{\sum_i s_i \gamma_i A_i} \times NE_t\right) \times \frac{1}{A_i}, \tag{1}$$

where the *shift-share* component is displayed in parentheses: The *shift variable*, NE_t, captures the yearly aggregate nationwide expansion of oil palm plantation area, and the *share variable* multiplies sub-district area A_i with γ_i, the share of sub-district area that was theoretically available for conversion in the initial period, as well as with s_i, the sub-district-level suitability index for growing oil palm and obtaining high yields (ranging from 0 to 1, where 1 indicates the best possible conditions), divided by the sum of total weighted areas in the sample.

This shift-share measure allocates the yearly nationwide expansion of oil palm plantation area to each sub-district, depending on the size of locally available and suitability-weighted sub-district area, relative to the nation-wide available suitability-weighted area. This results in a suitability- and area-based spatial redistribution of the yearly new palm oil production area within the country. Finally, the third element on the right-hand side is included to express expansion pressure as a share of sub-district area. The resulting expansion pressure can be interpreted as the yearly share of sub-district area that would have been converted to oil palm plantation if production decisions only depended on local suitability and land availability. Thus, for each location, expansion pressure does not measure the actual intensity of land-use change, but the strength of economic incentives to engage in land-use change. Robustness checks in section 4.4 demonstrate that the relationship between expansion pressure and conflict does not hinge on these idiosyncratic measurement choices but is very robust to how we formulate the shift-share variable.

3.3 Further sources

We extend our database by detailed information about the sub-districts taken from various sources. Information about population size, agricultural dependence, land ownership structures, and other local characteristics are derived from the *Village Potential Statistics* (PODES) census conducted by the Indonesian Central Bureau of Statistics (BPS) every 2 to 3 years. The about 80,000 villages are the smallest administrative unit in Indonesia, one level below sub-districts. We aggregate village characteristics to the sub-district level using administrative codes. We rely on three PODES survey rounds (conducted in 2003, 2006 and 2014) linked to village definitions from 2006. To obtain proxies for remoteness, we supplement our sub-district data with information about the historical travel time to the nearest major city in the year 2000 derived from data by Nelson (2008). For further remoteness proxies, population density and elevation come from the PODES data, information about the share of forest cover within sub-district borders is derived from remotely sensed maps by Hansen et al. (2013), nighttime lights are from DMSP-OLS (NOAA, 2013), and built-up area from the World Settlement Footprint Evolution dataset (Marconcini et al., 2021).

We further supplement our panel with administrative and policy information obtained from BPS and from Indonesia's Ministry of Environment and Forestry (MoEF). To capture economic shocks in oil palm areas, we add data on prices from UNCTAD (2020) and data on droughts derived from the SPEI index (CRU, 2022). Summary statistics for all variables in our main sample are displayed in Table A1.

4 Oil palm expansion and conflict

4.1 Empirical strategy

Endogeneity of oil palm expansion

There are good reasons to expect that a direct link between actual, remotely sensed plantation expansion and local conflict might be subject to endogeneity issues due to reverse causality, omitted variable bias, or measurement error. Research establishing causal links between land-use change and outcomes such as conflict is sparse. One main reason is that conflicts tend to slow down or prevent agricultural investments and land conversion altogether.[12] Even outside of the context of civil war, areas for further production expansion may be strategically selected to avoid anticipated conflict with locals. Also, resistance occasionally succeeds in preventing planned plantation establishment or extension (Dell'Angelo et al., 2021). Furthermore, land transformation, and especially the establish-

[12]Studies documenting the reverse relationship between conflict and land-use change include Burgess et al. (2015), who show that areas in Sierra Leone with more intense conflict had significantly lower deforestation rates; and Prem et al. (2020), who study deforestation in Colombia after the peace agreement with the FARC rebels and find that rebel presence had acted as a brake on deforestation. Further studies document how violence deters agricultural investments, for example Singh (2013) and de Roux and Martínez (2021).

ment of large plantations, is a lengthy process that could cause conflicts also in the years leading up to it, as well as in the long run, for example if initial agreements between plantation owners and local populations are broken. According to case studies, many palm-oil related conflicts in Indonesia drag on for years or even decades, with violence and protests erupting time and again when economic conditions change or plantation owners aim to expand their production (Berenschot et al., 2021a).

Focusing on expansion pressure, our synthetic measure of economic incentives for land use change, instead of the actual remotely sensed extent of the expansion of oil palm plantations at the local level, helps to reduce such concerns of reverse causality and omitted variable bias. It allows us to capture local fluctuations in violence related to the palm oil boom also in places where no agricultural expansion ultimately takes place, or where the timing of conflicts is detached from the timing of plantation expansion—for example, where economic incentives induce conflicts related to land-grabbing that precedes the actual establishment of plantations. Yearly variations in plantation expansion align with global demand and corresponding price fluctuations to a large degree (Cisneros et al., 2021; Gaveau et al., 2022), but are also influenced by political agendas and potentially unobserved factors like escalating competition or seasonal climate shifts. The total expansion at the national level serves as a proxy for all these factors and can be considered as exogenously given at the local level in our spatially very disaggregated setting: given the wide prevalence of oil palm cultivation across Indonesian sub-districts, the contribution of a single sub-district to the overall national expansion is almost entirely negligible.

However, as our expansion pressure variable is built as a shift-share measure with one time-invariant share per sub-district, methodological points raised in the literature about shift-share methodologies (see Jaeger et al., 2018; Adão et al., 2019; Goldsmith-Pinkham et al., 2020; Borusyak et al., 2022; Christian and Barrett, 2023) are also relevant to our analysis and will be discussed below.

Empirical model

Our empirical strategy links the variation in local violence over time and across space to sub-district-level exposure to the pressure to convert areas to oil palm, EP_{it}, by estimating two-way fixed effects panel regressions with sub-district and year fixed effects:

$$C_{it} = \beta \, EP_{it} + X_{i0} \times \eta_t + \lambda_i + \eta_t + v_{it} \quad (2)$$

where our dependent variable, C_{it}, is a binary indicator that takes the value of one if any conflict incidents have been reported in a sub-district i and year t. Expansion pressure, EP_{it}, measures the share of sub-district area that would have been converted into oil palm area in a given year if aggregate national dynamics together with local agricultural suitability and the availability of not-yet-converted area were the only factors driving local land-use change (see also section 3.2). The year fixed effects, η_t, control for the average effects of economic and political processes at the country level. The sub-district fixed effects, λ_i, capture all time-invariant sub-district-specific characteristics (relating among others to sub-district location and history) that influence the average propensity of a sub-district to experience community conflict but at the same time also their propensity to be subject to land-use change.

We further allow for differential yearly dynamics in land-use change and conflict among economically more and less remote places. Economic remoteness is an important potential confounder: it could influence both the pace of land-use change and lead to systematic measurement error in newspaper-reported violence. We capture remoteness through local initial conditions, X_{i0}, and interact them with a full set of year-fixed effects, allowing for flexibly changing dynamics in measuring conflict across time. Within our baseline specification, remoteness is controlled by average travel time to the nearest major city in 2000 within the district. Robustness checks expand remoteness controls to include population density, the share of sub-district area covered by forest, and the share of sub-district area covered by built-up structures, all measured in 2005. This ensures that factors like a higher prevalence of conflict in more densely populated areas, or systematic under-reporting biases in less accessible locations, do not drive our results. Standard errors are clustered at the sub-district level.

Identification assumptions

Our regression equation (2) relies on the identifying assumption that the shares in the shift-share measure are conditionally exogenous to local conflict. Hence, the main concern for identification in our setting is the possibility that the location-specific share of available land that is suitable for oil palm cultivation predicts changes in conflict over time through other mechanisms than by incentivizing land-use change (Goldsmith-Pinkham et al., 2020). To address this concern, our main specification is not only conditional on time and location fixed effects, but also controls for highly flexible trends in location-specific remoteness to capture potentially differential conflict dynamics in more and less remote locations. Further robustness checks extend these controls, and present parallel trends graphs for places split along different suitability quantiles.

A second way to view our identification strategy is through the lens of exogenous temporal shifts in the incentives themselves (Borusyak et al., 2022), which would relax the necessity to argue the exogeneity of shares. This assumption is less appealing as our temporal variation is substantially more restricted than our spatial variation, consisting of two relative boom- and bust-cycles over the 10 years period of analysis (see also Figure A4). In this setting, changes in our proxy for time-varying incentives—the nationwide changes in plantation area—need to be exogenous to local conflict. There are some reasons to believe that this assumption might be violated in our setting. For instance, conflicts might prevent or slow down aggregate plantation expansion, which would create a downward bias in our estimates. Hypothetically, the opposite could also be true: if conflict outbreaks were to trigger nationwide land-use changes, for example as investors seek to create facts on the ground before potential conflict escalation, this would bias our coefficient upward. However, we believe this scenario to be fairly unlikely and we did not come across any anecdotal evidence supporting such a notion.[13] Moreover, any other time series variation that closely mimics the Indonesian palm oil cycle could also produce similar results (Christian and Barrett, 2023). We further discuss this issue in section 4.4 and provide evidence that this is not a major concern in our setting.

4.2 Main results

Our main results in Table 1 show a clear association between oil palm expansion and conflict in our panel framework. We first look at direct correlations between remotely sensed plantation expansion and conflict in the first two rows of the table. Accounting for year and province fixed effects, the results reported in column 1 indicate that sub-districts with any plantation expansion in a given year are 6 percentage points more likely to experience conflict. This represents a relative increase of one-fifth compared to the mean conflict probability of 28.5%.

This extensive-margin relationship holds and becomes somewhat stronger in column 2, where we flexibly control for conflict dynamics across regions with different levels of remoteness by interacting travel time to the nearest major city for each sub-district with

[13] If we measured expansion pressure through price fluctuation instead, we might be also concerned that conflicts in oil palm areas could impede harvesting or processing activities, thereby causing supply shortages and corresponding price increases. This would lead to an overestimation of conflict-inducing effects of land use change. However, for yearly changes in national plantation expansion as a proxy measure, this is arguably much less of an issue.

year fixed effects. These differential trends account not only for differential development dynamics, but also for potential underreporting of conflict in more isolated regions. However, this correlation disappears in column 3, once we fully specify our panel model by including sub-district fixed effects. The same pattern holds at the intensive margin in row 2, where we look at the yearly new plantation area instead of a binary variable for any expansion.

These results suggests that while regions undergoing land use changes for oil palm cultivation are indeed generally more prone to conflict, there is no immediate correlation between current plantation expansion and local conflict in a given year once average differences across sub-districts are factored out. There are several potential explanations for this result. First, plans to convert land to oil palm plantations could spark conflicts already years before the actual land use change materializes, and conflicts might also arise years after the establishment of operational oil palm plantations. Second, conflict could also spill over to neighboring sub-districts of the same province, complicating the measurement of the true local effects of land use change. Furthermore, the estimated correlation might also be affected by reverse causality. As argued before, expansion of plantations may happen more frequently in areas with relatively less conflict, consistent with other studies demonstrating that violence discourages agricultural investments and can slow land conversion (Singh, 2013; Burgess et al., 2015; Prem et al., 2020; de Roux and Martínez, 2021). Finally, successful protests could prevent or slow down further expansion in certain areas.

