2015

Moving Rubber to a Better Place – and Extracting Rents from Credit Constrained Farmers along the Way

Thomas Kopp and Bernhard Brümmer

EFForTS discussion paper series Nr. 9

Kopp, Thomas; Brümmer, Bernhard: Moving Rubber to a Better Place – and Extracting Rents from Credit Constrained Farmers along the Way

Göttingen : GOEDOC, Dokumenten- und Publikationsserver der Georg-August-Universität, 2015
(EFForTS discussion paper series 9)

Bibliographische Information der Deutschen Nationalbibliothek

Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliographie; detaillierte bibliographische Daten sind im Internet über <http://dnb.ddb.de> abrufbar.

Erschienen in der Reihe
EFForTS discussion paper series

ISSN: 2197-6244

Herausgeber der Reihe
SFB 990 EFForTS, Ecological and Socioeconomic Functions of Tropical Lowland Rainforest Transformation Systems (Sumatra, Indonesien) - Ökologische und sozioökonomische Funktionen tropischer Tieflandregenwald-Transformationssysteme (Sumatra, Indonesien)

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No. 9 (February 2015)

Funded by the German Research Foundation (DFG) through the CRC 990 "EFForTS, Ecological and Socioeconomic Functions of Tropical Lowland Rainforest Transformation Systems (Sumatra, Indonesia)"

www.uni-goettingen.de/en/310995.html

SFB 990, University of Goettingen

Berliner Straße 28, D-37073 Goettingen, Germany

ISSN: 2197-6244

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Moving Rubber to a Better Place – and Extracting Rents from Credit Constrained Farmers along the Way

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Abstract

While traders of agricultural products are known to often exercise market power, this power has rarely been quantified for developing countries. In order to derive a measure, we estimate the traders' revenue functions and calculate the Marginal Value Products directly from them. We subsequently find determinants affecting their individual market power. An exceptional data set with detailed information on the business practices of rubber traders in Jambi, Indonesia is employed. Results show that market power at the traders' level exists and is substantial. This market power is amplified in situations of extreme remoteness, and weakens with increasing market size.

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JEL classification: F14, Q13, L14

[1] Thomas Kopp is the corresponding author. Financial support from DFG within Collaborative Research Centre 990 is greatly appreciated. The traders survey data were compiled within the Collaborative Research Centre 990 'Ecological and Socioeconomic Functions of Tropical Rainforest Transformation Systems in Sumatra, Indonesia' (EFForTS) funded by the German Research Foundation (DFG). Jenny Aker (Tufts University), Todd Benson (IFPRI, Kampala), and Ruth Vargas Hill (IFPRI, Washington) were so kind to provide the blank questionnaires they used for their respective trader surveys.

1. Introduction

It is widely recognized that traders and middlemen of agricultural raw products are able to exercise a certain amount of market power, contradicting standard economic theory of perfect arbitrage and zero profits (Aker, 2010; Subramanian and Qaim, 2011; Piyapromdee et al., 2014). Osborne (2005) argues that the body of literature on intermediaries of agricultural markets is extensive when looking at the markets of industrialised economies. Southern markets, however, have rarely been studied in this respect although it is to be expected that monopsonistic pricing might be much more pronounced there: 'traders in a typical source market engage in imperfectly competitive behaviour in purchasing from farmers' (Osborne, 2005, p. 1).

Some newer studies address this gap in the literature and pay attention to the role of traders. Most of these studies aim to find reasons behind the bad integration of agricultural markets in economically less developed countries, while only a few base their analysis on information stemming from traders. Fafchamps and Gabre-Madhin (2006) use data from a trader survey to quantify transaction costs, focusing on the cost of information. Fafchamps and Hill (2008) record prices paid at several stages of the value chain (including the farm gate) to collect evidence of market power, leading to imperfect price transmission. The abovementioned study by Aker (2010) analyses the effects of increased mobile telecommunication on the dispersion of prices. Even fewer studies estimate traders' production functions. Fafchamps and Minten (2002) estimate production functions to quantify the effect of social capital on the traders' levels of productivity.

No study was found to use traders' production functions for finding evidence of market power. This might be due to several reasons: firstly, it is difficult to measure the prices of the various outputs (i.e. services) offered by these individuals, such as changing the location of a good, or of providing credit. Besides that, in many cases the data on firms' individual output prices is not available at the level of detail required (Mairesse and Jaumandreu, 2005).

Our study investigates traders' market power by comparing the marginal value products (MVPs) of the agricultural raw input to their observed market price. A unique set of original survey data on Indonesian rubber traders – including detailed output prices on an individual level – enables us to estimate the traders' revenue functions and calculate the MVPs directly from them. The comparison to the observed market price is operationalised by calculating Lerner Indices (the normalised difference between market and observed prices) which are shown to be significantly different from zero. The traders exercise monopsonistic market power.

In a subsequent step, we search for determinants that influence this market power. Our results suggest that market imperfections such as high transaction costs (typical for remote areas) increase the imbalance. Factors that reduce the traders' ability to exercise power are the size of the market, such as the agricultural area dedicated to cash crop production, and the number of traders operating in the area.

This paper is structured as follows: the data used in this study is introduced in chapter two. Chapter three provides background information on the Jambinese rubber market and the business practices of the subjects of this analysis – the traders and middlemen. The empirical methods and data are discussed in chapters three and four, respectively. Chapter five presents the results, before conclusions are drawn in chapter six.

