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Oil Palm Boom, Contract Farming, and Rural Economic Development: Village-Level Evidence from Indonesia

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Summary. — Contracts between companies and local communities have been used in Indonesia for over 20 years to involve smallholder farmers in the emerging palm oil industry. Impacts of these contracts have not been analyzed systematically. Here, data from a village survey, spanning a time period from 1992 to 2012, are used to evaluate effects on rural economic development. Panel regression models with village fixed effects show that contracts have significantly contributed to wealth accumulation. Contracts signed before 1999 were more beneficial than contracts signed afterward, which is due to more public sector support and infrastructure investments during the earlier period. Contracts have contributed to decreasing inter-village inequality, not only because poorer villages were more likely to adopt a contract, but also because they benefited more from contract adoption than richer ones. The results suggest that well-designed contracts can be important for smallholder farmers to benefit from the oil palm boom. The village-level approach has clear advantages to evaluate direct and indirect economic effects, but it also has drawbacks in terms of analyzing environmental effects and issues of intra-village inequality. More research with various approaches is needed to better understand the multifaceted implications of oil palm contracts for sustainable rural development.

Key words — oil palm, contract farming, impact, village wealth, rural development, Indonesia

1. INTRODUCTION

In response to the increasing global demand for vegetable oil, the production of palm oil has been extensively promoted in many developing countries. The emerging palm oil sector offered opportunities to spur rural economic development and alleviate poverty. To harness these opportunities, the government of Indonesia—the largest palm oil producing country worldwide—promoted 'partnerships' between commercial agro-industrial plantations and local communities (Feintrenie, Chong, & Levang, 2010). Such contractual arrangements were usually made with groups of farmers (Susila, 2004; Zen, Barlow, & Gondowarsito, 2005). While offering opportunities for economic development, the growing palm oil sector has also been associated with negative environmental and social effects. Several studies showed that the expansion of oil palm plantations has contributed to deforestation, loss of biodiversity, reduced carbon stocks, and conflicts over land (Colchester, Jiwan, Andiko, Firdaus, Surambo, & Pane, 2006; Carlson *et al.*, 2012; Hansen, Stehman, Potapov, Arunarwati, Stolle, & Pittman, 2009; Koh & Wilcove, 2008; Margono *et al.*, 2012; Rist, Feintrenie, & Levang, 2010). Furthermore, contracts with groups of smallholders often lack transparency and sometimes benefit private companies more than local communities (Rist *et al.*, 2010). Also within communities, access to contracts may be unequal and benefits are not always evenly shared (Cahyadi & Waibel, 2013; Cahyadi & Waibel, 2016; McCarthy, Gillespie, & Zen, 2012). On the other hand, there are also studies showing that the emerging palm oil industry in Indonesia has contributed to improved livelihoods in rural areas (Cahyadi & Waibel, 2013; Feintrenie *et al.*, 2010; McCarthy, 2010; Rist *et al.*, 2010). Overall, the findings are mixed and often based on case-study evidence from a small number of communities.

We add to this literature by providing a quantitative analysis of the effects of contracting with palm oil companies on rural economic development, using data from a large number of communities. The study builds on village-level panel data that we collected through a survey in Jambi Province, Sumatra, one of the hotspots of the recent oil palm boom in Indonesia. Through recall questions asked to village leaders and other community representatives, the data span a time period from 1992 to 2012. The village-level perspective takes into account that it is usually groups of farmers, rather than individuals, who participate in contract schemes with palm oil companies (McCarthy & Cramb, 2009). Another important advantage of using the village as the unit of analysis is that this allows us to capture not only direct but also indirect effects of contract farming. For instance, wealth accumulation among contract participants may also benefit non-participants in the same community through economic spillovers. Moreover, the Indonesian government has supported the emerging palm oil industry through investments into transportation and market infrastructure (Larson, 1996). Such investments have likely affected all villagers to some extent, not only those directly engaged in contract schemes.

In spite of these advantages, using the village rather than the individual household as the unit of analysis also has drawbacks. In particular, with the village-level data we are not able to analyze effects of contracts on intra-village inequality, or on specific groups such as certain ethnicities or female-headed households. We try to estimate impact heterogeneity by focusing on inter-village differences, but acknowledge that this cannot substitute for more detailed analyses at the household level. Each approach has its advantages and disadvantages. This village-level research is part of a larger project looking at the effects of oil palm developments in Jambi (Drescher *et al.*, 2016), and this larger project also includes analyses with household-level data (Euler, Krishna, Schwarze, Siregar, &

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Qaim, 2017; Euler, Schwarze, Siregar, & Qaim, 2016). The different approaches complement each other and can thus contribute to a deeper understanding of the effects at different levels.

The remainder of this paper is organized as follows. In the next section, we present a brief historical account of oil palm developments in Indonesia with special emphasis on contract farming in Jambi. The village-level survey and the methods used for data analysis are introduced in Section 3, before the results are presented and discussed in Section 4. Section 5 concludes.

2. BACKGROUND

In Indonesia, two major phases of oil palm development can be distinguished: first, the government-led phase (1970–1998) and, second, the market-oriented phase (1999–present) that was initiated after the fall of Suharto's New Order regime (Budidarsono, Susanti, & Zoomers, 2013; Larson, 1996; McCarthy, 2010; Zen *et al.*, 2005). In this section, we present a brief historical account of oil palm developments in Jambi Province during these two phases with particular emphasis on the role of contract farming arrangements.

(a) *Government-led phase*

Throughout the first half of the twentieth century, the palm oil sector had only been marginally developed in Indonesia. Only during the late-1960s, the Indonesian government's involvement in the sector started to pick up when former Dutch plantation estates were reorganized into independent management units, or *Perseroan Terbatas Perkebunan* (PTP). During 1969–88, government investments in the palm oil sector were channeled through the PTPs (Larson, 1996). During this period, the Indonesian government also started to actively involve smallholder farmers in the sector as a mechanism to promote rural development (Budidarsono *et al.*, 2013; Zen *et al.*, 2005). Participation of smallholders in the palm oil sector was initially often linked to the government's transmigration program. The transmigration program involved the resettlement of families from densely populated islands, such as Java, to islands with lower population density, such as Sumatra (Fearnside, 1997).

During the PTP period until 1988, the government cleared lands and planted large-scale oil palm plantations close to newly established state-owned palm oil mills. Sponsored smallholders, mostly transmigrant families, were given 2–4 ha of oil palm land and technical assistance on oil palm production and management. Smallholder families managed their plots themselves, including the harvest of the fresh fruit bunches which they delivered to the state-owned palm oil mills for further processing (Larson, 1996).

During 1988–94, the Indonesian government sought to further stimulate the palm oil sector by gradually involving private companies. To support private companies, the government invested in infrastructure development, issued large land concessions, and provided subsidized loans. In exchange, companies were required to involve smallholders into their plantation plan (Larson, 1996). The community–company partnerships during that time period are referred to as *Perkebunan Inti Rakyat (PIR)*, Nucleus Estate and Smallholder (NES) schemes, or Inti-Plasma systems. Typically, these partnerships had the company estate at its core (Inti) and were surrounded by smallholder plantations (Plasma) (Feintrenie *et al.*, 2010).

Inti-Plasma systems could involve transmigrant families or also autochthonous smallholder farmers. As before, transmigrants received 2–4 ha of oil palm land. Autochthonous smallholders, on the other hand, had to surrender a certain amount of community land to the company. While the amount of land that had to be surrendered could vary from case to case, a typical Inti-Plasma mix during that period was 80/20, meaning that 80% of the total community land involved in the scheme had to be surrendered (Larson, 1996; Rist *et al.*, 2010). In return, the smallholders received an oil palm "package" from the company, comprising several services such as the preparation of the land, planting of high-yielding oil palms, and agricultural training during the first four to five years. Furthermore, the package included the provision of agricultural inputs, such as fertilizers, herbicides, and pesticides (Zen *et al.*, 2005), as well as loan schemes with long repayment periods of usually 20 years. Participating farmers could use these loans to cover operational costs (Fearnside, 1997). Companies also provided employment on their large-scale plantations. Especially during the initial four to five years, this employment was critical to bridge the initial income gap experienced by smallholders before their oil palms started to yield.

Transmigrants obtained a formal land title for the land allocated to them. This land title was kept by the bank as collateral until the loan was fully repaid. In comparison, most autochthonous farmers in Sumatra do not hold formal land titles but rather rely on customary land rights (Murdiyarso, Noordwijk, Wasrin, Tomich, & Gillison, 2002). McCarthy *et al.* (2012) argued that the autochthonous population in Jambi remained poor because they frequently rejected offered contract terms that they considered in conflict with customary land-use practices.