To tackle these issues of endogenous expansion and potential reverse causality, specifications in the third row of Table 1 focus on our preferred shift-share measure of local oil palm expansion pressure instead. As described in section 3.2, this synthetic measure captures the magnitude of local economic incentives to convert locally available land area to oil palm plantations. Column 1 of row 3 again conditions the estimates on year and province fixed effects only, whereas column 2 additionally controls for remoteness-specific dynamics by including remoteness-year interactions. Finally, column 3 presents our preferred specification, conditional on year and sub-district fixed effects, together with differential trends in initial remoteness. While the magnitude of the estimated coefficient fluctuates across the three specifications, it is highly significant in all. In the fully specified model (column 3), an increase of the expansion pressure to plant oil palm by one, corresponding to incentives to convert 1 percent of the sub-district area to plantations, yields a 19 percentage point increase in local conflict, increasing its likelihood by about two thirds.[14]

[14]The average yearly increase in oil palm plantation area among sub-districts with actual expansion was approximately 0.56 percent of sub-district area, which would correspond to an increase in the likelihood of

Table 1: Expansion of oil palm area and local conflict

Dependent variable:	Any conflicts		
	(1)	(2)	(3)
Any new plantation area	0.060***	0.077***	0.007
	(0.013)	(0.012)	(0.013)
ln New plantation area	0.011***	0.017***	0.000
	(0.003)	(0.003)	(0.003)
Oil palm expansion pressure (EP)	0.179***	0.063***	0.190***
	(0.023)	(0.021)	(0.047)
Mean dependent variable	0.285	0.285	0.285
Year FE	Yes	Yes	Yes
Province FE	Yes	Yes	No
Sub-district FE	No	No	Yes
Remoteness × year FE	No	Yes	Yes
Observations	27,550	27,550	27,550

Notes: The dependent variable is an indicator variable for at least one local conflict event being reported in a given sub-district and year. New plantation area measures the yearly expansion of oil palm area according to remotely sensed maps and is transformed as $\ln(x+1)$. Oil palm expansion pressure measures the potential yearly plantation expansion as a share of sub-district area, depending on oil palm suitability, available area in 2005, and national expansion trends, as described in equation 1. Remoteness measures average travel time within the district to the nearest city in 2000. Robust standard errors are clustered at the parent sub-district level (in 2005) and reported in parentheses. */**/*** denote significance levels at 10/5/1 percent respectively.

Thus, unlike the correlation between actual land use change and contemporaneous conflict, this more exogenous measure for economic incentives shows a clear link between land use change and conflict. Conflict increases in places that still have highly suitable area to grow oil palm in times when the area for oil palm is strongly expanding within the country as a whole.

4.3 Income shocks in production areas

Our results establish a positive link between social conflict and the local incentives to expand oil palm area. It is important to note, however, that the palm oil boom—accompanied by rising palm oil prices—does not only foster land use change but could affect social conflict also through a second, more direct channel. Beyond increasing competition for convertible land, rising palm oil prices also generate additional rents on already existing plantations. These rents potentially mitigate the conflict inducing effects of the palm oil boom by increasing the local returns to labor and thereby the opportunity costs of engaging in conflict. Conversely, when palm oil prices fall, the negative income shocks on

conflict by about 10 percentage points.

existing plantations might induce conflict the same way as a negative income shock due to a bad harvest would (Harari and La Ferrara, 2018). At the same time however, falling prices can be also expected to relieve the competition for land.

To address this second channel, we extend our specification by different measures capturing income shocks in existing production areas. First, to measure palm oil price shocks we employ commodity price data from UNCTAD (2020). We derive our price shock measure by calculating standardized yearly deviations from the 5-year rolling mean of world market prices, adjusted by exchange rates and inflation. Second, to capture precipitation and especially drought shocks, we rely on the Standardised Precipitation-Evapotranspiration Index (SPEI) from the University of East Anglia that captures drought and excessive rainfall conditions at the local level on a monthly basis (CRU, 2022).[15] Our drought measure is defined as the number of months with at least moderate drought conditions within a given year.[16]

We interact all of these shock variables with the local share of sub-district area covered by oil palm plantations in the year 2000, capturing the extent to which palm oil production is important for each subdistrict. Additionally, the 5-year delay ensures that plantations are already productive at the start of our observation period in 2005, as it usually takes up to 5 years for palms to start yielding substantial amounts of fruit (Corley and Tinker, 2015).

Our results reported in Table 2 reveal that income shocks in production areas have an effect on local conflict that is in line with predictions from the literature on the opportunity cost of conflict, and that this effect is distinct from the impact of expansion incentives. On aggregate, price shocks in oil palm areas are negatively linked to conflict (column 1). This effect is driven by increases in conflict resulting from falling palm oil prices, as becomes evident in column 2 where we split the price shock variable into positive and negative deviations from the rolling average. However, the price shock estimate is only marginally significant, yielding only weak evidence for an opportunity cost effect from price shocks on existing productive area.[17] Instead, if we measure localized droughts, which have been employed frequently in the literature as a proxy for negative agricultural income shocks (e.g., Harari and La Ferrara, 2018), we find more robust evidence for the opportunity cost

[15] The SPEI is a standardized index that relates monthly precipitation and modeled potential evapotraspiration at the spatial resolution of 0.5 degrees to their historical average. We follow usual definitions and consider a month as excessively wet if the SPEI is above 1 and as a drought month if it is below -1.

[16] Since oil palms are harvested all year and have no particular growing season (Corley and Tinker, 2015), we disregard the actual timing of the droughts within a particular year.

[17] Another common way of capturing price shocks in the literature on the economic causes of conflict is to employ the logarithm of prices. When using this specification, the effect of prices in production areas becomes insignificant, suggesting that log prices might not always pick up the "innovation" resulting from rapid changes in commodity prices.

Table 2: Income shocks in oil palm areas

Dependent variable:	Any conflicts			
	(1)	(2)	(3)	(4)
Oil palm expansion pressure (EP)	0.192***	0.193***	0.193***	0.199***
	(0.047)	(0.047)	(0.047)	(0.048)
Historical oil palm share × Price shock	−0.034*			
	(0.019)			
× Positive price shock		0.005		
		(0.032)		
× Negative price shock		0.098*		
		(0.050)		
× SPEI			−0.110**	
			(0.054)	
× Excess rain months				0.022
				(0.016)
× Drought months				0.038***
				(0.013)
Mean dependent variable	0.285	0.285	0.285	0.285
Year FE	Yes	Yes	Yes	Yes
Sub-district FE	Yes	Yes	Yes	Yes
Remoteness × year FE	Yes	Yes	Yes	Yes
Observations	27,550	27,550	27,550	27,550

Notes: The dependent variable is an indicator variable for at least one local conflict event being reported in a given sub-district and year. The price shock variable measures standardized deviations (positive and negative) from a five-year rolling average. SPEI is a standardized measure of the sub-district-year-level deviations of the precipitation and evapotraspiration index from its long-run mean. Excess rain/drought months count the number of months with SPEI above 1/below −1 in a given year. Baseline effects of SPEI and excess rain/drought months are included in estimations (3) and (4), but the respective coefficients are not reported in the table and are insignificant. Remoteness measures average travel time within the district to the nearest city in 2000 and is interacted by year fixed effects. Robust standard errors are clustered at the parent sub-district (*kecamatan*) level (in 2005) and reported in parentheses. */**/*** denote significance levels at 10/5/1 percent respectively.

channel. Our results in column 3 show a significant negative relationship between local levels of rainfall conditions—proxied by SPEI—and conflict that is increasing with the size of mature oil palm plantations. When we decompose the SPEI measure into negative and positive shocks by counting the months with excessive rain and droughts in column 4, it is especially drought shocks that increase the likelihood of conflict in oil palm growing areas. This is in line with the predictions of the literature as we expect that especially negative shocks will increase the fight for the shrinking economic rents from agricultural production.

Importantly, throughout all of these specifications, our main coefficient of interest capturing the plantation expansion incentives remains a highly significant predictor of local outbreaks of conflict, whose magnitude is barely affected by adding income shock variables. We take this as evidence that the effect of expansion pressure is indeed distinct from that of income shocks in production areas, a finding that, to the best of our knowledge, is new in the literature.

4.4 Robustness checks

Alternative measures of expansion pressure To ensure that the estimated link between expansion pressure and conflict is not driven by our specific way of measuring local incentives for oil palm expansion, in Table 3 we present alternative ways of constructing such a local incentive measure, demonstrating that the overall findings hold independent of the exact specification. In a series of estimations, we introduce step-wise variation to the shift and share components of our preferred shift-share measure from equation (1) that weights the national trend of oil palm area expansion with the share of available and suitable land. Our main measure translates national fluctuations in land-use change into a hypothetical share of locally convertible land, expressed in percent. Estimates from this baseline specification are again reported in row 1 of Table 3.

The first alternative specification in row 2 substitutes area shares by the local area in logs within our shift variable (relying on the $\ln(x+1)$ transformation), which once again yields a rescaled but highly significant effect. Results in row 3 demonstrate that instead of relying on initial available land area, we could also use the more endogenously varying but also more precise actually unconverted land in each year to calculate the scope for current expansion pressure. In this case the estimated relationship becomes somewhat weaker but still remains highly significant. Row 4 displays estimates obtained for a highly simplified version of our measure of expansion pressure, where local suitability for oil palm is simply interacted with the standardized national expansion trend, while in row 5 we replace this time variation with yearly fluctuations in international prices for palm oil.[18] Since the shift variable in these two specifications is differently scaled (standardized), we find smaller coefficients between expansion pressure and conflict, but generally the link between conflict and expansion pressure persists.

Beyond those shown above, in Table A2 we present a variety of additional specifications, which mainly show the differences between including or excluding the initial availability of land and thus relying only on suitability to grow oil palm for defining the local exposure

[18] We lag world market prices by one year to account for the fact that oil palm expansion generally seems to follow global price trends with a slight delay, reflecting a natural gap between observing market trends and implementing land use change decisions. This pattern is evident when comparing trends in aggregate expansion and trends in prices (see Figures A4 and A5 in the appendix), where price peaks are followed by high expansion rates one year later. Results also hold when using contemporaneous prices, but are slightly smaller in magnitude (see Table A2).

Table 3: Alternative specifications of expansion pressure

	Shift	Share	Formula	Estimate: Any conflicts
(1)	Aggregate national expansion	Suitability-weighted available sub-district area relative to total	$\left(\frac{s_i \gamma_i A_i}{\sum s_i \gamma_i A_i} \times NE_t\right) \times \frac{1}{A_i}$	0.190*** (0.047)
(2)	Aggregate national expansion	Suitability-weighted available sub-district area	$ln\left(\frac{s_i \gamma_i A_i}{\sum s_i \gamma_i A_i} \times NE_t + 1\right)$	0.107*** (0.035)
(3)	Aggregate national expansion	Suitability-weighted yearly available sub-district area relative to total	$\left(\frac{s_i \gamma_{it} A_i}{\sum s_i \gamma_{it} A_i} \times NE_t\right) \times \frac{1}{A_i}$	0.149*** (0.044)
(4)	Aggregate national expansion (std.)	Suitability	$s_i \times NE_t^s$	0.053*** (0.012)
(5)	Palm oil price (std.)	Suitability	$s_i \times P_{t-1}$	0.072*** (0.014)
Mean dependent variable				0.285
Year FE				Yes
Sub-district FE				Yes
Remoteness × year FE				Yes
Observations				27,550

Notes: The dependent variable is an indicator variable for at least one local conflict event being reported in a given sub-district and year. The explanatory variable is a measure capturing localized incentives to convert land to oil palm (expansion pressure), obtained by interacting a time-varying shift variable with a location-specific share variable. Each model (row) includes a different specification of expansion pressure, described by the respective formula, where s_i is the sub-district specific suitability to grow oil palm, ranging from 0 to 1; γ_i is the share of available sub-district area that is not covered by plantations, settlements, water, or protected areas, at the start of the observation period in 2005; P_t is the average yearly world market price for palm oil, standardized and adjusted for inflation; NE_t is the aggregate national area expansion of oil palm plantations; A_i is the individual sub-district area; γ_{it} is the yearly share of available sub-district area that is not covered by plantations, settlements, water, or protected areas, where yearly changes are due to actual plantation expansion. Remoteness averages travel time within the district to the nearest city in 2000. Robust standard errors are clustered at the parent sub-district (*kecamatan*) level (in 2005) and reported in parentheses. */**/*** denote significance levels at 10/5/1 percent respectively.

to land use change incentives.[19] Neither of these variations of our measure changes our conclusions in any way, although they do affect the magnitude of our estimates to some degree. Finally, Table A2 also shows results for constructing the expansion pressure measure in a leave-one-out instrument fashion instead, where the expansion of plantations specific to each location is subtracted from the aggregate expansion. This modification does not affect our coefficient estimates at all. This is not surprising as given the large number of considered subdistricts, each one's contribution to the national expansion of oil palm area is entirely negligible (see Table A2).

