Contract Farming and Production Constraints: Evidence from a Field Experiment in Benin*

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Abstract

In recent decades contract farming has emerged as a popular mechanism to encourage vertical coordination in developing country agriculture. The goal of such coordination is to better integrate smallholder farmers into the modern agricultural food system, fostering rural transformation. We use panel data from a randomized control trial to quantify the impact of different contract attributes on rural transformation and welfare of smallholder rice farmers in Benin. We vary the terms of contract, with some farmers being offered a contract that only guarantees a price, while other contracts add extension training or input loans. While all three types of contracts had positive and significant effects, we find that contracts which only included an agreement on price had nearly as large of an impact as did contracts with additional attributes. This suggests that once price uncertainty is resolved, farmers are able to address other constraints on their own.

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1. Introduction

Structural transformation is a fundamental challenge in developing countries and key to overcoming food insecurity and poverty, particularly in Sub-Saharan Africa. Value chain development, especially in staple crops, is one potential method for fostering rural transformation (Poulton et al. 2014; World Bank, 2016). In countries where smallholder farmers are a large percentage of the population, the transition from subsistence to commercial agriculture, has proven elusive. For rural transformation to occur, smallholder farmers must increase their area planted, increase their productivity level, and sell more of their crop into the market, thereby increasing their income and profit from production. However, smallholder farmers generally lack access to credit (Berg, 2013; Stephens and Barrett, 2011), limiting their ability to increase input use as well as profit from their output (McArthur and McCord, 2017). In addition, evidence shows that smallholder farmers frequently produce well below the technical efficiency frontier, limiting the marginal returns to inputs (Michler and Shively, 2015; Sherlund et al., 2002). Finally, limited access or price uncertainty in the output market can reduce the incentives to invest in improved inputs (Kim et al., 1992) or result in reduced revenue from production (Saha, 1994). These constraints affect input demand, as well as productivity, sales, and income resulting in a perpetuation of the agrarian status quo.

One approach towards making the transition from subsistence to commercial agriculture is to increase vertical coordination between farmers and processors. In recent years, contract farming has emerged as a popular mechanism to encourage such vertical coordination (Barrett et al., 2012; Reardon et al., 2009; Swinnen and Maertens, 2007). Farm contracts can shift risk and the need for initial capital from smallholders to medium and large processors better able to manage these issues. In return, firms secure a stream of quality inputs for processing. While many see contract farming as a way to spur rural transformation and growth in local economies the view is far from universal.[1] As Bellemare and Bloem (2018) and Ton et al. (2018) recently point out, one reason for the lack of consensus on the impacts of contract farming in developing countries is that, up till now, studies have relied exclusively on observational data and many have been limited to cross-sectional data.

In this paper, we present results from the first field experiment on contract farming in a developing country context.[2] We work with a rice processing company in Benin to vary the terms of the contracts

[1] Studies have found positive impacts of contract farming on income (Bellemare, 2012; Bellemare and Lim, 2018; Gatto et al., 2017; Miyata et al., 2009; Soullier and Moustier, 2018), on food security (Bellemare and Lim, 2018; Bellemare and Novak, 2017; Mishra et al., 2018; Soullier and Moustier, 2018), on subjective wellbeing (Vath et al., Forthcoming), and on increased input use (Deb and Suri, 2013). The literature has documented problems affecting contract farming performance, which include biased terms of trade (Singh, 2002), higher production costs (Ragasa et al., 2018), lack of compensation for crop failure (Guo et al., 2005), and high opportunity costs (Bellemare, 2018).

[2] Ashraf et al. (2009) is a potential candidate for the first field experiment on contract farming. However, their study randomized "services offered" by an NGO that helps farmers export crops, not with the processing and export firm itself. Additionally, while these services resemble farming contracts, Ashraf et al. never refer to the treatments as contracts.

offered to smallholder farmers. To establish causal identification, we first conducted a baseline survey on household farm production. We then conduct a randomized control trial (RCT) in which we offer one of three farm contracts to a randomly selected subset of households. Our experimental design allows us to compare differences in outcomes between farmers offered contracts and those in the control, differences within farmers, and differences between contract attributes.

We begin by developing a model of stochastic farm production, in which farmers face uncertainty regarding the price of their product, can produce below the technical efficiency frontier, and may also face binding capital constraints. Our theoretical model demonstrates that any one of these risk/constraints results in suboptimal levels of input demand, and by extension input productivity, output supply, and profitability. To address these issues, we return to the early work of Mighell and Jones (1963) to develop three types of production contracts. The first is a market-specifying contract in which our implementing partner offers farmers a guaranteed price for their rice production.[3] The second is a production-management contract in which the processor sends extension agents three to five times throughout the growing season to provide technical training and backstopping. The third is a resource-providing contract in which the processor provides input loans for seed and fertilizer and deducts the cost at harvest. Because of our implementing partner's finite resources and the need to ensure sufficient power, in our RCT we randomly offer 1) a contract the provides a price guarantee, 2) a contract the combines extension training with the price guarantee, and 3) a contract that provides input loans in addition to the extension training and price guarantee.