After 1995, the Indonesian government decided to retreat from its active role in community–company partnerships and assumed a monitoring function instead. The government continued to provide subsidized loans to palm oil companies. In return, these companies had to follow particular rules for Inti-Plasma systems. The transmigration program was gradually phased out. Hence, new contracts with smallholders predominantly involved community land. While smallholders still received the above-mentioned oil palm package as part of their contracts, some of the other conditions changed. Villages interested in obtaining a contract were required to establish a farmer cooperative that would function as an intermediary between farmers and the private company. Cooperatives were responsible for gathering suitable village land, which would then be handed over to the company collectively for plantation development (Larson, 1996). Contracts established at the cooperative level were binding for all members, even though in most cases not all farmers living in the village became cooperative members. After a contract was signed, it was usually not possible for other farmers to join the scheme at a later stage (McCarthy, 2010).

A few more details on how the contracts between companies and local communities were negotiated may be useful as a basis for the empirical analysis below. Before a contract was concluded, a company representative—hereafter called an 'investor'—visited a village, in order to start initial discussions. The investor usually attended a few village meetings to socialize with local farmers and communicate the possible benefits of oil palm cultivation for the village and the participating smallholders in particular. When both parties were generally interested, the investor proposed a contract. The components included in the oil palm package were relatively fixed, even though prices for inputs and outputs, loan amounts, interest rates, and a few other details were negotiable (Feintrenie

et al., 2010). After these negotiations, the village cooperatives could either accept or reject the contract. The process of contract negotiation and conclusion was often assisted by government officials and bank representatives. However, as not all villagers were involved, elite capture and uneven benefit distribution within communities could occur (McCarthy *et al.*, 2012; Zen *et al.*, 2005).

(b) *Market-oriented phase*

The most recent period in the development of Indonesia's palm oil sector is the *laissez-faire phase*, which started after the fall of the Suharto regime in 1998 and was associated with a process of liberalization and decentralization. During this phase, the palm oil sector was opened up for private investment, and budgetary responsibilities were shifted from the central government to the district level (McCarthy *et al.*, 2012). Decentralization also meant that the rights of village communities were strengthened (Rist *et al.*, 2010).

As a result of liberalization, private companies investing in the palm oil sector can no longer benefit from subsidized capital. Instead, companies now have to rely on credits from private banks at commercial interest rates. When companies want to get access to land from local communities they need to negotiate with these communities, but the central government's previous rules for Inti-Plasma systems are no longer binding (Larson, 1996). District governments are now free to establish their own regulations (McCarthy *et al.*, 2012). As most district governments see the establishment of new oil palm plantations as a welcome source of revenue, regulations are often rather lax. The general process for contract negotiations between companies and village communities is still similar to the one described above for the government-led phase. But most of the details are now flexible, so that the benefits for the village and for individual farmers depend much more on the bargaining skills of the community leaders and their personal integrity.

It is noteworthy that during the market-oriented phase the number of independent smallholders that grow oil palm without a company contract has increased substantially. Previously it was difficult for smallholders to grow oil palm without contract, because the capital, the planting material, other inputs, and the knowledge needed for proper plantation establishment and management were not easily accessible. After liberalization, credit and input markets have developed. Some of the independent oil palm growers are previous contract farmers who decided to expand their oil palm area individually. Other independent oil palm farmers never had a contract. Interestingly, independent oil palm adoption occurs especially in those villages where contracts with palm oil companies existed in the past or continue to exist, which is largely due to the better access to input markets and palm oil mills in those locations (Euler *et al.*, 2016). In spite of the rapid expansion of oil palm in Jambi during the last 20 years, rubber continues to be the major cash crop in the area in terms of area coverage (Gatto, Wollni, & Qaim, 2015).

3. MATERIALS AND METHODS

(a) *Village survey*

This study builds on a survey that was implemented in the lowlands of Jambi Province. These lowlands are characterized by major agricultural transformation toward oil palm monoculture (Gatto *et al.*, 2015). The research area comprises five districts, namely Muaro Jambi, Batanghari, Sarolangun, Bungo, and Tebo. To account for spatial variability, in each of the five districts we randomly selected five sub-districts. Based on the official PODES (Village Potential Statistics) list of villages in these sub-districts, we drew a random sample of 100 villages. Due to logistical difficulties in the field we had to drop two villages from the sample, resulting in a total sample size of 98 villages. Figure 1 depicts a map of the selected villages in Jambi.

Data collection took place between September and December 2012. The unit of observation is the village. Interviews at the village level were conducted together with six students from Jambi University, who were intensively trained for this purpose. Before visiting the villages we made appointments with the village head to inquire about his and other village officials' availability. We organized group interviews to which we invited key village officials (i.e., village head, secretary, group leaders). For the interviews, we used a structured questionnaire to elicit village-level data on assets, land-use change, demographics, technology use, and contractual arrangements with companies. On average, the group interviews took three to four hours and were held in the house or the office of the village head. In addition to collecting data on the current status of each village in 2012, we used recall questions to also obtain data for past village characteristics, in particular for the years 2002 and 1992. To maximize the quality of the recall data, we also invited senior villagers to the interviews. In most villages, a village 'monograph' existed, documenting past and current socioeconomic data, such as demography, land use, land titles, and other information.

To fully harness the panel structure of the data over the three points in time (1992, 2002, 2012) we had to drop several village observations, for which information was incomplete for past time periods. Incompletion in past data was mainly due to two reasons. First, some of the villages in our sample did not yet exist in 1992. Second, a few villages were subject to administrative changes during 1992–2012. In particular, in several cases a village neighborhood was separated from the mother village, which was usually associated with substantial changes in demographic and land-use characteristics. In those cases, village-level data cannot be compared over time. We finally ended up with a sample of 78 villages that have complete data for all three points in time. These 78 villages are used in this analysis.

(b) *Modeling contract adoption*

The main objective of this paper is to analyze effects of contracts with palm oil companies on economic development at the village level. In this connection, it is important to first better understand the factors influencing whether a village actually adopted a contract or not. This can be modeled in a binary choice framework, as follows:

$$C_i = \alpha_0 + \alpha_1 X_i + \varepsilon_{1i} \quad (1)$$

where C_i is a dummy that takes a value of one if village i (or a group of farmers within the village) adopted a contract any time during 1992–2012 and zero otherwise. X_i is a vector of village-level variables that could influence contract adoption, such as village population, land availability, land titling, infrastructure conditions, village wealth, among others. The selection of variables follows earlier studies to explain land-use change (e.g., Lambin, Geist, & Lepers, 2003; Mitsuda & Ito, 2011). To avoid issues of reverse causality, the variables included in X all refer to the situation in the village in 1992. α_0 and α_1 are parameters to be estimated, and ε_{1i} is a random error term.