[19] In our main specifications, we prefer to rescale this measure by the locally available land area as this allows us to translate incentives into hypothetical land use change directly. However, results Table A2 demonstrate that this choice just effects the scaling of our expansion pressure variable but is not crucial for our identification strategy as our main cross-sectional variation comes from the spatial variation in suitability to grow oil palm.

Together, these results show that our specific choice of how to to model local economic incentives does not drive the overall findings: as long as we interact local suitability with time varying incentives, measured either through actual national trends or price variation, we find that conflict is increasing with this synthetic measure of expansion pressure.

Palm oil vs. other crops A further concern with our measure of expansion pressure arises if the location-specific suitability of a location for oil palm cultivation is correlated with other, potentially unobserved variables beyond those we control for. This is particularly possible for the suitability of other agricultural commodities that thrive in similar conditions, or for socioeconomic or cultural characteristics linked to some determinants of oil palm suitability, such as altitude or climate. While the focus of this paper is on the effects of incentives to convert land for palm oil production on conflict, due to the unique role of this commodity in the Indonesian context, Indonesia also produces a wide variety of other agricultural commodities beyond palm oil. If suitability of oil palm indeed proxies for general agricultural suitability, our measure might for example capture the effects of business cycles (or other temporal fluctuations coinciding with oil palm expansion or demand)[20] in areas generally suitable for agriculture. To address this concern, we first compare our main results to those obtained from relying on general agricultural suitability rather than oil-palm specific suitability. In columns 1 and 2 of Table A3 we construct a measure of overall agricultural suitability by averaging the suitabilities of all crops for which he have data and which have at least moderate suitability ($s > 0.5$) in at least one of Indonesia's sub-districts. In columns 3 and 4, we only focus on the suitability of the 10 major crops according to their contribution to Indonesia's agricultural revenue. Together, results in Table A3 show that national expansion trends for oil palm do not induce any conflicts in areas generally suitable for agriculture. Instead, if anything, the impact of oil palm expansion in areas suitable for many crops other than palm oil appears to have been negative, although we prefer not to over-interpret this finding.

Moreover, to further address the concern that we might misattribute the effect of the palm oil boom to the impacts of other agricultural changes, we contrast our oil palm expansion measure with a composite price exposure measure that combines further crops. Table A4 shows a comparison of the effects of oil palm expansion incentives with other agricultural commodities. Due to a lack of remotely sensed data on production expansion for most other crops, replicating our empirical approach identically for commodities other than

[20] In further robustness tests, we interact the share-component of our measure for expansion pressure with other time series, such as the Indonesian business cycle or election cycle, neither of which give us a comparable effect to that of the oil palm cycle (results available upon request).

palm oil is not feasible. However, we can construct a shift-share measure of world market price exposure similar to the one for palm oil shown in Table 3. This involves using international commodity prices as a proxy for time-varying incentives, which we then interact with location-specific agricultural suitability for the respective commodity. In a final step, we combine the different crop exposures into one combined shift-share measure of local agricultural commodity price exposure by weighting each individual measure according to the importance of the respective crop in the Indonesian context.[21] Results in columns 1 and 2 reveal that contrasting this combined shift-share measure of commodity price exposure with our palm oil-specific measure does not change our main conclusions. The effect of palm oil is distinct, and the main coefficient even becomes slightly bigger in magnitude.

Conditional exogeneity of shares As outlined in sections 3.2 and 4.1, our measure of oil palm expansion pressure relies on an interaction between the local geo-climatic condition to grow oil palm (share) and a national trend in the production area (shifter) and hence identification relies on the usual assumptions behind shift-share strategies. The main input into our local shares, soil suitability, is not fully exogenous, and may be correlated with other location-specific characteristics that may affect the probability of conflict. We first test the validity of our shift-share approach by controlling flexibly for further time dynamics that might be correlated with our shift variable that combines agricultural oil palm suitability with available sub-district area (Borusyak et al., 2022; Goldsmith-Pinkham et al., 2020, cf.). Table A6 in the appendix presents broadly comparable results when controlling flexibly for time dynamics in a list of further variables that are potentially correlated with agricultural oil palm suitability or available area. We control for differences in time dynamics that vary by the initial share of forested area, the average elevation of the subdistrict, the initial share of settlement area, its initial population density, as well as initial nighttime luminosity, all of which we interact with a full set of year-fixed effects to capture reasons for non-parallel year-specific trends. Even when we include all of these controls jointly in column 6 of Table A6, our main coefficient of interest remains significant at the 5% level and becomes only somewhat smaller in its magnitude. Overall, the only variable that affects our estimated coefficient to some extent, is elevation, which is an important predictor of oil palm suitability itself.

[21] In column 1, we rely on the ex-ante share of each commodity in Indonesia's agricultural revenue (FAO, 2022) to define the relative importance of each crop for which we have suitability information, and restrict this sample to the 10 most important crops. Excluding palm oil, this results in a combined index involving the following agricultural commodities: rice, sugarcane, banana, maize, cassava, coffee, groundnut, soybean, cacao and rubber. In column 2, we weight crops by their sectoral value added (BPS), which changes their order slightly.

Nonetheless, there is still further scope of bias due to the non-exogeneity of our share variables. For instance, highly suitable but undeveloped land has been most abundant on the island of Kalimantan during our time period, resulting in high measures of expansion pressure on the island. At the same time, the relatively lower population density and larger remoteness of some "frontier" areas from urban centers might have reduced the overall conflict potential in these areas, putting them on differential dynamics. Moreover, even when conflicts materialize, they might be under-reported in provincial newspapers if they happen in very remote locations. These factors might lead to an underestimation of the general link between land-use change and conflict. If our control for economic remoteness captures such spatial differences only imperfectly, our estimates may still be subject to a certain bias.

Despite these tests, we cannot entirely rule out the possibility that our finding may be spuriously related to unobserved location-specific traits associated with suitability. However, the anecdotal evidence supporting our interpretation of the estimates, coupled with the significant role of palm oil in the Indonesian context, renders this highly unlikely in our view.

Finally, as a type of placebo test, we re-estimate our main specification but shift our measure of expansion pressure along the time dimension. This gives some indication as to whether future values of expansion pressure predict current conflict, and vice versa. Reassuringly, results presented in Figure A7 reveal that future expansion pressure does not predict current conflict, mitigating potential concerns that we are merely capturing slow-moving nonlinear trends in areas suitable for oil palm expansion. Using past values of expansion pressure as our explanatory variable, on the other hand, does reveal a positive and significant link with current conflicts, suggesting that some of the effects persist after years with high expansion pressure, although at a lower level than in the baseline year.

Correlation of standard errors There is a notable spatial correlation of both oil palm suitability and the actual plantation locations among neighboring sub-districts, and potentially within provinces or islands as well. This correlation could result in an underestimation of our standard errors. To account for this potential issue, we re-estimate our main specification, but instead of clustering standard errors at the level of administrative units, we allow for arbitrary spatial correlation within a specified distance cutoff (Conley, 1999; Colella et al., 2019). We follow Colella et al. (2019) in using the spatial correction radius for a uniform kernel that yields the most conservative estimates for our standard errors, which is the case for a radius of 200 km.[22] Even in this most restrictive specification, our estimates reported in column 2 of Table A7 remain highly significant ($p < 0.001$). One possible explanation for this is that spatial correlation appears to be present in our explanatory variable, but not in the dependent variable (Colella et al., 2019). In column 3, we further correct for the additional possibility of a serial autocorrelation of our standard errors within individual sub-districts (Hsiang, 2010), which again does not change our conclusions ($p < 0.002$).

Furthermore, there is room for concern that our standard errors are correlated across observations with similar values of our initial share variable as suggested by Adão et al. (2019). To account for this possibility, we cluster our standard errors across percentiles of our share variable in columns 4 and 5 of Table A7. Again, our estimates remain highly significant throughout, suggesting that correlation of standard errors across similar shares is not driving our results.

Sample composition To address the possibility that our results are driven by specific time periods or specific locations, we re-estimate our main specification but systematically change the sample composition. First, we exclude each of the major island groups one at a time from our estimation, to investigate their influence on our results. The estimated coefficients from this exercise are displayed in Figure A6, confirming that our overall conclusions remain unaffected. Although omitting Sumatra, and the smaller eastern island groups of Nusa Tenggara and Maluku, seems to slightly reduce the estimated effect size, these variations are not statistically significant, and our primary conclusion consistently holds. Second, we repeat the same process, but now exclude groups of years from the sample instead. Results in Figure A6 show that splitting our sample in half along the time dimension does not change our overall findings either. The main conclusions hold also in a much shorter panel of 5 years. While the adverse effects of expansion pressure appear to have been more pronounced before 2010, the difference is again not statistically significant. Overall, our findings seem to be quite robust to variations of the sample composition.

[22] This distance very roughly corresponds to the shortest distance from coast to coast across most of Indonesia's islands in our sample, and to the distance from coast to center on the largest island of Borneo.

5 Mechanisms

5.1 Relevance of land-use rents

If our measure of expansion pressure indeed captures conflicts caused by increasing competition for agricultural land, then its adverse impacts should be more pronounced where land is more scarce, and where its importance as an income source for the local population is higher. To test these predictions, in Table 4 we analyze the heterogeneous impacts of expansion pressure by including interactions between the measure and location-specific indicators proxying for these dimensions.[23] In column 1, we interact our main explanatory variable with a continuous variable capturing the relative size of available area per household. We define this as the total sub-district area (in hectares per household) that is not yet converted to oil palm in 2005, and is not covered by water, settlements, or protected areas. The estimated coefficients reveal that the negative impact of expansion pressure diminishes when more land is still available within a given sub-district, suggesting that increasingly scarce land could be a driver of the adverse impacts we observe in our main specification.

Table 4: Expansion pressure and the relevance of land-use rents

Dependent variable:	Any conflicts			
	(1)	(2)	(3)	(4)
Expansion pressure	0.220***	0.228***	0.201***	0.249***
	(0.050)	(0.049)	(0.047)	(0.051)
Expansion pressure	−0.004**			−0.002
× available area per household (ha)	(0.002)			(0.002)
Expansion pressure		−0.219***		−0.198**
× any mining/oil/gas concessions		(0.080)		(0.082)
Expansion pressure			−0.218*	−0.211*
× low farming dependence			(0.123)	(0.124)
Mean dependent variable	0.285	0.285	0.285	0.285
Year FE	Yes	Yes	Yes	Yes
Sub-district FE	Yes	Yes	Yes	Yes
Remoteness × year FE	Yes	Yes	Yes	Yes
Observations	27,550	27,550	27,550	27,550

Notes: Robust standard errors are clustered at the parent sub-district (*kecamatan*) level (in 2005) and reported in parentheses. */**/*** denote significance levels at 10/5/1 percent respectively.

[23] While this approach is ultimately descriptive in its nature, since the relationship between these location-specific characteristics and oil palm expansion and conflict could be co-determined, it still yields interesting insights about the heterogeneity of the measured effect. To further minimize this concern, we rely on location characteristics that are measured before the start of our observation period, whenever possible.