2. Data

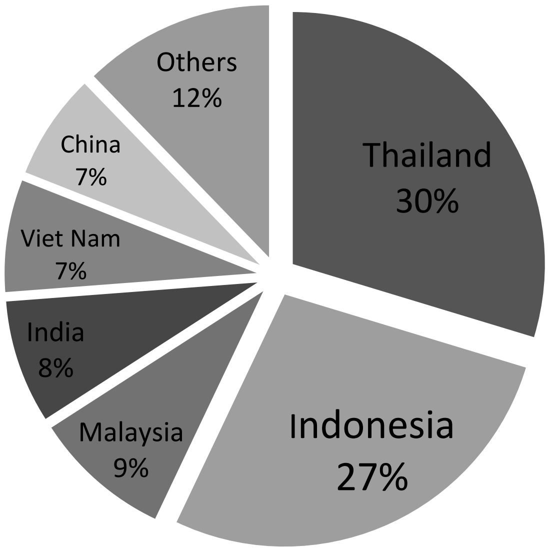
The data that this study is based on were generated during a survey taking place from September to December 2012 in five districts of the Jambi Province on Sumatra, Indonesia in a joint project between the universities of Göttingen, Jambi, and Bogor.[2] These five districts are the primary production areas of rubber in Jambi. In these five districts, 40 villages were selected randomly, stratified on a sub-district level (Faust et al., 2013). The total population of rubber traders in these 40 villages could be determined by a snowball-like search in the survey phase and totals to 313 individuals. Out of these, 221 were interviewed, which is equivalent to a response rate of 71%. All prices, values and quantities refer to September 2012. Since the figures mainly stem from accounting documents of the respondents, a high level of accuracy can be assumed (if no accounting was available, we relied on recall data). The traders were asked about details of the three most important buyers whom they deliver to. It is safe to assume that this covers all their buyers because 99% of the respondents sell to only one or two.

3. Background: rubber in Jambi

Why did we select rubber and the Jambi province? The fact that raw rubber has a high value per volume compared to other raw products and is not perishable makes it an extensively traded good that can be moved along complex value chains. Jambi is representative of a rubber producing province in Indonesia, the second largest producer in the world (Figure 1). Rubber is also important for the Jambi province in particular and is seen by policy makers as one key for reducing unemployment and poverty (Feintrenie et al., 2010). This all makes it an interesting case study for the application of the proposed method of estimating revenue functions in order to find evidence for market power.

[2] Collaborative Research Centre 990: http://www.uni-goettingen.de/en/310995.html.

Figure 1: Global rubber production in 2012



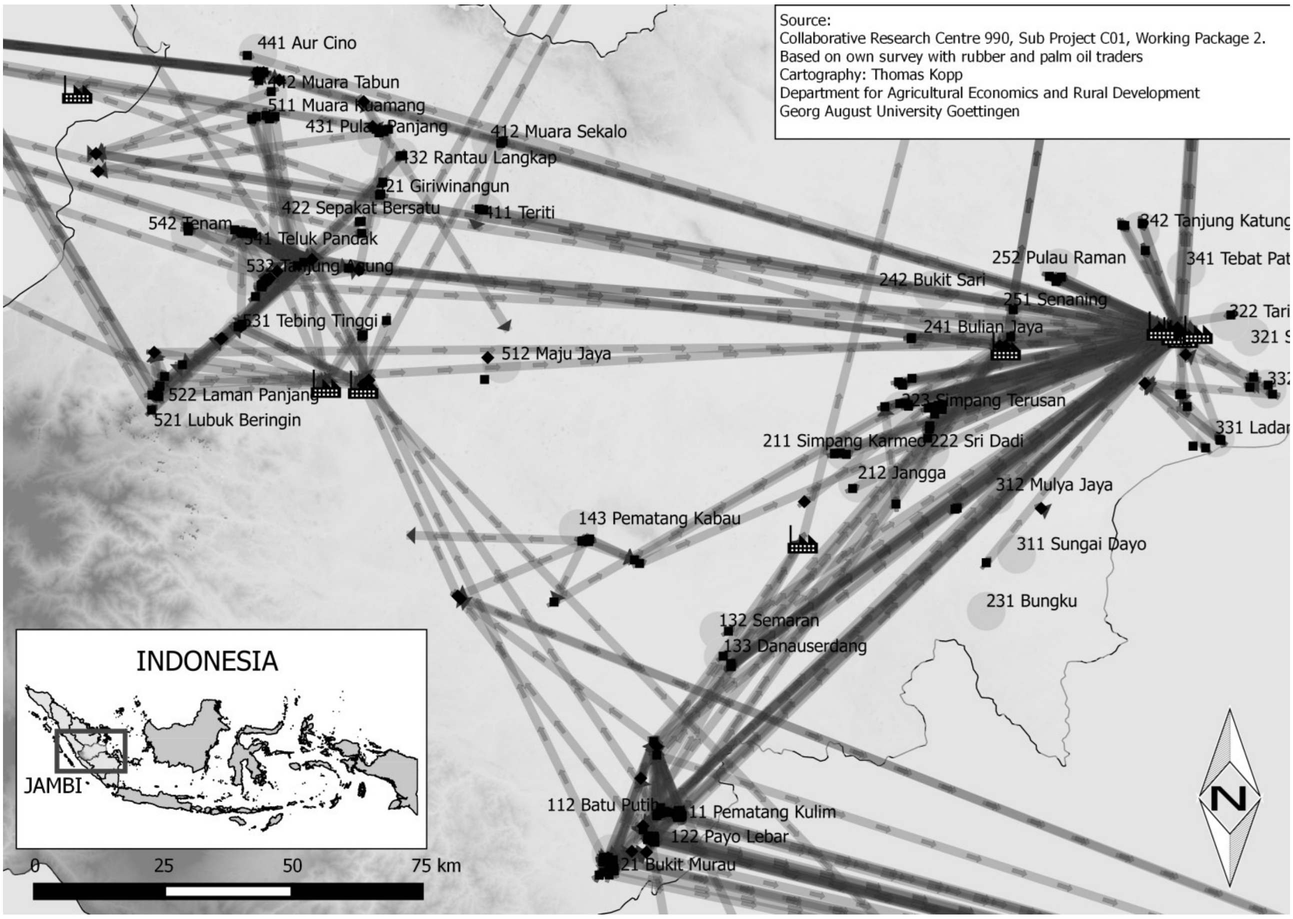
Source: Own production, based on data from FaoStat (accessed on 08.10.2014).

Today, rubber is the main commodity produced by smallholders in Jambi. Jambi is a key producer of palm oil too, but a lot of this production takes place in the form of large scale plantation agriculture while rubber is predominantly produced by smallholders. Martini et al. (2010) argue that a mixed portfolio of rubber and palm oil would be the best strategy for smallholders to insure against price volatilities on both markets and provide an income which can keep up with wages earned from providing labour in the cities. It can be observed, however, that the Jambinese population generally seems to prefer rubber. With 250000 rubber producing households, 31% of all Jambinese livelihoods rely on rubber (Statistics of Jambi Province, 2013). Policy makers also agree that rubber cultivation plays a key role for Jambi's future economic and social development. In contrast to palm oil, its primary production mode is smallholder agriculture because of the labour intensity. Rubber production's compatibility with food production increases food security as rubber can be intercropped with food crops such as rice, vegetables and fruit (Feintrenie et al., 2010). This is especially true in the current time of land pressure. However, at present this is rarely exercised (Euler et al., 2012). Even larger scale rubber plantations have weaker negative environmental externalities than palm oil monocultures, for example on biodiversity (Fitzherbert et al., 2008) and the probability of flooding (Adnan and Atkinson, 2011).

