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Marie-Catherine Riekhof

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Marie-Catherine Riekhof
CER-ETH – Center of Economic
Research at ETH Zurich
Zürichbergstrasse 18
8092 Zurich, Switzerland
mcriekhof@ethz.ch

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Abstract

Interest payments based on income flows are a common feature of informal loans. Such so-called 'interlinked loans' can be seen as an insurance against very low disposable incomes, as interest payments are lowest when income turns out to be low. This paper examines whether interlinked loans indeed contain an insurance premium and how those premia are determined. A simple theoretical model predicts that interest rates of interlinked loans increase with income volatility when insurance premia exist. Based on data from a small-scale fishery in India, calculations show that on average, lenders receive 25% of the income, which corresponds to an average interest rate of 49% p.a.. A panel data analysis confirms theoretical predictions that interlinked loans contain an insurance component paid by the borrowers.

Keywords: Interlinked loan, Insurance premium, Interest rate, Small-scale fishery, Informal insurance, Informal credit markets, Interlinked contracts, Risk-sharing, India

JEL Classification: O16, O17, Q22

H23; Q54; O31

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1 Introduction

In the rural areas of developing countries, many households have low and risky incomes. Formal insurance and credit are rarely available. Informal credit may be available, but high interest rates of 40—80 % p.a. are common (Duflo and Banerjee, 2010). High interest rates render credit-financed investments to increase future income or to lower its riskiness impossible. When income turns out to be low, interest payments lower the disposable part of this income even further.

The described situation may explain the prevalence of a special kind of loan that asks for interest payments in the form of income shares.[1] This type of loan is usually offered by whole-sale traders and often termed 'interlinked' loan, as it links conditions in the wholesale market to the loan's interest rate.[2] For interlinked loans, interest payments are high when income turns out to be high, but low when income turns out to be low. Thus, disposable income in low-income situations may turn out to be higher with an interlinked loan than with a standard loan. Interlinked loans can be interpreted as insurance against very low disposable incomes. This interpretation is related to the idea of Stiglitz (1974), who discusses sharecropping as a risk-sharing device: interlinked contracts in which workers provide a share of the harvest to the landlord instead of paying rent for the land.

The interpretation of interlinked loans as insurance raises the question whether borrowers pay for this additional service in the form of higher interest rates. Empirical evidence is rare, probably because the observation of these interest rates is difficult. Households may even report zero interest rates for interlinked loans, and may mention a price reduction when selling their output to the trader only if explicitly asked. The few existing calculations report relatively higher average interest rates from interlinked credit-output contracts in agriculture (Crow and Murshid (1992, 1994) and Bell et al. (1997)) and similar or relatively lower interest rates in the fisheries (Platteau and Abraham, 1987). Empirical investigations of interest rates that also consider variation within interest rates only exist for loans

[1] See Crow and Murshid (1992, 1994) as well as Bell and Srinivasan (1989); Bell et al. (1997); Minten et al. (2012) for the agricultural sector in Bangladesh and India, respectively, and this paper for fisheries in India, and Platteau and Abraham (1987) for fisheries in general.

[2] Contracts are called 'interlinked contracts' when they jointly determine the transaction conditions in at least two markets (Bell, 1988).

from money-lenders (e.g. Iqbal (1988); Mallick (2012)) and micro-finance institutions (e.g. Baquero et al. (2012))—at least to my knowledge.[3] Although interlinked loans play an important role in many developing countries with respect to their prevalence on informal credit markets[4] and possibly also with respect to their functionality as insurance, there is only limited understanding how their interest rates compare to other interest rates and how interest rates of interlinked loans are determined.

This paper contributes to the discussion by empirically examining which factors determine interest rates of interlinked loans and whether the interest rates from these loans contain an insurance premium. The analysis is based on data from a household survey in the small-scale fishery of Chilika Lagoon, India, in 2011. The data allow to construct an unbalanced panel comprising 319 loan contracts held by 234 households. In the empirical analysis of the interest rates, I can control for household unobservables and deal with possible endogenous matching—brought up with respect to interlinked contracts by Ackerberg and Botticini (2002)—by applying fixed effects at household level. A theoretical model is used to derive a testable hypothesis whether interest rates from interlinked loans contain an insurance premium.

The results are as follows. The calculation of the interest rates from interlinked loans around Chilika Lagoon shows that these interest rates are—on average—higher than other interest rates, namely 49% p.a. compared to 37% p.a. for other loans. If only interest rates from other informal loans are considered—which are 45% p.a. on average—, the average interest rate from interlinked loans is not significantly different. The theoretical model predicts that the interest rates of interlinked loans increase with the borrower's average income and decrease with the amount borrowed. If risk-aversion is taken into account, the model predicts that interest rates from interlinked loans contain an insurance premium that is increasing with the income volatility of the borrower working in fishery. The results from the econometric analysis of the panel data confirm the theoretical predictions. An increase in one standard deviation of the coefficient of variation of fishing income leads to

[3]Further, Ghatak (1983) analyzes rural interest rates at state level. Hatlebakk (2009) only uses one loan per household and explicitly excludes interlinked contracts.

[4]Wholesale traders provide the lion's share of informal credit (Hoff and Stiglitz, 1997). Also, interlinked loans often exist next to standard loans (see e.g. Minten et al. (2012)).

an increase of 0.17 percentage points in the interlinked interest rate, e.g. from 40% p.a. to 57% p.a.. This provides evidence for an insurance premium in the interest rates of interlinked loans. I additionally examine if downside risk-aversion matters for the interest rates of interlinked loans, but the empirically-estimated coefficient is not significant.

The key message of the analysis is that interest rates from interlinked loans contain an insurance premium. My results are in line with results from Guirkinger (2008), who provides evidence that borrowers are willing to pay a higher interest rate if this lowers the transaction costs or the risks. The close connection between informal loans and insurance has also been documented before—e.g. in Northern Nigeria, informal loan repayment is conditioned on the realization of random production shocks of the lender and the borrower (Udry, 1990).

The policy implications of the results relate to the insurance function of interlinked loans. First, the expansion of formal credit[5] is unlikely to reduce the prevalence of interlinked loans because of its insurance role, at least as long as few other insurance opportunities exist. Second, recent experimental studies focus on insurance take-up in combination with loans. Interestingly, insurance take-up seems to be higher when the characteristics of the insurance come close to the informal insurance provided by interlinked loans, e.g. when no upfront payment is needed and payments are guaranteed in case of need.[6] Quantitative information on the terms of interlinked loans may also help to design other insurance types. Third, interest rates influence intertemporal choices. In the case of natural resources, high interest rates may render the exhaustion of a renewable resource optimal (Clark, 1973). The idea that the introduction of insurance reduces interest rates is thus good news for natural resource management, as resource conservation may become more likely.

[5]Demirguc-Kunt et al. (2015) discuss the expansion of formal loan in rural areas. The expansion of financial services impacts interest rates of micro finance institutions (Guha and Chowdhury, 2013) and of money lenders (Mallick, 2012).

[6]Gin and Yang (2009) observe a lower loan take-up when the loan is coupled with a weather insurance that implies an upfront payment. Banerjee et al. (2014) find similar results for the purchase of mandatory health insurance with loan renewal. Liu et al. (2013) find a higher insurance take-up when the insurance fee is paid at the end of the period insured. Karlan et al. (2014) initially provide free rainfall index insurance and find that the demand for insurance is higher in subsequent years, once farmers have seen that payouts occur in case of need. Casaburi and Willis (2014) test an insurance in which the buyer of the crop deducts the premium from farmer revenues at harvest time—similar to the informal arrangements reported here—, and they find a very high take-up rate.

The paper proceeds as follows. The next section reviews further related literature and discusses differences between interlinked loans and sharecropping as well as other explanations for higher interest rates from interlinked loans. Section 3 describes the fishery around Chilika Lagoon. Section 4 presents the theoretical framework that guides the econometric model. Section 5 presents my empirical strategy, while Section 6 gives the main results. The following section presents the sensitivity analysis. Section 8 discusses the findings and concludes.

2 Literature

Interlinked contracts were initially discussed in relation to sharecropping,[7] meaning that instead of paying rent for the land, workers give the landlord a share of the output. A large literature attempted to explain why sharecropping exists although it seems to be inefficient: workers equate their marginal disutility from work to their share in output, times the marginal productivity of labor, instead of to equating it to the entire marginal productivity of labor (see e.g. Stiglitz (1974)). As mentioned, Stiglitz (1974) advanced the idea that interlinked contracts are a risk-sharing device in the setting of sharecropping. Thus, a higher output variance of a risk-averse worker in sharecropping should increase the landowner's share (see Stiglitz (1974) and Steiner (2011)[8]).

Limited liability of the worker is another explanation (see e.g. Basu (1992)). Limited liability relates to the understanding that a worker will not pay land rent in case of a crop failure. Accordingly, the worker's preferences are not aligned with land owner's. The worker maximizes expected income, while the land owner prefers the minimization of the possibility of a crop failure. Giving a share of the harvest to the land owner instead of a fixed land rent aligns preferences. Yet, in the case of limited liability, exploitation may occur (Shami, 2012) or a poverty trap may evolve (Mookherjee and Ray, 2002).[9]

Empirical evidence yields mixed results on whether the contract choice in sharecropping is

[7] See Bell (1988) and Bardhan (1980) for a general overview on interlinked contracts.

