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# In-kind credit provision through contract farming and formal credit markets

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## Abstract

Access to credit is a key prerequisite for the development of smallholder agriculture. However, rural credit markets are typically characterized by market failures and smallholder credit access is limited. Resource-providing contracts are an institutional tool to overcome credit market failures through the provision of production inputs in the form of in-kind credit. Previous research has shown that interlinkage of contract and credit helps farmers overcome financial constraints, foster production investments, and hence increase productivities and income. However, if and how such contract schemes affect farmers' overall demand for and access to formal credit from other sources is not yet well understood. In this article, we therefore investigate the associations of the provision of in-kind credit and farming households' formal credit demand and ability to receive formal credit. We use data of 463 oil palm producers in Ghana and show that participation in contract farming is associated with an increase in credit demand. Concerning credit approval, we find that the outstanding debt of the in-kind credit scheme is associated with a substantially lower likelihood of credit acceptance. However, the results also suggest that farmers can fully compensate this negative effect by informing the bank about the contract, and thus the source of the debt. This indicates that debt acquired from resource-providing contract schemes does not

necessarily pose an additional credit constraint to farmers. [EconLit Citation G21, G23, O16, O17].

**KEYWORDS**
contract farming, credit constraints, Ghana, inkind credits, oil palm

## 1 | INTRODUCTION

Access to credit is a key prerequisite for the further development of smallholder agriculture (Abraham & Pingali, 2020; Burke et al., 2019). The ability to obtain credit permits timely purchase of inputs or the realization of profitable investments, thereby significantly increasing agricultural productivity and efficiency (Ali et al., 2014; Martey et al., 2019; Nordjo & Adjasi, 2020; Seven & Tumen, 2020). However, the rural credit market is typically characterized by information asymmetries and selection biases leading to credit rationing or in extreme cases to the nonexistence of formal credit markets (Carter, 1988; Conning & Udry, 2007; Duong & Izumida, 2002; Stiglitz & Weiss, 1981). To date, credit as a means of financing agricultural operations in sub-Saharan Africa is therefore very rare (Adjognon et al., 2017) and strategies to increase credit access bear the potential for considerable welfare gains (Burke et al., 2019).

Contract farming is an institutional tool to overcome failures in agricultural markets and has gained relevance in the agricultural sector of developing countries. Such contracts generally specify output conditions, such as the quantity, quality, and price of a sale. Contract farming has shown to improve the welfare of farmers, especially if contracts include input provisions in the form of in-kind credit, so called resource-providing contracts (Otsuka et al., 2016; Ruml et al., 2020). In-kind credit can include planting materials or agrochemical inputs that farmers pay back through parts of their harvest. For capital-intensive crops, credit duration can last several seasons and repayments are typically coordinated in cooperation with formal bank institutes. Thereby, resource-providing contracts interlink the credit, input, and output market. Previous research has shown that interlinkage of contract and credit helps farmers overcome financial constraints, foster production investments, and hence increase productivities as well as income (Khanal et al., 2020; Mishra et al., 2018; Otsuka et al., 2016; Ragasa et al., 2018; Ruml & Qaim, 2020; Ruml et al., 2020). If and how resource-providing contract schemes affect farmers' overall demand for and access to formal credit, however, is not yet well understood. In this article, we aim to address this research gap.

Due to the provision of in-kind credit, resource-providing contracts are likely to directly alleviate some of the credit constraints farmers may face. However, in-kind credit schemes typically only include credit provisions for the contracted crop. Given that smallholder farmers often grow more than one kind of crop and have inseparable production and consumption decisions (Singh et al., 1986), effects of resource-providing contracts on farmers' demand for and access to credit are complex. In particular, the changes in the demand for and access to credit with respect to inputs and investments for other (non-contracted) crops or for household needs such as school fees or medical expenditures are unclear. In addition to demand side aspects of credit, entering a contract is likely to have both positive and negative implications for the supply of credit by formal lenders. For example, if contracts enable farmers to use written contracts or land titles as collateral, lenders may be more likely to approve credit applications. If in-kind credit from contracts increase farmers' outstanding debt, lenders might consider contracted farmers as riskier applicants and reject credit applications.

To the best of our knowledge, Khan et al. (2020) is so far the only study concerned with the implications of contract farming for credit behavior of farmers. However, Khan et al. (2020) mainly focus on farmers' loan repayment ability and only analyze farmers' credit demand for a relatively short time frame of one planting season. Loans for long term investments such as the installment of plants, which are often needed for capital intensive and high value crops, are therefore not covered by Khan et al. (2020). The objective of this study is, therefore, to investigate how the provision of in-kind credit affects farming households' formal credit demand and ability to receive formal credit. To approach these research objectives, this article uses primary data on 463 oil palm farmers

in the South of Ghana. Ghana is a particularly telling context for research on strategies to enhance credit access, since less than 8% of Ghanaian farming households have full access to credit (Issahaku et al., 2020). The data in this article cover farmers within distinct institutional arrangements, as 106 farmers produce without any contracts, 193 farmers produce with verbal marketing contracts that do not include in-kind credit provisions, and 164 households have resource-providing contracts with a long-term in-kind credit scheme.

The results of this case study show that an in-kind credit scheme is associated with an increased demand for credit. Concerning credit approval, we find that the outstanding debt of the in-kind credit scheme is associated with a substantially lower likelihood of credit acceptance. However, the results indicate that farmers can fully compensate this negative effect by informing the bank about the contract, and thus the source of the debt. This suggests that banks most likely differentiate between general outstanding debt and outstanding debt as part of a contract farming scheme. Debt acquired from the resource-providing contract scheme thus does not have to pose an additional credit constraint to contracted farmers.

## 2 | CONCEPTUAL FRAMEWORK

Productive activities often involve a time lag between the point in time at which inputs need to be procured and the point at which outputs are achieved. If self-financing is not possible or not desired, inputs need to be obtained on credit (Giné, 2011). Because farmers in developing countries often have limited options for self-finance, smallholders require credit for several different purposes (Duong & Izumida, 2002). Agricultural production is a main purpose of credit demand due to the seasonality of most crop production systems and capital-intensive investments, such as the installation or extension of plots or the adoption of new technologies. But also, other off-farm income activities, school expenses, or emergency situations may require farm households to demand credit.

An extensive body of theoretical research has shown that prevailing information asymmetries about borrowers' conditions and efforts as well as considerable enforcement costs in the rural credit market lead to situations in which farmers with insufficient collateral are neither capable of borrowing the amount they desire at the current interest rate, nor can they obtain more credit by increasing their willingness to pay a higher interest rate (Carter, 1988; Duong & Izumida, 2002; Stiglitz & Weiss, 1981). Theory also shows that lack of credit can be caused by farmers' demand characteristics. When insurance markets are absent or incomplete, asymmetric information forces lenders to shift much of the contractual risk onto the borrower. In this scenario, farmers may find it too risky to borrow and voluntarily withdraw from the credit market, even when sufficient collateral is in principle available (Boucher et al., 2008).