To investigate the role of other sources of income we first focus on an indicator variable that captures whether any concessions for mining, oil, or natural gas are present in the sub-district. This should proxy for natural resource extraction as an income source that is a potential alternative to farming, and is the case in 17% of the sub-districts. In column 2, the significant negative interaction between this indicator and our measure of oil palm expansion pressure shows that the potential for rents from natural resource extraction indeed fully mitigates the conflict-inducing effect of the oil palm boom. As an alternative measure of the relative role of agriculture, in column 3 we interact expansion pressure with a binary indicator for sub-districts with a low farming dependence in 2005, as measured by PODES. Since farming is the main income source for the vast majority of the population in our sample (the median share of agriculture-dependent households is 85%), reflecting the rural nature of our dataset, we define any sub-district as 'low farming dependence' whenever less than half of all rural households depend on farming. This corresponds to roughly 8% of rural sub-districts in our sample. The estimates show that the adverse impacts of expansion pressure are also not present in this group of sub-districts.[24] In column 4 we jointly estimate all three indicators. While the size of available area per household loses significance, concessions for mineral resources and low farming dependence both remain significant and similar in magnitude, ruling out the possibility that they simply proxy for the same (unobserved) variable. Overall, the findings reported in Table 4 suggest that incentives to expand oil palm plantations have adverse impacts mainly in those rural areas where agriculture is an important source of income. This effect is mitigated somewhat by a relative abundance of land, but especially by other income opportunities.

Beyond heterogeneous effects due to alternative income sources, the existing conflict literature offers a wide-range of hypotheses for further heterogeneous effects. Environmental grievances, immigration and quick population growth in the boom regions, or ethnic heterogeneity might all have a mediating role also in the case of land-use change induced conflict. Table A5 in the appendix shows that basic proxies for these potential mechanisms do not yield significant results. Expansion pressure is not related to more conflict in places where the losses of natural forest have been the largest during this time period, neither where population grew more quickly.[25] There is also no significant relationship between historic ethnic fractionalization or polarization (in the year 2000) at the sub-district level

[24] This is not due to oil palm suitability being lower in these sub-districts – their mean suitability of 0.28 is very similar to the overall sample mean of 0.25.

[25] While these results are informative, they cannot be interpreted causally as they interact long-run trends (from 2005 to 2014) in population dynamics and forest loss with the expansion pressure variable. These trends are likely also endogenous to the local oil palm boom, but still show no magnifying relationship with conflict.

and the conflict-inducing effects of oil palm expansion pressure.

5.2 Heterogeneities by conflict types

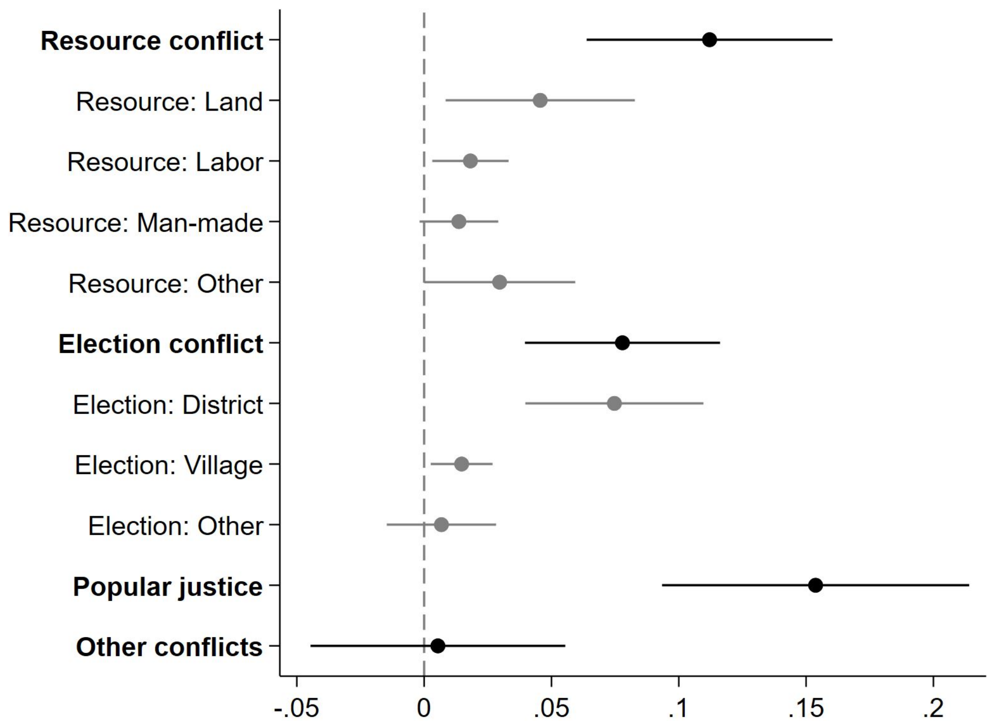
Types of conflict The NVMS conflict database contains rich contextual information on the types and circumstances of social conflict as reported by the regional newspapers. This detailed information allows us to distinguish between various types of conflict, which might also help us to better understand how economic incentives to expand the oil palm area translate to social conflict. Figure 1 distinguishes between different categories of conflict and displays the estimated coefficients obtained from individual regressions that follow our main specification but replace our aggregate measure for *Any conflict* by more-specific conflict types. The results show that the overall effect is mainly driven by three categories of violence: resource conflicts, election conflicts, and conflicts related to popular justice.[26]

Within these broad conflict types, we further distinguish between various sub-categories of resource and election conflicts. Resource conflicts are divided into conflicts over land, labor-issues, man-made resources, and the combined category of other resources, which refer to other natural resources, resource access issues, pollution, and undefined resource-related conflicts. Election-conflicts are split up by government tiers. Here we single out district and village elections as these are the government tiers that played a central role for local land-use decisions. The "other" category collects conflicts related to national, provincial, and sub-district-level elections, none of which we expect to having played a central role within our time period of interest.

While the definition of individual conflict types and their sub-categories is fuzzy and there is some overlap between groups, this separation nevertheless indicates a pattern: First of all, land conversion incentives induce conflicts over resources, mainly over land and labor opportunities. Second, they lead to more conflicts related to political representation at the local but not national level. The 'election' conflict type includes outbreaks of violence clearly linked to either elections or official appointments at various administrative levels. The aggregate increase in this category is mainly driven by incidents related to elections and appointments at the district level, where most land-use decisions are made, and to a lesser degree also at the very local level of villages. Village heads are often directly involved in negotiations about plantation development and have a strong influence over

[26] We group the remaining categories of conflict into on single category labeled "Other conflicts"; none of these types are individually significant in regressions. This left-over category combines identity- and governance-related conflicts, and conflicts without a clear reported trigger.

Figure 1: Expansion pressure and conflict types



Note: This figure reports the size of individual regression coefficients obtained from regressing the local probability of the indicated conflict types on a measure of oil palm expansion pressure, as described in equation 2. All estimates include sub-district and year fixed effects as well as remoteness-specific year fixed effects. Remoteness measures average travel time within the district to the nearest city in 2000 and is interacted by year fixed effects. Spikes indicate 90% confidence intervals. Other resource conflicts include conflicts caused by natural resources, resource access, pollution and others (undefined trigger). Other election conflicts include conflicts related to elections and appointments at the national, provincial and sub-district level as well as conflicts caused by appointments of government officials and by disputes over political influence. Other conflicts include identity-related conflicts, governance-related conflicts and others (undefined trigger).

land governance within villages, which might explain the result. Both elections at the provincial and at the national level are not associated with increases in conflict whenever expansion pressure is stronger, neither jointly, as displayed in the figure, nor separately. Finally, expansion pressure strongly increases the incidence of incidents coded as "popular justice". This category is generally frequent in the data and a catch-all category for events in which where a group of people uses violence to punish the perpetrator of an actual or perceived injustice or crime. Since a large share of these events appear to be related to the punishment of thievery and assault, we believe that the category captures both increases in property-related crime at the local level, as well as social grievances more generally. This finding also aligns with observations by Kenny et al. (2022), who argue that the expansion of the oil palm sector caused increases in crime in rural areas.

Resource conflicts and land ownership The increase in expected land values should not lead to conflict if property rights are clearly defined and hence the main actors are able to negotiate a socially desirable outcome. However, there are several potential reasons why such a peaceful agreement might not be achieved in practice: For example, if property rights are not secure and hence land is contestable (Fetzer and Marden, 2017), or if its distribution causes social grievances. Indeed, according to case studies, conflicts triggered by rising land prices often have overlapping claims and economic inequality as underlying causes (de Jong et al., 2021). In this section of our analysis we analyze whether there is support for such mechanisms in our context using fine-grained data on land ownership structures.

To investigate how local land ownership structures influence conflicts over resources whenever incentives for land conversion are strong, we rely on data reported in the 2003 PODES village census.[27] We aggregate the detailed village-level ownership data at the sub-district level to construct proxies for the contestability of land, as well as for the land distribution among different local groups. We loosely follow Barron et al. (2009) in categorizing village lands in two categories, where the first is assumed to be more contestable: village owned (common) land, and private land.[28] To obtain a proxy measure of local land distribution, we rely on de-facto ownership information reported for private lands, which implicitly distinguishes between two categories: land that is self-cultivated by the owner, and land owned by a third party (which in the PODES data is further distinguished according to whether it is cultivated by a tenant, or not at all). Such third-party owners may include both landlords from within the village as well as outside investors.[29]

We then interact our main coefficient of interest with these pre-determined local condi-

[27] While relying on data from 2003 further reduces our sample due to a difficulty of accurately matching administrative units over time, subsequent PODES rounds did not include this information anymore, making this the best possible data available.

[28] This includes private land both with and without a formal title. Although our data would allow us to further distinguish along this dimension, we do not find that it makes a difference. Both high shares of titled and untitled private lands are associated with approximately equal decreases in the distributional conflicts caused by oil palm expansion incentives. This mirrors findings of Barron et al. (2009), who argue that common lands in Indonesia are most often associated with conflicts, whereas the distinction between titled or non-titled private land does not seem to matter substantially in this regard. However, this lack of distinction could also reflect potential measurement error in the underlying variable from the village census, as the definition of what constitutes a "formal" land title is strongly disputed between different levels of government and definitions are potentially heterogeneous across locations (Kunz et al., 2016).

[29] We interpret a higher share of owner-cultivated land as being indicative of a more equitable land distribution from the perspective of local communities, given the fact that absentee ownership of agricultural land in Indonesia is often a form of investment for the urban middle class (Lucas, 1992), or a form of land-banking by companies (McCarthy et al., 2012). Nevertheless, we acknowledge that this is based on the strong assumption that the land is relatively evenly distributed among the self-cultivators, which may not always be the case.

tions to assess whether different ex-ante scenarios of local ownership structures mediate the conflict-inducing effects of plantation expansion incentives.

Table 5: Land ownership

Dependent variable:	Any conflicts		Resource conflicts		Other conflicts	
	(1)	(2)	(3)	(4)	(5)	(6)
Oil palm exp. pressure	0.337***	0.323***	0.335***	0.283***	0.290*	0.222
	(0.186)	(0.132)	(0.128)	(0.095)	(0.172)	(0.142)
Expansion pressure ×	−0.065		−0.215**		−0.075	
% private land, of total	(0.189)		(0.131)		(0.174)	
Expansion pressure ×		−0.070		−0.202*		−0.006
% owner-cultiv. land, of private		(0.167)		(0.118)		(0.177)
Mean dependent variable	0.345	0.345	0.090	0.090	0.300	0.298
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sub-district FE	Yes	Yes	Yes	Yes	Yes	Yes
Remoteness × year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	17,210	17,800	17,210	17,800	17,210	17,800

Notes: The sample is restricted to sub-districts that can be matched between 2003 and 2014 and further excludes the top 5% of sub-districts with the highest number of villages in 2003, which likely result from mismatches. Robust standard errors are clustered at the parent sub-district (*kecamatan*) level (in 2005) and reported in parentheses. */**/*** denote significance levels at 10/5/1 percent respectively.