[8] Steiner (2011) argues in terms of grower and winery. The theoretical result was empirically tested by Allen and Lueck (1999) with data on contracts in North American agriculture.

[9] Exploitative contracting is also discussed by Koszegi (2014).

due to limited liability or to risk-sharing.[10] When examining contract choices empirically, Ackerberg and Botticini (2002) stress the problem of possible endogenous matching in some of the earlier research on sharecropping, while Prendergast (2002) addresses the issue of responsibility delegation.[11]

Risk-sharing and limited liability may also explain interlinked loans. One major difference between sharecropping and interlinked loans is that with the latter, the loan will be repaid at some point, transforming the initial borrower into the owner of the investment and allowing her to keep the total income. This reduces the possible inefficiency of share contracts, as the reduction in income is only temporary. It also gives an additional incentive to repay the loan. Then, referring to the literature on corporate finance, one can interpret the interlinked loan as 'common stock' and compare it to 'straight debt' (e.g. Ellingsen and Kristiansen (2011)).[12] Platteau and Nugent (1992) discuss the role of share contracts in the fishery and carve out differences between agriculture and fishing. Among others, fishing is risky compared to agriculture (Platteau and Nugent, 1992).

The present paper is also related to the literature on informal credit markets. In this literature, the general explanation for high informal interest rates started with monopoly power or perfect competition with high rates due to a high default probability to end with the imperfect information view (Hoff and Stiglitz, 1990), stressing fixed costs and transaction costs. For interlinked loans, transactions costs are comparably lower, as lenders who also do business on other markets already know the borrower. In addition, these lenders are in the unique position of taking specialized production assets or future income flows as collateral as e.g. discussed in Riekhof (2014), Noack (2013) and Hoff and Stiglitz (1997), respectively. Limited liability is also discussed there (see e.g. Stiglitz and Weiss (1981)). Bell et al. (1997) show that lenders are willing to advance larger loans in connection with interlinked contracts. The authors relate this to the debt seniority of the loans. In

[10] See Fukunaga and Huffman (2009), Arimoto (2005), Ackerberg and Botticini (2002), Laffont and Matoussi (1995), Allen and Lueck (1999), for instance.

[11] Other work on interlinkages focuses on financial services, e.g. interlinkages of wholesale transactions and saving (Casaburi and Macchiavello, 2015; Macchiavello and Morjaria, 2015).

[12] In rural economies, 'firms' are usually family businesses that operate on the subsistence level, face various market imperfections and informal arrangements, and for whom personal preferences may play a more important role, such that the household level may be the more appropriate level for analysis than a firm.

terms of interest rates, transaction costs saving suggest lower interest rates from interlinked loans.

The present study is closely connected to Platteau and Abraham (1987) and to Minten et al. (2012). Platteau and Abraham (1987) give a very comprehensive qualitative description of interlinked loan-output contracts, which corresponds to the situation of Chilika Lagoon in many ways. One major difference is that they report that fishermen have to pay a sales commission to the trader, which we did not find around Chilika Lagoon. The sales commission may be one reason why they find that interlinked interest rates tend to be lower or equal to other interest rates. In a similar direction as the one developed in this paper, Minten et al. (2012) use a regression analysis to compare prices in interlinked loan-output contracts with non-interlinked contracts in agriculture. They do not calculate interest rates, but compare prices on the output markets. They include a dummy for loan use in the past five years in a regression model with output prices as dependent variable. As the coefficient of the dummy is insignificant, they conclude that interlinkages do not lead to lower output prices. However, this result could also stem from the fact that borrowers already repaid their loans.

3 Data and descriptive analysis

3.1 Data collection

The dataset used in this analysis is based on a household survey. Frederik Noack and I conducted the survey together with an interviewer team in 17 fishing villages around Chilika Lagoon, Odisha, India, from February 21^{st} to April 12^{th}, 2011. Chilika Lagoon is located at the Bay of Bengal. It is the largest coastal wetland ecosystem on the Indian sub-continent (Mohapatra et al., 2007). Our survey was part of the 'Integrated Coastal Zone Management' Program, funded by the World Bank.

To collect the information, we stratified the entire fishing community according to ecological regions and village size. Within villages, we interviewed a total of 508 randomly-chosen

heads of households. In addition to the interviews, we conducted group discussions and spoke to local stakeholders like money-lenders, micro-finance organizations and teachers.

3.2 Description of the sample

This study focuses on interest rates. From the 508 interviewed households, 436 households were indebted. In total, 555 loans were reported, but information on the interest rate is only available for 430 loans. As the data set only provides information on current debt and not on loans already repaid, I only use information from loans that were taken out in 2009, 2010 and the first months of 2011. This gives 319 loans held by a total of 234 households.[13] Including loans from earlier years could lead to a selection bias, as information on loans taken out during that period, but already repaid, is missing. Solely considering these relatively recent loans reduces the probability of missing loans.

3.3 Chilika Lagoon fisheries

Chilika Lagoon is around 65 km long and 18 km wide (Sahu et al., 2014). It is a brackish water body with saltwater inflows from the sea and freshwater inflows from rivers. This generates different ecological conditions within the lagoon. They are reflected in the four sectors of the lagoon, namely the Northern, the Central, the Southern and the Outer Channel Sector. The Outer Channel Sector encompasses the lagoon's main connection to the sea. Villages in this sector are more difficult to reach. The Chilika Development Authority reports 32,530 active fishermen in the lagoon in 2010/11. Total annual catches 2010/11 of fish, crab, shrimp and prawn were 13 thousand metric tons (Directorate of Fisheries, Government of Odisha, India, 2013).

Predominantly, the male household members go fishing. They fish in groups and share the catch. On average, these so-called 'fishing units' have three members. If not all members belong to the same household, the groups use different remuneration systems. In most cases, the catch is divided into equal shares. The number of shares depends on

[13] Also, three observations are lost due to missing information on catches, reducing the sample from 323 recently taken out loans to 319 loans used in the sample.

the remuneration of capital: each member receives one share, but often, the boat owner receives an additional share. Sometimes, the net owner also receives an additional share. This implies that the catch is divided into n, $n+1$ or $n+2$ equal shares, with n denoting the number of fishing unit members. Paying wages to collaborators is not very common. Table 1 gives an overview of the frequency of the different remuneration systems. If the members of a fishing unit do not belong to the same family, the most important sharing mechanism includes that an additional share is given to the boat owner. Accordingly, the income share of capital is 25% for an average fishing unit with three members.

Table 1: Remuneration system of fishing units, n=234.

	Same family	Equal shares	Add. share boat owner	Add. share boat & net owner	Pay wage	Other/ no answer
Share of households with a certain system in their fishing unit	42.7 (in %)	8.5 (in %)	20.1 (in %)	9.0 (in %)	3.9 (in %)	15.8 (in %)

Fishermen use different methods to target different species. Fishing methods used to be related to the subcastes of the fishermen, but that system is disappearing. Over 80% of the households go fishing by boat. Fishing trips last two days on average. The fish caught is usually brought to so-called 'landing centres', where fish traders buy the fish and transport it to national or international markets or re-sell it on local markets.

Fishing incomes are low and vary across the three fishing seasons—summer, monsoon and winter—as shown in Table 2. There is no lean season as e.g. in agriculture, but interannual income variability, as in many fisheries (Kasperski and Holland, 2013).

Table 2: Average monthly fishing income per fishing unit for the three seasons, n=234.

Season	Summer	Monsoon	Winter
Average monthly catch per fishing unit in Rs ($\approx$ \$)	5829.01 (116.8)	6485.35 (130.0)	3844.17 (77.0)

Rs = Indian Rupees

The average of the coefficients of variation of all households' fishing incomes in the different seasons is 0.51, with a standard deviation of 0.33 across households. Some households face a rather stable fishing income over the seasons—e.g. for a coefficient of variation of $0.51 - 0.33 = 0.18$—while others face quite a lot of variation—e.g. for a coefficient of variation close to one ($0.51 + 0.33 = 0.84$).

Few households have an additional income source besides fishing. If they do, fishermen usually work as unskilled laborers to supplement fishing income.

3.4 Interlinked loans

Fish traders provide loans without asking for fixed interest payments, but with special agreements about buying the fish at a lower price from the borrower. Price differences are fixed at the beginning of the contract. The indebted fisherman has to offer his entire catch to the fish trader. If the fisherman catches a lot in terms of weight, the income lost because of the interest payments is larger than if he catches little. The principal is repaid separately. One could say that interest is paid in fish and the principal is paid in money. The principal is usually repaid at once.

As the interlinked loans normally do not have a fixed maturity, the repayment of the principal terminates the contract. This set-up is also reported by Platteau and Abraham (1987). The fishermen have an incentive to quickly repay the loan to keep the additional income. Still, due to their low income, it takes some time.[14] Traders do not necessarily favor quick repayment, as they have preferential access to the fish catch as long as the fisherman is indebted. As the data does not report a lot more old interlinked loans compared to standard loans, interlinked loans do not seem to create life-long indebtedness. Also, it is usually possible to take out another loan to repay an existing one.