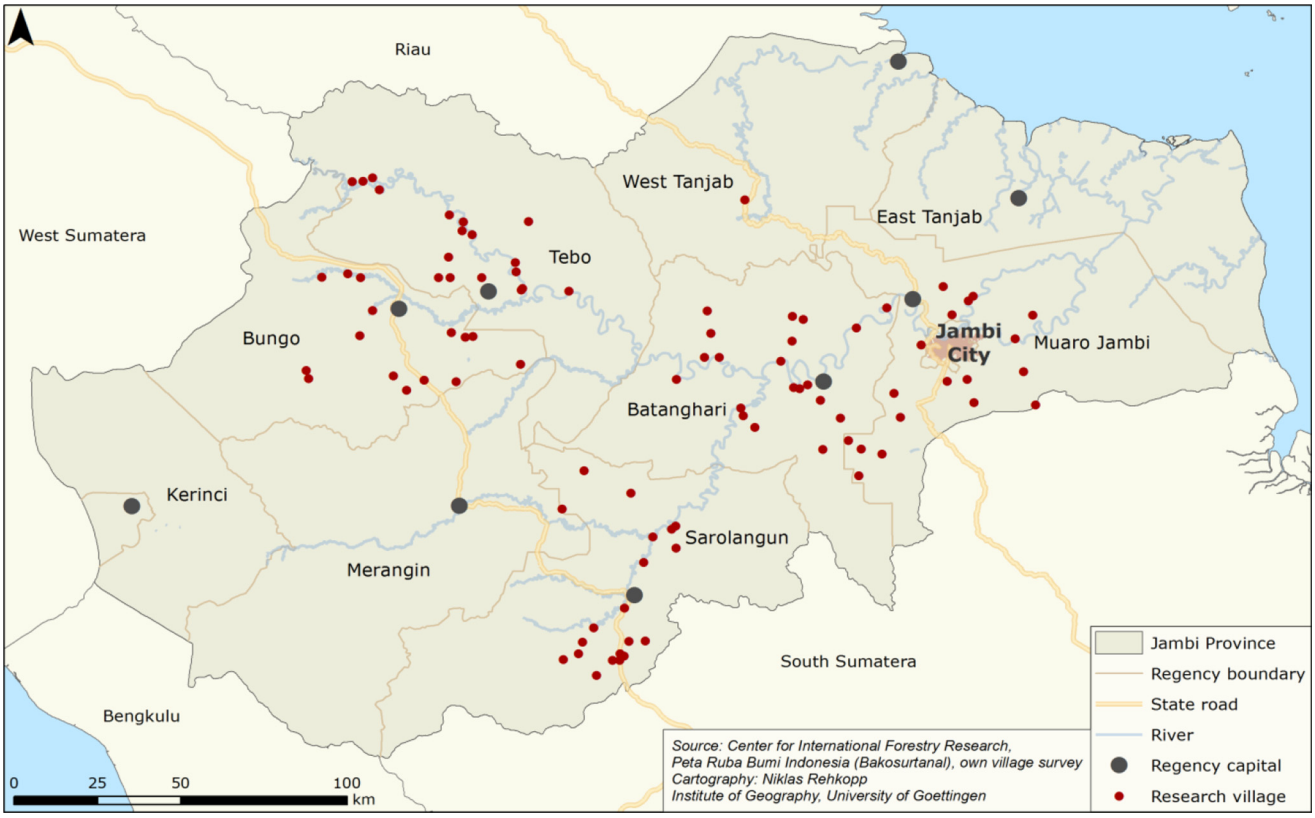

Figure 1. *Map of Jambi Province with sample villages.*

In principle, the model in Eqn. (1) could be estimated with a simple probit estimator. However, contract adoption can only occur if an investor visited the village and actually proposed a contract. Hence, for consistent estimation we need to estimate a conditional probit model, where the probability of an investor visiting the village is modeled in a first stage, as follows:

$$V_i = \delta_0 + \delta_1 Z_i + \varepsilon_{2i} \tag{2}$$

where V_i is a is dummy that takes a value of one if village i was visited by an investor and zero otherwise, and Z_i is a vector of variables that could influence the decision of an investor to visit the village. While Eqn. (2) is estimated with all village observations, Eqn. (1) only includes those villages for which $V_i = 1$.

One problem that may arise when estimating the conditional probit model is that V and C are jointly influenced by certain unobserved factors, which would lead to correlation between the error terms ε_1 and ε_2. Such correlation could lead to biased parameter estimates. To test for error term correlation, we use a bivariate probit specification (Greene, 2008, p. 817). For the bivariate probit to be correctly specified, Z in Eqn. (2) should contain the same variables as X in Eqn. (1), plus at least one identifying variable that is correlated with V but has no direct effect on C (Cameron & Trivedi, 2009, p. 558). We identified the 'average land slope' in the village as a suitable identifying variable.

(c) *Modeling the effects of contracts on village welfare*

In order to analyze the impact of contract adoption on economic development at the village level, we estimate the following panel data model:

$$VAI_{it} = \gamma_0 + \gamma_1 C_{it} + \gamma_2 S_{it-10} + \gamma_3 2012_i + \omega_i + \mu_{it} \tag{3}$$

where VAI_{it} is a village asset index referring to village i at time t. This asset index, the construction of which is explained below, is used as a quantitative indicator of economic development at the village level. The treatment variable C_{it} is the contract adoption dummy, as defined before, but now specifically referring to time period t. S_{it-10} is a vector of socioeconomic controls referring to time period $t - 10$. We use lagged values for these socioeconomic controls to avoid issues of reverse causality. For this reason, the outcome is only considered for 2002 and 2012, not for 1992. Furthermore, we include a dummy variable taking the value one for observations in 2012 (zero for 2002) to control for a possible time trend. γ represents parameters to be estimated, ω_i captures unobserved time-invariant heterogeneity across villages, and μ_{it} is a village-specific time-varying error term. We control for unobserved time-invariant heterogeneity through using a fixed effects estimator. A Hausman test confirmed that the fixed effects estimator is preferred over the random effects estimator. In this model, we are particularly interested in the parameter γ_1. A positive and significant coefficient would indicate that contracts have spurred village economic development net of other factors.

For construction of the village asset index, we follow an approach similar to Sahn and Stifel (2003). Technically, VAI_i is a weighted sum of different assets owned by households living in village i as follows:

$$\begin{aligned} VAI_i = {} & \beta_1 motorbike_i + \beta_2 car_i + \beta_3 truck_i + \beta_4 tv_i + \beta_5 dish_i \\ & + \beta_6 mobile_i + \beta_7 fridge_i + \beta_8 aircon_i + \beta_9 computer_i \end{aligned} \tag{4}$$

where β represents weights generated by principle component analysis. The different assets refer to the percentage of house-

holds in village i owning the following items: motorbike, car, truck, television, satellite dish, mobile phone, fridge, air conditioner, and computer. [1] *VAI* is normalized resulting in an index with scores between 0 and 1, where values closer to zero reflect lower asset ownership. Thus, the estimation coefficients in Eqn. (3) can be interpreted as changes in percentage points.

The vector of socioeconomic village controls includes population density, institutions (e.g., share of titled land), and infrastructure conditions (availability of electricity, distance to all season road, distance to palm oil mill). Furthermore, we include the share of oil palm land managed by independent smallholders, because oil palm cultivation outside of contracts may possibly also contribute to economic development. Finally, we include the incidence of contractual conflicts between farmers and companies. Conflicts may arise because of ambiguous terms and conditions or also because of one party behaving opportunistically. Such incidents may negatively affect village economic development.

(d) *Alternative specifications of the treatment variable*

In Eqn. (3), the contract treatment variable is defined as a simple dummy that takes a value of one if a contract was signed irrespective of the number of farmers actually involved in the contract. Yet, the share of farmers involved in contract schemes varies substantially between villages. We therefore estimate an alternative specification, in which we replace the contract dummy with the variable 'contract size'. Contract size measures the share of farmers in the village participating in the contract. If contracts are beneficial, we would expect that villages with a larger share of farmers involved may have stronger economic development than villages where the share of farmers involved is small. More farmers involved means that a larger group can benefit directly from contract farming. Additionally, companies are likely to invest more in villages with larger contracts, which may also lead to more significant spillovers to non-contracted households in the community.

In another specification of the impact model, we replace the contract dummy with a variable that measures contract duration. The variable 'contract duration' takes a value of zero if no contract was signed, a value of one if a contract was signed in 2012, two if a contract was signed in 2011, etc. If a contract was signed only recently, it may not yet have translated into positive development effects, because the benefits of plantation and infrastructure investments can only materialize after some time. Thus, we expect that contract duration has positive effects on economic development. We also include a square term of contract duration to control for potential non-linear effects.

(e) *Heterogeneous treatment effects*

Beyond analyzing average treatment effects of contract adoption on village economic development, we are also interested in understanding possible treatment heterogeneity. In other words, we want to investigate whether impacts differ by contract type or by village characteristics. First, we analyze whether contracts adopted during the government-led phase are more beneficial than those adopted during the market-oriented phase. This is looked at by including two separate contract dummies, one for each phase, into the model in Eqn. (3). Stronger development effects during the government-led phase might be expected because of more financial support and stricter public regulations of contract terms and conditions.

Second, we analyze whether contracts had differential development effects by village economic status. If the effects were stronger in villages that were already richer initially, contracts would contribute to rising inter-village inequality. In contrast, a stronger effect in initially poorer villages would indicate falling inter-village inequality. To investigate this, in addition to using the contract dummy itself in the model, we also include interaction terms between the contract dummy and lagged indicators of village economic development. In separate models, we use four different indicators, namely the village asset index (*VAI*), electricity, distance to all season road, and share of households holding formal government land titles, all referring to 1992. Significant interaction coefficients would indicate heterogeneous treatment effects.

Third, we are also interested in understanding whether contracts benefited transmigrant villages more than autochthonous villages. This is possible, because—at least during the government-led phase—transmigrants involved in contract schemes were allocated a new piece of land, for which they obtained a formal title, conditions that did not hold in the same way for autochthonous people. However, including an interaction term between the contract dummy and transmigrant villages into the model proved impossible, because of the close correlation between both variables. The number of transmigrant villages without a contract in our sample is very small. Hence, we can analyze possible differences in economic development between transmigrant and autochthonous villages only descriptively.