Our results demonstrate that contract farming has positive and significant impacts on a number of different measures of rural transformation, including area planted to rice, yield, the share of output sold in the market, and income earned from rice production. We also find that impacts on these four outcome variables are heterogeneous depending on the terms of the contract. The contract that only provides a price guarantee had positive and significant results on rice area, market participation, and income, but not on productivity. The contract that includes all three elements significantly increased productivity, market participation, and income, but not rice area. Besides the positive and significant impact of contract farming on rural transformation, a key finding of our study is that contracts that offer only a price guarantee produced extremely strong effects. The provision of a price guarantee frequently resulted in outcomes statistically indistinguishable from more complex (and costlier) contracts that provide extension training

[3] This contract, as with all the contracts, also specifies a given quantity which the processor is willing to purchase and defines the requisite level of quality. The quantity level was set high enough to ensure that farmers could produce has much rice as they wanted without exceeding their limit. The quality constraint was focused on the amount of particulate matter in the rice (stones, leaves, dirt) mainly to ensure farmers did not simply fill their bags with debris instead of rice.

and/or input loans. This suggests that once price uncertainty is resolved, farmers can, on their own, address issues of technical efficiency and capital constraints.

Our study contributes to the existing literature in several ways. First and foremost, it provides the first experimental evidence on the impact of contract farming in the developing world. Second, it assesses the impact of different contract attributes on rural transformation. Although empirical studies in developing countries provide diverse analysis of the participation and welfare effects of contract farming (Bellemare and Bloem, 2018; Ton et al., 2018), the existing literature does not address the impact of different contract attributes on production and welfare. We show that while contract farming has a positive impact on several measures of smallholder production and welfare, the terms of the contracts matter. Our study provides a more detailed picture of which attributes of a typical farming contract have significant impacts, and which attributes do not. These insights should provide useful to policymakers interested in fostering or expanding contract farming for rural transformation. Finally, we focus our experiment on contract farming of a staple crop. The majority of the literature on contracting farming in developing countries focus on high-value and specialty crops (Swinnen et al., 2010; Mishra et al., 2018). Unlike specialty crops, the margins, and therefore the incentives, for staple crop cultivation are small, even given the generous terms of the contracts offered to farmers by our implementing partner. This suggests that our results should not only be generalizable to contract farming for other staple crops but may be a lower bound on the impacts that contract farming has on higher margin specialty crops.

2. Theoretical framework

In this section we present a model of agricultural production to help clarify the issues facing rural farmers and how various contract attributes address these issues. We start with a stochastic specification of the production technology, as in Just and Pope (1978). To this we add a measure of technical inefficiency, as in Khumbakar (1993). Following Khumbakar (2001), we also allow for output price uncertainty. Finally, we introduce a capital constraint which limits the farmer's ability to purchase inputs.

Assume the production technology can be represented as:

$$y = f(x) + g(x)\epsilon \qquad (1)$$

where y is output, x is a vector of inputs, and $f(x)$ is mean output. Production risk is captured by $g(x)\epsilon$, where $\epsilon = \upsilon - \tau$. τ is a measure of technical inefficiency and $\upsilon \sim (0,1)$ captures random shocks to production. We model price uncertainty as in Zellner et al. (1966), such that:

$$p^e = pe^u \tag{2}$$

where $e^u \sim (1, \sigma)$. Farmers face a capital constraint which can limit their ability to purchase the optimal level of inputs:

$$r \cdot x \leq k \tag{3}$$

where r is a vector of input prices and k is the amount of capital available to the farmer.

We assume farmers maximize expected utility of anticipated profits subject to their capital limitation. We can write the farmer's problem as

$$\max_x E[U(\pi^e)] = p^e y - r \cdot x + \lambda(k - r \cdot x) \tag{4}$$

$$= pf(x) - r \cdot x + pf(x)\sigma\left(\frac{e^u - 1}{\sigma}\right) + pg(x)\left\{\sqrt{1+\sigma^2}\left(\frac{e^u v}{\sqrt{1+\sigma^2}}\right) - \tau\right\} + \lambda(k - r \cdot x) \tag{5}$$

$$= \mu_\pi + pf(x)\sigma z_1 + pg(x)\left\{\sqrt{1+\sigma^2} z_2 - \tau\right\} + \lambda(k - r \cdot x) \tag{6}$$