The results reported in columns 3 and 4 of Table 5 confirm that resource conflicts caused by increasing incentives for land conversion are indeed related both to the contestability of land and to its distribution. In column 3 we interact our main coefficient of interest with a continuous variable capturing the ex-ante share of village land that is privately owned. The results reveal that the conflict-inducing effects of expansion pressure are strongly mitigated in sub-districts without any common, village-owned land. This implies that common lands might have been a strong driver of resource conflicts during the oil palm boom – in line with anecdotal reports of grievances arising over village elites claiming and selling parts of the communally-owned land (Cramb and McCarthy, 2016). In column 4 we investigate how ownership structures of private land further mitigate resource conflicts arising from expansion incentives. We now include an interaction with a continuous variable capturing the share of private land that is owner-cultivated (the baseline coefficient now captures the effect of oil palm expansion pressure on private lands that are third-party owned). The findings for resource conflicts show that especially owner-cultivated private land reduces the adverse impacts of expansion pressure, while the same is not true for third-party (or landlord) owned area. This leads us to conclude that conflicts related to land conversion incentives appear to be mainly driven by sub-districts with more imbalanced ownership structures from the perspective of local communities, where a higher share of land is owned (and potentially rented out) for investment purposes.

For comparison, we re-run the same regressions using our baseline measure of any conflict, and an additional binary measure for all conflicts excluding resource conflicts, in columns 1–2 and 5–6 of Table 5. The corresponding interaction terms are insignificant, suggesting that this heterogeneity is indeed linked to resource conflicts more specifically, but does not play a role on aggregate, when other types of conflict are considered.

Overall, the findings from this analysis suggest that both the distribution of village lands among different economic groups, as well as their contestability, are an important driver behind the resource conflicts caused by the oil palm boom. Decreasing the contestability of land, and addressing imbalanced ownership structures, seem to be important steps in ensuring a more peaceful land-use transformation.

Electoral incentives Our results as reported in Figure 1 have shown that electoral violence constitutes a substantial part of the conflicts caused by rising incentives for land-use change, especially violence surrounding elections at the district level, where most land-use decisions are made during our period of observation. The devolution of power over the allocation of land to district governments and especially district mayors (*bupati*) during Indonesia's decentralization period likely led to a large increase in the potential returns from holding local office (Burgess et al., 2012). Beginning in 2005, direct elections of district mayors were introduced, leading to intensified electoral competition at this level (Martinez-Bravo et al., 2017). Combined, the higher stakes of winning could lead to a higher risk of violence surrounding elections (Bazzi and Gudgeon, 2021), which would explain why we observe increases in electoral violence caused by the oil palm boom. Furthermore, anecdotal evidence suggests that the introduction of direct elections caused the costs of electoral campaigns to rise substantially, thus incentivizing local politicians to collude with companies and investors in exchange for campaign finance (Aspinall and Berenschot, 2019; Afrizal and Berenschot, 2020). This could make it more difficult for local populations to rely on political representatives to solve their land-related problems (Afrizal and Berenschot, 2020), and hence it could turn elections into a release mechanism for grievances over political representation. To provide some evidence for these hypotheses, we further investigate how expansion pressure affects electoral violence in Table 6.

We investigate whether this effect is indeed driven by the elections of district mayors that were in charge of granting plantation concessions and wielded substantial influence over land-use decisions. To do this, we exploit the fact that the timing of local elections in Indonesia is very heterogeneous and plausibly exogenous during our period of observation

Table 6: Election conflicts

Dependent variable:	Any conflicts	Election conflicts	Other conflicts
	(1)	(2)	(2)
Oil palm expansion pressure	0.207***	0.073***	0.166***
	(0.048)	(0.024)	(0.046)
Expansion pressure × mayor election year	0.047**	0.042***	0.034*
	(0.020)	(0.014)	(0.020)
Mayor election year	–0.015*	0.028***	–0.031***
	(0.009)	(0.005)	(0.009)
Mean dependent variable	0.288	0.037	0.271
Year FE	Yes	Yes	Yes
Sub-district FE	Yes	Yes	Yes
Remoteness × year FE	Yes	Yes	Yes
Observations	27,090	27,090	27,090

Notes: Robust standard errors are clustered at the parent sub-district (*kecamatan*) level (in 2005) and reported in parentheses. */**/*** denote significance levels at 10/5/1 percent respectively.

(Martinez-Bravo et al., 2017; Bazzi and Gudgeon, 2021).[30] This results in quasi-random variation in when districts had their first direct *bupati* election after their introduction in 2005, ensuring that election years are not systematically correlated with the timing of the oil palm boom. In Table 6 we add a dummy indicator for years with local mayoral elections and an interaction of this indicator with our explanatory variable. This specification shows that while mayoral election years are generally associated with higher incidences of election conflict, this is especially true when expansion incentives are stronger. The residual effect of expansion pressure on election conflict stays significant, suggesting that the elections of district mayors are not the sole driver of election conflicts, but an important one. We re-run this analysis both for aggregate conflict types (column 1) and for election conflicts (column 2) as well as for any non-election conflicts (column 3). The interaction term stays significant throughout, suggesting that expansion pressure in election years increases especially the incidence of election conflict, but potentially also the incidence of other conflict types. However, it is worth noting that our binary measure of conflict cannot clearly separate these categories whenever multiple types of conflict coincide in a given sub-district and year.

Our results on election violence related to plantation expansion pressure have one caveat though: We cannot differentiate whether this increase in electoral violence is caused by grievances over political representation, or by more intense electoral competition, or both.

[30] In more recent years, elections have been systematically shifted to better synchronize them across the country.

The majority of electoral violence reported in the NVMS data directly targets candidates, rather than voters or government agencies (Harish and Toha, 2017). While on the one hand this could indicate that the violence is indeed a display of discontent with politicians, on the other hand Harish and Toha (2017) also suggest that the attacks might be a strategy to intimidate candidates and remove them from the race, which would speak in favor of intensified competition being the underlying mechanism. In either case, electoral violence seems to be closely linked to expansion pressure, with elections becoming more violent if they coincide with periods of stronger land conversion incentives.

6 Conclusion

By combining highly disaggregated data on community conflict in rural Indonesian sub-districts with remotely sensed oil palm plantation expansion data, we analyze whether the oil palm boom in Indonesia caused local conflicts. Our findings for the years 2005 to 2014 imply that incentives to expand oil palm plantations led to significant increases in social conflict at the sub-district level. Oil palm expansion pressure especially increases conflicts triggered by resource disputes over land and labor opportunities. At the same time, land conversion incentives overall resulted in more conflicts over political representation and around elections. The adverse impacts observed in this context appear to be related to competition over increasingly scarce lands, and grievances over an unequal distribution of the benefits from rising land values. Indonesia's institutional framework for the distribution of land rents likely contributes to the escalation of these grievances into violence, as it compels involved actors to bypass legal mechanisms. We do not find evidence that these effects are linked to regions with higher ethnic or religious fragmentation, or to environmental grievances. Instead, we find that conflicts are mainly related to the importance of land as an income source and to its economic potential. The conflicts associated with land expansion incentives are distinct from those associated with income shocks in pre-existing production areas, which instead have effects that clearly align with predictions from the literature about opportunity-cost mechanisms.

While economic development should generally increase the opportunity cost of violence, we have shown that the oil palm boom likely increased conflicts in Indonesia despite its positive effects on income and employment. We provided evidence that this effect is driven by economic motives, distributional grievances, and an insecure institutional setting that has historically favored local and political elites. We believe that our findings are not limited to Indonesia and might also apply in other contexts where rapid land conversion occurs. They are especially relevant in light of the fact that palm oil production in other regions of the world, such as tropical Africa and Latin America, is expected to increase significantly in the next few decades (Pirker et al., 2016). This could lead to similar problems to those identified in the Indonesian context and deserves attention from policymakers.

Understanding the social implications of commodity booms more generally is crucial due to their wide-ranging impacts on local communities, economies, and ecosystems. Our study has focused on one particularly pivotal commodity—palm oil—and its link to conflicts in Indonesia. Both the environmental externalities of the this boom, including deforestation, loss of biodiversity, and increased greenhouse gas emissions, as well as potential negative socioeconomic impacts ranging from land rights conflicts to labor issues, are common features of many recent agricultural commodity booms around the world (e.g., soybean in South America, avocados in Mexico, or cocoa in West Africa). Although the challenges associated with each commodity are unique, all of them share similar dynamics with the palm oil boom in terms of rapid expansion in response to global demand, with resultant pressures on natural resources, land use, local economies, and social structures. This recurring pattern highlights the necessity of further research to resolve conflicts and guide sustainable practices and policies for managing future commodity booms.

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A Online Appendix

A.1 Description of NVMS conflict types

The presented definitions are adapted from the NVMS Coding Manual, publicly accessible via the World Bank data base (https://microdata.worldbank.org/index.php/catalog/2626, last accessed: September 8, 2022).

Resource conflict Violence triggered by resource disputes (land, mining, access to employment, salary, pollution, etc.).

Resource - Land disputes Violence triggered by land disputes (public or private).

Resource - Natural resource Violence triggered by natural resources such as mining, water etc. (public or private).

Resource - Man-made resource Violence triggered by man-made resource (public or private).

Resource - Resource access Violence triggered by access to employment, market, route, customers, etc.

Resource - Environmental damages Violence triggered by environmental damage, air pollution, noise pollution, etc.

Resource - Salary/labor issues Violence triggered by complaints over wage, labor condition, industrial relations between laborers and the management, etc.

Governance and elections conflict Violence is triggered by government policies or programs (public services, corruption, subsidy, region splitting, etc.), electoral competition or bureaucratic appointments.

Separatist conflict Violence triggered by efforts to secede from the Unitary State of the Republic of Indonesia (NKRI).

Identity-based conflict Violence triggered by group identity (religion, ethnicity, tribe, etc).

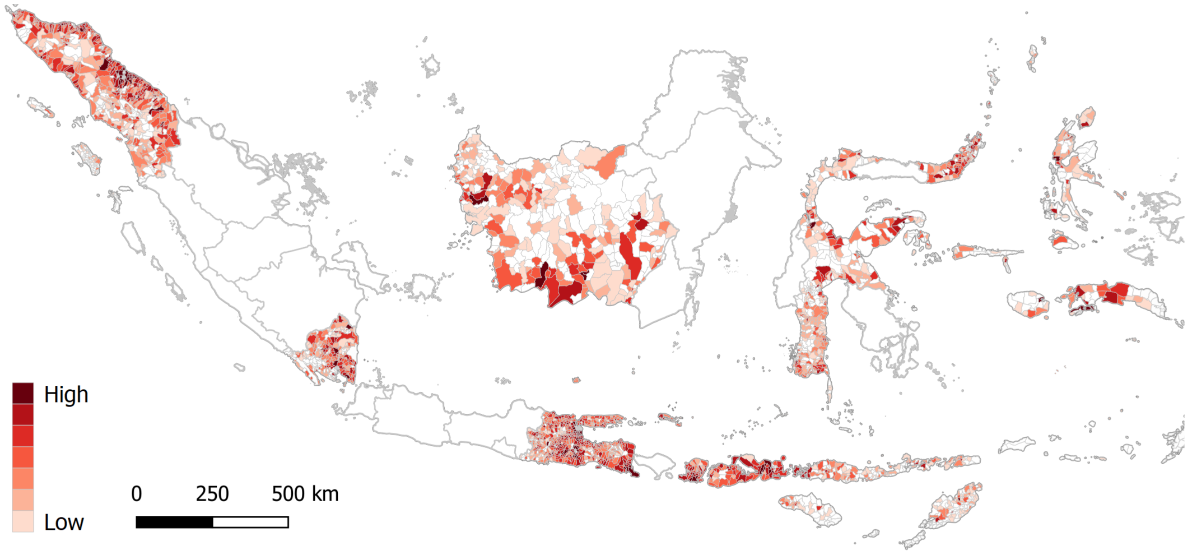
Popular justice conflict Violence perpetrated to respond to/punish actual or perceived wrong (group violence only)

Other conflicts Trigger of violence is not clear or conflict triggered by issues other than those listed in the coding key.