4. RESULTS AND DISCUSSION

(a) *Descriptive statistics*

We look at the adoption of contracts with palm oil companies by local village communities in Jambi during 1991–2012. [2] Out of the total sample of 78 villages that existed in 1992, 49 were visited by an investor and 27 accepted a contract during the period of observation. Figure 2 shows in what years investor visits and contract conclusions occurred. Until 1998, most of the investor visits resulted in the conclusion of a contract. From 1999 onward, a larger share of investor visits did not lead to a contractual agreement. Interestingly, 1998 happens to be the year when the government-led phase of developments in the palm oil sector ended.

Figure 3 provides insights into the size of contracts, by showing the average share of village households included in a village contract per year (referring to the year when the contract was concluded). We observe considerable variation in contract size over time. In some of the years, contracts included more than 50% of the village households. But especially after 2007 the average share of contracted households has become very small.

Table 1 reports additional contract-specific descriptives. The first row looks at average contract size, now referring to all ongoing contracts, not only those concluded in a particular year. According to this indicator, average contract size decreased from 43% of village households in 2002 to 35% in 2012. During the study period, several new contracts were concluded (see Figure 2), but none of the contracts was terminated. Average contract duration increased from 6.8 years in 2002 to 12.4 years in 2012. The last row in Table 1 shows the incidence of contractual conflicts. According to the interviews, conflicts often resulted from poor understanding of contractual terms or from arbitrary alterations of the terms by the company after the contract had been signed. This is consistent with earlier case studies in the Indonesian palm oil sector (Rist *et al.*, 2010).

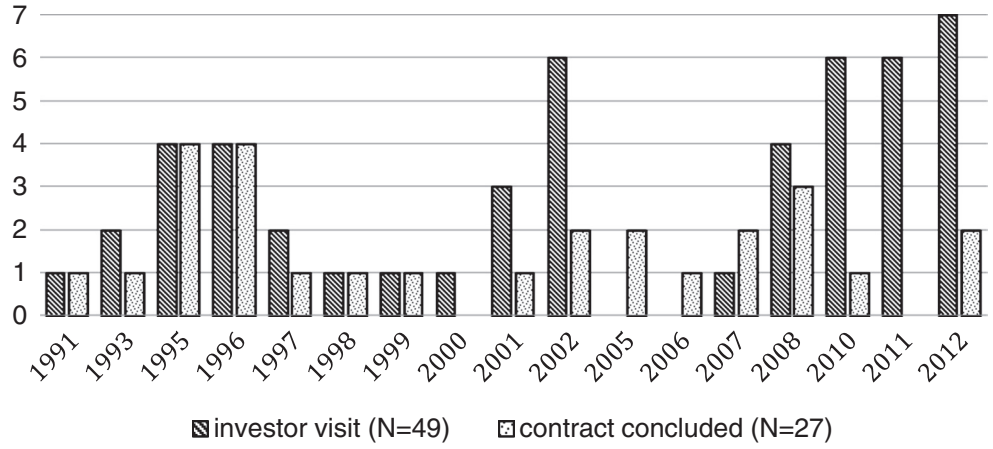

Figure 2. *Number of investor visits and contracts concluded.*

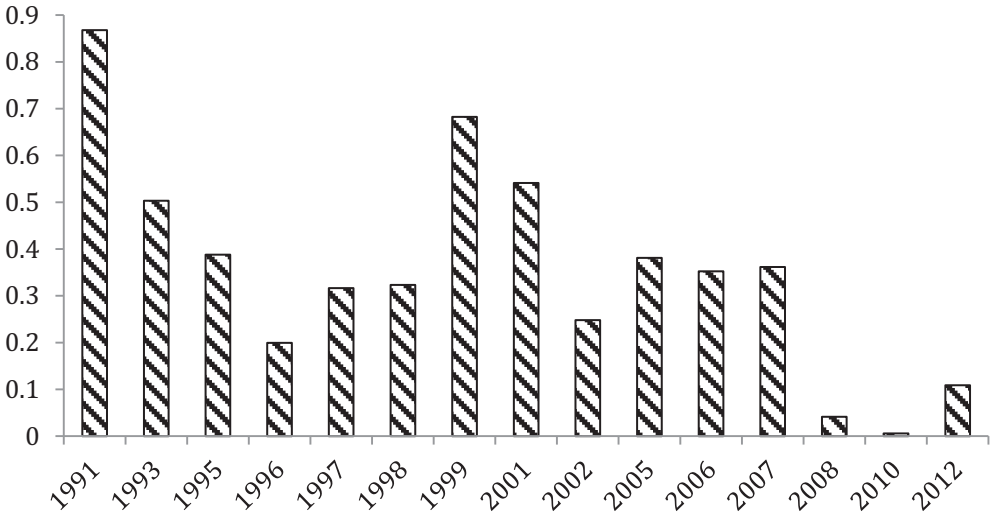

Figure 3. *Mean share of village households included in village contracts.*

Table 1. *Descriptive statistics for contract villages*

	2002 ($N = 17$)	2012 ($N = 27$)
Contract size (share of village households included)	0.434 (0.341)	0.353 (0.322)
Contract duration (dummy)	6.765 (2.704)	12.41 (6.351)
Contractual conflict (dummy)	0.235 (0.437)	0.185 (0.396)

Notes: Mean values are shown with standard deviations in parentheses. Only villages that adopted a contract are included.

Tables 2 and 3 summarize descriptive statistics for the explanatory variables used in the regression models. While the fraction of households included in contracts has decreased in recent years, a growing number of farmers started to cultivate oil palm independently. Table 2 shows that in 1992 only 5% of the oil palm area was cultivated independently; by 2012 this share had increased to 74%. Table 2 also shows that the village asset index increased considerably over time, pointing at rapid economic development. In 1992, villages had an average asset index of 0.27. By 2012, the average index had increased to 0.74.

Table 3 differentiates between contract adoption status of villages. Columns (2) and (3) compare villages visited and not visited by an investor. Note that the comparisons refer to the time period right before the investor visits occurred. Villages visited by an investor were characterized by steeper average land slopes, higher shares of land with government titles, and closer proximity to a palm oil mill. In terms of the other village characteristics, no significant differences can be observed. Columns (4) and (5) of Table 3 compare villages that did and did not adopt a contract, after having been visited by an investor. Again, the comparisons refer to the time period right before the contract was offered. Most of the village characteristics do not differ significantly between these two groups. One exception is the village asset index, which was significantly lower in villages that adopted a contract. Possibly, in poorer villages farmers saw a greater need to engage in contracts with the hope that this would improve their situation. Another significant difference is that transmigration villages were more likely to adopt a contract.

(b) *Determinants of contract adoption*

Results of the bivariate probit model are reported in Table 7 in the Appendix. The Wald test of independent equations is

Table 2. *Descriptive statistics by year*

	1992	2002	2012
Village asset index (*VAI*)	0.266	0.509	0.742
	(0.223)	(0.249)	(0.137)
Population density	0.466	0.753	1.021
	(0.558)	(0.813)	(1.097)
Distance to an all season road (km)	4.438	2.639	1.152
	(14.07)	(7.831)	(5.711)
Distance to palm oil mill (km)	61.44	45.39	30.63
	(61.24)	(50.87)	(24.64)
Electricity (dummy)	0.374	0.756	0.910
	(0.477)	(0.432)	(0.287)
Government land title (share of households)	0.201	0.335	0.466
	(0.346)	(0.389)	(0.351)
Share of oil palm land under independent cultivation	0.051	0.178	0.738
	(0.163)	(0.304)	(0.368)

Notes: Mean values are shown with standard deviations in parentheses. For all three years, the full sample with $N = 78$ villages is included.