The set-up of interlinked loans implies that each household can only have one interlinked loan, because it involves offering the entire catch to the fish trader the household is indebted to. An additional standard loan is possible.

[14] We have no information on the average duration of an interlinked loan.

To distinguish a trader that lends money from a trader that does not, I will call the former a 'trader-lender'. Some people around Chilika Lagoon reported that trader-lenders often deduct some baseline amount from the price they give to an unknown fisherman, as they first have to ensure that this fisherman is not indebted to another trader-lender.

I calculate the interest rates from interlinked loans based on the borrower's income loss from selling the fish at a lower price to the trader-lender. These calculations of the interlinked interest rates are either based on income forgone per day due to selling to the trader-lender instead of another trader, or on the fisherman's lost number of Indian Rupees per kg per day due to selling to the trader-lender instead of another trader. In the first case, I multiply the income forgone per day with the fishing days per month, differentiated for the three seasons, and then sum over all months to attain the yearly interest payments. In the second case, I multiply the amount lost with the catch in kilograms. The catch in kilograms means the catch of the total fishing unit times the share the household receives according to the sharing mechanism (see Table 1). Then again, I multiply the amount lost per day with the fishing days per month, differentiated for the three seasons, and then sum over all months to attain the yearly interest payments.[15]

Relating the resulting *total yearly interest payments* to the *yearly fishing income of the household* yields the share the trader-lender receives from the fisherman's income as interest payment. On average, the trader-lender receives 26.1%. This is very close to the average income share of capital in fishing income for an average fishing unit with three members, based on the sharing mechanism used most widely if the members of the fishing unit do not belong to the same family (see Table 1).

Relating the yearly interest payments to the loan amount yields the yearly interest rate. The average interest rate for a loan from a trader-lender is 49% p.a. In the next section, I connect the information on interlinked loan contracts with other credit contracts.

[15]This is an approximation. For loans taken out less than a year before the survey, it may over-estimate the interest rate, as the loan may haven been repaid the day after the survey. Still this is not very likely to be the case. Usually, it takes some time to accumulate the money to repay the loan. Otherwise, a loan would not be needed in the first place.

3.5 Informal credit markets around Chilika Lagoon

The description of the credit market is based on the collected data as well as on information from group discussions in the surveyed villages. It seems to be rather representative for the *fishing*-related part of the local population, but may not carry over to households mainly active in agriculture.

Several lender types are available on the credit markets around Chilika Lagoon. This is typical for rural credit markets in less developed economies (see e.g. Menkhoff et al. (2012)). Besides trader-lenders, who provide 16% of all loans, other informal sources—i.e. money-lenders, family, friends, neighbors—provide 34%. Formal sources—i.e. banks, micro-finance institutions, cooperatives—provide 50%. From the formal sources, 83% of the loans are loans from micro-finance institutions. Interlinked loans become more important if one considers the amount lent instead of the number of loans (see Table 3).

Interest rates are high and loan amounts comparably small, which is also typical for many rural credit markets in less developed economies. Table 3 depicts the average yearly interest rates as well as the average loan amounts. Interest rates are nominal and calculated as of 2011. The inflation rate is around 10% p.a., based on the consumer price index for agricultural laborers in Orissa (Government of Orissa, India, 2011). On average, interest rates from formal sources are lower than from informal sources, and interest rates from interlinked loans are highest. The difference between interest rates from interlinked loans compared to interest rates from all other loans—37% p.a.—is significant at the 5% level.[16] The result is similar to the findings from Crow and Murshid (1992, 1994) and Bell et al. (1997). When comparing interest rates from interlinked loans to interest rates from other informal loans, the Null-Hypothesis of equality cannot be rejected.[17]. This result is in line with the results from Minten et al. (2012) and Platteau and Abraham (1987)

The average loan amount is lowest from formal sources and highest in interlinked loans (which corresponds to the results in Bell et al. (1997)). The maximum loan amount, in turn, is from a standard informal loan.

[16]The p-value based on a Welch Two Sample t-test is 0.039.
[17]The p-value based on a Welch Two Sample t-test is 0.5802.

Table 3: Data on credit markets, n=319.

Loan type	Share in total number of loans	Min. amount	Max. amount	Average amount	Mean interest rate p.a.
Interlinked	16.0%	3000 Rs	200000 Rs	39894 Rs	49%
Other informal	34.2%	1000 Rs	300000 Rs	33759 Rs	45%
Formal	49.5%	3000 Rs	100000 Rs	17130 Rs	31%

Rs = Indian Rupees, in 2011, 50 Rs $\approx$ 1 US$. The 'share in total number of loans' does not add up tp 100% due to rounding errors.

The loans are usually not secured by formal collateral. Furthermore, only some loans—mainly loans from formal sources—have a fixed maturity.

Fishermen are self-employed such that households need credit for productive as well as consumptive purposes. In the case of productive needs, one sometimes differentiates between fixed capital and working capital (Ray, 1998). The need to finance fixed capital, like boats and nets, is relatively more important around Chilika Lagoon because fishermen normally sell the fish on the day they catch it. The need to finance working capital is only relevant if they go on longer fishing trips. Demand for consumptive credit arises if the income falls, for example, due to seasonality in fish catches, a decrease in prices or fish stocks, or if consumption needs increase, for example due to weddings, illness or death. The main purposes for taking out a loan for the fishery households around Chilika Lagoon are fishing activities as well as consumption needs (see Table 4).

Table 4: Importance of loan purposes, n=319.

Loan purpose	Share of loans with certain purpose
Fishing activities	55%
Consumption needs	19%
Ceremonies	10%
Repayment of other debts	4%
Education of children	2%
Emergencies	4%

One single loan can have several purposes.

4 Theoretical background

A special focus of this paper is on whether interest rates from interlinked loans contain an insurance premium. Households only demand insurance if they are risk-averse. In the following, I examine how risk-aversion of the borrower impacts the interest rate from interlinked loans. In share-cropping, theoretical results predict that risk-aversion of the borrower translates into a higher income share given to the land owner. In this section, I develop a simple model to derive a testable hypothesis that relates risk-aversion to the interest rate of interlinked loans.

The model should incorporate two important empirical observations. First, interlinked and standard loans usually co-exist. Second, interest rates of interlinked loans lie above interest rates of standard loans.[18] Many variables will be taken as exogenous. These variables are then being controlled for in the empirical analysis.[19]

4.1 Credit supply

Consider a small open economy in which two credit-contract types may be offered. The loan types only differ with respect to their interest payment rule. One contract is the standard credit contract that implies constant interest payments α, the α-contract. It encompasses all different kinds of 'business models' and does not distinguish, e.g. between a money lender and a micro-finance organization. The other contract is the β-contract, an interlinked contract. Here, interest payments occur in the form of the income share $1-\beta$, with $\beta > 0$ such that the borrower keeps a positive income.

Assume that the α-contract is always offered and that its interest rate is fixed in the sense that it is fully determined by household's and credit's characteristics. For the α-contracts, one can think of contestable monopolies with free entry and zero expected profits as market structure, as in Bell et al. (1997).[20]

[18] The set-up is tailored to the study case of the Indian small-scale fishery in the sense that I take the occurrence of a standard loan and an interlinked loan as given. In the end, this set-up seems to be rather the norm that the exception, as the studies on interlinked loans always state a reference interest rate.

[19] For a more encompassing treatment see Stiglitz (1974) and Steiner (2011).

[20] There could also be perfect competition on that market. The decisive feature is that α-contracts

For the β-contract, two aspects have to be taken into account. First, with lenders acting risk-neutral, e.g. because they can diversify between different borrowers, they will only offer the β-contract if interest payments are at least α. Otherwise, they will also offer an α-contract. Second, the β-contract calls for a monitoring of the borrower's income, as the borrower has an incentive to hide parts of his income to reduce interest payments. Not all lenders are in the position to do so. Only traders can easily observe the borrower's income,[21] but even they have to cooperate with each other to ensure that an indebted fisherman is not selling part of his catch before reporting to the trader he is indebted to. Together, the fish traders have a monopoly on β-contracts. As the α-contracts represent the exit option for the borrower, the traders will choose a limit-price policy. They will set β in a way that the household just prefers the β- to the α-contract.

4.2 Credit demand

Consider a household who demands loan amount A to increase its income. Income $g(A)$ is stochastic, with expected income $E(g(A)) = \mu$ and variance $\sigma^2 = E(g(A)^2) - \mu^2$. The loan amount A is taken as exogenous. Thus, the household only chooses between the two credit-contracts, the α-contract and the β-contract.

Let

$$r_\beta := (1 - \beta)\mu/A \tag{1}$$

denote the interest rate in the β-contract and

$$r_\alpha := \alpha/A$$

the interest rate in the α-contract.

are offered, that there is free entry in the sense that those lenders offering the β-contract could also offer α-contracts, and that expected payments below α would lead to an expected loss of the lender.