Here $\mu_\pi = pf(x) - r \cdot x$, $z_1 = \left(\frac{e^u - 1}{\sigma}\right)$ and $z_2 = \left(\frac{e^u v}{\sqrt{1+\sigma^2}}\right)$ are standardized random variables, and λ is the Lagrange multiplier on the capital constraint. This yields the first order condition:

$$E\left[U'(\pi^e)\left(pf_j(x) - r_j + pf_j(x)\sigma z_1 + pg_j(x)\sqrt{1+\sigma^2} z_2 - pg_j(x)\tau - \lambda r_j\right)\right] = 0 \tag{7}$$

By passing through the expectation operator, we can rewrite the above equation as:

$$pf_j(x)\left(1 + \sigma\frac{E[U'(\pi^e)z_1]}{E[U'(\pi^e)]}\right) = r_j(1+\lambda) - \ pg_j(x)\sqrt{1+\sigma^2}\left(\frac{E[U'(\pi^e)z_2]}{E[U'(\pi^e)]}\right) + pg_j(x)\tau \tag{8}$$

Further simplifying, we get

$$pf_j(x)(1 + \sigma\psi) = r_j(1+\lambda) - \ pg_j(x)\sqrt{1+\sigma^2}\theta + pg_j(x)\tau \tag{9}$$

where $\psi = \frac{E[U'(\pi^e)z_1]}{E[U'(\pi^e)]}$ and $\theta = \frac{E[U'(\pi^e)z_2]}{E[U'(\pi^e)]}$ are risk preference functions. If we assume farmers are risk averse, then $\psi < 0$ and $\theta < 0$. An increase in v, u, z_1, or z_2 increases π^e, which in turn reduces $U'(\pi^e)$ since utility is concave (i.e., $U''(\pi^e) < 0$).

We can rewrite the first order condition as:

$$pf_j(x) = r_j\varphi_j \tag{10}$$

where

$$\varphi_j = \frac{(1+\lambda) - pg_j(x)\sqrt{1+\sigma^2}\theta + pg_j(x)\tau}{1+\sigma\psi} \tag{11}$$

For risk averse farmers, $\varphi_j \neq 1$, which means that farmers do not equate the expected marginal value of an input to its price. The size of the distortion to optimal input use depends on the size of σ, τ, and λ. If Farmer A faces uncertainty in output price ($\sigma^2 > 0$) compared to an identical Farmer B facing no uncertainty ($\sigma^2 = 0$), Farmer A will have a larger φ_j than Farmer B, resulting in Farmer A using less of input j relative to Farmer B. Similarly, it can be shown that technical inefficiency ($\tau \neq 0$) as well as a binding capital constraint ($\lambda \neq 0$), increases the size of φ_j, resulting in underutilization of input j relative to identical farmers who are not capital constrained ($\lambda = 0$) and/or are technically efficient ($\tau = 0$). Consequently, anything that depends on input demand functions, such as input productivity, output supply, and profitability, will also be affected by σ, τ, and λ.

Contract farming is a mechanism that can reduce or eliminate price uncertainty (σ), technical inefficiency (τ), and capital constraints (λ). In their seminar work, Mighell and Jones (1963) classify farming contracts into three categories: 1) market-specifying contracts, which describe the terms of the sales transaction with regard to price, quantity, timing, and product attributes; 2) production-management contracts, which specify the way the commodity is to be grown, such as the planting density, use of pesticides, and timing of harvest; and 3) resource-providing contracts, in which the buyer provides inputs, often on credit. Each type of contract addresses a different source of risk or constraints. Figure 1 presents these contract attributes in the context of household livelihood improvement and rural transformation. Since reduction in any of the three risks/constraints will impact input demand functions, and by extension input productivity, output supply, and profitability, any of the three types of contracts can have a positive effect on rural transformation. It is therefore an empirical, and context dependent, question regarding which contract attributes will be most effective in reducing risks and easing constraints.

3. Study design and data collection

3.1. Data and sampling

The data for this study come from two rounds of a household-level experimental panel survey. The baseline survey was conducted in July 2016, prior to the experiment, followed by an endline survey conducted in January 2017. The baseline survey collected information on the 2015-16 rice growing season, along with sociodemographic characteristics.[4] The endline survey collected information on the 2016-17 growing season, as well as any changes to household characteristics.