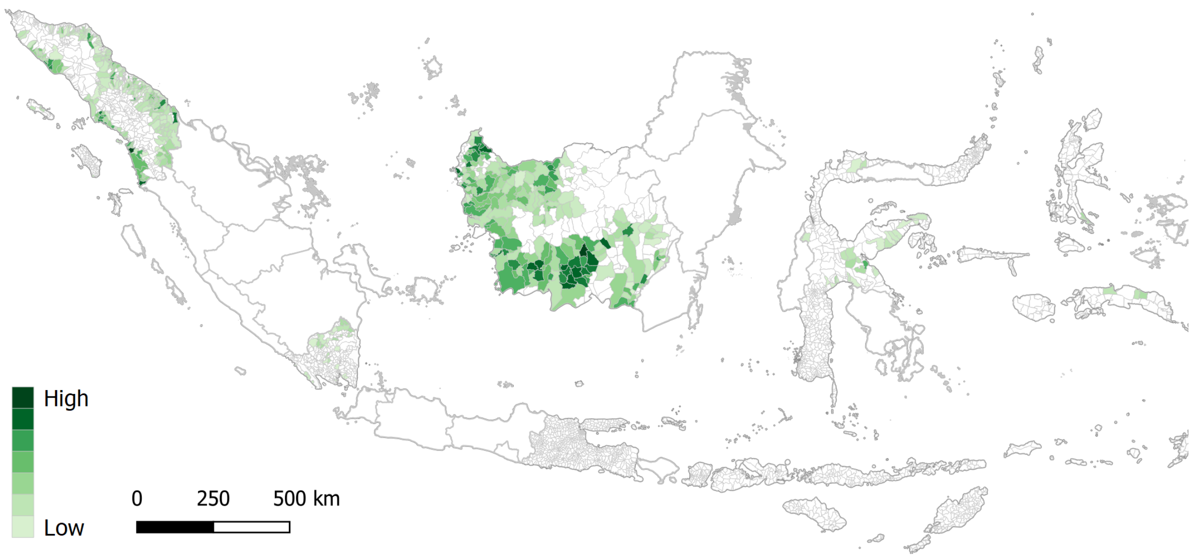
A.2 Online Appendix: Figures

Figure A1: Sub-district-level conflicts and oil palm expansion

(a) Conflicts (2005–2014)

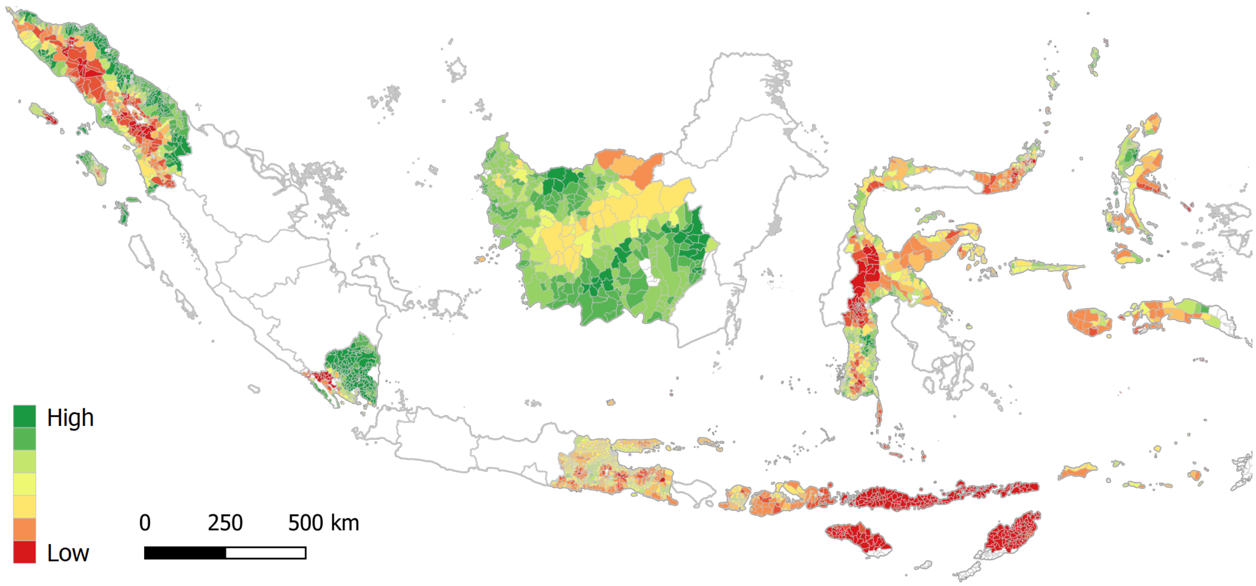


(b) Oil palm expansion (2005–2014)



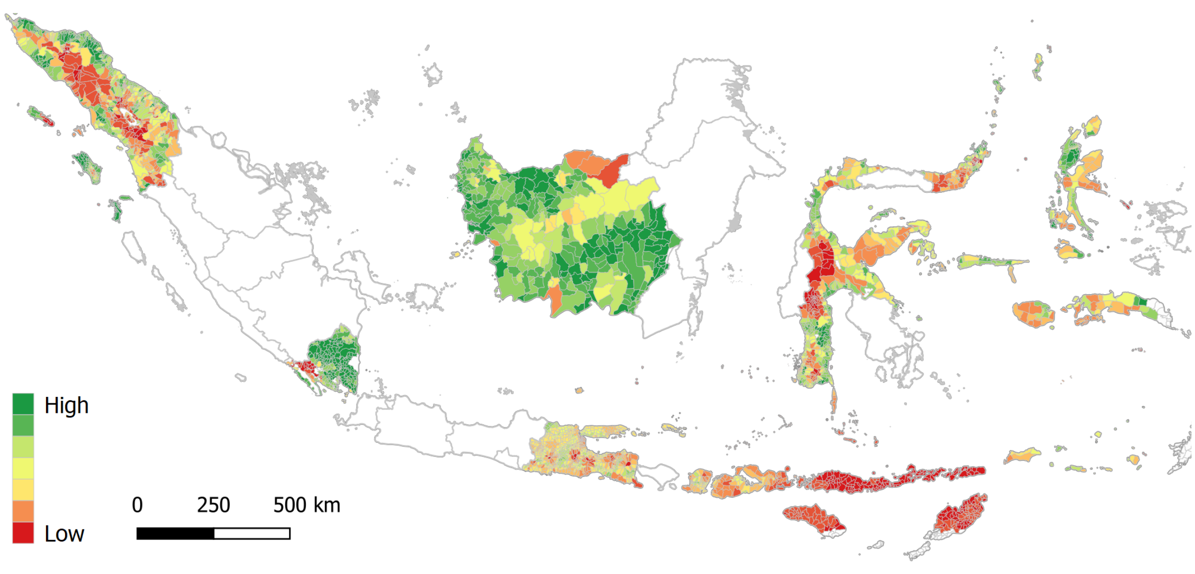
Note: This figure shows (a) the cumulative number of conflicts at the sub-district level in Indonesia between 2005 and 2014 as reported in the National Violence Monitoring System (NVMS) data, and (b) the cumulative expansion of oil palm plantations as a share of sub-district area between 2005 and 2014 as measured by Gaveau et al. (2022). Both maps focus only on the 14 provinces consistently included in NVMS and further exclude Jakarta and Papua.

Figure A2: Oil palm suitability



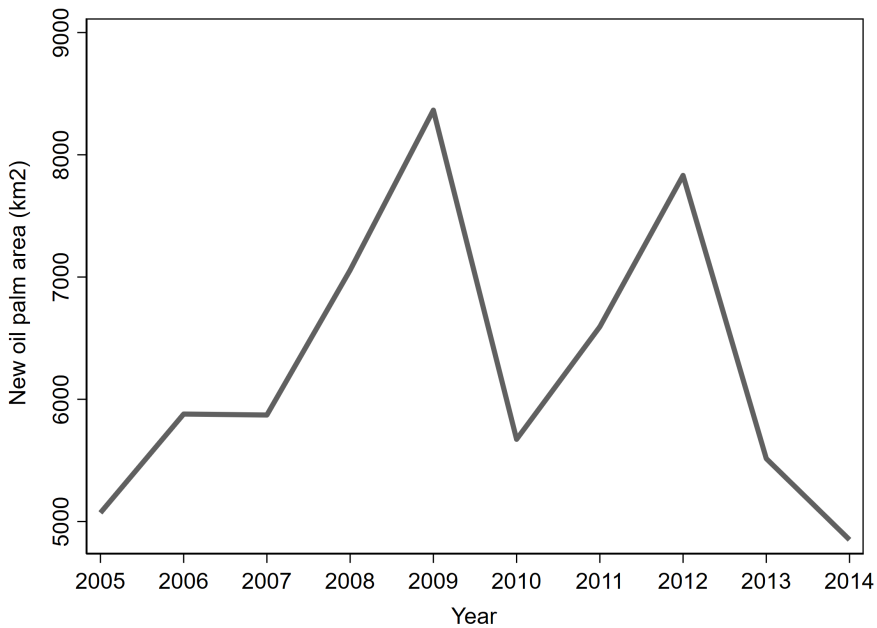
Note: This figure shows the average agricultural suitability to grow oil palm in each sub-district, ranging from 0 to 1. The map focuses only on the 14 provinces consistently included in NVMS and further excludes Jakarta and Papua.

Figure A3: Oil palm suitability weighted by available area



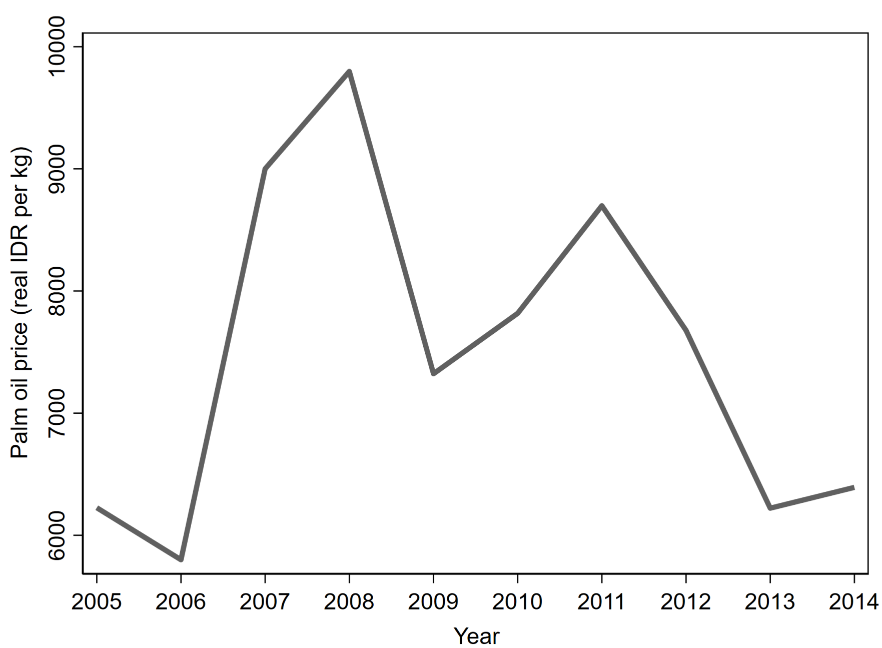
Note: This figure shows the average agricultural suitability to grow oil palm in each sub-district, weighted with the share of sub-district area available for expansion in 2005, ranging from 0 to 1. The map focuses only on the 14 provinces consistently included in NVMS and further excludes Jakarta and Papua.