In Jambi, the stakeholders in rubber trade (middlemen and agents of other traders) are heterogeneous along several dimensions and form complex networks (Figure 2). Traders can either be independent entrepreneurs or agents working for a larger trader. The latter are referred to as *Anak Ular* ('children of the snake') which indicates their low popularity and perceived powerful position. The traders in our sample differ considerably in business size (trading between 300 kg and

200 tons per week, and buying regularly from three to 800 providers) and other characteristics, including ethnicity, age, etc.

Figure 2: Trade flows of rubber in the Jambi Province

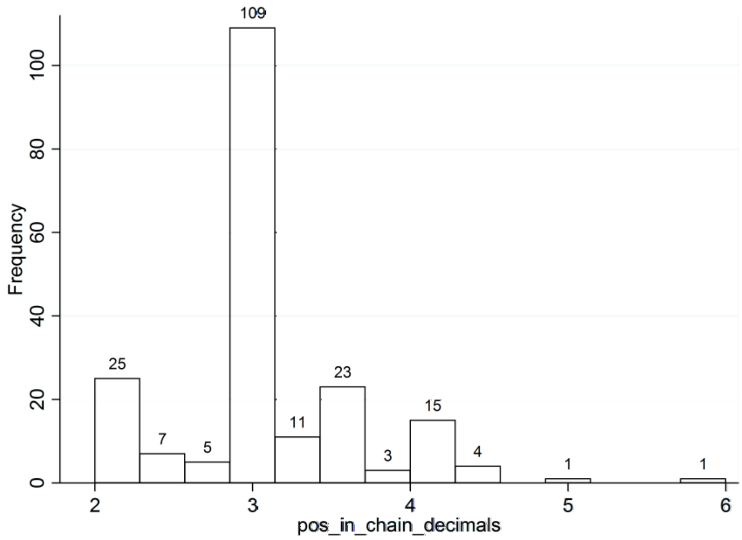


Source: Own production, based on original survey data. Borders of Jambi and Sumatra from Center for International Forestry Research, surface of Jambi from NASA / EOSDIS.

The buying procedure works as follows: the trader either lives in the village, or comes to the village at a fixed point in time (e.g. one day per week) to buy rubber. In either case, the rubber provided by the farmers comes in the form of a slab of coagulated rubber of 50-100kg. The rubber is then typically weighed by the trader's employees before the trader assesses its quality by calculating the Dry Rubber Content (DRC). The ideal DRC would be 100%, but is most commonly graded down for several reasons. First is the *basi* content which refers to the contamination with water. Most farmers increase their rubber slabs' weight by storing them in water pools to make the slabs soak up water like a sponge. The second contamination is in the form of *tatal* ('rubbish') from the harvesting process, such as leaves, bark or dirt from coagulation boxes. Finally, the chemical that has been used for coagulation also affects the quality. While the highest quality is achieved with acetic acid, many farmers use cheap alternatives such as battery acid, triple super phosphate fertilizer, vinegar, or even floor cleaner (Akiefnawati et al., 2010). It has to be noted that the terms *basi* and *tatal* are used interchangeably and some people may never have heard of one of them. However, all three kinds of quality determinants are known, and most commonly referred to in the way explained above. In this work, we use the term DRC to refer to all quality aspects combined. Traditionally the farmers produced sheets of unsmoked rubber, but had to switch to the production of thick slabs due to policy changes in the early 1970s, after which only the export of Technically Specified Rubber was allowed and lower grades were prohibited (Pitt, 1980). The disadvantage from the farmers' perspective is that the quality of unsmoked rubber sheets is less variable than the quality of slabs, which are therefore more prone to manipulation.

The downstream trading network (i.e. for selling the rubber) is very dense and complicated as one can observe in Figure 2 (above). When moving along the value chain from the village trader, the product passes on average 3.1 other traders before reaching the factory (dispersion: see Figure 3). While the prices that the middlemen receive for the product traded depend on their position in the chain, the prices that they pay do not (see Table 1). The fact that the prices received from selling rubber downstream are not transmitted to the providers shows that some traders are not operating at their marginal costs. This is already a first indicator of the traders acting as price setters.

Figure 3: Position of respondents in the value chain, starting from the factory



Source: Own production, based on original survey data.

Notes: Number three indicates, for example, that the produce passes two other traders before reaching the factory. Decimal values are possible, because averages were taken for traders who sell along more than one downstream channel, if these differ in length.

Table 1: Spearman's rank correlation coefficients between buying and selling prices, and the traders' positions in the value chains

Variable A	Variable B	p-value (H0: Variable A and Variable B are independent)
selling_price	pos_in_chain	0.0871
buying_price	pos_in_chain	0.3748

Source: Own production, based on original survey data.

The market for processing rubber in Jambi is very concentrated. Nine crumb rubber factories are active in the province, of which five are located in the capital, Jambi City. 76.1% of all rubber that is produced in the province ends up in one of these, with the remaining share being sold to factories in neighbouring provinces (calculations based on survey data). The factories process the slabs from the smallholders by cutting, washing and pressing it to Standard Indonesian Rubber 20 (SIR20) which is equivalent to the international standard Technically Specified Rubber. These factories sell the rubber on the international market, mainly to tyre producers in Japan, China, the U.S. and Europe. One exception is a local manufacturer of tyres, located in the Northern Sumatra Province (PT Bridgestone) which buys a share of their raw rubber supply directly from Jambinese traders.

While these factories are price takers on the international market, they do exercise market power towards their suppliers. Kopp et al. (2014) find that the prices received by traders and farmers in Jambi from the eventual buyers – the factories – are transmitted from the international prices asymmetrically: in times of price hikes (i.e. when the factories' margins increase), the price changes are transmitted to the local market much slower than in times of price declines. The welfare effect stemming from the asymmetric price transmission alone was quantified at around three million U.S. dollars. It can be assumed that the total welfare loss is much larger, since the oligopsonistic behaviour is also likely to affect the absolute level of the prices.