To select the study area and representative households in our sample, we used a multi-level stratified sampling approach. First, we selected four districts in the central part of Benin. These districts were selected due to their importance in rice production in Benin and because they were areas in which our implementing partner had previously operated. Second, we obtained a list of rice farmers in these districts from the National Office of Agricultural Statistics. We contacted these farmers to determine their willingness to participate in an experiment on contract farming. Third, among those farmers who consented to participate, we requested that they form farmer group of 16 farmers each, which was our level of randomization.[5] In total, we had 953 farmers organized into 107 farmer groups.[6]

In the baseline survey we asked farmers about their previous experience with contract farming. Contract farming was relatively well known among participant farmers, with 87 percent aware of the existence of contract farming and 71 percent having engaged in at least one contract for crop production (Table 1). The vast majority of these contracts, 91 percent, were oral agreements. Twenty-eight percent of farmer had participated in contracts that provided input loans. Farmers who had participated in contracts that stipulated price or quantity 33 and 40 percent respectively. The most common type of contract stipulated quality, 83 percent. It is important to note that most farming contracts were for cotton, which represents a cash crop in the surveyed area.

[4] Due to delays in the release of some funds, the survey team was unable to conduct the baseline immediately after harvest (January 2016).

[5] Randomization was at the group level to avoid potential spillover effects from neighboring farmers offered different contract terms. It was also necessary as a way to simplify the logistics of delivering inputs and collecting output at the end of the season.

[6] While farmers were instructed to form groups of 16, in reality group size varied. Mean group size ended up being 16.9 farmers.

3.2. Experimental design

The experiment was designed by the Africa Rice Center (AfricaRice) in collaboration with the University of Illinois at Urbana-Champaign and implemented in collaboration with *Entreprises de Services et Organisations de Producteurs de Bante* (ESOP), an NGO with a private rice processing and marketing unit that has experience in purchasing rice through farming contracts.

Subsequent to the household-level baseline survey, farmer groups were randomly assigned to either treatment or control. In order to increase power to detect effects between the various contracts, our treatment arm was three times as large as our pure control. Among those assigned to treatment, groups were further randomly assigned to receive one of three types of contracts. Random assignment was conducted at a meeting at the end of July 2016 in which the objectives of the experiment were explained and the farmers were sensitized on the necessity to not switch from one treatment group to another. At the end of the meeting, each farmer allocated to the treatment group signed a written contract with the rice milling unit of ESOP.[7] For all contracts, the sale price was fixed at US$0.27 per kg.[8] The market price at harvest typically ranges from US$0.20 to US$0.36 per kg, depending on the buyer (collectors, traders, or consumers) and the place of sale (farm gate, village, or market).

The first treatment (T1) provided a contract to farmers which specified the price and quantity of rice that ESOP was willing to buy, conditional that the rice met a minimum threshold for the percentage of impurities present (pebbles and other debris). In addition to setting price, quantity, and quality, the contract specified the variety of rice that the farmer must grow (IR841), the date and location where the rice would be collected, and the size of bags the rice must be delivered in (80-100kg bags). The contract also defined how breach of contract was to be resolved. Contracts were signed by an ESOP representative with individual farmers in the presence of fellow group members and were witnessed as well.

The second treatment (T2) provided a contract that included all the attributes of T1 and added the provision of extension training. The contract stipulated that throughout the season, farmers would receive between three and five technical training and backstopping visits from ESOP extension agents. The extensions agents advise the farmers on good agricultural practices, in regards to planting, the application of fertilizer, the tending of rice at its various stages of growth, and post-harvest handling.

The third treatment (T3) provided a contract that included all the attributes of T2 and added the provision of inputs, on loan, from ESOP. The contract stipulated the amount of seed and fertilizer to be provided as well as the price. At the end of the season, the total cost of inputs provided would be deducted from the price paid to the farmers.

[7] Contracts were all written in French. See Appendix A for English language translations of these contracts.
[8] The sale price was 150 CFA equivalent to US$0.27 at an average exchange rate of US$1= 550 CFA during the period of study.

3.3. Balance

Table 2 presents descriptive statistics for our dependent and independent variables for the different treatment groups. The first four columns of the table present means and standard deviations for each treatment and the control at baseline. The final five columns of the table present coefficients and standard errors from OLS regressions comparing households across treatments and with the control. For each cell, we regress the variable of interest (row) on an indicator of treatment status (column) along with arrondissement fixed effects. Standard errors are clustered at the farmer-group-level, which is our unit of randomization.

Average rice area for households in the study ranges between 0.6 and 1.1 hectares, with average yields of between 800 and 1,000 kilograms per hectare but with large standard deviations. Market participation is the only dependent variable where we see differences across multiple treatments. Households randomly assigned to the control and T1 sold about 25 percent of their pre-experiment rice production into the market. By comparison, households randomly assigned to the other two contracts sold about 45 percent of their pre-experiment rice production in the market. Despite this greater share of market participation prior to the experiment, rice income was no different across the four groups, with average income being about US$250 per hectare.

Among our control variables, the average household had eight members with the head of the household being around 40 years old. Around 60 percent of households were male headed with the household head having grown rice for around eight years. Only around ten percent of household heads had even a primary education while 90 percent of households listed farming as their primary business or activity. Nearly 100 percent of household heads were members of a farming association. Households did vary in whether or not they had participated in training in rice production. While only around 20 percent of households randomized into T1 had undergone training in rice production, around 60 percent of households in the control and other two treatments had training in rice production.