Within a contract farming scheme, farmers and contracting companies may be able to overcome some of these failures through output and input market interlinkages. Farmers and contracting companies enter a (mostly written) contractual agreement, in which the farmer obliges to supply the harvest produce to a company. In return, the company obliges to purchase the supplied produce at a preagreed price. Because the farmer is able to commit credibly to credit repayment through a deduction from the harvest, the contracting company is able to provide production inputs in the form of in-kind credit such as planting material, tools, and agrochemicals.[1] For these arrangements, the crop itself or the plot is generally used as collateral for the loan (Grosh, 1994; Otsuka et al., 2016). Moreover, agribusinesses have additional advantages over formal banks with regard to agricultural lending since agribusiness can control the quality of the production inputs that they provide (Abebe et al., 2013; Grosh, 1994) and have an intrinsic motivation to ensure high quality produce (Marcoul & Veyssiere, 2010). As a result, agribusinesses have higher incentives to monitor farmers and their credit behavior than formal banks and thus tend to have more information on farmers' resource endowments and expected

[1]Similarly, Casaburi and Willis (2018) show that contract farming can substantially improve agricultural insurance markets. Through contract farming, farmers do not have to pay insurance premiums before the planting season, since they can commit credibly to pay the insurance premium at harvest time. This removes the intertemporal transfer of money usually entailed in insurance purchases and can thereby lead to higher take-up of insurance among farmers.

credit behavior (Grosh, 1994; Key & Runsten, 1999). The advantageous position of agribusinesses as lenders has helped them use the provision of in-kind credit to incentivize farmers' engagement in contractual relations (Abebe et al., 2013; Ashraf et al., 2009; Codjo et al., 2020; Marcoul & Veyssiere, 2010).

Beyond the in-kind credit provided by the contracting company, farmers can have additional credit demands from external sources. This external demand for credit is a composite of the demand for credit for the production of the contracted crop that may not be covered by the contracting firm, for the production of other noncontracted crops, and for other, nonagricultural household needs. Through several different channels can participation in a contract farming scheme affect this aggregate demand for external credit.

First, under the assumption of diminishing returns to inputs, participation in a contract and the provision of in-kind credit is likely to reduce the external credit demand for inputs for the contracted crop. Second, farmers may decide to use some of the inputs, such as tools or agrochemicals, that were originally reserved for the contracted crop, for noncontracted crops instead.[2] In both cases, aggregate demand for external credit is lower for contracted farmers than for noncontracted farmers. Third, entering a contract can reduce credit demand also beyond the direct provision of in-kind credit due to income gains. Since contract farming schemes often lead to higher income among farmers (Otsuka et al., 2016; Ragasa et al., 2018; Ruml et al., 2020), farmers' ability to self-finance productive activities rises and the demand for credit is reduced.

Yet there are also several channels through which contract farming participation potentially increases aggregate demand for external credit. First, to cover for emergency expenses, farmers may choose or need to sell farm produce (Dillon, 2020). Depending on how much of their harvest farmers have committed to the contracting company, farmers lose all or some of this self-finance ability, thereby causing an increase of external credit demand. For many crops, premature selling of produce represents a very costly form of self-finance and often results from an unavailability of credit in the first place (Stephens & Barrett, 2011). However, some crops, such as cassava, can be harvested throughout the year and therefore are widely sold by farmers to cover emergency expenses (Barratt et al., 2006; Haggblade et al., 2012). Second, since the contract provides farmers with a secure sales market, farmers' business risk is substantially reduced. The risk balancing framework by Gabriel & Baker, 1980 postulates that farmers may then choose to take higher risks elsewhere. Therefore, contract participation may help farmers produce crops or apply production techniques for which they would otherwise be too risk averse (Escobal & Cavero, 2012; Fafchamps & Pender, 1997), or too financially constrained (Simmons et al., 2005).

Since theory provides arguments for both an increase and a decrease of aggregate credit demand from external sources due to contract farming participation, the direction of the net effect is unclear. Yet, we hypothesize that provision of in-kind credit and positive income effects reduce credit demand to an extent that is larger than the positive effects coming from reduced possibilities to self-finance through selling of produce and changes in production systems from higher incomes and risk-taking abilities.

Our first hypothesis therefore reads:

H1: *Aggregate credit demand from external sources decreases due to participation in a resource-providing contract farming scheme.*

A farmer's involvement in contract farming can also positively as well as negatively affect the willingness and ability of external lenders to supply credit to that farmer. Negative effects can first come from the fact that the in-kind provision of credit implies that the farm household has an outstanding debt throughout the production period. If the contract and in-kind credit is only seasonal, the debt is repaid in full immediately after the harvest. Most contracts, however, have longer durations and in-kind credit results in outstanding debt lasting several seasons.

[2]A wide variety of contracts with different characteristics exists and it should be noted that some contract farming schemes offer farmers cash credit for general operation purposes (Mishra et al. 2018) or for private expenditures (Deb & Suri 2013). However, such cases are rarely reported in the existing literature and do not represent the norm.

Such contracts are prevalent in capital-intensive cash crop sectors, particularly for palm or tree crops. Outstanding debt and negative bank account balances have shown to be a source of credit rationing by formal lenders in the context of Ghanaian smallholder farmers (Awunyo-Vitor et al., 2014). Second, the involvement of agribusinesses in the rural credit market as potential suppliers of credit raises the level of competition among lenders. Theoretically, Petersen and Rajan (1995) have shown that lenders are less likely to finance credit-constrained firms when market concentration is reduced due to fewer possibilities for lenders to internalize the benefits of assisting firms.

At the same time, there are also a few channels through which contracting of farmers can increase the supply of credit by formal lenders. Participation in contract farming often leads to higher incomes (Maertens & Vande Velde, 2017; Otsuka et al., 2016; Ragasa et al., 2018; Ruml & Qaim, 2020), more stable incomes (Minten et al., 2009), as well as higher levels of commercial orientation (Maertens & Vande Velde, 2017). These factors are associated with better access to credit from formal lenders by farmers in Ghana (Asante-Addo et al., 2017; Awunyo-Vitor et al., 2014). Furthermore, own screening of credit applicants is costly for lenders, especially in rural setting. Oftentimes, lenders will therefore look for borrower characteristics that are more easily observable and can be associated with high repayment rates. Such signals may be costly voluntary insurance or the possession of formal land titles (Bauchet et al., 2018; Dower & Potamites, 2014). It is therefore plausible that the simple fact that an agribusiness was willing to commit to a contract with a farmer acts as a positive signal to external lenders that the farmer has successfully undergone screening by the contracting firm (Grosh, 1994). This signal is stronger the riskier the contract is for the agribusiness.

Since there are again positive and negative channels through which participation in contract farming can affect the supply of credit by formal lenders, the direction of the net effect is ambiguous and will most likely depend on the factors that lenders consider for their decision to approve or reject a credit application and the information that is available to the lender. Our second hypothesis therefore states:

H2: *The effect of participation in a resource-providing contract farming scheme on the likelihood that formal lenders approve credit applications depends on the information about the farmer that is available to the lenders.*

## 3 | METHODOLOGY

### 3.1 | Case study

The objective of this article is to test how in-kind credit, provided through resource-providing contracts, affect households' demand for and access to formal credit. The resource-providing contract considered here is an oil palm contract for farmers in the South of Ghana. This specific contract sets an annual price per ton of fresh fruit bunches (FFBs) and guarantees farmers that the company will buy the delivered output at this price. After signing the contract, farmers receive in-kind assistance for the establishment of their plantations. This assistance includes planting materials, tools, agrochemicals, and labor. In contrast to Khan et al. (2020), the credit considered here is not a fixed package as every farmer decides individually what kind of support and how much she wants to take up. On average, the amount of debt accumulated until palm maturity and repayment is around 1500 EUR per hectare of contracted oil palm plantation.