Table 3. *Descriptive statistics by contract adoption status*

	Full sample ($N = 78$) (1)	Investor visit ($N = 49$) (2)	No investor visit ($N = 29$) (3)	Contract adoption ($N = 27$) (4)	No contract adoption ($N = 22$) (5)
Village asset index (*VAI*)	0.355	0.363	0.342	0.321*	0.415
	(0.241)	(0.231)	(0.261)	(0.224)	(0.235)
Village population (people)	1217	1466	1427	1472	1457
	(750.4)	(884.4)	(785.6)	(890.1)	(898.1)
Village land (ha)	6614	6854	6206	6469	7326
	(11482)	(9484)	(14,425)	(6831)	(12,140)
Population density (pop/ha)	0.526	0.521	0.535	0.523	0.516
	(0.619)	(0.705)	(0.451)	(0.727)	(0.693)
Average land slope†	1.934	2.116***	1.628	2.252	1.949
	(0.862)	(0.881)	(0.746)	(0.997)	(0.701)
Distance to all season road (km)	4.438	3.735	2.061	3.931	3.493
	(14.06)	(11.65)	(6.154)	(12.675)	(10.555)
Distance to palm oil mill (km)	61.44	49.75*	71.36	52.55	46.32
	(61.24)	(60.34)	(60.46)	(72.66)	(41.99)
Electricity (dummy)	0.374	0.535	0.621	0.415	0.682
	(0.477)	(0.492)	(0.494)	(0.479)	(0.477)
Government land title (share of households)	0.201	0.283**	0.141	0.283	0.283
	(0.346)	(0.378)	(0.288)	(0.388)	(0.375)
Transmigrant village (dummy)	0.154	0.184	0.103	0.259*	0.091
	(0.363)	(0.391)	(0.309)	(0.446)	(0.294)

Notes: Mean values are shown with standard deviations in parentheses. Mean value comparisons between columns (2) and (3) and between columns (4) and (5) are based on data for the years 1992 or 2002, depending on the year of investor visit/contract adoption. If investor visit/contract adoption occurred during 1992–2001, we used data from 1992; if investor visit/contract adoption occurred during 2002–12, we used data from 2002. This is also the way the data are organized in the regression models to avoid reverse causality.

*** Significant at the 1% level.

** Significant at the 5% level.

* Significant at the 10% level.

† Average land slope is the mean value of total village land allocated to steep/flat slopes on a scale of 1–5 where 1 represents flatter and 5 steeper land.

insignificant, meaning that that the null hypothesis of zero correlation between the error terms of the investor visit and contract adoption equations cannot be rejected. We therefore proceed with the standard conditional probit model, results of which are shown in Table 4.

We start the discussion by looking first at the results for the investor visit equation. Investors were more likely to visit villages with steeper average land slopes. Steeper slopes are found especially in more remote areas of Jambi, where farmers tend to have fewer economic alternatives. This may increase the prospect for successful contract conclusion from the investor's point of view.[3] Investors also prefer villages that are located nearer to palm oil mills. Investing companies often established oil palm plantations with own mills in certain locations, and then they tried to gradually develop additional land in the vicinity through village contracts. Proximity to a mill reduces transport costs and post-harvest losses. The marginal effect in column (3) implies that one additional kilometer of distance between the village and the mill decreases the probability of an investor visit by 0.2 percentage points. Finally, investors prefer villages with a higher share of formal land titles. Customary land rights are relatively secure within the local communities, but are associated with more uncertainty for investors from outside the region. Land conflicts between

Table 4. *Probit estimation results for determinants of investor visit and contract adoption*

	Investor visit $N = 78$	Contract adoption $N = 49$	Investor visit $N = 78$	Contract adoption $N = 49$
	Coefficient		Marginal effects	
	(1)	(2)	(3)	(4)
Average land slope	0.633***	.	0.234***	
	(0.248)	.	(0.088)	
Village land area (thousand ha)	−0.002	−0.028	−0.001	−0.011
	(0.018)	(0.025)	(0.001)	(0.011)
Village population (thousand)	−0.024	0.406	−0.009	0.161
	(0.206)	(0.274)	(0.081)	(0.111)
Electricity (dummy)	−0.181	−0.887*	−0.067	−0.349*
	(0.382)	(0.509)	(0.141)	(0.201)
Distance to all season road (km)	0.004	−0.009	0.002	−0.003
	(0.013)	(0.017)	(0.001)	(0.011)
Distance to palm oil mill (km)	−0.005*	0.000	−0.002*	−0.000
	(0.003)	(0.002)	(0.001)	(0.000)
Village asset index	0.204	−0.798	0.075	−0.315
	(0.795)	(1.114)	(0.029)	(0.438)
Transmigrant village (dummy)	0.296	0.611	0.104	0.227
	(0.436)	(0.512)	(0.146)	(0.172)
Government land titles (share of HH)	1.454***	−0.289	0.538***	−0.114
	(0.587)	(0.501)	(0.212)	(0.197)
Constant	−0.854	0.512	.	.
	(0.618)	(0.564)	.	.
Log likelihood	−42.19	−29.64		
Wald chi^2 (9/8)	15.65	8.00		
Prob. > chi^2	0.07	0.43		
Pseudo R^2	0.18	0.12		

Notes: Robust standard errors are shown in parentheses. Explanatory variables are based on data from the years 1992 and 2002, depending on the year of investor visit/contract adoption. If investor visit/contract adoption occurred during 1992–2001, we used data from 1992; if investor visit/contract adoption occurred during 2002–12, we used the data from 2002. **Significant at the 5% level.
*** Significant at the 1% level.
* Significant at the 10% level.

local communities and palm oil companies are not uncommon in Jambi (Colchester *et al.*, 2006). In this context, formal government land titles can reduce the risk of conflicts and thus improve the business environment. [4]

Column (2) of Table 4 shows the factors influencing contract adoption, conditional on investor visit. Column (4) shows the corresponding marginal effects. Only one of the explanatory variables significantly influences contract adoption, namely electricity. Conditional on having been offered a contract, villages without electrification are 35 percentage points more likely to adopt. This can be explained by the lower economic opportunities that these villages without electricity have. Especially for many off-farm economic activities, electricity can be an important prerequisite (Kanagawa & Nakata, 2008). The marginal effect for the village asset index is also negative, but not statistically significant. Due to the small number of observations in this equation, the standard errors are relatively large. In any case, the results show there was no systematic exclusion of poorer villages, and, if anything, less developed villages were more likely to be involved in contract schemes for oil palm cultivation.

(c) *Impact of contracts on village economic development*

Results of the fixed effects panel models to evaluate the impact of contract adoption on village wealth are shown in Table 5. We use different specifications. In all models, the year dummy for 2012 is positive and statistically significant, confirming general economic growth at the village level over time. On average, during 2002–12 the village asset index (*VAI*) increased by 20–23 percentage points.

Column (1) of Table 5 only includes the contract dummy as treatment variable and no other controls. The treatment effect is positive and significant, suggesting that contract adoption has spurred economic development over and above the simple time trend. The treatment effect remains positive and significant also after inclusion of various village-level covariates (column 2). After controlling for other factors, adoption of a contract has increased the *VAI* by 15 percentage points.

Column (3) of Table 5 uses contract size as an alternative treatment variable. This effect is also positive and significant, meaning that contracts with a larger share of village households included add more to village wealth than contracts with only fewer households participating. The coefficient of 0.73 implies that a contract with all village households included would increase *VAI* by 73 percentage points (compared to a village where zero households participate). But full participation by all households in a village rarely exists. A 10% participation rate would increase *VAI* by 7.3 percentage points on average.

Column (4) shows the results of a specification where contract duration is used as treatment variable. Again, the treatment effect is positive and significant, implying that contracts that already started several years ago are more beneficial than recently started contracts. Obviously, it takes some time until the economic benefits of contracts and related investments fully materialize. The coefficient estimate suggests that one additional year of contract duration increases the

Table 5. *Factors influencing village economic development (panel model results)*

	(1)	(2)	(3)	(4)
Year 2012 (dummy)	0.216***	0.223***	0.230***	0.199***
	(0.025)	(0.047)	(0.043)	(0.047)
Contract (dummy)	0.129*	0.154*		
	(0.089)	(0.086)		
Contract size			0.729***	
			(0.224)	
Contract duration (years)				0.048***
				(0.017)
Contract duration squared (years)				−0.002**
				(0.001)
Share of oil palm land under independent cultivation$_{t-10}$		0.074	0.084	0.119
		(0.103)	(0.106)	(0.111)
Distance to palm oil mill$_{t-10}$ (km)		0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)
Distance to all season road$_{t-10}$ (km)		−0.005*	−0.005*	−0.003
		(0.003)	(0.003)	(0.002)
Population density$_{t-10}$ (pop/ha)		−0.017	−0.028	−0.032
		(0.082)	(0.081)	(0.081)
Electricity$_{t-10}$ (dummy)		−0.031	−0.043	−0.025
		(0.047)	(0.046)	(0.048)
Government land titles$_{t-10}$		0.041	0.049	0.075
		(0.085)	(0.082)	(0.086)
Contractual conflict$_{t-10}$		−0.082	−0.103	−0.142*
		(0.056)	(0.067)	(0.087)
Constant	0.481***	0.457***	0.431***	0.436***
	(0.025)	(0.073)	(0.074)	(0.073)
Observations	156	156	156	156
R^2 (overall)	0.19	0.22	0.08	0.17
Hausman	3.55	14.28**	31.84***	53.72***
Model specification	FE	FE	FE	FE

Notes: The dependent variable in all models is the village asset index (*VAI*). Coefficient estimates are shown with standard errors clustered at village level in parentheses. FE, fixed effects.
*** Significant at the 1% level.
** Significant at the 5% level.
* Significant at the 10% level.