In general, the balance check suggests that our randomization was effective with treatment groups well balanced across our variables of interest. For cases where differences between groups are significant, the differences do not appear to be indicative of systematic variation across multiple treatments.

3.4. Attrition

Our experimental designed involved a baseline survey prior to randomization, random assigned at planting, and an endline survey six months later, after harvest. Because of this time delay we did experience attrition among the households in our experiment. Of the 953 households interviewed at baseline, we were unable to follow-up with 98 households, an attrition rate of ten percent. To test for the presence of attrition bias, we compare dependent and independent variables at baseline across the returning and attriting households.

As in our balance check, we regress each variable on an indicator for if the household was an attritor, along with arrondissement fixed effects. Table 3 presents means and standard deviations for each group along with coefficients and standard errors, clustered at the farmer-group-level, from the regressions. We find very few differences between returning and attriting households. Attriting households had significantly lower yields in 2015 than returning households. Attritors also tended to be older and less educated, suggesting that they may be less adept at farming than returning households. However, significantly more attritors reported that farming was their primary activity.

While some differences do exist in our simple mean difference tests, the low attrition rate among treated households and in the entire sample, coupled with a lack of significant differences in the majority of our tests, suggests attrition bias is likely not an issue in our study.

4. Empirical framework

4.1. Expected outcomes

We focus on estimating the direct impacts of randomly assigned farming contracts on four measures of rural transformation: rice area, productivity, market participation, and rice income. To estimate these impacts, we compare potential outcomes for treated households with the potential outcomes in the absence of the treatment. We are not only interested in the effect of being offered a farming contract but the marginal effects of each contract characteristic. As such, we present a large complement of results comparing treatment (any type of contract) to control, comparing each contract to control and comparing differences in outcomes between the various treatment groups.

From our theoretical model, we expect any contract that reduces price uncertainty, increases technical efficiency, or eases capital constraints to positively and significantly affect all four outcome variables. When it comes to expected differences between the impacts of each contract, our theoretical model suggests the effect size will be heterogenous, depending on where the largest gains are to be had for each individual farmer. That said, *a priori* we expect that contracts which address more of the limitations facing farmers will have larger impacts. Because of this, we expect larger and more significant impacts from T3, which embeds a market-specifying, production-management, and resource-providing contract, compared to either of the other two treatments. Similarly, we expect T2, which includes the price guarantee (market-specifying) and the extension training (production-management), to have larger impacts than T1, which only includes the price guarantee.

4.2. Intention to Treat (ITT)

Because we have both baseline and endline data, we can estimate the Intention to Treat (ITT) using three different approaches. We first estimate the ITT using a Simple Mean Difference (SMD) model:

$$y_{ir} = \alpha + \delta_{SMD} T_i + X_{ir}\beta + \rho_r + \epsilon_{ir} \tag{12}$$

where y_{ir} is the outcome of interest for household i in arrondissement r. Let T_i be our indicator of treatment, variously defined, for the household and δ_{SMD} the coefficient on the SMD estimate of the ITT. In some specifications we include a vector of household characteristics, X_{ir}, along with arrondissement fixed effects, ρ_r. Lastly, ϵ_{ir}, is an idiosyncratic error term orthogonal to T_i as a result of our randomization.

Our second estimator is a pooled Difference-in-Differences (DID) estimate of the ITT:

$$y_{irt} = \alpha + \gamma T_i + \omega W_t + \delta_{DID} W_t \times T_i + X_{irt}\beta + \rho_r + \epsilon_{irt}. \tag{13}$$

Here W_t is an indicator for the 2016-17 growing season and δ_{DID} is the coefficient on the DID estimate of the ITT. The DID estimator removes any time-invariant unobserved heterogeneity captured in the SMD error term, making it more efficient than the SMD estimator.

Our final estimator is a household Fixed Effects (FE) estimate of the ITT:

$$y_{irt} = \alpha + \delta_{FE} T_i + X_{irt}\beta + \rho_r + \omega W_t + \mu_i + \epsilon_{irt} \tag{14}$$

Here μ_i is an indicator for each household, which strips out any time-invariant unobserved heterogeneity at the household level. Given that we only have two time periods in our data, the FE and DID estimates of the ITT should be almost exactly the same, differing only when time-invariant household characteristics drop out of the FE regression. However, the FE estimator is more efficient than the DID estimator, resulting in more precise standard errors.