The value of the in-kind assistance is registered as a debt at a formal bank with 11.5% annual interest rates. The plantation itself is used as collateral in this transaction. As soon as the palms bear fruit, farmers sell their harvest to the contracting company, which detracts 25% of the sales value for credit repayment. Thus, the contracting company monitors and manages the repayment schedule. The term of the contract depends on the time it takes the household to repay the initial loan, which in most cases is somewhere between 20 and 25 years. Throughout this time, farmers can demand additional production inputs for the maintenance of the plantation, such as agrochemicals. The costs for these in-kind provisions are additionally deducted from the remaining 75% of the sales value.

This contract presents an interesting case study for the objective of this article. Farmers' access to in-kind credit is nearly unlimited and therefore the volume of the in-kind credit that a farmer obtains depends solely on her

individual demand. The resulting debt is registered at a formal bank and the written contract specifies a secure sales market at stable prices for approximately 20–25 years. Against this background, we examine in the following whether and how participation in such an in-kind credit program through contract farming affects farmers' demand for and access to additional credit from external formal lenders.

## 3.2 | Sampling and data

In 2018, we collected cross-sectional data in three bordering regions in the South of Ghana. In the Central Region, we sampled farmers with resource-providing contracts. In the Western Region, we sampled farmers with a verbal marketing contract that only arranges the terms of the sales, such as quantity and price in advance, and does not provide any in-kind credit or other form of support. In the Ashanti Region, we sampled independent producers without any contract. The latter two groups of farmers are used to construct a valid counterfactual, as will be discussed in more detail.

Due to the location of the contract farming schemes and their catchment areas, farmers with marketing contracts and farmers with resource-providing contracts could not be sampled within the same region. These areas were initially determined by the availability of large lands for the establishment of the company plantation and processing facilities. Moreover, independent producers are scarce within the contracted areas, because almost all oil palm producing households in the contracted villages participate in the schemes. Few non-contracted villages in the area were not considered eligible for contract farming by the companies and could not be a suitable counterfactual. However, the industrial oil palm value chain in the South of Ghana is continuously growing and new contract farming schemes are emerging. Thus, we sampled independent producers in the bordering region, where a new scheme (offering marketing contracts) was scheduled for implementation. The selected villages in the Ashanti region were already preregistered to participate in this new contract farming system,[3] although farmers were unaware of the scheme at the time of the survey.

Whether companies offer marketing contracts or resource-providing contracts strongly depends on their long-term market strategy and financial capacity. Offering in-kind credits requires vast initial investments and well-developed financial infrastructure yet enables a long-lasting partnership with farmers who remain under contract until the debt is paid in full. Establishing such a partnership is becoming increasingly important, with rising competition among contracting companies in the sector. However, at this point, the catchment areas of companies do not overlap, as discussed above.

Before the sampling, we investigated whether the three regions are comparable in our analyses. The local Ministry of Food and Agriculture assisted in the selection of the schemes and regions with their regional expertize. Subsequently, we held focus group discussions across regions to check for differences in farm, household, and village structures. Lastly, Table A1 in the appendix shows that the regions are very similar in their agroecological and socioeconomic conditions.

We applied a two-stage sampling procedure for all three groups of farmers. First, villages were sampled based on lists provided by the contracting companies. In the villages in the Ashanti region where no contract farming scheme is yet in place, villages were sampled based on a list provided by the Ministry of Food and Agriculture containing all villages selected for the upcoming contract farming scheme. Within the sampled villages, the team of interviewers compiled lists of all contracted households or independent producers with the help of village officials. Based on these lists 75% of the households were randomly sampled and interviewed.

In addition to the information on farm production and household welfare, we collected data on all credit applications households had filed within the 10 years before the data collection. Since the resource-providing contract launched in 2008, the time span of 10 years before the survey captures the entire time a farmer has been under contract.[4] The data include the amount of credit for which a household applied, the documents that were

[3]We received the list of preselected villages from the Ministry of Food and Agriculture.

[4]Although the credit scheme launched in 2008 and all farmers participating signed up in 2008, some plantations were only established in 2009 and 2010. Thus, we checked the data for any cases in which a household has applied for a credit before plantation establishment to avoid identification bias. No such cases were reported.

provided as information, and the collateral, as well as the socioeconomic and demographic characteristics of the applicant. The final sample consists of 463 households, out of which 164 produce with the resource-providing contract. Overall, 115 credit applications were filed by the farmers in the sample. For the following analyses, we restricted the sample to 96 credit applications that were filed at formal credit institutes. Thus, loan requests made towards informal local lenders, family, and friends are excluded.

## 3.3 | Variables and models

We investigate the relationship between in-kind credit schemes through resource-providing contracts and the demand for additional credit from external sources (Hypothesis 1) using two different outcome variables. First, we investigate if participation in the resource-providing contract farming scheme is associated with an increased likelihood to apply for credit from a formal lender.

We therefore estimate the following model:

$$Y_i = \beta_0 + \beta_1 RPC_i + \beta_2 MC_i + X_i'\beta + \varepsilon_i, \tag{1}$$

where $Y_i$ is a dummy variable that equals unity if a member of household $i$ has applied for at least one credit within the 10 years before the survey and zero otherwise. $RPC_i$ and $MC_i$ represent binary variables for the household's participation in the resource-providing contract farming scheme and the marketing contract farming scheme respectively. The vector $X_i'$ denotes a set of household socioeconomic characteristics. The error term $\varepsilon_i$ is clustered at the village level to account for the random selection of villages in the sample selection design. We are mostly interested in $\beta_1$, since this coefficient indicates whether households with the in-kind credit scheme are more or less likely to apply for formal credit. We treat the model as a linear probability model (LPM) estimated via ordinary least squares (OLS).

The LPM can produce unreasonable predictions that lie outside the range of [0;1]. Alternative models such as probit or logit prevent this. However, using logit and probit can lead to identification by functional form and since our main objective is not the prediction of probabilities but rather the size and statistical significance of specific parameters, we primarily rely on LPMs.

In a second model concerned with the relationship between contract farming and credit demand, we investigate if participation in the resource-providing contract farming scheme is associated with a higher demand in terms of credit volume. For this matter, we use the same model as presented in Equation (1), but now $Y_i$ represents the aggregated volume of all credit applications made by household $i$ in the last 10 years. To account for the meaningful zeros as corner solutions, we treat the model as a tobit model. Here the results allow us to draw conclusions about whether households with the in-kind credit scheme apply for smaller or larger amounts of credit. For this analysis, subsequent credit applications are excluded, that is, the amount of credit for which a household had unsuccessfully applied and subsequently applied for the same credit at a different institution is only counted once.

To isolate the association between contract participation and the two outcome variables, we control for observable characteristics across the households in both models. This includes the land availability of the household, which is likely correlated with the requirement for credit.[5] We further control for age and gender of the household head, the number of adult household members, the distance to the next market as a measure of rurality, and the number of shocks the household experienced in the past 5 years.

[5]The land availability at the time of survey may be endogenous to contract participation, which is why we include the land availability in 2008, before contracting.