Figure A4: Yearly new oil palm area



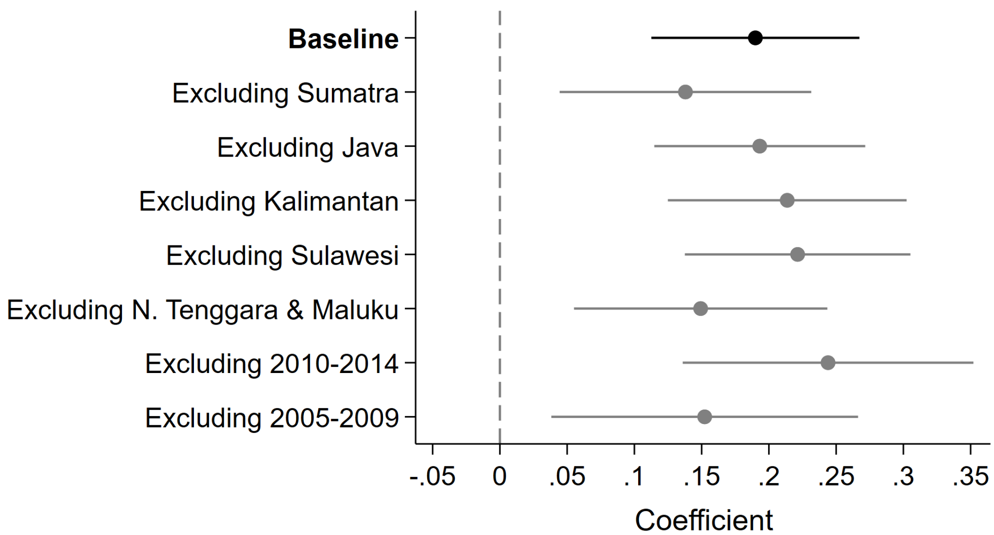
Note: This figure shows the yearly increase in oil palm plantation area in Indonesia between 2005 and 2014 according to remotely sensed data by Gaveau et al. (2022).

Figure A5: Palm oil price trend



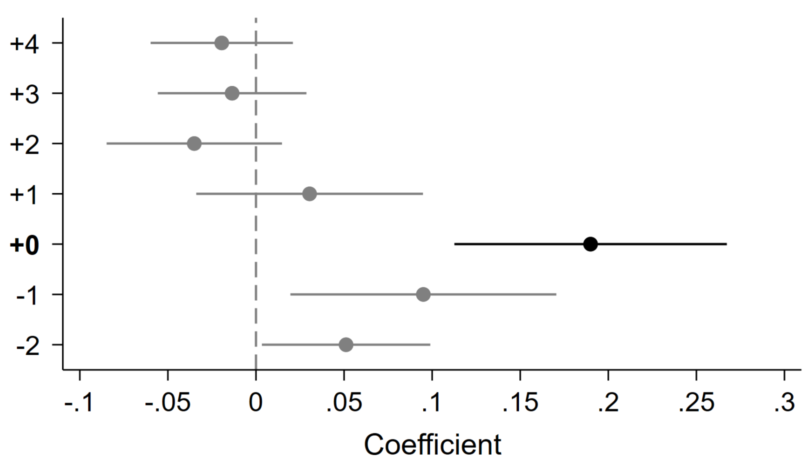
Note: This figure shows the average yearly price for palm oil between 2005 and 2014 (UNCTAD, 2020), measured in Indonesian Rupiah per kg and adjusted for inflation.

Figure A6: Robustness: Varying the sample



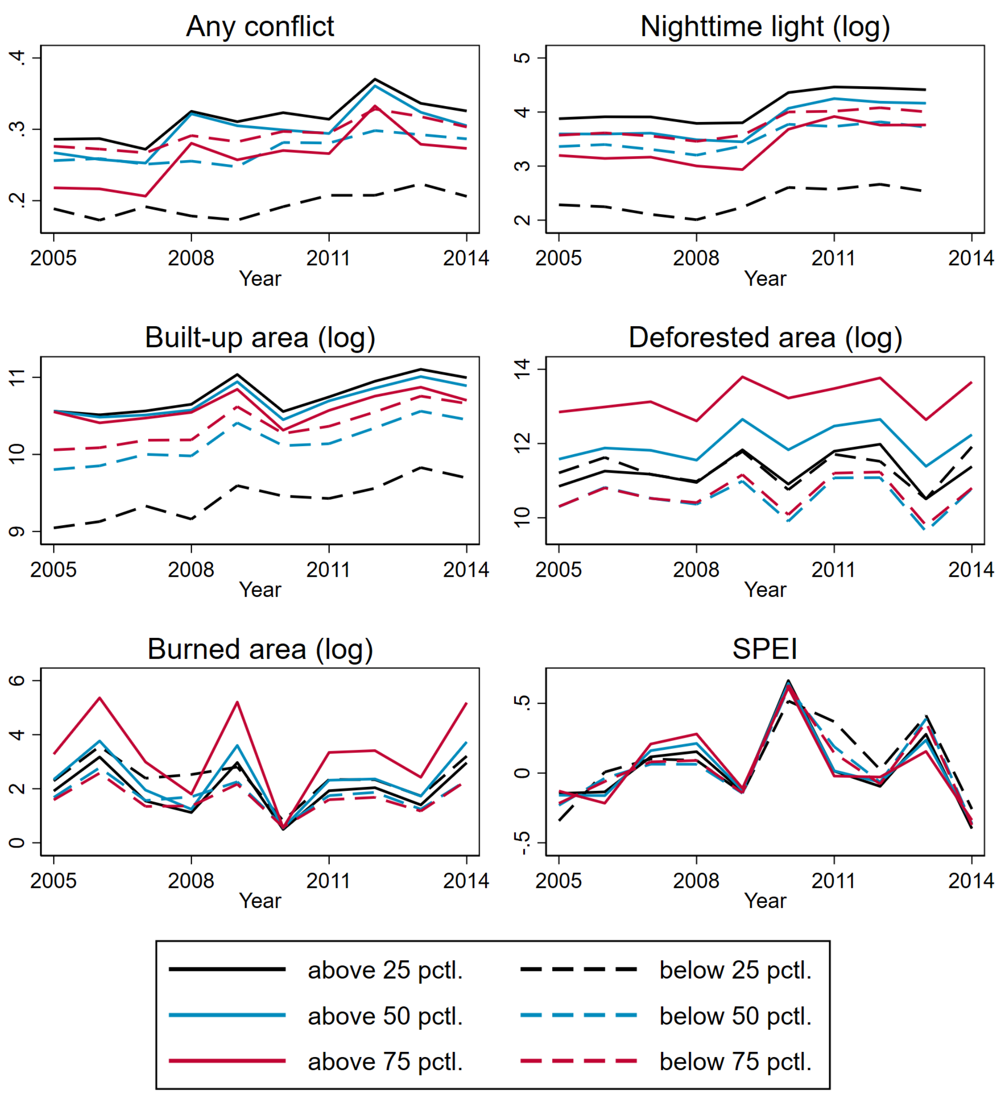
Note: This figure displays estimated coefficients for the effect of expansion pressure on conflict obtained from estimating our baseline specification, but dropping individual islands groups from the sample in turn, as well as splitting the sample into two 5-year periods. Spikes indicate 90% confidence intervals.

Figure A7: Robustness: Leads and lags of expansion pressure



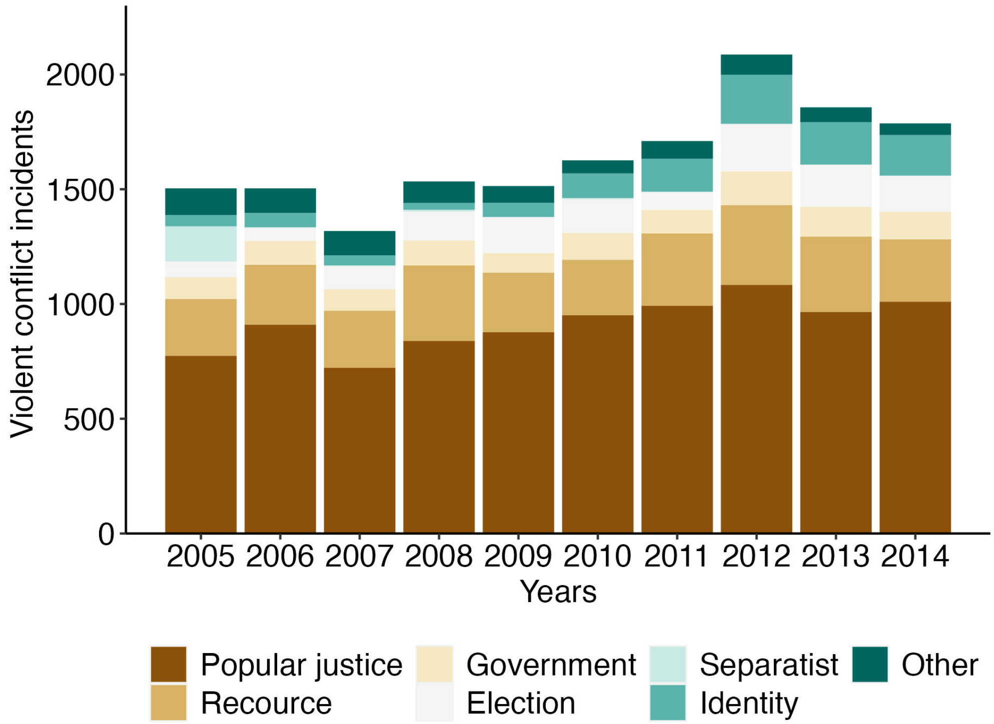
Note: This figure displays estimated coefficients for the effect of expansion pressure on conflict obtained from estimating our baseline specification, but using different leads and lags of the explanatory variable in each estimation. Spikes indicate 90% confidence intervals.

Figure A8: Robustness: Time trends in other variables



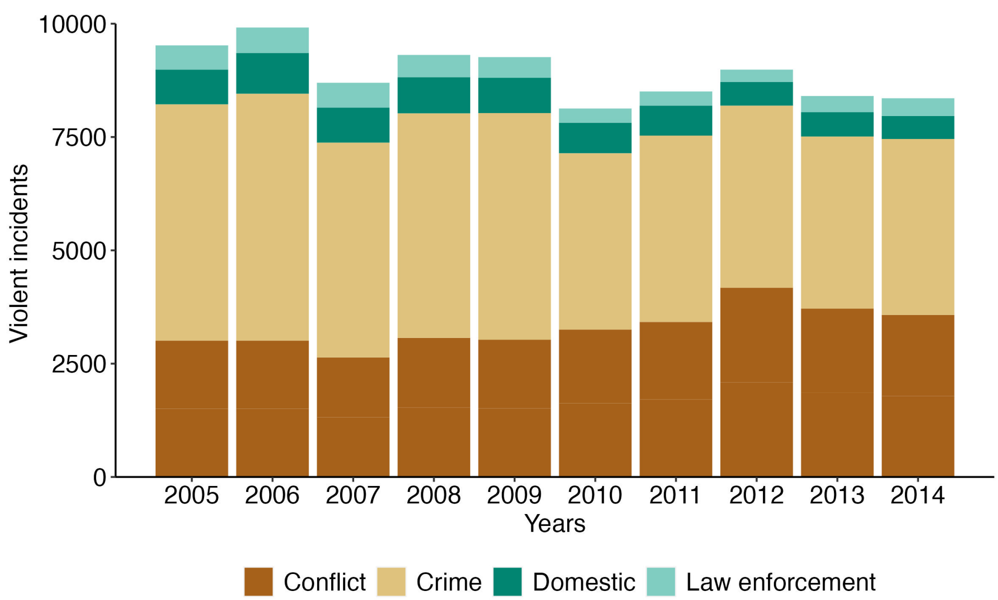
Note: This figure displays time trends for the means of different variables in our sample, according to different quartiles of our share variable (suitability-weighted share of available sub-district area).

Figure A9: NVMS yearly conflicts by type



Note: This figure displays the yearly number of different types of violent conflicts reported in NVMS across 2,755 rural sub-districts.

Figure A10: NVMS yearly violence events by type



Note: This figure displays the yearly number of different types of violent incidents reported in NVMS across 2,755 rural sub-districts.