4.3. Multiple hypothesis testing

Because we are testing a large number of hypothesis, it is possible that significant results emerge from our analysis due not to actual treatment effects but rather to chance. While the problems arising from multiple inference is well known, dating back to Bonferroni (1935), the literature has yet to arrive at a consensus regarding the best way to correct for multiple hypothesis testing. Some suggest adjusting only when making inferences for multiple outcomes (Anderson, 2008; Casey et al., 2012; Heckman et al., 2011; Kling et al., 2007) while others suggest correcting only for multiple subgroups (Lee and Shaikh, 2014). Still others suggest correcting for both multiple outcomes and subgroups (Heckman et al., 2010). Both Bonferroni (1935) and Holm (1979) have proposed their own ways to adjust *p*-values to correct for multiple inference. More recently, List et al. (2018) have developed a step-wise multiple testing procedure. Alternatively, Anderson (2008) and Ksoll et al. (2016) use sharpened *q*-values to adjust for multiple hypothesis testing. We take a catholic approach and present results, in Appendix B, from the Bonferroni adjustment, the Holm adjustment, List et al.'s step-wise correction, and Anderson's sharpened *q*-values. Our results are robust across specifications in terms of statistical significance when we adjusted standard errors for multiple hypotheses testing.

5. Results and discussion

5.1. Impact of contract farming on rural transformation

Table 4 presents the ITT effects of a household being randomly offered any of the three farming contracts on four measures of rural transformation. We present results from SMD, DID, and FE regressions, without and with household covariates. In Panel A we present treatment effects on rice area, measured hectares; in Panel B we present treatment effects on productivity, measured as kilograms of paddy rice harvest per hectare; in Panel C we present treatment effects on market participation, measured as the percentage of harvested rice sold into the market; and in Panel D we present treatment effects on rice income, measured as the value of rice harvest in U.S. dollars.

Farmers randomly selected to receive one of the three contracts were provided with the written and signed contract prior to planting, which gave them time to rent in more land if they desired. Yet while the SMD effect of a farming contract does have a positive and significant effect on rice area, the DID and FE estimates of the treatment effect are not significant. This null result could be due to several factors, including a thin land rental market and the fact that land is a lumpy input.

Examining results of farming contracts on the other three variables of interest, we find consistently positive and significant effects. Focusing on the FE estimates with covariates, being offered a farming contract increases productivity by 346 kg per hectare or about one quarter of a standard deviation from the baseline. Households with farming contracts increased their market participation by selling 23 percentage points more of their rice harvest, an increase of well over half of a standard deviation. This increased productivity and greater market participation resulted in treated households earning $692 more income per hectare, an increase of 1.6 standard deviations above mean income at baseline. Treated household earned over five times more income per hectare from rice production than they had prior to the intervention.

5.2. Impact of contract attributes on rural transformation

While contract farming clearly had a large, positive impact on productivity, market participation, and income, we are primarily interested in which type of contract is most effective in reducing risks and easing production constraints. In Table 5 we compare households randomly offered a contract that provides a price guarantee (T1) to the control group. In Table 6 we compare households randomly offered a contract that provides extension training, in addition to a guaranteed price (T2), to the control group. In Table 7 we compare households randomly offered a contract that provides input loans, in addition to extension training and a price guarantee (T3), to the control group. As previously, we provide SMD, DID, and FE estimates, with and without covariates, of the ITT on rice area, productivity, market participation, and income.

Focusing first on the contract that only offers a guaranteed price, we find positive and significant effects for three of our four variables of interest. Unlike our comparison of any farming contract to the control, we find that households offered the market-specifying contract did take the opportunity to increase their rice area. Household offered a guaranteed price for their rice production increased their rice area by 0.2 hectares, a small but statistically significant increase. Possibly because these households increased their rice area, we do not find any effect of the market-specifying contract on productivity. We do, however, find that households offered the contract increased their market participation by 29 percentage points and earned on average $532 more per hectare.

Table 6 reports results from a comparison of the production-management contract combined with the market-specifying contract. Here we find that farmers offered contracts that provided extension training and a price guarantee neither add to their rice area nor increased their productivity. They did however increase their market participation and rice income. It is curious that providing a price guarantee resulted in households increasing their rice area while combing that guarantee with extension training had no impact on rice area. We explore these differences in more detail in the next subsection.

The impact of a contract that provides input loans in addition to extension training and a price guarantee are presented in Table 7. These results appear very similar to the results in Table 4, where we compared any farming contract to the control. Farmers offered contracts that provided extension training and a price guarantee did not add to their rice area but did increase their productivity, market participation, and rice income.

5.3. Differences in the impact of contract attributes on rural transformation

Our piecewise comparison of each contract type with the control group demonstrates that there are differences in the impacts contract attributes have on rural transformation. To investigate these differences further, we estimate ITT effects of each treatment, relative to the control, in a single regression. This not only allows us to test for differences between each treatment and the control but also test for differences between one treatment and another. Results from these regressions are presented in Table 8, with Bonferroni-adjusted Wald tests for differences between coefficients on the treatment dummies in Table 9.