We investigate the relationship between contract participation and credit access (Hypothesis 2) using individual credit applications as the unit of observation. We estimate the following two models:

$$Y_{ji} = \gamma_0 + \gamma_1 RPC_{ji} + \gamma_2 MC_{ji} + \Pi'_{ji}\gamma + \epsilon_{ji}, \quad (2)$$

and

$$Y_{ji} = \alpha_0 + \alpha_1 RPC_{ji} + \alpha_2 (RPC_{ji} \times Info_{ji}) + \alpha_3 MC_{ji} + \Pi'_{ji}\alpha + u_{ji}, \quad (3)$$

where $Y_{ji}$ is a dummy variable that equals unity if credit application $j$ by applicant $i$ was accepted, and zero if the credit application was denied. $RPC_{ji}$ and $MC_{ji}$ represent binary variables that take on the value of unity if the applicant household of credit application $j$ participates in the resource-providing contract farming scheme and the marketing contract farming scheme, respectively. In both equations, the vector $\Pi'_{ji}$ denotes the same set of control variables capturing credit application characteristics and applicant characteristics. In particular, we control for the amount that was applied for and the collateral offered in the credit application. We further control for the gender of the applicant. The distance of the household to the next market is included as a measure of rurality and potential transactions costs of the credit institute for screening. We further control for the year in which the credit application was submitted to account for potential time trends.

In Equation (3), we further add an interaction between the participation of the applicant in the resource-providing contract with a binary variable indicating whether or not the applicant informed the bank of the resource providing contract and thus the source of the outstanding debt. By interviewing farmers, it should be noted that we only have data on what information the farmer provided to the bank as part of the loan application, and not on what factors the bank ultimately evaluated and what collateral was accepted by the bank. Throughout both models, the error terms $\epsilon_{ji}$ and $u_{ji}$ are again clustered at the village level. Both models are estimated with an LPM.

We control for the marketing contract in all our models because we are interested in both, a comparison of contracted farmers to noncontracted farmers and a comparison of contracts with and without an in-kind credit scheme. As mentioned earlier, the marketing contract included in this study is a verbal contract that formal lenders may not accept as a viable asset. At the same time, farmers under the verbal contract do not receive any in-kind credit and therefore have no contract-related outstanding debt. Farmers under the marketing contract experience an increase in household income (Ruml et al., 2020) and a reduction in market risk, similar to the farmers under the resource-providing contract scheme. However, they do not receive in-kind credit and do not have an outstanding debt.

## 3.4 | Selection bias and identification

The decision of a farmer to participate in contract farming is likely based on unobservable characteristics, such as her entrepreneurial skills, risk, and time preferences (Widadie et al., 2020). These unobservable characteristics might also be associated with the outcome variables of interest, which would lead to endogeneity of participation in contract farming due to unobserved heterogeneity. In the absence of randomization, controlling for all potentially relevant characteristics is challenging in cross-sectional settings such as this one. To produce credible results, we therefore rely on a combination of approaches to control for potential selection bias and to indicate the sensitivity of the results to omitted variable bias.

First, we alleviate some issues of individual self-selection into contracts through the institutional context of the study region. The argument here is that the reason that comparison farmers do not participate in the resource-providing contract is not primarily an outcome of a household's decision process and thus affected by numerous unobservable household characteristics, such as preferences or entrepreneurial skills, but rather due to the fact that

only farmers in the Central Region are eligible to participate in the resource-providing contract. This institutional setup alone cannot eliminate all potential sources of endogeneity with certainty, because not every farmer in the Central Region participates in the contract farming scheme, and it is unlikely that every farmer sampled in the two comparison regions would have participated in the resource-providing contract farming scheme, had the scheme been available there. Furthermore, even though comparability of the three regions is high, the choice of the contracting firm to operate in the Central Region is unlikely to be entirely at random.

Therefore, to further reduce selection bias from unobserved heterogeneity, we also employ an alternative approach to control for potential selection bias, which has recently become more prominent in the existing literature on contract farming, namely the inclusion of a willingness-to-participate and a risk preference measure as additional controls in the regressions. The risk preference measure was derived through a small choice experiment in which the respondent had the choice between two crops that differed in their production risk. The variable captures the respondent's decisions and ranges between 0 (risk averse) and 5 (risk loving). The willingness-to-participate was derived through a set of hypothetical contract offers that each required an initial investment. The initial investment increased in each hypothetical contract offer, whereas all other contract features remained constant. The choice sets for both risk preferences and willingness-to-participate are presented in the supplementary material.

Because contract farming provides farmers with a secure sales market, it is plausible that farmers with aversion to price risks have a higher propensity to engage in such contracts. Even if the outcome of a risk preference elicitation is not perfectly correlated with such aversion to price risk, it is arguably able to control for a large part of this source of unobserved heterogeneity. In a similar manner, the inclusion of a willingness-to-participate measure is likely to control for many factors that influence farmers' preferences for contract farming, such as entrepreneurial skills, technical skills, and time preferences (Bellemare, 2012; Bellemare & Novak, 2017). The variable included as additional control in the regressions expresses the highest initial investment the respondent was willing to make to participate under contract. For the household level analyses, we include the willingness-to-participate and risk preference of the household head. For the credit level analyses, we include the willingness-to-participate and risk preference of the credit applicant, which is in all cases either the household head or the contracted farmer.

Both the institutional context of the study region and the inclusion of the risk preference and willingness-to-participate measures can arguably reduce selection bias. Yet, just as any other method applied to non-random cross-sectional data, they are unlikely to capture all sources of endogeneity. Consequently, the results presented in this study should be interpreted with some caution and do not present causal effects. Nonetheless, we are confident that the identification strategy can produce meaningful estimates and reveal important associational relationships between participation in a resource-providing contract and demand for and access to credit.

To better understand the bearing of potentially remaining omitted variable bias, we provide two robustness checks. First, to assess the stability of the associations' size and statistical significance, we estimate and plot key coefficients with all potential combinations of control variables. Second, we employ the Unobservable Selection and Coefficient Stability Test proposed by Oster (2019) as a more formal method to assess how sensitive our results are with respect to omitted variable bias.

Based on the assumption that the selection into contract farming on the observed controls is proportional to the selection into contract farming on the unobserved controls, we can use the following equation proposed by Oster (2019) to approximate a bias-adjusted coefficient estimate.

$$\eta^{*}(R_{\max}, \delta) = \hat{\eta}_1 - \delta\left[\hat{\eta}_0 - \hat{\eta}_1\right]\frac{R_{\max} - R_1}{R_1 - R_0}. \tag{4}$$

The bias-adjusted coefficient $\eta^{*}$ depends on two key parameters. The first parameter, $\delta$, defines the importance of the unobservables relative to the observables in their influence on participation in the contract farming scheme. A value of $\delta = 1$ implies that observables and unobservables are assumed to be equally important and both affect the regression coefficient in the same direction. Values for $\delta$ between 0 and 1 suggest that unobservables are

assumed to be less important than observed factors and values larger than one imply that unobservables are relatively more important. $R_1$ and $R_2$ are the $R^2$ obtained from the univariate regression and the regression with all control variables included, respectively.

The second key parameter, $R_{max}$, defines the theoretical maximum $R^2$ from the model where all observed and unobserved variables are included. Both δ and $R_{max}$ are unknown parameters, even though $R_{max}$ can naturally only take on values between the $R^2$ of the regression with observed control variables and one. As a starting point, Oster (2019) suggests that most causal effects are bounded by $\hat{\eta}_1$, and $\eta^*(\min\{1.3R_1, 1\}, 1)$, although the threshold of $\delta = 1$ is somewhat arbitrary.

Similarly to Lee et al. (2020), we therefore do not estimate the bias-adjusted effect, but rather show the δ that would produce an effect size of $\eta^*(R_{max}, \delta) = 0$. We show results for both $R_{max} = \min\{1.3R_1, 1\}$ and a more conservative value of $R_{max} = \min\{2.2R_1, 1\}$, which has also been suggested by Oster (2019). Our estimated delta can then be understood as the maximum influence that unobserved variables can have relative to the observables so that $\eta^*$ does not yet change sign. Large absolute values of $\delta$ imply that results are likely more robust to omitted variable bias and although there is no clear-cut theoretical threshold, we loosely orient ourselves to the threshold of $\delta = 1$ as done in several previous studies (see e.g., Bevis & Barrett, 2020; Wuepper et al., 2020).