The traders, on the other hand, are not only subject to market power exercised by their downstream buyers: they are also able to exercise market power themselves. There are a number of examples in the literature where indicators for market power could be found at the traders' level (McMillan et al., 2002; Pokhrel and Thapa, 2007). In the case of Jambi, up until now the evidence for these sorts of market imperfections is mostly anecdotal. Studies that focused on the middlemen in the Jambinese rubber market are Martini et al. (2010), and Arifin (2005).

One of the traders' strategies to implement and secure their superior bargaining position is by granting credits to smallholders. Subramanian and Qaim (2011) find that markets of agricultural output are interlocked with markets for other goods. This interlock explains why non-competitive (and therefore non-pareto efficient) market organizations can persist in an otherwise competitive market. These interlocks have the potential to offset imperfections on another markets. Applied to this case, the initial imperfection is the constrained access of smallholders to credit. The most prominent reasons for smallholders' limited access to formal credit in many developing countries are limited possibilities of contract enforcement and a lack of collateral due to non-formal property rights (Barnett et al., 2008). Rubber traders are traditionally providers of informal credit. Observations of our survey showed that no collateral is needed because the credit agreement is based on trust, stemming from ongoing personal interaction and close ties within the village community. This confirmed the observations made by Akiefnawati et al. (2010). However, this credit also increases the traders' bargaining power tremendously, since it is expected that an indebted farmer sells his or her produce exclusively to the provider of his or her credit. This strategy has also been reported in the cases of Benin and Malawi: the credits' '[...] main purpose is not to exploit farmers' need for cash in order to finance agricultural production, but rather a means for traders to secure future deliveries' (Fafchamps and Gabre-Madhin, 2006, p. 36). This behaviour could also be documented for the case of Jambi: 94.1% of the rubber traders who provide credit answered 'yes' to the question 'Does a farmer have to sell his/her rubber / palm oil to you if he/she wants to take a credit from you?'. 72.9% replied with 'no' when they were asked: 'If a farmer/other trader owes you money, can she sell her produce to another trader?' (All figures for this and the following paragraph are based on original survey data; for more information on the data see below).

The credit not only attaches the farmers to the traders, but these traders also manipulate the DRC level of the delivered rubber if the farmer is indebted. This would be an implicit interest since, for cultural reasons, the traders do not officially charge any interest on the credit. In interviews, 11.8% of the responding traders stated that they manipulate the *basi* estimation for suppliers who are indebted. This seems to be a small share, but given that this practice is understood as immoral, it can be expected that the figure given here is underestimating the true share because respondents might not 'admit' in interviews that they follow this practice. However, it is reasonable to understand this hidden interest as the traders' own capital costs which they pass on to the farmers.

It is the target of this analysis to empirically verify whether Jambinese rubber traders do indeed exercise market power towards their suppliers and – if so – what determines the extent of it. The key question is whether factor prices of the rubber input equal their marginal value products.

4. Methodology

The intuition of our empirical approach to test for market power at the traders' level is to estimate the revenue functions of the traders. We use these estimated functions to directly calculate the marginal value product (MVP) of raw rubber which would– in the situation of perfect competition – be equal to the observed market prices that the traders pay for this input. If the latter ones were smaller, this would be an indication of market imperfection. In a second stage, we find determinants for deviations from the MVP by calculating Lerner Indices for each trader, and regressing them on characteristics of the transactions (characteristics of the geographic location, of the traders, and of the trader-provider relationships).

4.1. Model development

Berndt (1996) argues that in situations of exogenous input quantities and endogenous input prices, the production (or revenue) functions need to be employed.[3] The advantage over estimating a cost function is that input prices do not enter the model which we wish to avoid, since these are the observed prices that are to be compared to the MVPs deducted from the estimated revenue functions. 'Production' is, in this case, understood as improving the value of the raw rubber that the traders buy, for example by changing its location, i.e. providing the service of transportation. Since the selling prices of rubber which the traders are confronted with vary substantially between the traders – depending on whom they sell to – the standard approach of generating the output quantity by dividing the revenue by an industry-average of the prices would not account for these price differences and therefore lead to a serious bias (Mairesse and Jaumandreu, 2005). Instead we weight the output by the selling prices, resulting in the estimation of a revenue function. Mairesse and Jaumandreu (2005) find that it does not systematically change the estimated results if the LHS of a production function is deflated by the output prices or not (apart from the desired effect from the weighting).

A potential problem in the estimation of traders' production functions is one of endogeneity: traders who are generally more efficient might handle larger volumes, which would cause a correlation between the error term and this input quantity. However, in Jambi it is not the trader's choice how much rubber he or she trades, since they usually buy everything they can get, due to the good margins. According to Zellner et al. (1966), the problem does not apply if the choice of how much input is used is not made by the trader. The same is true for the credit: the amount of the credit that the traders provide is determined by their providers' needs rather than their own choice. The credit is, as in other settings, too (e.g. Benin and Malawi, see Fafchamps and Gabre-Madhin, 2006), used

[3] The reason why we do not estimate a value added function is that knowing which factors affect the value-added would not facilitate any conclusions on market power. It would be interesting to assess how the value added is distributed amongst all stakeholders of the value chain, but this is not feasible within the scope of this study since it would require detailed data on the cost structures of all stakeholders.

as an instrument to attach providers to them. Thus the output/revenue per input is not correlated to the 'size' of the trader.