A.3 Online Appendix: Tables

Table A1: Summary statistics

	Mean	SD	Observations	Min.	Median	Max.
Dependent variables						
Any conflict	0.28	0.45	27550	0	0	1
Any resource conflict	0.08	0.38	27550	0	0	1
Any election conflict	0.04	0.31	27550	0	0	1
Any popular justice	0.18	0.13	27550	0	0	1
Any other conflict	0.08	0.16	27550	0	0	3
Explanatory variables						
OP expansion pressure	0.33	0.27	27550	0	0.28	1.95
Oil palm share (2000)	0.04	0.13	27550	0	0	0.92
New oil palm area (ha)	98.89	642.34	27550	0	0	23557.31
log(New oil palm area+1)	0.82	1.88	27550	0	0	10.07
Oil palm suitability	0.25	0.19	27550	0	0.22	0.89
Price shock	0	1	27550	-1.47	-0.24	1.85
Price shock (negative)	0.41	0.46	27550	0	0.24	1.47
Price shock (positive)	0.41	0.68	27550	0	0	1.85
SPEI	0.04	0.42	27430	-1.05	0.01	1.47
Drought months	1.93	1.68	27430	0	2	8
Excess rain months	2.24	1.83	27430	0	2	10
Control variables						
log(Remoteness+1)	5.45	1.20	27550	0.34	5.58	8.35
Forest share	0.62	0.31	27550	0.00	0.71	1.00
Elevation	316.07	364.31	27550	-13.46	169.58	2301.61
Built-up share	0.06	0.09	27550	0	0.02	0.84
Population density	118.23	186.44	27550	0.37	55.64	3228.61
log(Nighttime light+1)	3.65	2.51	27550	0	4.45	8.46
Other variables						
Avail. area per HH (ha)	6.14	15.87	27550	0.00	1.47	271.47
Any mining concession	0.17	0.38	27550	0	0	1
Low farming dependence	0.08	0.27	27550	0	0	1
Oil palm share (2005)	0.05	0.26	27550	0	0	0.95
Oil palm share (2014)	0.06	0.19	27550	0	0	0.96
Sub-district area (ha)	26326.23	50406.13	27550	171.60	11874.36	848204.20
Election year	0.21	0.41	27090	0	0	1
Share of private land	0.88	0.24	17780	0	0.98	1
Share of landlord-owned land	0.31	0.21	17780	0	0.29	1
Share of owner-cultivated	0.58	0.26	17780	0	0.60	1
Share of uncertified priv. land	0.61	0.32	17780	0	0.69	1
Share of certified priv. land	0.27	0.26	17780	0	0.20	1

Table A2: Additional alternative specifications of expansion pressure

	Shift	Share	Formula	Estimate: Any conflicts
(1)	Aggregate national expansion	Suitability-weighted available sub-district area share relative to total	$\left(\frac{s_i\,\gamma_i\,A_i}{\sum s_i\,\gamma_i\,A_i} \times NE_t\right) \times \frac{1}{A_i}$	0.190*** (0.047)
(2)	Aggregate national expansion	Suitability-weighted available sub-district area relative to total	$ln\left(\frac{s_i\,\gamma_i\,A_i}{\sum s_i\,\gamma_i\,A_i} \times NE_t + 1\right)$	0.107*** (0.035)
(3)	Aggregate national expansion	Suitability-weighted sub-district area share relative to total	$\left(\frac{s_i A_i}{\sum s_i A_i} \times NE_t\right) \times \frac{1}{A_i}$	0.221*** (0.049)
(4)	Aggregate national expansion	Suitability-weighted yearly available sub-district area share relative to total	$\left(\frac{s_i\,\gamma_{it}\,A_i}{\sum s_i\,\gamma_{it}\,A_i} \times NE_t\right) \times \frac{1}{A_i}$	0.149*** (0.044)
(5)	Aggregate national expansion, excluding *i*	Suitability-weighted available sub-district area share relative to total	$\left(\frac{s_i\,\gamma_i\,A_i}{\sum s_i\,\gamma_i\,A_i} \times NE_t^{-i}\right) \times \frac{1}{A_i}$	0.190*** (0.047)
(6)	Palm oil price (std.)	Suitability	$s_i \times P_t$	0.040*** (0.014)
(7)	Palm oil price (std.)	Suitability	$s_i \times P_{t-1}$	0.072*** (0.014)
(8)	Palm oil price (std.)	Suitability-weighted available sub-district area share	$s_i\,\gamma_i \times P_t$	0.042*** (0.016)
(9)	Palm oil price (std.)	Suitability-weighted available sub-district area share	$s_i\,\gamma_i \times P_{t-1}$	0.057*** (0.013)
(10)	Aggregate national expansion (std.)	Suitability	$s_i \times NE_t^s$	0.107*** (0.024)
(11)	Aggregate national expansion (std.)	Suitability-weighted available sub-district area share	$s_i\,\gamma_i \times NE_t^s$	0.113*** (0.028)
Mean dependent variable				0.285
Year FE				Yes
Sub-district FE				Yes
Remoteness × year FE				Yes
Observations				27,550

Notes: The dependent variable is an indicator variable for at least one local conflict event being reported in a given sub-district and year. The explanatory variable is a measure capturing localized incentives to convert land to oil palm (expansion pressure), obtained by interacting a time-varying shift variable with a location-specific share variable. Each model (row) includes a different specification of expansion pressure, described by the respective formula, where s_i is the sub-district specific suitability to grow oil palm, ranging from 0 to 1; γ_i is the share of available sub-district area that is not covered by plantations, settlements, water, or protected areas, at the start of the observation period in 2005; P_t is the average yearly world market price for palm oil, standardized and adjusted for inflation; NE_t is the aggregate national area expansion of oil palm plantations; A_i is the individual sub-district area; γ_{it} is the yearly share of available sub-district area that is not covered by plantations, settlements, water, or protected areas, where yearly changes are due to actual plantation expansion. $NE_t^- i$ is the aggregate national area expansion of oil palm plantations, excluding each sub-district's own expansion. Remoteness averages travel time within the district to the nearest city in 2000. Robust standard errors are clustered at the parent sub-district (*kecamatan*) level (in 2005) and reported in parentheses. */**/*** denote significance levels at 10/5/1 percent respectively.

Table A3: Oil palm expansion pressure and general agricultural suitability

Dependent variable:	Any conflicts			
	(1)	(2)	(3)	(4)
EP (general agricultural suitability)	−0.018	−0.104**		
	(0.048)	(0.050)		
EP (suitability of top 10 crops)			0.088	−0.175**
			(0.061)	(0.085)
EP (oil palm suitability)		0.225***		0.284***
		(0.049)		(0.065)
Mean dependent variable	0.285	0.285	0.285	0.285
Year FE	Yes	Yes	Yes	Yes
Sub-district FE	Yes	Yes	Yes	Yes
Remoteness × year FE	Yes	Yes	Yes	Yes
Observations	27,550	27,550	27,550	27,550

Notes: The dependent variable is an indicator variable for at least one local conflict event being reported in a given sub-district and year. Expansion pressure (EP) in row 3 measures the potential yearly plantation expansion as a share of sub-district area, depending on available area in 2005, national expansion trends, and on oil palm suitability, as described in equation 1. The first specification of expansion pressure (row 1) replaces oil palm suitability with the average location-specific suitability for all crops that can be grown in Indonesia. The second specification of expansion pressure (row 2) replaces oil palm suitability with the average location-specific suitability for the 10 major crops grown in Indonesia according to agricultural revenue. Remoteness measures average travel time within the district to the nearest city in 2000. Robust standard errors are clustered at the parent sub-district level (in 2005) and reported in parentheses. */**/*** denote significance levels at 10/5/1 percent respectively.

Table A4: Palm oil price exposure compared with other crops

Dependent variable:	Any conflicts	
	(1)	(2)
Palm oil price exposure	0.038**	0.037**
	(0.016)	(0.017)
Other crops price exposure (weighted by revenue)	0.008	
	(0.032)	
Other crops price exposure (weighted by value added)		0.012
		(0.032)
Mean dependent variable	0.285	0.285
Year FE	Yes	Yes
Sub-district FE	Yes	Yes
Remoteness × year FE	Yes	Yes
Observations	27,550	27,550

Notes: The dependent variable is an indicator variable for at least one local conflict event being reported in a given sub-district and year. Palm oil price exposure is calculated by interacting standardized world market palm oil prices with local suitability for oil palm. Other crops price exposure is a combined index for the 10 most important agricultural commodities in Indonesia, calculated by multiplying local suitability for each crop with standardized world market prices for that crop. Different price exposures are aggregated into one index by weighting them according to their share in Indonesia's agricultural revenue (column 1), or by their contribution to Indonesia's GDP (column 2). Remoteness measures average travel time within the district to the nearest city in 2000. Robust standard errors are clustered at the parent sub-district level (in 2005) and reported in parentheses. */**/*** denote significance levels at 10/5/1 percent respectively.

Table A5: Other mechanisms: environmental grievances, population growth and ethnicity

Dependent variable:	Any conflicts			
	(1)	(2)	(3)	(4)
Expansion pressure	0.139**	0.193***	0.240***	0.237***
	(0.057)	(0.067)	(0.075)	(0.087)
Expansion pressure × share of forest loss	0.363			
	(0.244)			
Expansion pressure × population growth		0.029		
		(0.141)		
Expansion pressure × ethnic fractionalization			−0.119	
			(0.121)	
Expansion pressure × ethnic polarization				−0.098
				(0.129)
Mean dependent variable	0.285	0.285	0.285	0.285
Year FE	Yes	Yes	Yes	Yes
Sub-district FE	Yes	Yes	Yes	Yes
Remoteness × year FE	Yes	Yes	Yes	Yes
Observations	27,550	27,550	27,550	27,550

Notes: Robust standard errors are clustered at the parent sub-district (*kecamatan*) level (in 2005) and reported in parentheses. */**/*** denote significance levels at 10/5/1 percent respectively.

Table A6: Additional control variables

Dependent variable:	Any conflicts					
	(1)	(2)	(3)	(4)	(5)	(6)
Oil palm expansion pressure	0.190***	0.164***	0.190***	0.184***	0.186***	0.149**
	(0.047)	(0.057)	(0.047)	(0.047)	(0.047)	(0.058)
Mean dep. variable	0.285	0.285	0.285	0.285	0.285	0.285
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Sub-district FE	Yes	Yes	Yes	Yes	Yes	Yes
Remoteness × year FE	Yes	Yes	Yes	Yes	Yes	Yes
Forest share × year FE	Yes	No	No	No	No	Yes
Elevation × year FE	No	Yes	No	No	No	Yes
Built-up share × year FE	No	No	Yes	No	No	Yes
Population density × year FE	No	No	No	Yes	No	Yes
Nighttime light × year FE	No	No	No	No	Yes	Yes
Observations	27,550	27,550	27,550	27,550	27,550	27,550

Notes: Robust standard errors are clustered at the parent sub-district (*kecamatan*) level (in 2005) and reported in parentheses. */**/*** denote significance levels at 10/5/1 percent respectively.

Table A7: Spatial correlation and clustering

Dependent variable:	Any conflicts				
	(1)	(2)	(3)	(4)	(5)
Specification:	Clustering: District	Spatial correction	Spatial+ temporal HAC	Clustering: Share pctiles (50)	Clustering: Share pctiles (100)
Oil palm exp. pressure	0.188***	0.188***	0.188***	0.188***	0.188***
	(0.056)	(0.058)	(0.060)	(0.043)	(0.040)
Mean dep. variable	0.285	0.285	0.285	0.285	0.285
Year FE	Yes	Yes	Yes	Yes	Yes
Sub-district FE	Yes	Yes	Yes	Yes	Yes
Observations	27,550	27,550	27,550	27,550	27,550

Notes: Standard errors are clustered at the district-level (1), clustered at the level of initial shares (4, 5), and corrected for spatial correlation (2) and for spatial and serial correlation (3). The spatial cutoff in (2, 3) is 200 km, and the temporal cutoff in (3) is 10 periods. */**/*** denote significance levels at 10/5/1 percent respectively.