VAI by 4.4 percentage points. However, this effect is nonlinear: the squared term of contract duration has a negative and significant coefficient, meaning that the positive effects associated with contract duration diminish over time. The maximum average benefit is reached after 12 years of contract duration.

Many of the control variables are not statistically significant. On the one hand, this may be related to the relatively small sample size. On the other hand, we note that all models were estimated with a fixed effects estimator that concentrates on data variation within villages over time. For many of the variables, this data variation within villages is limited. In random effects models, which also consider data variation between villages, more of the control variables are significant. However, for the impact assessment here the fixed effects specification delivers more consistent estimates of the treatment effects, as is confirmed by the significant Hausman test statistics in the lower part of Table 5. In spite of the relatively low data variation within villages, distance to an all season road is significant in most models. Longer distances have a negative effect on economic development, as one would expect. Moreover, in column (4) the negative effect of contractual conflict is statistically significant.

To capture wider village and regional developments, we specified an alternative *VAI*, as explained above. We keep the initial set of assets to construct the *VAI*, but additionally added distance to market, distance to health clinic, and distance to elementary school. Model results with this alternative *VAI* as dependent variable are shown in Table 8 in the Appendix. Most of the contract treatment effects remain significant, which further underlines the robustness of the general finding that contract adoption has contributed to rural economic development. As community–company partnerships were accompanied by public and private sector infrastructure investments, the development effects of contract participation go beyond household asset accumulation.

(d) *Heterogeneous treatment effects*

In this subsection, we analyze whether differences in the type of contract or in village characteristics influenced the magnitude of the estimated treatment effect. In column (1) of Table 6, we differentiate between contracts in the government-led phase and the market-oriented phase. Results indicate that contracts adopted during the government-led phase significantly contributed to village economic growth, while contracts adopted in the market-oriented phase did not. Controlling for other factors, villages with a contract signed during the government-led phase had a 45 percentage point stronger growth in *VAI* than villages without a contract. Column (2) additionally controls for contract duration, which is insignificant in this specification. Hence, the significant contract dura-

Table 6. *Estimations of heterogeneous treatment effects*

	(1)	(2)	(3)	(4)	(5)	(6)
Year 2012 (dummy)	0.225***	0.206***	0.217***	0.209***	0.248***	0.243***
	(0.046)	(0.047)	(0.046)	(0.036)	(0.049)	(0.044)
Contract (dummy)			0.313**	0.218**	0.110	0.027
			(0.126)	(0.108)	(0.106)	(0.099)
Contract duration (years)		0.011				
		(0.008)				
Government-led contract (1991–1998; dummy)	0.444***	0.437***				
	(0.083)	(0.085)				
Market-oriented contract (1999–2012; dummy)	0.121	0.091				
	(0.089)	(0.088)				
Contract × VAI_{1992}			−0.925*			
			(0.539)			
Contract × electricity$_{1992}$ (dummy)				−0.199		
				(0.143)		
Contract × distance road$_{1992}$ (km)					0.051	
					(0.059)	
Contract × land titles$_{1992}$						0.289*
						(0.170)
Constant	0.389***	0.386***	0.475***	0.424***	0.365***	0.489***
	(0.082)	(0.085)	(0.074)	(0.074)	(0.121)	(0.073)
Observations	156	156	156	156	156	156
R^2 (overall)	0.13	0.10	0.07	0.19	0.00	0.23
Model specification	FE	FE	FE	FE	FE	FE

Notes: The dependent variable in all models is the village asset index (*VAI*). Coefficient estimates are shown with standard errors clustered at village level in parentheses. Other control variables were included as in Table 5, but are not shown here for brevity. FE, fixed effects.
*** significant at the 1% level.
** significant at the 5% level.
* significant at the 10% level.

tion effect above may largely be due to the fact that many of the older contracts were signed during the government-led phase, when more public support and subsidies were provided.

In column (3) of Table 6, we interact the simple contract dummy with the *VAI* in 1992, in order to test whether relatively poorer or richer villages benefited more. The negative and significant interaction term implies that villages with a higher initial *VAI* (i.e., villages that were richer in 1992) benefited less from contracts than villages with a lower initial *VAI* (i.e., villages that were poorer in 1992). Thus, contracts with palm oil companies seem to have contributed to decreasing inter-village inequality in Jambi. In column (4), we use an interaction term between the contract dummy and electricity in 1992. The coefficient of this interaction term is negative

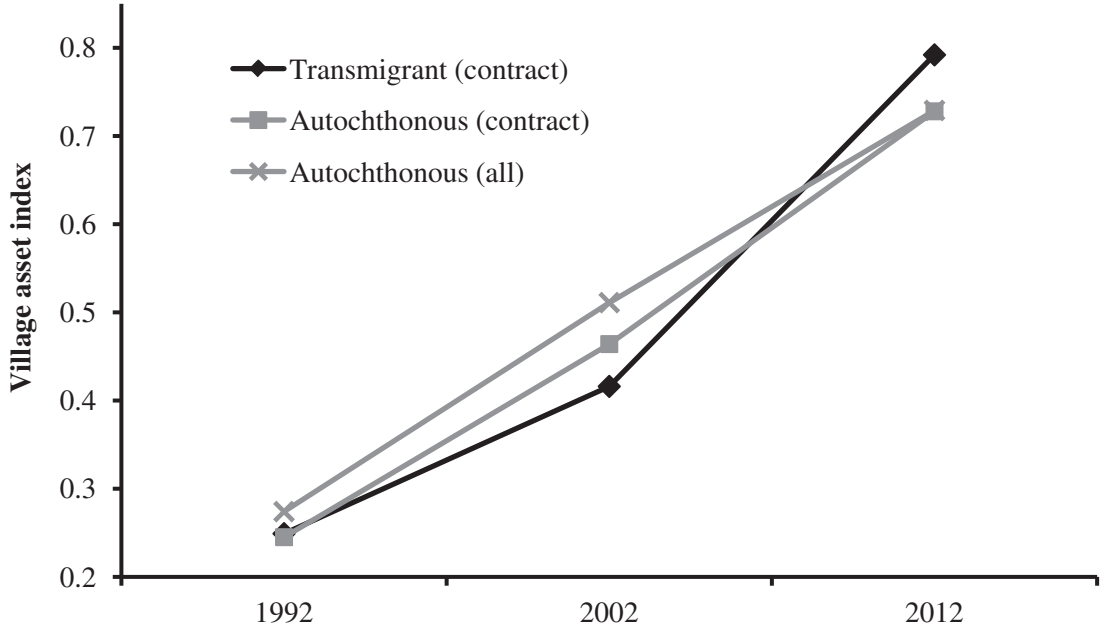

Figure 4. *Developments of the village asset index by village type (1992–2012).*

but not statistically significant. Nor is the interaction term with distance to all season roads in column (5) statistically significant.

In column (6), we use an interaction term between the contract dummy and the share of households that held formal land titles in 1992. This interaction term is positive and significant, meaning that the benefits of contracts are higher in villages with more farmers having formal titles for their land. As argued above, land titles can reduce the risk of contractual conflicts. On the other hand, we control for contractual conflicts in this model, so that other reasons also seem to play a role. One reason may be the greater tenure security associated with land titles, providing more incentives for farmer investments. Such investments may be facilitated through the economic gains resulting from contract farming.

We use Figure 4 to analyze development differences between transmigrant and autochthonous villages. As discussed above, the number of transmigrant villages without a contract is too small to analyze heterogeneous treatment effects with a regression model. [5] The descriptive comparisons in Figure 4 do not control for any confounding factors, so the trends and differences observed should not be hastily interpreted as the impact of contracts. Nevertheless, it is interesting to see that transmigrant and autochthonous villages started at similar wealth levels in 1992, whereas transmigrant villages were significantly wealthier in 2012. This is consistent with earlier findings for Jambi by Gatto *et al.* (2015). The stronger development in transmigrant villages may be related to the greater support that these villages received as part of the contract schemes and the government's transmigration program more generally. Even though transmigrant villages overtook autochthonous villages in terms of higher *VAI* only after 2002, when the transmigrant program had already ended, wealth accumulation takes time. Hence, the effects after 2002 may still be related to contracts signed during the government-led phase. Stronger wealth accumulation among transmigrants and their ownership of land titles may also have facilitated earlier entry into independent oil palm cultivation, which was also found to be beneficial for farmers in Jambi (Euler *et al.*, 2017).