4.2. Application

We base the specification of our model on the following transcendental revenue function in logarithmic form (Boisvert, 1982)[4]:

$$\ln Y = \ln \alpha_0 + \sum_{i=1}^{N}(\alpha_i \ln x_i) + \frac{1}{2}\sum_{i=1}^{N}\left(\sum_{j=1}^{N}(\alpha_{ij} \ln x_i \ln x_j)\right) + e \qquad (1)$$

Y on the LHS represents the value of the output while x_i on the RHS refers to the quantities of the inputs. *N* denotes the total number of inputs and *e* the error term. For the reasons laid out above, the output enters in the form of gross revenue. The raw rubber that the traders buy is included as an intermediary input. Other variables that are included in the RHS are the bilateral distance between the trader and his or her buyer as a proxy for trade costs, the weekly hours that the traders work themselves, and their total transport capacity as a proxy for capital. Concerning the costs of hired labour, it cannot be deduced from theory if they are to be modelled in terms of working hours or total costs: the price of labour might account for unobserved quality differences which would argue for using the total costs. However, price differences might also be due to regional differences which would be a reason for using the amount of working hours. The latter two variables cannot enter the regression together due to double counting. We therefore estimate three models: one without hired labour (1), one with the total labour costs (2) and one with total hours worked (3). A Likelihood Ratio Test is then employed to compare (2) and (3) with (1). If the reduced model is shown to represent the data best, its results are used further on. If the models that include the hired labour are better, the Vuong's Closeness Test for non-nested models (Vuong, 1989) will be employed to determine whether to use (2) or (3).

The traders produce – from their suppliers' point of view – two services: changing the location of the product and providing credit. However, since from the traders' perspective their sole motivation of providing credit is to expand their market base and to attach providers to them, this is to be understood as a (quasi-fixed) input. Thus, the credit enters the regression on the RHS, together with the other inputs.

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[4] We also estimated a Cobb Douglas function. An LR test showed that it does not represent the data as good as the translog specification. Results are available on demand.

The DRC does not enter the revenue function, since the input amount is equal to the output amount. This means that on the LHS the quantity is already deflated by the output quality which is equal to the (weighted) average input quality. Accordingly, there is no need to control for this in the revenue function.

Before taking the logarithms of all variables, they are mean-scaled in order to be able to interpret the results as elasticities. One common challenge in the estimation of revenue functions is the occurrence of zeros in the input variables which results in missing values when the log is taken. This is the case – for example – if a very small trader does not make use of hired labour. These missing zeros are handled following Battese (1997): the observations with $ln(0)$ are replaced by 0. An additional dummy variable, which represents the zero-inputs, is set to unity, and to zero elsewhere.

The variable indicating the credit that the respective trader provides is zero inflated and left censored (about 50% of the respondents did not give any credit in September 2012). So instead of normalising and taking the logs of this variable, the inverse sine hyperbolic transformation was employed, as suggested by Burbidge et al. (1980). Since the size of the credit given by traders is not exclusively determined by their choice, but also based on their providers' needs, it is also plausible to represent the credit as a dummy variable (unity if credit was given). This specification was tested against the alternative of treating the credit given just like the other inputs via an LR test which gave a prob>chi2 of 0.0771. It was therefore decided to employ the unrestricted model.[5]

4.3. Requirements and properties of the revenue function

We test whether the estimated revenue function satisfies the required properties at each data point. These are the homogeneity condition (Boisvert, 1982), as well as the curvature properties for satisfying the conditions of positive and diminishing marginal products for every single observation (Morey, 1986). The condition of positive marginal products is checked by taking the partial derivatives with respect to each of the inputs. If they are > 0 at every data point, the first condition is fulfilled. The decreasing marginal products are clarified by taking the second-order partial derivatives with respect to each of the inputs which is the diagonal of the bordered Hessian matrix (Morey, 1986). These need to be < 0 at every observation in order to satisfy the condition. As it will turn out, the application of a standard OLS estimator produces estimates which violate the constraints 760 times. We thus impose the inequality constraints mentioned above, following the approach suggested by Henningsen and Henning (2009) using the R-packages *micEcon* and

[5] The results of the alternative model can be made available upon request.

frontier.[6] For the first step, we estimate the unrestricted translog revenue function before imposing the monotonicity constraint by minimum distance in the second step. In the third step, the non-restricted parameters are estimated conditionally on the restricted parameters. Imposing the constraints on every single point in the data is not desirable, because this would eradicate the flexibility of the transcendental logarithmic (translog) revenue function, and one would be left with a Cobb Douglas function. In order to keep the advantage of the translog specification, we impose the constraints for only one arbitrarily chosen point, as suggested by Ryan and Wales (2000) and applied by Chua et al. (2005). We select the sample mean to be this point. Imposing the monotonicity condition already significantly reduces the number of data points that violate the revenue function's curvature properties to twelve cases (quasi-concavity achieved in 94.3% of all observations).

4.4. Calculation of Marginal Value Products

In order to calculate the MVPs, Equation (1) is differentiated with respect to *ln(xR)*:

$$\frac{\delta \ln Y}{\delta \ln x_R} = \alpha_R + \alpha_{RR} \ln x_R + \left(\sum_{j=1}^{M} (\alpha_{Rj} \ln x_j)\right) \qquad [M = N \setminus R] \tag{2}$$

Substituting the assumption of perfect competition $\frac{\delta Y}{\delta x_R} = p_R^c$ and the expression[7] $\frac{\delta Y}{\delta x_R} = \frac{\delta \ln Y}{\delta \ln x_R} \frac{Y}{x_R}$ into (2) yields

$$p_R^c = \left(\hat{\alpha}_R + \hat{\alpha}_{RR} \ln x_R + \left(\sum_{j=1}^{M} (\hat{\alpha}_{Rj} \ln x_j)\right)\right) \frac{Y}{x_R} \tag{3}$$

with $p^C{}_R$ representing the price under perfect competition. In the subsequent step, the Lerner Index is calculated for each trader. The original formula normalises the positive difference between marginal costs and observed prices (i.e. prices minus marginal costs, since the former ones tend to be larger) by the observed prices (Lerner, 1934). Since we are comparing the marginal revenues and factor prices, we calculate the index as $LI = \frac{p_R^c - p^*}{p^*}$ with p* standing for the observed price in order to get positive numbers.

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[6] A list of the imposed constraints can be found in Appendix 1.

[7] Steps: (a) δlny/δy=1/y and (b) δlnx/δx=1/x; (a) / (b) gives the abovementioned expression.