[21] The study of Jacoby and Mansuri (2007) on share-tenants in Pakistan support this set-up. They find that monitored sharecroppers achieve a higher output than unmonitored sharecroppers. Thus, the standard credit-contract would be the better alternative for lenders who cannot monitor the fishermen easily.

H-μ The interest rates from interlinked loans are increasing in the mean income:

$$\frac{\partial r_\beta}{\partial \mu} = \frac{1-\beta}{A} > 0.$$

H-A The interest rates from interlinked loans are decreasing in the loan amount:

$$\frac{\partial r_\beta}{\partial A} = -\frac{(1-\beta)\mu}{A^2} < 0.$$

Now assume that the household is risk-averse. Let the utility function u represent preferences over disposable income. Based on expected utility maximization, the household is indifferent between the two contracts if

$$E[u(\beta g - A)] = E[u(g - \alpha - A)]. \tag{2}$$

To derive further results, I approximate the utility function by a second order Taylor expansion. A third order Taylor expansion is discussed in Appendix A.2.[22] With a second order Taylor approximation, expected utility depends on mean income and income variance. This is compatible with expected utility maximization if the utility function is a quadratic function or if all distributions of the choice set of the household belong to the same linear class[23] (Sinn, 1990).

To derive an expression for the interlinked interest rate, re-write equation (2) in terms of the approximated utility function. With a second order Taylor approximation around the mean μ and assuming $u(\mu) = \mu$, one obtains

$$\beta\mu + u''(\beta\mu)/2\beta^2\sigma^2 = \mu - \alpha + u''(\mu - \alpha)/2\sigma^2. \tag{3}$$

Re-arranging and dividing by the loan amount A gives

$$r_\beta = r_\alpha + \frac{\sigma^2}{2A}(\beta^2 u''(\beta\mu) - u''(\mu - \alpha)). \tag{4}$$

[22] Appendix A.1 also gives results without using a Taylor-approximation.
[23] G and F belong to the same linear class if $F(x) = G(\delta x + \lambda)$ with $\delta > 0$.

For the comparison among several households, the income variance relative to the income level is a more appropriate measure. It can be depicted by the coefficient of variation $V := \sigma/\mu$. Another advantage is that the coefficient of variation is dimensionless. Also, with μ-σ preferences, $u'' < 0$, $u''' = 0$ and $u''(\beta\mu) = u''(\mu - \alpha) =: u''$. Then,

$$r_\beta = r_\alpha + \frac{V^2\mu^2}{2A}(\beta^2 - 1)u''. \tag{5}$$

Equation (5) shows the insurance premium in the interest rate from interlinked loans compared to standard loans when borrowers are risk-averse. Based on Equation (5), one can derive the following testable hypothesis for a risk-averse household:

H-V The interest rates from interlinked loans are increasing in the coefficient of variation:

$$\frac{\partial r_\beta}{\partial V} = 2V\frac{\mu^2}{2A}(\beta^2 - 1)u'' > 0.$$

The hypotheses $H - \mu$ and $H - A$ are related to the definition of the interest rate of interlinked loans (see Equation (1)), while $H - V$ depends on the preferences, i.e. on whether the borrower is risk-averse.

Two remarks are in order. First, the results also hold with free entry into the β-segment as long as lending traders are risk-averse and ask for a compensation of their risk-taking.[24] If the traders act risk-neutrally, free entry would drive the mark-up down to zero. Second, the model illustrates the importance of the α-segment in limiting the interest rates in the β-segment. Related to this, if the fishing income is permanently reduced, e.g. because of a long-run decrease in the resource stock, a lending trader will adapt β in new contracts to earn again at least the same expected interest payments as with an α-contract.

[24] They still have to be in a position to ensure that borrowers cannot secretly sell to a different fish trader.

5 Empirical strategy

To investigate the influences of income volatility, mean income and loan amount on the interest rates of interlinked loans—hypotheses *H-V*, *H-*μ and *H-A* derived in Section 4—, I run regressions. Two remarks are in order when specifying the empirical model based on the theoretical model. First, in the theoretical model, agents form expectations, while in the empirical model, I work with data on outcomes. As the fishermen are usually known quite well by the traders, e.g. in terms of fishing skills, methods used and past fishing record, it is sensible to assume that the expectations formed are quite accurate. Second, in the theoretical model, each interest rate of an interlinked loan has a corresponding standard interest rate (see Equation 5). The standard interest rate captures impacts from further household and loan characteristics on the general interest rate level. For example, if the household has a good credit history, it can borrow at lower rates compared to a household with a bad credit history. The household with the good credit history faces a lower standard interest rate and also a lower interest rate from an interlinked loan compared to a household with a worse credit history, all else equal. The standard interest rate that 'matches' the interlinked interest rate is a theoretical concept that cannot be observed in the data. To still capture this theoretical concept in the empirical analysis, I use interest rates both from standard loans and from interlinked loans as dependent variables. The coefficient of the independent variables measure the impacts on the interest rates in general, i.e. on the hypothetical interest rate. To capture the direct influences on the interest rates from interlinked loans, I interact those independent variables with a direct influence on the interlinked interest rate—i.e. on the insurance premium—with a dummy that is one if the interest rate belongs to an interlinked contract.

An important empirical problem within the context of this paper is that not all relevant household characteristics—especially with respect to risk preferences—can be observed. Non-observable household characteristics may influence the choice of an interlinked loan and thus its interest rate. To deal with the problem, I estimate a household fixed effect (FE) model. This approach can also deal with the possibility that unobservable household characteristics lead to endogenous matching (see e.g. Ackerberg and Botticini (2002)).

The loss of information from households with only one loan is a drawback of the fixed effect specification. To compare outcomes, I also apply an ordinary least square (OLS) estimation without household fixed effects. In both specifications, I control for variables taken as exogenous in the theoretical model.

Estimation with household fixed effects

From the 319 loans in the sample, 168 loans are held by households with only one loan in total, while 151 loans are held by households with more than one loan in total (see Table 5). The 151 loans are held by 67 households. When using households fixed effects, I lose the information from the households that only took out one loan. To be transparent on this, I exclude those loans from the sample used for the FE-estimations. Including those loans will not change the results, as their impacts are captured by the household fixed effects.

Table 5: Descriptive statistics loans, n= 319.

Number of loans of a household	interlinked loan	Standard loan	Total
One	25	143	168
More than one	27	124	151
Total	52	267	319

Interpretation: 124 standard loans are held by households that—in total—have more than one loan.

The baseline specification with household fixed effects takes the form

$$\begin{aligned}\text{interest rate}_{l,h} = {} & \xi_1 \text{interlinked dummy}_l + \xi_2(\text{interlinked dummy}_l \times \text{coefficient of variation}_h) \\ & + \xi_3(\text{interlinked dummy}_l \times \log(\text{mean income}_h)) \\ & + \xi_4(\text{interlinked dummy}_l \times \log(\text{loan amount}_l)) + \xi_5 \log(\text{loan amount}_l) \\ & + \Gamma L_l^T + \Lambda_h + c + \Theta D_y^T + \epsilon_{l,h}. \end{aligned} \tag{6}$$

The interest rate relates to the loan l from household h. The interlinked dummy is one if the interest rate belongs to an interlinked loan and is zero otherwise. The coefficient ξ_2 is the effect of income volatility on interest rates from interlinked contracts (H-V). 'Mean income'

denotes the household's average fishing income per year. Mean income and loan amount are included in logs. Both are interacted with the interlinked dummy to test H-μ and H-A. The 'log loan amount' is also included on its own to control for its general influence on interest rates. The general impact of mean income and income volatility is controlled for through the fixed effects. Further loan characteristics are summarized in the vector L_l. In line with the literature on credit markets, the vector L_l includes a dummy that is one if the loan is from a formal sources as well as a dummy that is one if a repayment date is fixed. This maturity dummy is always zero for interlinked loans, but especially for formal loans, repayment dates are specified. Table 12 in the Appendix gives more information on the credit market variables. The superscript T in Equation (6) indicates that the row vector is transposed to a column vector. The vector Λ_h represents the household fixed effects. The constant c captures the conditions in 2011 such that the yearly dummies in the vector D_y capture the difference of a specific year compared to 2011. The error term is $\epsilon_{l,h}$.

Ordinary least square estimation

The specification is similar to (6). Instead of the household fixed effects, several controls on the household level are included. Table 6 gives an overview over the variables and their definitions. It also gives some descriptive statistics. I briefly introduce the variables in the following.

The vector of household variables includes the log-income as well as the coefficient of variation. It also includes dummies that indicate whether the household owns a boat, a motor for the boat, or a cellphone, respectively, and dummies that indicate whether the household head has an additional income generating activity, whether he is literate and whether he ever attended vocational training. Another variable gives the number of working-age (age 12-60) male household members in the household. The vector also inlcudes dummies that control for the geographical sector the household lives in and a dummy that indicates whether the household belongs to the subcaste Khartia[25]. Two

[25]Khartia is the third most frequently observed subcaste around Chilika lagoon and the only subcaste with a significant influence on the interest rate.

Table 6: Definition and summary statistics of key variables on the household level, n=234.