5. CONCLUSION

The main objective of this paper was to analyze the effects of contracts between local communities and palm oil companies on rural economic development in Jambi, Sumatra. We used data from a village-level survey covering a time period of 20 years. Panel regression models showed that contract adoption has contributed significantly to economic development at the village level. Contracts have benefited farm households that participated in the contract schemes. Non-participating households in the same villages benefited, too, owing to public and private sector infrastructure investments associated with the contracts and other types of spillovers. Such spillovers, which we capture with the village-level data, could not have been analyzed with household-level data alone. The benefits of contracts increase with a larger share of village households participating in the contract scheme.

We also differentiated between different types of contracts and found that contracts adopted during the government-led phase (before 1999) were more beneficial than contracts adopted during the more recent market-oriented phase. These differences are likely due to the particular conditions under which contractual agreements were made during the two phases. During the government-led phase, contracted farmers benefited from input provision, technical support, subsidized loans, and public investments in infrastructure. During the market-oriented phase, the government exerted less control over contract formation, resulting in more variable contractual terms that much depended on the negotiating skills of community leaders. Analyzing the heterogeneity in contract conditions and their effects in greater detail would be interesting, but is beyond the scope of this study. This would either require a much larger data set or a qualitative research approach.

Another interesting finding from our data is that contracts with palm oil companies have contributed to decreasing inter-village inequality. First, poorer villages were more likely to adopt a contract than richer villages. Second, poorer villages benefited more than richer ones from contract adoption. We also analyzed differences in economic development between transmigrant and autochthonous villages, finding that transmigrant villages experienced faster economic growth. This may be related to transmigrant villages being more often involved in contract schemes, even though we were not able to prove causality due to data limitations. In general, transmigrants in Jambi benefited more from government support than autochthonous people, and they also started to get involved in oil palm cultivation earlier (Gatto *et al.*, 2015; McCarthy, 2010).

Over time, contracts have lost their importance in Jambi. More and more farmers have now started to grow oil palm independently. Independent oil palm cultivation was difficult for smallholders in the past, due to limited access to credits, inputs, and technical knowledge. However, by now many farmers have gained experience with oil palm and have accumulated wealth through their previous involvement in contracts. Also, input and credit markets have developed. As a result, independent oil palm adoption has now become much easier for farmers. Nevertheless, independent adoption occurs especially in villages with previous contractual ties with palm oil companies (Euler *et al.*, 2016). Hence, contracts have been an important starting point for further smallholder involvement in the palm oil industry.

The positive economic effects of smallholder contract farming found here are in line with recent empirical evidence for the palm oil sector in Indonesia (Cahyadi & Waibel, 2013; Euler *et al.*, 2017) and with the contract farming literature more generally (e.g., Barrett, Bachke, Bellemare, Michelson, & Narayanan, 2012; Miyata, Minot, & Hu, 2009; Reardon, Barrett, Berdegue, & Swinnen, 2009). However, the results should not mask the fact that contracts with palm oil companies can also lead to problems. Environmental issues associated with deforestation are one aspect. In addition, conflicts over land are not uncommon. Such conflicts can negatively affect the impact of contracts and can be detrimental for rural development more generally. Our results suggest that formal land titles, which many local farmers do not have, can be an important mechanism to reduce conflicts and spur rural economic development.

Contracts can also contribute to rising intra-village inequality, when richer farmers benefit more than poorer ones, or when village elites, who are often more involved in contract negotiations, influence terms and conditions primarily for their own benefit (Cahyadi & Waibel, 2013; McCarthy, 2010; McCarthy *et al.*, 2012). Rising inequality among farmers resulting from unequal access to contracts has often been reported, also beyond the palm oil sector (Briones, 2015). In this respect, the use of village-level data has shortcomings, because the distribution of benefits within villages cannot be analyzed. Indeed, a complementary study with household-level data from Jambi has found that richer farmers benefit

more from oil palm cultivation than poorer ones in absolute terms (Euler *et al.*, 2017). In relative terms, however, no significant differences in benefits between richer and poorer household were observed.

A general policy implication of our results from Jambi is that the contract schemes between village communities and palm oil companies contributed positively to economic development. This holds true in particular for those contracts that were made during the government-led phase, underlining that public sector support and monitoring is important in order to maximize the welfare effects for local communities. In Jambi, contracts have now become much less important for smallholders to benefit from growth in the palm oil industry. However, in other parts of Indonesia and globally, the palm oil sector is still emerging, so that well-designed contract schemes will be important for smallholders to get involved in an equitable way.

The village-level quantitative approach used here has its advantages to evaluate direct and indirect economic effects, but it also has its drawbacks especially when it comes to social and environmental effects. Hence, more research is needed to better understand the multifaceted implications of smallholder oil palm contracts for sustainable rural development.

NOTES

1. As a robustness check, we also constructed an alternative *VAI* including additional variables, such as distances to market, health clinic, and elementary school. Results are reported below.

2. While our study period is 1992 to 2012, there is one village in our data set that signed a contract in 1991. This was also recorded.

3. It should also be mentioned that much of the flat land near to the river banks in Jambi was traditionally cultivated with rice or was already covered with rubber plantations when oil palm development started. Hence, uncultivated land was more likely to be found in steeper terrain.

4. Investors also have a preference for contracts with transmigrant villages. Due to the positive correlation between the transmigrant village dummy and the share of land titles, the transmigrant dummy itself is not statistically significant.

5. In the contract adoption model above (Table 4), the transmigrant village dummy was positive but not statistically significant. Nevertheless, transmigrant villages are significantly more likely to have adopted a contract than autochthonous villages, as is indicated by a simple probit model of adoption that excludes other explanatory variables (see Table 9 in the Appendix).

REFERENCES

Barrett, C. B., Bachke, M. E., Bellemare, M. F., Michelson, H. C., & Narayanan, S. (2012). Smallholder participation in contract farming: Comparative evidence from five countries. *World Development, 40*(4), 715–730.

Briones, R. (2015). Small farmers in high-value chains: Binding or relaxing constraints to inclusive growth?. *World Development, 72*, 43–52.

Budidarsono, S., Susanti, A., & Zoomers, A. (2013). Oil palm plantations in Indonesia: The implications for migration, settlement/resettlement and local economic development. In *Biofuels – Economy, environment and sustainability* (pp. 173–193). Rijeka (Croatia): Intech.

Cahyadi, E. R., & Waibel, H. (2013). Is contract farming in the Indonesian oil palm industry pro-poor?. *Journal of Southeast Asian Economies, 30*(1), 62–76.

Cahyadi, E. R., & Waibel, H. (2016). Contract farming and vulnerability to poverty among oil palm smallholders in Indonesia. *Journal of Development Studies, 52*(5), 681–695.

Cameron, A. C., & Trivedi, P. K. (2009). *Microeconometrics using Stata* (Vol. 5) College Station, TX: Stata Press.

Carlson, K. M., Curran, L. M., Ratnasari, D., Pittman, A. M., Soares-Filho, B. S., Asner, G. P., ... Rodrigues, H. O. (2012). Committed carbon emissions, deforestation, and community land conversion from oil palm plantation expansion in West Kalimantan, Indonesia. *Proceedings of the National Academy of Sciences, 109*(19), 7559–7564.

Colchester, M., Jiwan, N., Andiko, S. M., Firdaus, A. Y., Surambo, A., & Pane, H. (2006). *Promised land; palm oil and land acquisition in Indonesia: Implications for local communities and indigenous peoples*. Moreton-in-Marsh (England): Forest Peoples Programme.

Drescher, J., Rembold, K., Allen, K., Beckschäfer, P., Buchori, D., Clough, Y., ... Scheu, S. (2016). Ecological and socioeconomic functions across tropical land-use systems after rainforest conversion. *Philosophical Transactions of the Royal Society B, 371*, 20150275.

Euler, M., Krishna, V., Schwarze, S., Siregar, H., & Qaim, M. (2017). Oil palm adoption, household welfare, and nutrition among smallholder farmers in Indonesia. *World Development, 93*, 219–235.

Euler, M., Schwarze, S., Siregar, H., & Qaim, M. (2016). Oil palm expansion among smallholder farmers in Sumatra, Indonesia. *Journal of Agricultural Economics, 67*(3), 658–676.

Fearnside, P. M. (1997). Transmigration in Indonesia: lessons from its environmental and social impacts. *Environmental Management, 21*(4), 553–570.

Feintrenie, L., Chong, W. K., & Levang, P. (2010). Why do farmers prefer oil palm? Lessons learnt from Bungo district, Indonesia. *Small-Scale Forestry, 9*(3), 379–396.