To correct for potential pretreatment imbalances in the observables, we perform an additional robustness check. Here, the inclusion of the willingness-to-participate and risk preference measure could be extended by propensity score matching, as recently done by Bellemare et al. (2021). However, possibilities are limited due to the multinomial treatment variable and the required interaction term used in Equation (3). Thus, we employ a more flexible alternative and rerun the regressions using inverse probability of treatment weights (IPTW). In a first step, we estimate the probability of each household to participate in the marketing contract or the resource-providing contract, using a multinomial logit model. In a second step, the inverse of this probability is used as a weight in the regressions (McCaffrey et al., 2013). Thus, each household in the sample is assigned a weight that expresses the likelihood that the household would be under contract. This way, a non-contracted household with a high probability to be under contract contributes more to the analysis compared to a household with a low probability. For the contracted farmers, the weights have the opposite effect. This approach further increases the comparability of the three groups, by balancing the observable heterogeneity.

## 4 | RESULTS

### 4.1 | Descriptive statistics

Table 1 presents descriptive statistics on control variables, indicating few statistically significant differences across farmer groups in the age of the household head, the willingness-to-participate, the distance to the closest market, and the number of shocks experienced in the last 5 years before the survey. The lower part of Table 1 shows descriptive statistics of the credit-related variables. Approximately 23% of the households with resource-providing contracts applied for at least one credit in the last 10 years prior to the survey. Among those households who actually applied for credit, the average amount that households applied for within these 10 years is approximately 3800 GHS[6]. In comparison, only 20% of the households under the verbal marketing contract and 11% of the households without contracts applied for at least one credit in the last 10 years before the survey, while the average amount applied for is higher at around 5400 and 6100 GHS, respectively. The difference in the share of households with credit applications is statistically significant between households without a contract to both

[6]The exchange rate at the time of the survey was approximately 0.22 GHS = 1 US$.

**TABLE 1** Descriptive statistics

| | Mean values | | | Difference | | |
|---|---|---|---|---|---|---|
| | Resource-providing contract (RPC) | Marketing Contract (MC) | Comparison (NC) | RPC-MC | RPC-NC | MC-NC |
| *Control variables* | | | | | | |
| Household level ($n$ = 463) | $n$ = 164 | $n$ = 193 | $n$ = 106 | | | |
| Land availability in 2008 (in acres) | 14.88 | 13.23 | 12.37 | | | |
| | (1.32) | (0.93) | (1.50) | | | |
| Gender of the household head | 0.20 | 0.15 | 0.15 | | | |
| | (0.03) | (0.03) | (0.04) | | | |
| Age of the household head | 57.24 | 53.09 | 50.51 | *** | *** | * |
| | (0.93) | (0.81) | (1.12) | | | |
| Willingness-to-pay of the household head (in 500 GHS) | 2.08 | 2.14 | 2.73 | | ** | ** |
| | (0.16) | (0.14) | (0.20) | | | |
| Risk preference of the household head | 2.79 | 3.03 | 2.75 | | | |
| | (0.12) | (0.10) | (0.15) | | | |
| Number of adult household members | 2.79 | 2.63 | 2.66 | | | |
| | (0.10) | (0.10) | (0.12) | | | |
| Distance to the market (in km) | 7.21 | 3.26 | 2.35 | *** | *** | * |
| | (0.76) | (0.37) | (0.25) | | | |
| Number of shocks experienced in the last 5 years | 0.58 | 0.22 | 1.15 | *** | *** | *** |
| | (0.12) | (0.04) | (0.13) | | | |
| Applicant level | $n$ = 32 | $n$ = 41 | $n$ = 23 | | | |
| Gender of the applicant (dummy) | 0.28 | 0.15 | 0.04 | | ** | |
| | (0.08) | (0.06) | (0.04) | | | |
| Age of the applicant | 51.91 | 56.34 | 56.35 | * | | |
| | (1.89) | (1.30) | (2.55) | | | |
| Willingness-to-pay of the applicant (in 500 GHS) | 2.78 | 2.78 | 2.30 | | | |
| | (0.47) | (0.33) | (0.20) | | | |
| Risk preference of the applicant | 2.66 | 3.49 | 2.96 | ** | | |
| | (0.28) | (0.24) | (0.20) | | | |
| *Credit variables* | | | | | | |
| Household level ($n$ = 463) | $n$ = 164 | $n$ = 193 | $n$ = 106 | | | |
| Application for credit (dummy) | 0.23 | 0.20 | 0.11 | | ** | * |
| | (0.03) | (0.03) | (0.03) | | | |
| | $n$ = 37 | $n$ = 38 | $n$ = 12 | | | |

**TABLE 1** (Continued)

| | Mean values | | | Difference | | |
|---|---|---|---|---|---|---|
| | Resource-providing contract (RPC) | Marketing Contract (MC) | Comparison (NC) | RPC-MC | RPC-NC | MC-NC |
| Total credit amount applied for (applicants only) | 3798.78 | 5363.16 | 6141.67 | | | |
| | (406.31) | (2352.25) | (2376.92) | | | |
| Credit level information ($n$ = 96) | $n$ = 32 | $n$ = 41 | $n$ = 23 | | | |
| Credit accepted | 0.75 | 0.93 | 0.96 | ** | ** | |
| | (0.08) | (0.04) | (0.04) | | | |
| Amount applied for (in GHS) | 4031.72 | 4604.88 | 2965.22 | | | |
| | (484.88) | (2164.44) | (381.93) | | | |
| Contract information provided | 0.44 | n.a. | n.a. | | | |
| | (0.09) | | | | | |

*Note*: Fourteen percent of the accepted credit applications were rationed and only partially accepted. For the purpose of this study, we consider them accepted applications. GHS = Ghanaian Cedi. The exchange rate at the time of the survey was approximately 0.22 GHS = 1 US$. Standard errors in parentheses. Differences are tested for statistical significance with a two-tailed $t$-test.

*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

contracted farmer groups. However, there is no statistically significant difference between the contracted farmer groups. Differences in the amount of credit applied for are not statistically different across all groups.

For applicants with resource-providing contracts, 75% of credit applications were accepted with an average credit volume of 4031 GHS. It also becomes apparent that in only 44% of the applications did the farmers inform the bank about the contract. While the average application amount is similar across all three groups, the success rate of credit applications is statistically different. Approximately 93% of credit applications by households with marketing contracts and 96% by households without contracts were accepted, while the respective success rate for farmers with resource-providing contracts is significantly lower at around 75%. This provides first indication that resource-providing contracts are potential obstacles to the access of formal credit. In the following, we expand on these stylized facts through multivariate regression analyses that also control for other factors that may affect loan demand and the probability of loan acceptance.

## 4.2 | Contract farming and credit demand

Table 2 presents the regression results for the associations between participation in the resource-providing contract and credit demand. Producing under a resource-providing contract is associated with a 16-percentage point (p.p.) increase in the likelihood of having applied for a credit at a formal credit institute in the last 10 years before the survey. This association is statistically significant. We also find that the resource-providing contract leads to an increase in the loan amount for which the household applied for. Thus, overall credit demand seems to rise with participation in a resource-proving contract. Similarly, participation in the marketing contract is associated with both a 13-percentage point increase in the likelihood of applying for a formal credit and also with higher amounts of credit for which households apply.