Variable	Definition	Mean	St. Dev.	Min	Max
μ	Yearly fishing income (RS)	64,634.100	72,947.900	2,000.000	800,000.000
V	Coefficient of variation, seasonal fishing income	0.506	0.334	0.006	1.732
Boat	Dummy, equal to one if household owns a boat	0.808	0.395	0	1
Motor	Dummy, equal to one if household owns a motor	0.440	0.497	0	1
Literacy	Dummy, equal to one if household head is literate	0.641	0.481	0	1
Activity	Dummy, equal to one if household head has additional income generating activity besides fishing	0.179	0.385	0	1
Cell phone	Dummy, equal to one if household owns at least one cell phone	0.513	0.501	0	1
Males 12-60	Number of male household members aged 12-60	2.359	1.243	0	6
Training	Dummy, equal to one if household head ever attended vocational training	0.171	0.377	0	1
Attitude I	Dummy, equal to one if open to newcomers*	0.077	0.267	0	1
Attitude II	Dummy, equal to one if in favor of supporting people with self-inflicted problems*	0.115	0.320	0	1
Skewness	Standardized skewness, seasonal fishing income	0.071	0.255	−0.385	0.385
Central Sector	Dummy, equal to one if household lives in Central Sector	0.299	0.459	0	1
Northern Sector	Dummy, equal to one if household lives in Northern Sector	0.235	0.425	0	1
Southern Sector	Dummy, equal to one if household lives in Southern Sector	0.359	0.481	0	1
Outer Channel	Dummy, equal to one if household lives in Outer Channel Sector	0.107	0.310	0	1
Khatia	Dummy, equal to one if household belongs to the subcaste Khatia	0.073	0.260	0	1
Asset Index	For description see Table 11	0.014	1.218	−1.402	9.351

* The household head's attitude is measured by the answers to the following questions:
'Imagine: Two farmers keep goats on community land. Now, the land should be privatized and divided among the two farmers. After the division and privatization, each farmer can sell the land to get some money or he can keep it and use it for whatever he likes. The two farmers are of the same age, are healthy and have similar families. Both farmers have exactly the same amount of goats.
(a) The first farmer has always grazed his goats on the land. The second farmer has started to graze his goats on this land only one year ago.
(b) The first farmer, however, has sold most of his goats to buy luxury consumption goods. Now he is poor and only few of his goats remain. The second farmer has led a modest life. Now he is rich and has increased the size of his goat herd.
Which division of land would you think is fair? (A) The first farmer gets more land. (B) The second farmer gets more land. (C) Both get the same amount.'
I create one dummy called 'attitude I' that equals one if the answer in the first case was (B), i.e. the newly-arrived should receive more land, and a second dummy, 'attitute II' that equals one if the answer to the second question was (A).

additional dummies measure the attitude of the household head. One attitude-dummy measures whether the household head is open to newcomers while the other measures his attitude towards supporting people with self-inflicted problems (see Table 6 for details). In the OLS specification, the constant c captures the situation in 2011 in the Outer Channel sector.

6 Results

Table 7, column (1) gives results for the specification with household fixed effects. It shows that income volatility has a positive and significant impact on interest rates from interlinked loans. This confirms H-V. If the coefficient of variation is increased by one, the interest rate from interlinked loans is increased by 0.518 percentage points. If it is increased by one standard deviation—0.33 for all households—the interest rate is increased by 0.17 percentage points, i.e. from, say, 50% p.a., to 67% p.a.. The effect is quantitatively relevant. Moreover, the results provide evidence for an insurance premium in interlinked loans.

The average income has a positive and the loan amount has a negative impact on the interest rate level when the loan is part of an interlinked contract. This confirms H-μ and H-A.

Interest rate levels are lower when the loan is from a formal lender. The other variables have no significant influence.

Table 7, column (2) presents results for the OLS-specification. The impact of income volatility on the levels from interest rates of interlinked loans is still positive and significant, but smaller than in the specification with household fixed effects. Re-estimation based on the same sample used for the FE-specification gives a coefficient around 0.4 (see Table 7 column (3)). To examine whether the different sample sizes drive the differences in estimates, I test whether estimated coefficients differ significantly. The Null-hypothesis of equal coefficients between the two OLS-estimations cannot be rejected.[26] The result

[26]To test cross-model hypotheses, I apply a 'Seemingly unrelated estimation'. Then, I test whether the coefficients of 'V x Interlinked' in the estimations based on the larger and the smaller sample, respectively, are identical. The χ^2 statistic is 0.62 with the corresponding p-value of 0.4300. The Null-hypothesis of

Table 7: Fixed effect (FE) and OLS regression results for interest rates.

Dependent variable:	(1)		(2)		(3)	
Interest rate	FE, households with several loans		OLS, whole sample		OLS, households with several loans	
	Coeff	(p-value)	Coeff	(p-value)	Coeff	(p-value)
Interlinked Contract	0.0462	(0.970)	0.569	(0.371)	0.316	(0.806)
V x Interlinked	0.518**	(0.012)	0.286**	(0.023)	0.412**	(0.013)
Log(μ) x Interlinked	0.336**	(0.014)	0.209***	(0.009)	0.198*	(0.060)
Log(A)	0.0371	(0.416)	−0.00970	(0.528)	−0.00445	(0.884)
Log(A) x Interlinked	−0.384***	(0.002)	−0.288***	(0.000)	−0.260**	(0.015)
Maturity	0.0195	(0.743)	−0.00778	(0.700)	−0.0174	(0.736)
Formal loan	−0.176**	(0.016)	−0.161***	(0.000)	−0.109	(0.123)
Y2009	0.0215	(0.812)	−0.0479	(0.260)	0.0134	(0.858)
Y2010	−0.00261	(0.962)	−0.0261	(0.472)	0.0176	(0.761)
V			−0.0576	(0.105)	−0.159**	(0.019)
Log(μ)			0.0104	(0.451)	0.0130	(0.580)
Boat			−0.0488	(0.298)	−0.211	(0.131)
Motor			−0.0284	(0.304)	−0.105**	(0.021)
Literacy			0.0101	(0.722)	−0.0210	(0.668)
Activity			0.0550	(0.128)	0.103	(0.168)
Khartia			−0.0960**	(0.037)	0.0733	(0.515)
Cell phone			−0.0427	(0.193)	−0.0390	(0.512)
Males 12-60			0.00719	(0.520)	0.0116	(0.468)
Training			0.0685	(0.101)	0.0679	(0.234)
Attitude II			0.0107	(0.811)	0.170*	(0.062)
Attitute I			0.0396	(0.217)	−0.0221	(0.728)
Central Sector			−0.145***	(0.009)	−0.455***	(0.002)
Northern Sector			−0.101**	(0.042)	−0.430***	(0.004)
Southern Sector			−0.0495	(0.329)	−0.374**	(0.010)
Constant	0.104	(0.827)	0.676***	(0.001)	1.098***	(0.005)
Observations	151		319		151	
Adjusted R^2	0.369		0.265		0.324	

p-values in parentheses;* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; error terms clustered at the household level.

suggests that the difference in estimated coefficients is not driven by the different samples. The higher estimated coefficient in the FE-specification points towards an omitted variable bias in the OLS-specification.

The influences of mean income and the loan amount on interlinked interest rates remain significant and of similar size as in the fixed effect specification.

7 Robustness

The results from Table 7 show that the interest rates from interlinked loans increase with the coefficient of variation. I perform various checks to assess the robustness of this finding. The robustness checks for the specification with fixed effects are reported below. Results for the OLS-specification can be found in Appendix A.4.

First, informal loans in general—and not only interlinked loans—may play an insurance role. To assess this, I construct a dummy that equals one if the loan is a standard loan from an informal source, namely from money lenders, friends, neighbours or relatives. I then interact the dummy with 'V', 'log(μ)' and 'log(A)', as I did with the interlinked dummy. Column (1) of Table 8 gives the results for the FE specification. The effect of income volatility on the interest rate from other informal loans is not significant.

Second, one could suspect that in addition to the coefficient of variation—related to the second moment of a distribution—, standardized skewness—related to the third moment of a distribution—also affects the interest rates. It may possibly change the impact of 'V' (see Appendix). In the FE specification, the impact of standardized skewness is not significant and income volatility remains highly significant (Column (2) of Table 8).

Third, one could argue that the interest rate is jointly determined with other conditions of the credit contract. To properly deal with this, a simultaneous equation approach with well-identified instruments would be needed. As it is difficult to find these instruments, I follow Menkhoff et al. (2012) and check the robustness of the results by comparing results when taking the respective variables out. The respective variables are 'log(A)' and 'log(A) x

equal coefficients cannot be rejected.

Table 8: FE regression results for interest rates, different specifications.