4.5. Determinants

In the second stage regression, the calculated Lerner Indices from stage one are regressed on several characteristics of the traders' environment in order to find determinants of the market prices' deviations from the competitive prices. These characteristics are differentiated between proximate causes (variable, such as market and trader characteristics), and ultimate causes (stable over time, such as characteristics of the geographic location). The former ones include the trader density in the survey village, the traders' 'size' (their wealth and trading quantity), their respective positions in the value chain, their access to information, their access to capital (credits), and their status (agent or independent trader). Unobserved trader heterogeneity is controlled for by adding a dummy for each trader. Ultimate causes include the general remoteness, size of village population, the quantity of rubber production, availability of lending institutions or an auction market, as well as the participation in the governmental 'transmigration' program. The heterogeneity of the providers, from whom the traders under consideration source the rubber, is controlled for with the following variables: the provider's status as farmer/other trader, the typical size and quality of delivery, their ethnicity, and the credit that has been taken. We test for heteroscedasticity with the Breusch-Pagan Test, which is confirmed. We thus use robust standard errors.

Since Output quality is equal to the (weighted) average input quality, the hypothetical input price is for rubber of average quality. However, there is heterogeneity between farmers whom the traders buy from. As mentioned above, traders are accused of manipulating the estimation of the DRC for indebted suppliers. This accusation could be verified by a regression of the estimated DRC on the size of credits which were given out to farmers (Table 2). In case of zero-credits, log_credits takes the value 0 and the dummy of credits given is also set to 0, following Battese (1997). As can be seen, the credit that is given does indeed influence the DRC. The low R^2 can be explained by the fact that the main determinant of the DRC estimation is still the quality. However, the variables representing the credits are significant. To account for this in the estimation of the possible determinants of market power, we generated the *credit adjusted quality* as the residuals from regression (4) in Table 2. The variables that enter the estimation of the revenue function are listed in Table 3.

Table 2: Regression of estimated dry rubber contents on credits given (own production)

Dry Rubber Content	(1) Credit Size	(2) Credit Size	(3) Dummy and Credit Size	(4) Village Dummies Added
log_credits	0.0711*		-0.170	0.168**
	(0.0407)		(0.153)	(0.0757)
dummy_credit_given		1.211**	3.516	-2.588**
		(0.572)	(2.154)	(1.050)
Constant	5.388***	5.307***	5.307***	10***
	(0.324)	(0.327)	(0.327)	(1.829)
Observations	666	666	666	666
R-squared	0.005	0.007	0.009	0.803

Source: Own production, based on original survey data.

Notes: Standard errors in parentheses. Coefficients of village dummies in (4) are not reported.

*** p<0.01, ** p<0.05, * p<0.1.

Table 3: Variables entering the production function (own production)

Variable	Label	Mean	Std. Dev.
Y_R	Value of rubber sold (IDR)	1.29E+08	2.74E+08
x1	Quantity of rubber traded (kg)	10324.5	19175.12
x2	Respondent's weekly working hours	17.70894	19.08984
x3	Transport capacity (kg)	2292.569	4293.935
x4	Distance to buyer (km)	62.34715	97.34556
x5	Monthly costs of hired labour (IDR)	1824851	3812094
x6	Weekly working hours of hired labour	22.01606	43.53851
x7	Credit given to all providers (IDR)	1.88E+08	1.35E+09

Source: Own production, based on original survey data.

In order to identify drivers of market power in the Jambinese rubber markets, each trader was asked for detailed information on three arbitrarily selected providers. These, together with characteristics of the trader him/herself, as well as characteristics of the market that they are operating within are used in the second stage regression (Table 4). The value of the respondent's house is an indicator of his/her wealth. The variable 'Informal_credit' refers to a money-lender or a rubber-trading warehouse that provides credit to suppliers. 'General_remoteness' represents the average distance between the respondent's location and the crumb rubber factories that can be accessed by the

Jambinese traders. The number of households of each village, as well as the agricultural area that is not dedicated to rice production were drawn from the PODES2008 dataset.

Table 4: Possible determinants of market power (own production)

Variable	Label	Mean	Std. Dev.
Lerner_Index	Lerner Index	0.502913	0.338702
number_trade~et	Number of rubber traders in village	12.44495	5.533072
log_house_cost	Value of respondent's house	18.48302	1.335337
providing_farms	Number of farms that respondent buys from	34.00459	40.64648
providing_tra~s	Number of other traders that respondent buys from	1.293578	7.445116
pos_in_chain_~s	Respondent's position in the value chain	3.061083	0.564227
transmigrasi_~e	Dummy for 'Transmigrasi' village	0.316514	0.465472
general_remot~s	General remoteness of respondent	161.6141	15.26856
dist_to_close~y	Distance to closest rubber factory	21.22286	14.46878
households_in~e	Number of households in village	676.1468	385.1528
no_podes2008_~a	Dummy for no data availability of some village characteristics	0.036697	0.188161
agric_area_no~e	Agricultural area, non-rice	5626.314	5734.092
formal_credit~e	Availability of formal credit institutions	0.311927	0.463635
informal_cred~e	Availability of informal credit institutions	0.036697	0.188161
credit_mio	Debt of provider with respondent (in million Rupiah)	1.382712	5.576457
quality_credi~d	Credit-adjusted quality of delivered rubber	93.5097	7.043681
little_information	Respondent's access to information is restricted	0.463964	0.4990745
discuss_prices	Respondent discusses prices with other stakeholders	0.6486486	0.4777513
price_agreements	Respondent agrees on prices with other stakeholders	0.2117117	0.4088286
ethnic_resp_java	Respondent's ethnicity is Javanese	0.4253394	0.4947676

Source: Own production, based on original survey data.

5. Results and discussion

5.1. First stage regression

The results of the first stage regression are presented in Table 5.[8] It has to be kept in mind that this estimation was done at the trader level, i.e. each observation is equivalent to one trader in the sample.

The DRC does not enter this estimation because the estimation is executed at the trader level. The quality of the output is equal to the average input of the input. The manipulation of the *basi* estimation is just one strategy of pushing down the input price towards the monopson price.

5.2. Model choice

The Likelihood Ratio Tests indicate that the model which omits hired labour is superior to the models including hired labour in the form of working hours or total costs, respectively; both null hypotheses of the restricted model to represent the data better cannot be rejected (test results 92.1% and 55.0%, respectively). This observation is robust against changes in all model specifications which we have experimented with.[9] We thus assume that model (1) represents the data best. Column (2) shows the results of the estimation based on the same choice of regressors as column (1), with the constraints on the curvature properties being imposed. Standard errors are not reported because their calculation would be biased since the regression is subject to constraints. For the second stage we use all coefficients from column (2). The data used in the revenue function estimation have been cleaned for outliers (nine observations out of 218 were dropped). If the outliers are included, the estimated coefficients are not very different, but fewer are statistically significant.