These results do not confirm the previously stated hypothesis of a reduced demand for credit, but on the contrary show that contract farming can lead to higher credit demand. Based on the conceptual framework laid out in Section 2, it is therefore plausible that the reduced market risk under both contracts seems to incentivize higher risk taking in other areas, which then leads to higher credit demand. Table 2 further shows that land availability is strongly associated with the likelihood of applying for a credit and the amount applied for. Thus, larger-scale farmers are more likely to apply for credit and apply for larger amounts. Having a high willingness-to-participate under contract and low risk aversion are both associated with higher credit amounts in the applications. However, the effects are not statistically significant. The number of adult household members is also positively associated with the likelihood to apply for credit.

In Figure 1, we show the specification curves for the two regressions shown in Table 2 with all potential combinations of control variables. The coefficient $\beta_1$ is relatively stable and statistically significant at a 5%-level for all possible combinations (see Figure 1b,d). This indicates that the positive association between participation in a resource providing contract and higher credit demand is relatively robust. This is supported also by the results of

**TABLE 2** Associations between contract farming and credit demand

| | Probability of application (1) | Amount applied for (1000 GHS) (2) |
|---|---|---|
| Resource-providing contract (RPC) (1 = yes) | 0.16*** | 6.63*** |
| | (0.04) | (2.36) |
| Marketing contract (MC) (1 = yes) | 0.13* | 5.70** |
| | (0.07) | (2.54) |
| Land availability in 2008 (acre) | 0.00** | 0.12** |
| | (0.00) | (0.06) |
| Gender (dummy = 1 if applicant is female) | 0.01 | −0.94 |
| | (0.06) | (2.58) |
| Age of applicant (log of years) | −0.07 | −2.23 |
| | (0.10) | (4.42) |
| Willingness-to-participate | 0.01 | 0.60 |
| | (0.01) | (0.46) |
| Risk preferences | 0.01 | 0.94 |
| | (0.01) | (0.77) |
| Number of adult household members | 0.03* | 1.55* |
| | (0.02) | (0.79) |
| Distance to the market (log) | −0.03 | −1.53* |
| | (0.02) | (0.83) |
| Number of shocks experienced in the last 5 years | 0.04*** | 1.32** |
| | (0.01) | (0.67) |
| Constant | 0.19 | −18.34 |
| | (0.38) | (21.79) |

**TABLE 2** (Continued)

| | Probability of application (1) | Amount applied for (1000 GHS) (2) |
|---|---|---|
| Model statistics | | |
| $R^2$ | 0.06 | |
| Pseudo-$R^2$ | | 0.03 |
| Wald-test: RPC = MC | 0.22 | 0.17 |
| Unobservable selection and coefficient stability test | | |
| $\delta^{RPC}$ for $R_{max} = 1.3R^2$ | −4.04 | |
| $\delta^{RPC}$ for $R_{max} = 2.2R^2$ | −1.63 | |
| $\delta^{MC}$ for $R_{max} = 1.3R^2$ | −1.89 | |
| $\delta^{MC}$ for $R_{max} = 2.2R^2$ | −0.70 | |
| Observations | 463 | 463 |

*Note*: Estimates of a linear probability model (OLS estimator) are shown in Column (1). Estimates in Column (2) are based on a tobit estimator. Standard errors in parentheses are robust and clustered at the village level.

Abbreviation: GHS, Ghanaian Cedi.

*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

the Unobservable Selection and Coefficient Stability Test, which yields values for $\delta$ well above one. The value for $\delta$ is negative, which means that the control variables included in the regression are overall negatively correlated with contract farming participation.

Even the coefficient of $\beta_2$ is relatively stable (see Figure 1a and 1c), it is not statistically significant for most of the combination when the outcome variable is the probability of application. When the outcome variable is the total amount applied for, $\beta_2$ is relatively stable and statistically significant at least at a 10% level for nearly all possible specification. This indicates that even though the $\delta$ from the Unobservable Selection and Coefficient Stability Test is actually relatively high (−1.89 for the $R_{max} = 1.3R^2$), we should treat the association between a marketing-based contract farming scheme and credit demand with caution.

The results of the regressions using IPTW are presented in Table A3 in the appendix. The positive coefficients for the marketing contract and the resource-providing contract in Column 1 indicate a positive association with the likelihood of application, yet only the coefficient of the resource-providing contract is statistically significant. The results in the second column show that accounting for potential pretreatment imbalances again results in similar coefficients, yet only the association of the resource-providing contract is statistically significant. Thus, the findings are robust for the resource-providing contract. As indicated above, associations of the marketing contract should be treated with caution.

## 4.3 | Contract farming and credit access

Table 3 presents the associations between participation in the resource-providing contract and the likelihood of credit acceptance. The first results column shows that having a resource-providing contract is negatively associated with the likelihood of credit acceptance. In particular, participation is associated with a statistically significant 15-percentage points lower likelihood of having a credit accepted at a formal bank compared to farmers without contract.