Dependent variable: Interest rate	(1) with other informal loan dummy	(2) including skewness	(3) without amount	(4) without maturity	(5) without formal loan dummy	(6) only recent loans
Interlinked Contract	1.030	−0.0668	−2.447*	0.0698	0.630	0.841
	(0.504)	(0.957)	(0.060)	(0.956)	(0.664)	(0.655)
V x Interlinked	0.671***	0.421**	0.727***	0.513**	0.462*	0.880**
	(0.006)	(0.047)	(0.009)	(0.014)	(0.051)	(0.025)
Log(μ) x Interlinked	0.338**	0.343**	0.196*	0.330**	0.302*	0.319*
	(0.022)	(0.016)	(0.080)	(0.020)	(0.053)	(0.072)
Log(A)	0.121	0.0387		0.0343	0.0452	0.0642
	(0.216)	(0.398)		(0.436)	(0.328)	(0.270)
Log(A) x Interlinked	−0.492***	−0.378***		−0.380***	−0.398***	−0.458***
	(0.004)	(0.002)		(0.002)	(0.001)	(0.001)
Maturity	0.0140	0.0188	−0.0119		−0.0673*	0.0145
	(0.829)	(0.754)	(0.835)		(0.091)	(0.805)
Formal loan	−0.167*	−0.179**	−0.195**	−0.159***		−0.153**
	(0.094)	(0.014)	(0.015)	(0.002)		(0.039)
Y2009	−0.00827	0.00612	−0.0634	0.0118	0.0137	
	(0.930)	(0.946)	(0.603)	(0.901)	(0.879)	
Y2010	−0.00604	−0.00756	−0.00801	−0.00542	−0.0169	−0.00200
	(0.910)	(0.886)	(0.920)	(0.920)	(0.763)	(0.970)
Other informal	1.451					
	(0.180)					
Other informal x V	0.164					
	(0.356)					
Other informal x log(μ)	−0.0284					
	(0.668)					
Other informal x log(A)	−0.139					
	(0.143)					
Sk x Interlinked		0.261				
		(0.202)				
Constant	−0.707	0.0967	0.519***	0.137	−0.0212	−0.176
	(0.475)	(0.840)	(0.000)	(0.765)	(0.965)	(0.770)
Observations	151	151	151	151	151	129
Adjusted R^2	0.378	0.376	0.189	0.373	0.336	0.363

p-values in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; error terms clustered at household level.

Interlinked', 'maturity' as well as 'formal loan'. The impact on income volatility on interest rates of interlinked loans do not change much when taking out 'maturity' and 'formal loan' (see Table 8, columns (3)-(5)). When taking out 'log(loan amount)' and 'log(loan amount) x interlinked', the coefficient of the 'Interlinked Contract'-dummy becomes significant. Interlinked loans may be closely connected to the loan size. This is also suggested by Bell et al. (1997) and the descriptive statistics in Table 3: the average loan amount is highest for interlinked loans. Also, the coefficient of 'V x Interlinked' increases a little but, it is not significantly different from the value in the baseline specification.[27] This suggests that the insurance premium is not connected to the loan amount.

Another important empirical problem is that households may select only certain loans into an interlinked contract. I directly model the household's choice of loan contract type based on a treatment-regression (TR) model. The reason is a potential selection bias. The interlinked loans may differ from the standard loans for reasons other than the loan type—i.e. the treatment status—per se. I propose that the *purpose of the loan* is an exogenous instrument in this context. First, for the households, more risky loans are those that change their income stream—like fishery investments—while other loans may just cover needs. The purpose of the loan influences their choice of loan type, i.e. whether an insurance is warranted. Second, it can reasonably be argued that the lender cannot observe the true reason of a loan such that the interest rate will be independent of the true purpose. Hence, I construct two dummies, 'fishing loan' and 'consumption loan' that equal one if the loan purpose is either fishing or consumption, respectively, and that equal zero otherwise. Then, I estimate equation (6) with

$$I_l = \begin{cases} 1, & \text{if} \quad \lambda_1 \text{fishing loan} + \lambda_2 \text{consumtion loan} + \nu_{l,h} > 0 \\ 0, & \text{otherwise} \end{cases} \tag{7}$$

to model treatment assignment. The error term is $\nu_{l,h}$. For the estimation, I use 'treatreg'

[27] To test the difference in coefficients, I demean the variables and estimate both specifications—with and without 'log(loan amount)' and 'log(loan amount) x interlinked'—as Seemingly Unrelated Estimation. Then, I test whether the coefficients of 'V x Interlinked' in both specifications are significantly different from each other (HO: both are equal). The p-value is 0.2786.

in STATA, which is based on Heckman (1978), as well as 'itreatreg' discussed in Brown (2011). Table 9 reports results. The impact of income volatility of interest rates from interlinked loan-output contracts is as before.

Table 9: TR-Regression results for interest rates

Dependent variable: Interest rate		
Interlinked Contract	0.599	(0.329)
V x Interlinked	0.283**	(0.019)
Log(μ) x Interlinked	0.209***	(0.006)
Log(A)	−0.0102	(0.486)
Log(A) x Interlinked	−0.287***	(0.000)
Maturity	−0.00781	(0.688)
Formal loan	−0.162***	(0.000)
Y2009	−0.0506	(0.218)
Y2010	−0.0280	(0.424)
V	−0.0565*	(0.098)
Log(μ)	0.0103	(0.438)
Boat	−0.0499	(0.266)
Motor	−0.0292	(0.271)
Literacy	0.0106	(0.699)
Activity	0.0553	(0.111)
Khartia	−0.0944**	(0.033)
Cell phone	−0.0435	(0.170)
Males 12-60	0.00766	(0.478)
Training	0.0678*	(0.088)
Attitude II	0.0124	(0.776)
Attitute I	0.0391	(0.204)
Central Sector	−0.143***	(0.007)
Northern Sector	−0.0997**	(0.037)
Southern Sector	−0.0486	(0.318)
Constant	0.677***	(0.000)
Observations	319	

p-values in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; error terms clustered at household level.

The first stage is given in Table 10. The table does not report marginal effects, so only the sign of the coefficient can be easily interpreted. A fishing-related loan increases the likelihood of taking out an interlinked loan. The estimated correlation between the treatment-assignment errors and the outcome errors is −.274. Based on a likelihood-ratio test, the null hypothesis of no correlation between the treatment errors and the outcome cannot be rejected (p-vlaue = 0.541). It suggests that there is no impact through the selection of certain loans into an interlinked contract on the interest rate of interlinked loans.

Table 10: Probit regression results for interlinked contracts

Dependent variable: Interlinked contract		
Fishing loan	1.4707***	(0.307)
Consumption loan	0.0220	(0.3398)
Constant	−2.0492***	(0.294)
Observations	319	
Pseudo R^2	0.168	

p-values in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; error terms clustered at the household level.

Limited liability may be important for explaining the existence of interlinked loans around Chilika Lagoon. With the understanding that the borrower defaults if the disposable income turns out to be too low, the preferences of the lender and the borrower become disaligned. In this setting, all agents are assumed to be risk-neutal. A risk-neutal household prefers a behaviour which leads to the highest expected income. The risk-neutal lender prefers a behaviour that leads to the highest expected interest payments. In case of the α-contract, interest payments are fixed, but expected interest payments are lower when the household acts risky, as default becomes more likely. Usually, a collateral requirement aligns preferences. If a collateral is not available, interlinked loans can also align preferences. To examine whether indebted households with and without interlinked loans differ in their limited liability, I compare the group means of mean yearly fishing income, average asset index and the value of fishing assets. In addition, I also compare the average coefficient of variation between the two groups. To test for significant differences between the two groups, I apply a Welch Two Sample t-test with the equality of means in H_0. Table 11 reports descriptive statistics for indebted households with and without interlinked loans related to poverty. There are no significant differences between these two groups. Accordingly, limited liability at the household level does not seem to be a good explanation for why some households have an interlinked loan and others do not. The two groups do not differ in their possibilities to provide collateral.

Another fact that makes limited liability as explanation for high interest rates of interlinked loans less likely is the following. The reason for taking out most loans is related to fishing

Table 11: Comparing indebted households with and without interlinked loan, n=234.

	With interlinked loan	Without interlinked loan	p-value Welch Two Sample t-test*
Mean yearly fishing income	66,820 Rs	64,010 Rs	0.7828
Average asset index	-0.008	0.020	0.8571
Average coefficient of variation	0.48	0.51	0.4944
Value fishing assets	97	111	0.2817
Number of observations	52	182	

The asset index of a household is the first component from a principal component analysis based on different assets (here: Bike, Motorbike, Mobile Phone, TV/Radio, House, Land, all measures being normalized by subtracting the mean and dividing by the standard deviation) based on Filmer and Pritchett (2001). It is positively correlated with wealth.

*: H_0 is the equality of means.

activities. This usually means buying a boat, a motor or new nets. These items, in turn, can be seen as collateral. Similarly, most households own a fishing boat in the first place. Markets for used fishing boats exists, such that fishing boats can serve as collateral. Around Chilika Lagoon, limited liability may explain why certain borrowers choose informal over formal loans, but it is unlikely to explain interest payments in form of an income share.

Last, a selection bias may distort results. Contracts taken out after 2008, but already repaid, are missing. As the maturity of most contracts is at least one year, I reduce the sample to those contracts taken out in 2010 and 2011 and re-estimate the baseline specification. Results do not change tremendously (see Table 8, column (6)).