Gatto, M., Wollni, M., & Qaim, M. (2015). Oil palm boom and land-use dynamics in Indonesia: The role of policies and socioeconomic factors. *Land Use Policy, 46*, 292–303.

Greene, W. H. (2008). *Econometric analysis*. NJ: Prentice Hall, Pearson.

Hansen, M. C., Stehman, S. V., Potapov, P. V., Arunarwati, B., Stolle, F., & Pittman, K. (2009). Quantifying changes in the rates of forest clearing in Indonesia from 1990 to 2005 using remotely sensed data sets. *Environmental Research Letters, 4*(3), 034001.

Kanagawa, M., & Nakata, T. (2008). Assessment of access to electricity and the socio-economic impacts in rural areas of developing countries. *Energy Policy, 36*(6), 2016–2029.

Koh, L. P., & Wilcove, D. S. (2008). Is oil palm agriculture really destroying tropical biodiversity?. *Conservation Letters, 1*(2), 60–64.

Lambin, E. F., Geist, H. J., & Lepers, E. (2003). Dynamics of land-use and land-cover change in tropical regions. *Annual Review of Environment and Resources, 28*(1), 205–241.

Larson, D. F. (1996). *Indonesia's palm oil subsector*, Policy Research Working Paper 1654. Washington, DC: World Bank.

Margono, B. A., Turubanova, S., Zhuravleva, I., Potapov, P., Tyukavina, A., Baccini, A., ... Hansen, M. C. (2012). Mapping and monitoring deforestation and forest degradation in Sumatra (Indonesia) using Landsat time series data sets from 1990 to 2010. *Environmental Research Letters, 7*(3), 034010.

McCarthy, J. F. (2010). Processes of inclusion and adverse incorporation: Oil palm and agrarian change in Sumatra, Indonesia. *Journal of Peasant Studies, 37*(4), 821–850.

McCarthy, J. F., & Cramb, R. A. (2009). Policy narratives, landholder engagement, and oil palm expansion on the Malaysian and Indonesian frontiers. *Geographical Journal, 175*(2), 112–123.

McCarthy, J. F., Gillespie, P., & Zen, Z. (2012). Swimming upstream: Local Indonesian production networks in "globalized" palm oil production. *World Development, 40*(3), 555–569.

Mitsuda, Y., & Ito, S. (2011). A review of spatial-explicit factors determining spatial distribution of land use/land-use change. *Landscape and Ecological Engineering, 7*(1), 117–125.

Miyata, S., Minot, N., & Hu, D. (2009). Impact of contract farming on income: Linking small farmers, packers, and supermarkets in China. *World Development, 37*(11), 1781–1790.

Murdiyarso, D., Noordwijk, M. V., Wasrin, U. R., Tomich, T. P., & Gillison, A. N. (2002). Environmental benefits and sustainable land-use options in the Jambi transect, Sumatra. *Journal of Vegetation Science, 13*(3), 429–438.

Reardon, T., Barrett, C. B., Berdegue, J. A., & Swinnen, J. F. M. (2009). Agrifood industry transformation and small farmers in developing countries. *World Development, 37*(11), 1717–1727.

Rist, L., Feintrenie, L., & Levang, P. (2010). The livelihood impacts of oil palm: Smallholders in Indonesia. *Biodiversity and Conservation, 19*(4), 1009–1024.

Sahn, D. E., & Stifel, D. (2003). Exploring alternative measures of welfare in the absence of expenditure data. *Review of Income and Wealth, 49*(4) , 463–489.

Susila, W. R. (2004). Contribution of oil palm industry to economic growth and poverty alleviation in Indonesia. *Journal Litbang Pertanian, 23*(3), 107–114.

Zen, Z., Barlow, C., & Gondowarsito, R. (2005). *Oil palm in Indonesian socio-economic improvement: A review of options*, Working papers in trade and development, research. Canberra: Australian National University.

APPENDIX A.

Table 7. *Bivariate probit model estimates*

	Investor visit $N = 78$	Contract adoption $N = 49$	Investor visit $N = 78$	Contract adoption $N = 49$
	Coefficients		Marginal effects	
	(1)	(2)	(3)	(4)
Average land slope	0.632***	.	0.234***	.
	(0.247)	.	(0.087)	.
Village land area (thousand ha)	−0.002	−0.027	−0.001	−0.011
	(0.018)	(0.025)	(0.001)	(0.011)
Village population (thousand)	−0.018	0.397	−0.007	0.159
	(0.204)	(0.268)	(0.081)	(0.111)
Electricity (dummy)	−0.173	−0.805	−0.064	−0.336*
	(0.382)	(0.593)	(0.141)	(0.209)
Distance to all season road (km)	0.004	−0.009	−0.002	−0.003
	(0.013)	(0.017)	(0.001)	(0.011)
Distance to palm oil mill (km)	−0.005*	−0.001	−0.002*	−0.000
	(0.003)	(0.003)	(0.001)	(0.000)
Village asset index	0.177	−0.868	0.065	−0.341
	(0.819)	(1.133)	(0.303)	(0.463)
Transmigrant village (dummy)	0.284	0.539	0.101	0.221
	(0.426)	(0.606)	(0.143)	(0.178)
Government land titles (share of HH)	1.439**	−0.353	0.532**	−0.056
	(0.587)	(0.549)	(0.212)	(0.258)
Constant	−0.857	0.626	.	.
	(0.613)	(0.702)	.	.
Rho	−0.285			
	(1.003)			
Log likelihood	−71.79			
Wald test of independent equations				
Chi^2 (1) prob. > chi^2	0.78			

Notes: Standard errors are shown in parentheses.
*** Significant at the 1% level.
** Significant at the 5% level.
* Significant at the 10% level.

Table 8. *Factors influencing village economic development, using alternative village asset index (panel model results)*

	(1)	(2)	(3)	(4)	(5)	(6)
Year 2012 (dummy)	0.215***	0.222***	0.228***	0.207***	0.223***	0.212***
	(0.021)	(0.039)	(0.036)	(0.039)	(0.038)	(0.039)
Contract (dummy)	0.105	0.119*				
	(0.068)	(0.067)				
Contract size			0.536***			
			(0.182)			
Contract length (years)				0.037***		0.006
				(0.014)		(0.006)
Contract length squared (years)				−0.001**		
				(0.001)		
Government-led contract (1991–98; dummy)					0.296***	0.291***
					(0.066)	(0.068)
Market-oriented contract (1999–2012; dummy)					0.099	0.082
					(0.072)	(0.071)
Share of oil palm land under independent cultivation$_{t-10}$		0.073	0.079	0.103	0.047	0.061
		(0.073)	(0.075)	(0.081)	(0.075)	(0.080)
Distance to palm oil mill$_{t-10}$ (km)		0.000	0.000	0.000	0.000	0.000
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Distance to all season road$_{t-10}$ (km)		−0.002	−0.002	−0.000	−0.002	−0.001
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Population density$_{t-10}$ (pop/ha)		−0.025	−0.034	−0.032	−0.016	−0.031
		(0.071)	(0.070)	(0.073)	(0.073)	(0.075)
Electricity$_{t-10}$ (dummy)		−0.021	−0.030	−0.021	−0.016	−0.009
		(0.038)	(0.037)	(0.038)	(0.039)	(0.039)
Government land titles$_{t-10}$		0.039	0.045	0.070	0.035	0.023
		(0.070)	(0.069)	(0.072)	(0.069)	(0.070)
Contractual conflict$_{t-10}$		−0.007	−0.008	−0.025	−0.011	−0.033*
		(0.076)	(0.082)	(0.094)	(0.074)	(0.086)
Constant	0.454***	0.421***	0.403***	0.404***	0.379***	0.377***
	(0.019)	(0.065)	(0.064)	(0.064)	(0.073)	(0.074)
Observations	156	156	156	156	156	156
R^2 (overall)	0.23	0.20	0.15	0.19	0.18	0.16
Model specification	FE	FE	FE	FE	FE	FE

Notes: The dependent variable in all models is the alternative village asset index, which additionally includes distances to market, health clinic, and elementary school. Coefficient estimates are shown with standard errors clustered at village level in parentheses. FE, fixed effects.
*** significant at the 1% level.
** significant at the 5% level.
* significant at the 10% level.

Table 9. *Effect of transmigrant village on contract adoption*

	Coefficient (Standard Error)
Transmigrant village (dummy)	0.726*
	(0.402)
Constant	−0.516
	(0.163)
Observations	78
Pseudo R^2	0.03

* Significant at the 10% level.