The results for each treatment's impact on rice area is similar to the results presented in Tables 5-7. The market-specifying contract resulted in households increasing rice area while this contract combined with either extension training or input loans had no impact. It is unclear to us why a simple guaranteed price contract consistently has a positive impact on rice area while a price guarantee combined with other elements results in no change to rice area. We hypothesis that the provision of extension training and input loans focuses farmer attention on the optimal use of resources for the current rice area, while an absence of these components leaves farm expansion as the primary avenue for increasing income. The fact that the market-specifying contract results in no change to productivity supports this conjecture, but we lack the data to formally test these ideas.

Turning to each contract's effect on productivity, we find that only T3, with input loans, extension training, and a price guarantee, has a positive and significant impact. Yet, a Wald test for differences between each of these coefficients fails to reject the null of equality (Table 9). This suggests that while our experiment had sufficient power to detect differences in yield between T3 and the control we lack power to detect differences in yield between both T1 and the control and T2 and the control. Given that the impact between any farming contract and the control is only a quarter of a standard deviation, this lack of power to detect differences between each type of contract and the control is not surprising.

Results are more uniform when we look at the impact of each type of contract on market participation. We find that all three contracts have a positive and significant impact on market participation. This is to be expected, since each contract provided farmers with a guaranteed buyer for their rice crop. What is unexpected is that the market-specifying contract seems to result in the largest increase in the percentage of rice sold, though the results of the Wald test in Table 9 show these differences to be insignificant.

Examining the estimates of the ITT on rice income, we find that all three contracts resulted in a significant increase over the control group. However, unlike many of the previous comparison, here we do find significant differences between contract types. While the difference between T1 and T2 is not significant, the difference between T2 and T3, the difference between T1 and T3, and the differences between all pairwise comparisons are significant. Thus, while each contract increases income relative to the control, the level of increase differs between contracts. The market-specifying contract increases income by around $540 per hectare relative to the control while the market-specifying contract combined with the production-management contract has significantly less impact: a gain of only around $460 per hectare. The contract that combines the resource-providing contract with the other two contracts had the largest impact, increasing rice income by $975 relative to the control, significantly more than the other two contracts.

5.4. Pairwise comparison of differences in the impact of contract attributes

In the previous subsections we were able to test the ITT effects between each randomly assigned contract and the control, as well as differences between each contract. In an ideal world we would also be able to directly test between each contract characteristic separately, by offering a random set of farmers a contract that just provided extension training and no price guarantee or a contract that provided input loans and nothing else. However, due to the financial constraints of our implementing partner and the need to ensure sufficient power for comparisons between each treatment arm, we were limited to offering only three types of contracts.

In this subsection, we present results from comparing one type of contract with another and interpret the effects as due to the difference in contract attributes. Obviously, identification in this way requires the assumption that each new contract characteristic is additive and independent and expresses no complementarity or substitutability with the other contract attributes. Given this assumption, comparing the market-specifying contract (T1) with the contract that combines the price guarantee and extension training (T2) should provide the ITT effect of a production-management contract. Similarly, comparing T2 with the contract that also provides input loans (T3) should provide the ITT effect of a resource-providing contract. If the independence assumption does not hold, these comparisons are still informative regarding the differences in ITT effects, similar to those presented in Tables 8 and 9.

Table 10 presents estimates of the treatment effect of adding extension training to a contract by comparing the market-specifying and production-management contract (T2) to the market-specifying contract (T1). Here the differences between the two contracts implied by our previous results become explicit. Providing extension training had a negative and significant impact on rice area, market participation, and rice income compared to farmers who were simply provided with a price guarantee.

In Table 11, we present estimates of the treatment effect of adding input loans to a contract. Here we compare the contract that combines market-specification, production-management, and resource-provision to the contract that provides only the first two. We find that the provision of input loans increases rice area and rice income but has no significant impact on productivity and market participation.

Our final comparison is between the contract that combines market-specification, production-management, and resource-provision with the contract that only offers the price guarantee. Results are presented in Table 12. Here we find the addition of extension training and input loans has no significant effect over providing a price guarantee for rice area, productivity, and market participation. The only significant impact of these additional contract attributes is on rice income, which is about \$435 higher.