8 Discussion and conclusion

This study examines the interest rates of interlinked loans in the small-scale fishery of Chilika Lagoon, India. The interest rates of interlinked loans are, on average, higher than interest rates of standard loans, but not significantly different of interest rates of other informal loans. Still, the analysis provides evidence that interest rates from interlinked loans contain an insurance premium. The insurance premium increases with the income volatility of the borrower. Risk-averse fishermen are willing to pay for the insurance-like service of interlinked loans. In the risky small-scale fishery sector without any formal

insurance opportunities, the interlinked loan seems to provide an important additional service. As the income share the fish trader receives as interest payments is of a size similar to the average share allocated towards the remuneration of capital within fishing units, one could argue that the insurance premium is within a reasonable range.

In spite of the insurance mechanism in interlinked loans, the set-up of the contracts can be a source of worry. Once a fisherman has entered the contract, his income partly depends on the lender, and if price reductions are too high, the fisherman is not likely to be able to repay the loan. Potential misuse of the contracts can be reduced by the following factors. First, the analysis shows the importance of standard loans, as they limit the interest rate the fish trader can ask for. Second, it has to be ascertained that a certain level of competition between the lending fish traders still prevails, even though, up to a certain point, limited entry is needed for the system to work. Some competition between lenders gives the borrowers the possibility to repay the old loan with a new loan

The importance of interlinked loans can be reduced when other insurance means are introduced. The analysis also gives insights into successful set-ups of insurances connected to loans: interlinked loans contain no upfront payment for that insurance and automated 'payouts' in low income states.

The focus of this paper is on the interest rates of interlinked loans in fisheries. Although this includes a discussion of the reasons for interlinked loans, my analysis is on the level of the loans. Household characteristics are mainly controlled for by household fixed effects. The examination which kind of households takes out interlinked loans, either exclusively or in combination with standard loans, is left for future research. Such an analysis may also deepen the understanding of the connection between resource use, risk and interest rates when markets are missing.

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A Appendix

A.1 Results without approximation of the utility function with a Taylor-expansion

Assume the trader chooses β such that expected interest payments are equal to α, i.e. $(1-\beta)\,E[g] = \alpha$. In this case, $g - \alpha = g - (1-\beta)E[g]$. Also,

$$E[\beta\, g - A] = E[g] - (1-\beta)\,E[g] - A = \beta\, E[g] - A$$
$$\text{var}[\beta\, g] = \beta^2\,\text{var}[g] < \text{var}[g - (1-\beta)\,E[g]] = \text{var}[g].$$

By construction, contracts have the same mean, but the β-contract has lower variance. Thus, a risk-averse borrower will strictly prefer the β-contract. The trader can increase total payments in the β-contract such that they are higher than in the α-contract. Also, as there is no uncertainty about the loan amount A,

$$E(A) = A, \quad \text{var}[\beta\, g - A] = \text{var}[\beta\, g] \quad \text{and} \quad \text{var}[g - (1-\beta)\,E[g] - A] = \text{var}[g - (1-\beta)\,E[g]].$$

The insurance premium is $E[\beta g] - E[g - \alpha]$. In case of $\text{var}(g) = 0$, the trader has to set β such that interest payments are equal to α. This implies

$$\partial(1-\beta)/\partial\sigma > 0|_{\text{var}(g)=0}.$$

It shows that the income share kept by the trader-lender increases with the variance for an initial variance of zero.

A.2 The role of skewness for the insurance premium

As some empirical evidence suggests that downside risk-aversion matters (see e.g. Chiu (2010) and references therein), one could consider a third order Taylor approximation around the mean to examine the robustness of the results with respect to the inclusion of skewness.[28] Convex marginal utility, i.e. $u''' > 0$, represents downside risk-aversion. In that case, households prefer greater skewness. The set-up of the β-contract reduces the variance, but also the absolute value of skewness. As skewness can take positive as well as negative values, its effect on the insurance premium is ambiguous. In the following, I give details.

With unstandardized skewness $s := E[(g-\mu)^3]$, the absolute value of skewness in the case of a β-contract is smaller than in case of an α-contract,

$$|\text{s}[\beta\, g]| = |E[(\beta\, g - \beta\mu)^3]| = \beta^3|E[(\, g - \mu)^3]| < |E[(\, g - \mu)^3]| = |E[(\, g - \alpha - (\mu - \alpha))^3]|.$$

[28] See Chiu (2010) for a discussion on consistency between preferences for greater skewness and expected utility maximisation apart from a cubic utility function and a third-order Taylor approximation.

As skewness can take positive and negative values, one cannot determine a clear effect on the risk premium. For $s < 0$ ($s > 0$), the insurance premium a borrower who is downside-risk-averse is willing to pay in addition to the pure credit costs α is larger (smaller) than before, i.e. than with preferences that are independent of skewness or with $s = 0$.

With the standardize skewness $\bar{s} := s/\sigma^3$, equation (4) becomes

$$r_\beta = r_\alpha + \frac{\sigma^2}{2A}(\beta^2 u''(\beta\mu) - u''(\mu - \alpha)) + \frac{\bar{s}V^3\mu^3}{6A}(\beta^3 u'''(\beta\mu) - u'''(\mu - \alpha)).$$

The effect of a change in V on r_β is positive for $\bar{s} < 0$, and of $\bar{s}$ on r_β is negative,

$$\begin{aligned}
\frac{\partial r_\beta}{\partial V} &= 2V\frac{\mu^2}{2A}(\beta^2 u''(\beta\mu) - u''(\mu - \alpha)) + \frac{\bar{s}3V^2\mu^3}{6A}(\beta^3 u'''(\beta\mu) - u'''(\mu - \alpha)) \\
\frac{\partial r_\beta}{\partial \bar{s}} &= \frac{V^3\mu^3}{6A}(\beta^3 u'''(\beta\mu) - u'''(\mu - \alpha)).
\end{aligned}$$

A.3 Descriptive statistics

Table 12: Descriptive statistics loans

	All loans				
	count	mean	sd	min	max
Interest rate [p.a.]	319	0.385	0.254	0.020	1.680
Log(A)	319	9.839	0.802	6.908	12.612
Consumption loan	319	0.191	0.394	0	1
Fishing loan	319	0.545	0.499	0	1
Maturity	319	0.464	0.499	0	1
Interlinked loans					
Interest rate [p.a.]	52	0.485	0.399	0.039	1.680
Log(A)	52	10.218	0.866	8.006	12.206
Consumption loan	52	0.038	0.194	0	1
Fishing loan	52	0.942	0.235	0	1
Maturity	52	0.000	0.000	0	0
Other loans					
Interest rate [p.a.]	267	0.366	0.211	0.020	1.230
Log(A)	267	9.765	0.770	6.908	12.612
Consumption loan	267	0.221	0.416	0	1
Fishing loan	267	0.468	0.500	0	1
Maturity	267	0.554	0.498	0	1

Loan Amount 'A' measured in Rs, Maturity: Dummy, equal to one if a repayment date is fixed; Consumption loan: Dummy, equal to one if loan purpose is consumption (among others); Fishing loan: Dummy, equal to one if loan purpose is fishing (among others)

A.4 Additional Results OLS estimation

For the OLS specification, I perform the same robustness checks that I performed for the FE specification.

In the OLS specifications, the coefficient of 'Other informal x V' is positive and significant (see column (1) of Table 13). At first sight, this suggests that other informal loans also play an insurance role. Unlike before, the impact of the Coefficient of Variation 'V' in this specification is significant and negative. In absolute terms, the magnitude of its coefficient is similar to the magnitude of the coefficient of the interacted term. It turns out that the sum of both effects is not significantly different from zero (see Table 14). Overall, the income volatility has no significant impact on interest rates from other informal loans. The overall effect of income volatility on the interest rates from interlinked loans is significantly different from zero at the 10 percent level (see Table 14).

Standardized skewness has a significant effect on the interest rate of interlinked loans in the OLS-estimation. Also, the effect of income volatility on interest rates of interlinked loans slightly

Table 13: OLS regression results for interest rates, modified.