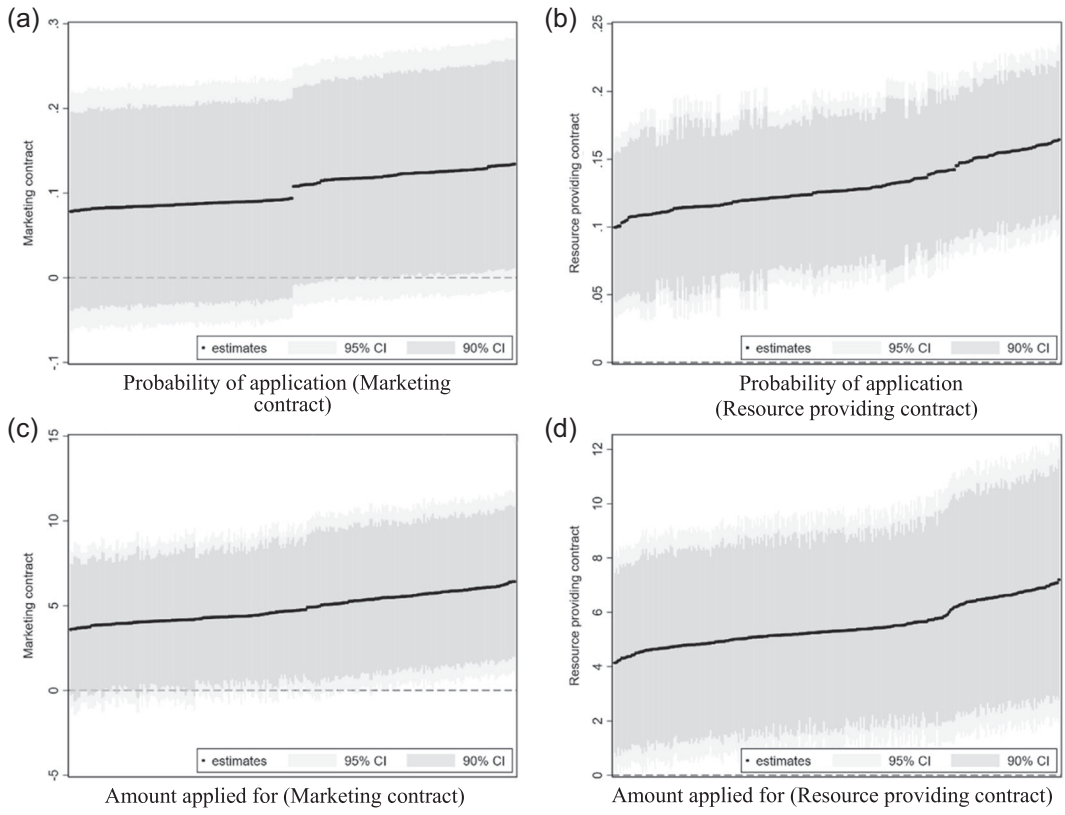


**FIGURE 1** Specification curves for the associations between contract farming and credit demand

To better understand the associations of the contract on credit approval, we estimate an alternative model specification in Column 2. Here, the participation in the resource-providing contract is interacted with a variable measuring whether or not the applicant has informed the bank about the contract. Including the interaction term and therefore distinguishing between whether or not lenders are informed about the contract substantially improves the fit of the model. The $R^2$ increases from 0.20 to 0.29. The results further indicate that if the bank is not informed about the contract and thus the source of the outstanding debt, the resource-providing contract is associated with a 30-percentage point reduction in the likelihood of having a credit application accepted. This relationship is statistically significant and plausibly due to the outstanding debt of the applicant. However, farming under the resource-providing contract and informing the bank about the contract is associated with a 41-percentage points increase relative to farming under the resource-providing contract and withholding informing about the contract. Thus, despite the outstanding debt, the production contract sends a positive signal to the creditor if the source of the debt is disclosed. As shown in the conceptual framework in Section 2, this signal could come from the fact that the applicant was previously screened and approved by an agribusiness lender or by the lenders' anticipation of a continuous flow of income due to preagreed sales to the contracting company. The verbal marketing contract has no statistically significant effect on the likelihood of credit approval. This is plausible, given that the marketing contract does not produce any outstanding debt for farmers.

Specification curves shown in Figure 2 and Unobservable Selection and Coefficient Stability Tests suggest that the coefficients $\alpha_1$ and $\alpha_2$ are mostly robust. The coefficients are statistically significant for all potential combinations of control variables and given a value of $R_{max} = 1.3R^2$, both values for $\delta$ are in absolute terms above one. If the more conservative values of $R_{max}$ is chosen, however, the relative importance of unobserved control variables that would cause an effect size of zero shrinks to 0.81 and −0.68. This again indicates that even though the results are overall quite robust, they are unlikely to hold when the selection on unobservables is severe.

**TABLE 3** Associations between contract farming and the acceptance of credit applications

| | Probability of credit acceptance (1) | Probability of credit acceptance (2) |
|---|---|---|
| Resource-providing contract (RPC) | −0.15* | −0.30** |
| | (0.09) | (0.14) |
| RPC × provision of contract information to the lender | | 0.41** |
| | | (0.15) |
| Marketing contract (MC) | −0.04 | −0.04 |
| | (0.07) | (0.07) |
| Log of amount applied for (in GHS) | −0.01 | −0.01 |
| | (0.03) | (0.03) |
| Land submitted as collateral (1 = yes) | −0.09 | −0.16 |
| | (0.16) | (0.15) |
| Log of land availability in 2008 | 0.05 | 0.02 |
| | (0.05) | (0.04) |
| Gender of applicant (1 = female) | −0.08 | −0.06 |
| | (0.14) | (0.15) |
| Willingness-to-pay | −0.05** | −0.06** |
| | (0.02) | (0.02) |
| Risk preference | 0.03 | 0.03 |
| | (0.03) | (0.03) |
| Log of distance to the market | −0.04 | −0.09* |
| | (0.03) | (0.04) |
| Year control | −0.00 | 0.01 |
| | (0.01) | (0.01) |
| Constant | 0.96** | 1.11*** |
| | (0.34) | (0.33) |
| Model statistics | | |
| $R^2$ | 0.20 | 0.29 |
| Wald-tests | | |
| *RPC* = MC | 1.99 | 4.12* |
| *RPC* + *RPC* × provision of contract information = 0 | | 1.88 |
| Unobservable selection and coefficient stability test | | |
| $\delta^{RPC}$ for $R_{max} = 1.3R^2$ | 1.35 | 2.16 |
| $\delta^{RPC}$ for $R_{max} = 2.2R$ | 0.42 | 0.81 |

(Continues)

**TABLE 3** (Continued)

| | Probability of credit acceptance (1) | Probability of credit acceptance (2) |
|---|---|---|
| $\delta^{Interaction}$ for $R_{max} = 1.3R^2$ | | −1.69 |
| $\delta^{Interaction}$ for $R_{max} = 2.2R$ | | −0.68 |
| Observations | 96 | 96 |

*Note*: Estimates from a linear probability model are shown. Standard errors in parentheses are robust and clustered at the village level. $N = 96$.

Abbreviation: GHS, Ghanaian Cedi.

$^{*}p < 0.1$.
$^{**}p < 0.05$.
$^{***}p < 0.01$.

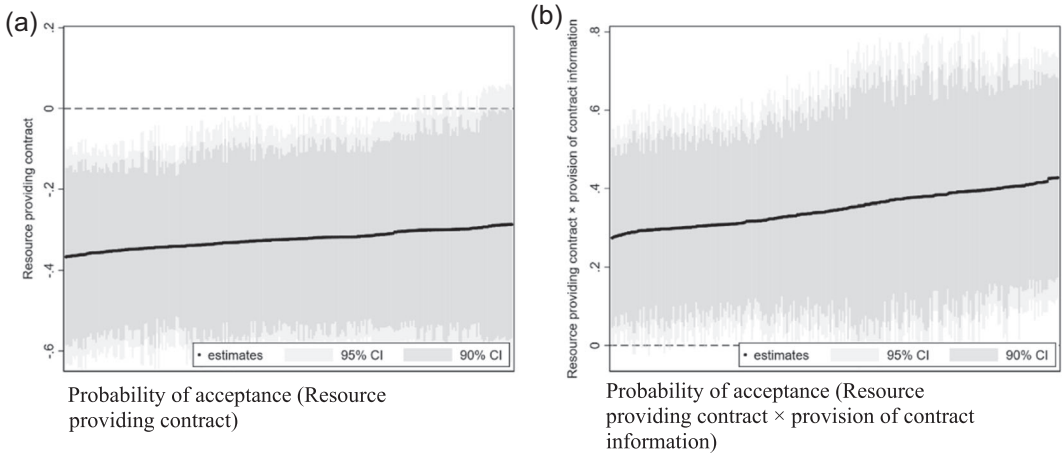


**FIGURE 2** Specification curves for the associations between contract farming and credit supply

The IPTW results in Table A4 in the appendix are largely consistent with the presented results. Column 2 shows that the resource-providing contract has a negative and statistically significant association with the likelihood of credit acceptance. The interaction term between the contract and the submitted information is positive and statistically significant. Thus, throughout the robustness checks, the associations are robust.

## 5 | CONCLUDING REMARKS

Access to credit is a key contributor to agricultural development. Thus, credit market failures and limited access to credit pose challenges to smallholder producers. Resource-providing contracts are a tool to facilitate access to credit for production inputs. While the existing literature had shown that such contracts are beneficial for farmers, the effects on formal credit demand and access are still unclear. In this paper, we have addressed this study gap by investigating the relationship between the contracts, credit demand, and credit access.