It comes as a surprise that the production factor 'hired labour' does not play a role in the revenue generating process. The explanation for this lies with the fact that the hired labour input is relatively unimportant, compared with the other inputs, since many traders do not rely on paid labour at all.

[8] x_R= rubber input, x_1=respondent's working hours, x_2=transport capacity, x_3=distance to buyer, x_4=hired labor, costs, x_5=hired labor, hours, x_6=all credit given

[9] Results for other specifications are available on demand.

Table 5: Regression results of revenue function

Elasticities at sample mean	(1) Unconstrained specification	(2) Constrained specification
ln_x1_Rubber	1.0268***	1.0236
	(0.0732)	
ln_x2_RespWork	0.0485***	0.0156
	(0.0001)	
ln_x3_TranspCapacity	-0.0214	0. 0137
	(0.274)	
ln_x4_Distance	0.0105	0.0118
	(0.4426)	
ln_x7_Credit	0.0019*	0.0003
	0.0735	
Constant	-1.274***	0.0764
	(0.0732)	
Observations	209	209
R-squared	0.987	0. 986

Source: Own calculations.

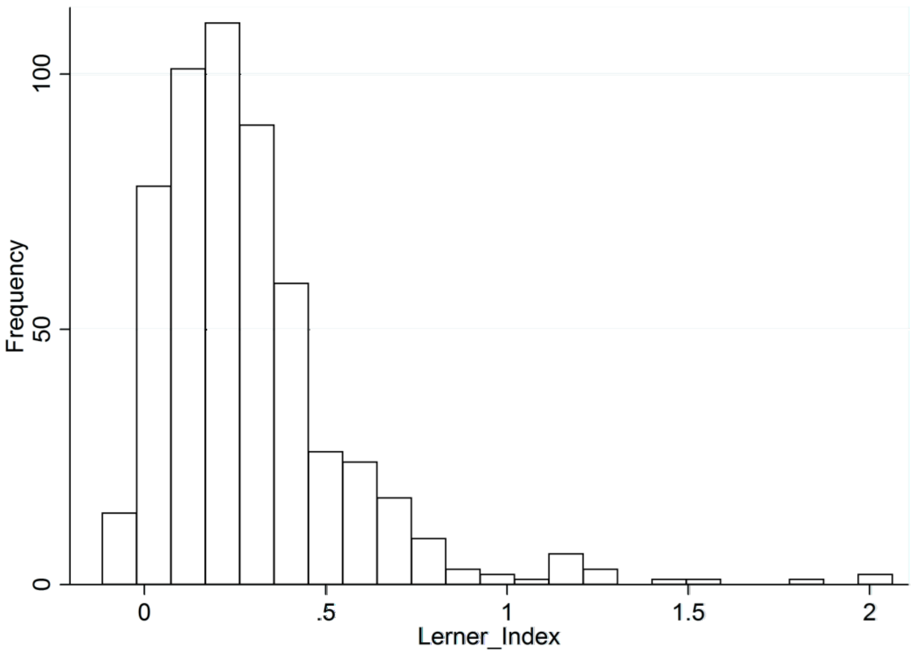
Notes: P-values in parentheses. Cross terms and dummies not reported. For full results, see Appendix 2.

*** p<0.01, ** p<0.05, * p<0.1.

5.3. Calculation of price deviation

Figure 4 shows the distribution of the calculated Lerner Indices. They indicate the percentage-deviation of the price that is paid from the MVP. If these values are equal, the Lerner Index takes the value 0. It is clear to see that the prices most traders pay for their rubber input is far below this input's MVP, a clear indication for market power.

Figure 4: Lerner indices of Jambinese rubber traders



Source: Based on own calculations.

5.4. Second stage regression

Table 6 shows the results of the second stage regression that evaluates determinants of the level of market power exercised by the surveyed traders. The number of observations is larger than in Table 5 because, in this case, the regression was done on a further disaggregated level. This was accomplished by integrating up to three different providers who the traders source from as separate observations. However, the number of observations is still smaller than in Table 2 as not all respondents bought rubber from each of the three providers under consideration in September 2012.

Table 6: Determinants of market power exercised by traders

Determinants	Lerner_Index
number_traders_karet	-0.0339***
	(0.0001)
log_house_cost	-0.00856
	(0.387)
providing_farms	-0.00130**
	(0.0344)
providing_traders	0.00558***
	(0.0001)
pos_in_chain_decimals	0.131***
	(0.0001)
transmigrasi_village	-0.119
	(0.494)
general_remoteness	0.00413**
	(0.0313)
dist_to_closest_auction_market	0.00479***
	(0.0001)
households_in_village	0.000445***
	(0.0001)
no_podes2008_data	0.406**
	(0.0155)
agric_area_non_rice	-3.32e-06**
	(0.0466)
formal_credit_available	-0.440***
	(0.0001)
informal_credit_available	-0.0701
	(0.541)
credit_mio	-0.00106*
	(0.0639)
quality_credit_adjusted	-0.00615
	(0.144)
little_information	0.157***
	(0.0001)
discusses_prices	0.148***
	(0.000110)
price_agreements	-0.248**
	(0.0115)
ethnic_resp_java	-0.0100
	(0.915)
Constant	-0.00257
	(0.996)
Observations	466
R-squared	0.869

Source: Own calculations.

Notes: Robust p-values in parentheses. Trader dummies not reported. Full results are available on demand.