Dependent variable: Interest rate	(1) with other informal loan dummy		(2) including skewness		(3) only recent loans	
	Coeff	(p-value)	Coeff	(p-value)	Coeff	(p-value)
Interlinked Contract	0.389	(0.574)	0.629	(0.326)	0.572	(0.493)
V x Interlinked	0.332**	(0.010)	0.211*	(0.098)	0.301**	(0.016)
Log(μ) x Interlinked	0.210***	(0.009)	0.208***	(0.009)	0.193*	(0.068)
Log(A)	−0.0289	(0.333)	−0.00956	(0.535)	−0.0295	(0.106)
Log(A) x Interlinked	−0.269***	(0.000)	−0.291***	(0.000)	−0.269***	(0.001)
Maturity	−0.00421	(0.839)	−0.00717	(0.725)	−0.0310	(0.267)
Formal loan	−0.132*	(0.084)	−0.160***	(0.000)	−0.123***	(0.002)
Y2009	−0.0483	(0.247)	−0.0451	(0.290)		
Y2010	−0.0238	(0.510)	−0.0307	(0.391)	−0.0249	(0.502)
V	−0.106**	(0.030)	−0.0551	(0.144)	−0.0750*	(0.052)
Log(μ)	0.00641	(0.713)	0.0119	(0.386)	0.00656	(0.661)
Boat	−0.0489	(0.293)	−0.0473	(0.306)	−0.0303	(0.566)
Motor	−0.0304	(0.266)	−0.0331	(0.228)	−0.0327	(0.302)
Literacy	0.00843	(0.767)	0.00303	(0.915)	0.0114	(0.725)
Activity	0.0529	(0.146)	0.0586	(0.101)	0.0339	(0.428)
Khartia	−0.0903*	(0.051)	−0.0876*	(0.062)	−0.158***	(0.006)
Cell phone	−0.0422	(0.196)	−0.0411	(0.211)	−0.0444	(0.255)
Males 12-60	0.00675	(0.550)	0.00845	(0.441)	0.0109	(0.387)
Training	0.0675	(0.107)	0.0637	(0.128)	0.0796*	(0.090)
Attitude II	0.0147	(0.742)	0.0189	(0.670)	0.0276	(0.602)
Attitute I	0.0369	(0.270)	0.0438	(0.169)	0.0364	(0.351)
Central Sector	−0.144***	(0.009)	−0.139***	(0.010)	−0.160**	(0.028)
Northern Sector	−0.0944*	(0.061)	−0.0994**	(0.042)	−0.114	(0.112)
Southern Sector	−0.0469	(0.357)	−0.0447	(0.369)	−0.0744	(0.313)
Other informal	−0.377	(0.329)				
Other informal x V	0.133**	(0.047)				
Other informal x log(μ)	0.00599	(0.795)				
Other informal x log(A)	0.0321	(0.357)				
Sk			−0.0138	(0.759)		
Sk x Interlinked			0.292*	(0.066)		
Constant	0.870**	(0.012)	0.665***	(0.001)	0.881***	(0.000)
Observations	319		319		250	
Adjusted R^2	0.263		0.272		0.273	

p-values in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; error terms clustered at household level.

Table 14: Comparison of the total impact of income volatility on the interest rates from (A) interlinked loans and (B) other informal loans.

	Other informal loans	Interlinked loans
H0	coef[V]+coef[V x Informal]=0	coef[V]+coef[V x Interlinked]=0
p-value	0.5791	0.0680

Based on Wald tests of linear hypotheses.

decreases (Columns (2) of Table 13). In the FE specification, the impact of standardized skewness was not significant and income volatility remained highly significant. As skewness is related to downside risk-aversion and thus to preferences, this suggests that controlling for household unobservables matters.

For the remaining robustness checks based on OLS, qualitative results are as for the FE specification.

Table 15: OLS regression results for interest rates, modified.

Dependent variable: Interest rate	(1) without amount		(2) without maturity		(3) without formal loan dummy	
	Coeff	(p-value)	Coeff	(p-value)	Coeff	(p-value)
Interlinked Contract	−0.725	(0.260)	0.574	(0.367)	0.829	(0.217)
V x Interlinked	0.326**	(0.040)	0.286**	(0.023)	0.263**	(0.039)
Log(μ) x Interlinked	0.0546	(0.348)	0.209***	(0.008)	0.210***	(0.009)
Maturity	−0.00752	(0.695)			−0.0628***	(0.001)
Formal loan	−0.173***	(0.000)	−0.167***	(0.000)		
Y2009	−0.0941*	(0.060)	−0.0472	(0.267)	−0.00785	(0.852)
Y2010	−0.0309	(0.465)	−0.0254	(0.482)	−0.0247	(0.501)
V	−0.0669*	(0.063)	−0.0573	(0.104)	−0.0439	(0.262)
Log(μ)	0.00958	(0.512)	0.0105	(0.442)	0.0145	(0.306)
Boat	−0.0358	(0.457)	−0.0486	(0.299)	−0.0499	(0.286)
Motor	−0.0447	(0.132)	−0.0298	(0.270)	−0.0230	(0.431)
Literacy	0.0109	(0.700)	0.0102	(0.720)	0.00530	(0.859)
Activity	0.0896**	(0.016)	0.0545	(0.129)	0.0462	(0.235)
Khartia	−0.139***	(0.005)	−0.0948**	(0.038)	−0.0945*	(0.054)
Cell phone	−0.0467	(0.179)	−0.0425	(0.194)	−0.0446	(0.178)
Males 12-60	0.00518	(0.675)	0.00700	(0.529)	0.00768	(0.509)
Training	0.0787*	(0.055)	0.0684	(0.100)	0.0613	(0.144)
Attitude II	0.00721	(0.875)	0.0107	(0.811)	0.00475	(0.915)
Attitute I	0.0411	(0.231)	0.0399	(0.207)	0.00483	(0.885)
Central Sector	−0.125*	(0.075)	−0.145***	(0.009)	−0.172***	(0.002)
Northern Sector	−0.110	(0.100)	−0.100**	(0.046)	−0.144***	(0.003)
Southern Sector	−0.0544	(0.432)	−0.0493	(0.335)	−0.0900*	(0.067)
Log(A)			−0.00885	(0.559)	−0.000129	(0.994)
Log(A) x Interlinked			−0.289***	(0.000)	−0.308***	(0.000)
Constant	0.607***	(0.000)	0.665***	(0.001)	0.529**	(0.014)
Observations	319		319		319	
Adjusted R^2	0.149		0.268		0.220	

p-values in parentheses; * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; error terms clustered at household level.

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16/256 H. Gersbach
Co-voting Democracy

16/255 H. Gersbach and O. Tejada
A Reform Dilemma in Polarized Democracies

16/254 M.-C. Riekhof and J. Broecker
Does the Adverse Announcement Effect of Climate Policy Matter? - A Dynamic General Equilibrium Analysis

16/253 A. Martinez-Cruz
Handling excess zeros in count models for recreation demand analysis without apology

16/252 M.-C. Riekhof and F. Noack
Informal Credit Markets, Common-pool Resources and Education

16/251 M. Filippini, T. Geissmann, and W. Greene
Persistent and Transient Cost Efficiency - An Application to the Swiss Hydropower Sector

16/250 L. Bretschger and A. Schaefer
Dirty history versus clean expectations: Can energy policies provide momentum for growth?

16/249 J. Blasch, M. Filippini, and N. Kumar
Boundedly rational consumers, energy and investment literacy, and the display of information on household appliances

16/248 V. Britz
Destroying Surplus and Buying Time in Unanimity Bargaining

16/247 N. Boogen, S. Datta, and M. Filippini
Demand-side management by electric utilities in Switzerland: Analyzing its impact on residential electricity demand

16/246 L. Bretschger
Equity and the Convergence of Nationally Determined Climate Policies

16/245 A. Alberini and M. Bareit
The Effect of Registration Taxes on New Car Sales and Emissions: Evidence from Switzerland

16/244 J. Daubanes and J. C. Rochet
The Rise of NGO Activism

16/243 J. Abrell, Sebastian Rausch, and H. Yonezawa
Higher Price, Lower Costs? Minimum Prices in the EU Emissions Trading Scheme

16/242 M. Glachant, J. Ing, and J.P. Nicolai
The incentives to North-South transfer of climate-mitigation technologies with trade in polluting goods

16/241 A. Schaefer
Survival to Adulthood and the Growth Drag of Pollution

16/240 K. Prettner and A. Schaefer
Higher education and the fall and rise of inequality

16/239 L. Bretschger and S. Valente
Productivity Gaps and Tax Policies Under Asymmetric Trade

16/238 J. Abrell and H. Weigt
Combining Energy Networks

16/237 J. Abrell and H. Weigt
Investments in a Combined Energy Network Model: Substitution between Natural Gas and Electricity?

16/236 R. van Nieuwkoop, K. Axhausen and T. Rutherford
A traffic equilibrium model with paid-parking search

16/235 E. Balistreri, D. Kaffine, and H. Yonezawa
Optimal environmental border adjustments under the General Agreement on Tariffs and Trade

16/234 C. Boehringer, N. Rivers, H. Yonezawa
Vertical fiscal externalities and the environment

16/233 J. Abrell and S. Rausch
Combining Price and Quantity Controls under Partitioned Environmental Regulation

16/232 L. Bretschger and A. Vinogradova
Preservation of Agricultural Soils with Endogenous Stochastic Degradation

16/231 F. Lechthaler and A. Vinogradova
The Climate Challenge for Agriculture and the Value of Climate Services: Application to Coffee-Farming in Peru

16/230 S. Rausch and G. Schwarz
Household heterogeneity, aggregation, and the distributional impacts of environmental taxes

16/229 J. Abrell and S. Rausch
Cross-Country Electricity Trade, Renewable Energy and European Transmission Infrastructure Policy

16/228 M. Filippini, B. Hirl, and G. Masiero
Rational habits in residential electricity demand

16/227 S. Rausch and H. Schwerin
Long-Run Energy Use and the Efficiency Paradox

15/226 L. Bretschger, F. Lechthaler, S. Rausch, and L. Zhang
Knowledge Diffusion, Endogenous Growth, and the Costs of Global Climate Policy

15/225 H. Gersbach
History-bound Reelections

15/224 J.-P. Nicolai
Emission Reduction and Profit-Neutral Permit Allocations