We find that participation in a resource-providing contract farming scheme is associated with a higher likelihood to apply for credit at the household level and also with higher amounts of credit for which households apply. Thus, in-kind credit schemes through contract farming do seem to affect the demand for additional credit from

external formal sources. We also find that contract farming is associated with changes in the likelihood of credit approval. Farming under contract is positively associated with the likelihood of credit approval, but only if the bank is informed about the contract, and consequently about the source of outstanding debt. This indicates that banks most likely differentiate between the sources of debt, and that debt acquired from the resource-providing contract scheme does not have to pose an additional credit constraint to contracted farmers. However, if farmers do not inform the bank about the contract, their chances of credit approval are substantially reduced.

This study has some limitations worth mentioning. The potential endogeneity that results from the self-selection of farmers into contract farming cannot be fully controlled for using cross-sectional data. We used several strategies to alleviate some concerns for selection biases, but the results should be treated with some caution and not be over-interpreted in a causal sense. Nevertheless, given the relevance of credit-enhancing strategies and the lack of quantitative evidence on the effects of contract farming on credit demand and access, the analysis here makes an important contribution to the existing body of literature and hopefully stimulates further research on this topic. In particular, follow-up research based on panel or experimental data could provide interesting insights on changes in credit demand and access. Moreover, expanding the database with a larger s ample of credit applications and including information provided on decision processes of local formal banks might shed more light on the potential pathways.

It should also be noted that the study uses recall data, which can be prone to bias. In the context presented here, however, such bias can be expected to be minimal due to the small number of credit applications, and is unlikely to differ across treatment groups. Lastly, the results of this study are contract and context specific. Similar research for other crops and regions would certainly help expand our knowledge of the impact of resource-providing contracts on credit demand and access.

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## PEER REVIEW

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## DATA AVAILABILITY STATEMENT

Data and dofiles will be made available under DOI: 10.17632/wskzt9y386.1.

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## SUPPORTING INFORMATION

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## APPENDIX A

**TABLE A1** Regional characteristics

| | Western region (Marketing contract) | Central region (Resource-providing contract) | Ashanti region (Comparison) |
|---|---|---|---|
| Area classification | Tropical savanna climate | Tropical savanna climate | Tropical savanna climate |
| Highest temperature (monthly average) | 28.86°C | 28.66°C | 28.63°C |
| Lowest temperature (monthly average) | 25.09°C | 25.30°C | 25.22°C |
| Mean temperature | 27.16°C | 27.19°C | 26.97°C |
| Average annual rainfall | 1268.03 mm | 1248.53 mm | 1245.79 mm |
| Gross income per capita (GNI) | 3782 GHS | 3634 GHS | 3598 GHS |
| Human development index (HDI) | 0.609 | 0.541 | 0.603 |
| Employment to population ratio | 66.3 | 66.1 | 64.8 |
| Rural unemployment rates | 3.8% | 4.1% | 4.6% |

*Note*: Temperature and rainfall data are derived from the World Bank Climate Change Knowledge Portal and refer to monthly averages between 1991 and 2015. Mean temperature and average annual rainfall are calculated based on monthly averages. GNI and HDI are derived from the Global Data Lab 2017. Employment rates are derived from the Ghana Statistical Service 2013.

*Source*: Ruml and Qaim (2021).

**TABLE A2** Contract participation (multinomial logit)

| | Marketing contract | Resource-providing contract |
|---|---|---|
| Land availability in 2008 (acre) | 0.01 | 0.01* |
| | (0.01) | (0.01) |
| Gender (dummy = 1 if applicant is female) | −0.06 | 0.38 |
| | (0.28) | (0.32) |
| Age of applicant (log of years) | 0.69 | 2.52*** |
| | (0.54) | (0.63) |
| Willingness-to-participate | −0.13** | −0.09* |
| | (0.06) | (0.05) |
| Risk preferences | 0.05 | −0.04 |
| | (0.08) | (0.08) |
| Number of adult household members | −0.03 | 0.04 |
| | (0.09) | (0.08) |
| Distance to the market (log) | 0.27 | 0.69 |
| | (0.55) | (0.52) |
| Number of shocks experienced in the last 5 years | −0.80* | −0.47 |
| | (0.43) | (0.39) |
| Constant | −1.71 | −9.83*** |
| | (2.33) | (2.40) |
| Pseudo $R^2$ | 0.1084 | |
| Observations | 463 | |

*Note*: Standard errors in parentheses are robust and clustered at the village level.

*$p < 0.1$.
**$p < 0.05$.
***$p < 0.01$.

**TABLE A3** Associations between contract farming and credit demand (IPTW)

| | Probability of application (1) | Amount applied for [1,000 GHS] (2) |
|---|---|---|
| Resource-providing contract (RPC) (1 = yes) | 0.13*** | 5.58** |
| | (0.03) | (2.69) |
| Marketing contract (MC) (1 = yes) | 0.07 | 2.88 |
| | (0.06) | (2.75) |
| Land availability in 2008 (acre) | 0.00 | 0.11* |
| | (0.00) | (0.06) |
| Gender (dummy = 1 if applicant is female) | 0.02 | −2.05 |
| | (0.08) | (4.99) |
| Age of applicant (log of years) | −0.06 | −0.61 |
| | (0.14) | (9.95) |
| Willingness-to-participate | 0.01 | 0.47 |
| | (0.01) | (0.57) |
| Risk preferences | 0.00 | 0.43 |
| | (0.01) | (0.92) |
| Number of adult household members | 0.03 | 0.99 |
| | (0.03) | (1.69) |
| Distance to the market (log) | −0.04* | −2.41* |
| | (0.02) | (1.22) |
| Number of shocks experienced in the last 5 years | 0.03 | 0.58 |
| | (0.03) | (1.24) |
| Constant | 0.24 | |
| | (0.48) | |
| $R^2$ | 0.0611 | |
| Observations | 463 | 463 |

*Note*: Standard errors in parentheses are robust and clustered at the village level.

Abbreviation: GHS, Ghanaian Cedi.

*$p < 0.1$.

**$p < 0.05$.

***$p < 0.01$.

**TABLE A4** Associations between contract farming and the acceptance of credit applications (IPTW)

| | Probability of credit acceptance (1) | Probability of credit acceptance (2) |
|---|---|---|
| Resource-providing contract (RPC) | −0.11 | −0.31** |
| | (0.10) | (0.11) |
| RPC × provision of contract information to the lender | | 0.53*** |
| | | (0.10) |
| Marketing contract (MC) | 0.03 | 0.08 |
| | (0.09) | (0.10) |
| Log of amount applied for (in GHS) | 0.08 | 0.09 |
| | (0.08) | (0.07) |
| Land submitted as collateral (1 = yes) | −0.64*** | −0.74*** |
| | (0.22) | (0.15) |
| Log of land availability in 2008 | 0.01 | −0.07 |
| | (0.06) | (0.07) |
| Gender of applicant (1 = female) | 0.08 | 0.10 |
| | (0.16) | (0.14) |
| Willingness-to-pay | −0.05 | −0.06* |
| | (0.03) | (0.03) |
| Risk preference | 0.02 | 0.01 |
| | (0.03) | (0.03) |
| Log of distance to the market | −0.12** | −0.15*** |
| | (0.05) | (0.05) |
| Year control | −0.02 | 0.02 |
| | (0.02) | (0.01) |
| Constant | 0.48 | 0.57 |
| | (0.74) | (0.71) |
| $R^2$ | 0.546 | 0.611 |
| Observations | 96 | 96 |

*Note*: Standard errors in parentheses are robust and clustered at the village level.

Abbreviation: GHS, Ghanaian Cedi.

*$p < 0.1$.

**$p < 0.05$.

***$p < 0.01$.