*** p<0.01, ** p<0.05, * p<0.1.

5.5. Discussion

The deviation from the hypothetical price under perfect competition is influenced by a number of factors. Generally, the results are robust to changes in model specification, differing mainly in the levels of significance and the magnitudes of the estimated coefficients. The rather large value of the R^2 value (87%) shows that most of the variance of the dependent variable is explained. This is especially remarkable considering that one key determinant of the exact price is unobserved: the true quality of the delivered rubber is approximated by the credit-adjusted quality. As expected, with a greater market (more rubber traders, as well as a larger area of plantation agriculture) the Lerner Index decreases which is a sign of increasing competition. Surprisingly, villages that are bigger in terms of population are more prone to market power exercised by rubber traders. This does not contradict the previous result, since the agricultural (non-rice) area is a better predictor for market size than population size. One explanation for the positive relationship between village size and market power could be that anonymity can be expected to be greater in larger settlements, which reduces the general level of mutual trust and fairness. Another factor that reduces the Lerner Index (i.e. increases competition) is the proximity to an auction market. Also, the more remote the location of a trader is, the more successful he or she is in exercising his or her market power. Traders who buy from many other traders (and relatively fewer farmers) can be considered to be in a relatively good bargaining position which is indicated by an increasing Lerner Index. According to the data, the availability of at least one formal credit institution reduces the market power of traders which supports the arguments laid out in the theoretical part. However, it seems that farmers who do get more credit from the traders are also the ones who receive better prices compared to the ones without credits. The reason behind this is that farmers taking relatively little credit receive a higher interest rate due to the fixed costs of providing credit. In the context of this study, these fixed costs consist of the time the trader invests to generate and continue personal ties with the debtor, as well as the time spent observing him or her. While traders' general access to information is negatively related to their ability to exercise market power, the ones who discuss the prices which they pay with other traders generate higher margins. This is another indicator pointing towards collusion.

6. Conclusions

The results of this study indicate that agricultural traders in Indonesia, more specifically the Jambinese rubber traders, possess monopsonistic market power. This could be shown via an innovative approach that was enabled by an exceptional set of data: we had access to detailed sales data on a single-transaction level. Such data are at a much more disaggregated level than in any other examples in the literature. These data enabled the estimation of a revenue function, which was used to directly calculate hypothetical rubber prices under the assumption of perfect competition. The hypothetical prices were compared to the observed prices that middlemen for rubber pay to their providers via calculating Lerner Indices. These proved to be significantly different from zero – a clear indication of market power.

In a second stage, the Lerner Indices were regressed on different characteristics of the market, of the traders and of the relationships between traders and their providers. If local markets are smaller (less agricultural output, fewer traders), the traders have more opportunities to exercise market power, as well as having a more remote location. Improving infrastructure could reduce the influence of 'remoteness' on the functioning of the Jambinese rubber markets, as does the establishment of auction markets in a larger number. Since the availability of formal credit institutions is also negatively related to the exercise of market power, the support of farmers through micro credit might also help.

If our explanation of the influence of village size on market power is correct (and the verification of this certainly calls for further research), policy makers should focus on measures improving trust and comradeship between villagers.

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Appendices

Appendix 1: List of constraints imposed on the revenue function

Condition (a): Positive marginal products: $\frac{\delta(Re)}{\delta(x_i)} = \alpha_i + \alpha_{ii}\ln x_i + \sum_{\mathrm{j}=1}^{\mathrm{M}}(\alpha_{ij}\ln x_{\mathrm{j}}) > 0$

(a.1) $\alpha_1 + \alpha_{11}\ln x_{1,} + \alpha_{12}\ln x_2 + \alpha_{13}\ln x_3 + \alpha_{14}\ln x_4 + \alpha_{15}\ln x_5 + \alpha_{16}\ln x_6 > 0$

(a.2) $\alpha_2 + \alpha_{22}\ln x_2 + \alpha_{12}\ln x_1 + \alpha_{23}\ln x_3 + \alpha_{24}\ln x_4 + \alpha_{25}\ln x_5 + \alpha_{26}\ln x_6 > 0$

[...]

The x_i enter as the sample mean. Since the variables are normalised, the mean is 1, and the logarithm therefore 0. This eliminates all the $\alpha_{ij}\ln x_{\mathrm{j}}$ terms and leaves us with

(a.1) $\alpha_1 > 0$

(a.2) $\alpha_2 > 0$

[...]

Condition (b): Diminishing marginal products: diagonals of the Hessian matrix < 0 (Morey, 1986): $\frac{\delta^2(Re)}{\delta^2(x_i)} = \big(\alpha_{ii} + \alpha_i(\alpha_i - 1)\big)(\alpha_{\mathrm{ii}} + \alpha_{\mathrm{i}}\alpha_i) \ldots < 0$

(b.1): $\big(\alpha_{11} + \alpha_1(\alpha_1 - 1)\big) < 0$

(b.2): $\big(\alpha_{22} + \alpha_2(\alpha_2 - 1)\big) < 0$

[...]

Appendix 2: Detailed results of production function estimation

Elasticities at sample mean	Unconstrained	Constrained
ln_x1_Rubber	1.0268***	1.0236
	(0.0732)	
ln_x2_RespWork	0.0485***	0.0156
	(0.0001)	
ln_x3_TranspCapacity	-0.0214	0.0137
	(0.274)	
ln_x4_Distance	0.0105	0.0118
	(0.4426)	
ln_x7_Credit	0.0019*	0.0003
	(0.0735)	
ln_x1_square	-0.014	-0.0056
	(0.3829)	
ln_x2_square	0.013	-0.0006
	(0.3673)	
ln_x3_square	0.0206*	-0.0048
	(0.0.0909)	
ln_x4_square	-0.0108	-0.0027
	(0.1225)	
ln_x7_square	0.0001*	-0.0001
	(0.0698)	
ln_x1_ln_x2	0.0082	-0.0001
	(0.3939)	
ln_x1_ln_x3	0.0064	0.0005
	(0.5154)	
ln_x1_ln_x4	0.0011	0.0019
	(0.9021)	
ln_x1_ln_x7	0.0001	0.0001
	(0.5940)	
ln_x2_ln_x3	-0.0372***	-0.0015
	(0.0002)	
ln_x2_ln_x4	-0.0123*	-0.0002
	(0.0002)	
ln_x2_ln_x7	0.0001***	0.0001
	(0.0001)	
ln_x3_ln_x4	0.0028	0.0011
	(0.7225	
ln_x3_ln_x7	0.0001	0.0001
	(0.0509)	
ln_x4_ln_x7	0.0001	-0.0027
	(0.3293)	
dummy__x2	-00732.	-0.502***
	(0.3613)	(0.0001)
dummy__x3	-0.0035	0.0252
	(0.8839)	(0.4793)
dummy__x4	-0.087*	0.0928
	(0.0565)	(0.1154)
dummy__x7	1.276*	-0.3314***
	(0.0728)	(0.0001)
Constant	-1.274***	0.0764
	(0.0732)	
Observations	209	209
R-squared	0.987	0. 986

Source: Own calculations.

Note: P-values in parentheses.