5.5. Discussion

The results from our field experiment present consistent, though somewhat unexpected, evidence regarding the impact of different farm contract attributes. Participation in contract farming had a positive and significant impact on productivity, market participation, and rice income, though not on rice area. We interpret this result as evidence that smallholder rice farmers in Benin are constrained less by land availability and more by lack of inputs such as seed, fertilizer and labor, and by limited market access. That land availability is not the binding constraint supports similar evidence from non-experimental studies conducted by Dries and Swinnen (2004) and Maertens and Vande Velde (2017). Our overall results also demonstrate that contract farming, at least the contracts ESOP offered to rice farmers in our study, are productivity and welfare increasing. However, this should not be interpreted as difinitive evidence that all contract farming is beneficial to the agent, as we designed the contracts to be generous to help ensure compliance in the study. That said, the contracting terms regarding compensation were well within the range of contracts ESOP had offered to farmers previous to our study.

While the overall positive effect of a farming contract was expected, we did not anticipate some of the differences in outcomes across contract type. In particular, contracts that provide extension training seemed to dampen incentives. Evidence from comparisons in Tables 6, 8, 9, 10, and 12 all show that the provision of extension training resulted in lower outcomes (though not always significantly lower) relative to the comparison group. As an example, in Table 11, providing input loans increases rice income by $516 but in Table 12 providing input loans in combinations with extension training results in an increase in rice income by only $435. Less directly but with more precison, Table 8 shows that the contract that offered extenion training in addition to a price guarentee but without input loans had to smallest impact on all four outcome variables.

These results may be explained by two factors. First, extension training is expected to increase technical efficiency. However, many smallholder farmers are resource-poor and may be unable to apply the knowledge they have gained. For instance, training regarding best practices for the application of fertilizer when the farmer cannot afford to buy the fertilizer is time ill spent. Second, the farmers in our experiment had very basic levels of education. The extension training developed with ESOP may have been pitched at too high a level to be effective. That extension training was ineffective in our study is disappointing but not abnormal. Both Feder et al. (2010) and Jones and Kondylis (2018) provide evidence that extension services received by farmers in developing countries often prove ineffective in producing positive and significant outcomes for smallholder farmers.[9] Furthermore, in many developing countries, extension services focus

[9] See also Bellemare (2010) for the impacts of extension services in the context of contract farming.

more on cash crops (cotton, cocoa, peanut, palm oil, etc.), neglecting staple food crops such as rice (Diagne and Pesche, 1995).

While extension training proved to provide low-powered incentives, contracts that only offered a price guarantee turned out to provide particularly high powered incentives. Across multiple comparison groups, the contract that only provided a price guarnatee frequently resulted in outcomes statistically indistinguishable from the contract that added input loans and extension training to the price guarantee. Focusing on the results in Table 9, the market-specifying contract resulted in a significantly larger positive impact on rice area relative to the other two contracts and the control. The market-specifying contract provided positive impacts on productivity and market participation that were statistically indistinguishable from the contract that also provided input loans. Rice income was the only outcome variable where the market-specifying contract failed to meet or exceed the contract that provided input loans.

This result is striking in its simplicity and enormously encouraging in its implications for contract farming and rural transformation. In contrast to Abebe et al. (2013), who find that farmers in Ethiopia prefer contracts the insulate them from input price risk, our results imply that the primary issue facing smallholders farmers, at least rice farmers in Benin, is output price risk. By providing a contract that eliminates price risk, farmers are able to, on their own, make the necessarily investment to increase their rice area, increase the percentage of output sold into the market, and as a result, increase their farm income. Our results demonstrate experimentally what has long been argued from observational data, that farmers respond to price incentives (Schultz, 1964). For organizations looking to provide contracts to farmers, this result is encouraging because it implies that they can provide strong incentives to farmers without undertaking the costs of providing training and input loans. By far the most binding constraint to expansion for ESOP is the need to raise sufficient capital to provide input loans to farmers at planting. Our results demonstrate that much of this expense is unnecessary and ESOP could greatly expand the number of farmers it contracts with, and thus its milling capacity, by only offering farmers a guaranteed price. With a price guarantee delivering market access, farmers can use the contract as collateral to rent in more land and obtain loans for inputs, improving outcomes for both parties and contributing to more rapid rural transformation.

6. Conclusion

The use of contract farming has a long tradition in modern agriculture and has become an increasing topic of discussion in developing country agriculture. Contract farming has been proposed as an engine for rural transformation and not just an outcome from the modernization of agriculture. However, concrete evidence for or against the role of contract farming in rural transformation has been lacking. Previous studies have been exclusively observational, while many studies have attempted to draw causal inference from cross-sectional data. Our study provides the first experimental evidence of the impacts of contract farming in a developing country context.

Our results demonstrate that contract farming has positive and significant impacts on a number of different measures of farm productivity and household welfare and contributes to rural transformation. Of particular interest to both contracting parties, as well as policymakers, are the strong incentives provided by a simple market-specifying contract. The provision of a price guarantee resulted in outcomes frequently indistinguishable from more complex (and more costly) contracts that provided extension training and/or input loans. This suggests that once price uncertainty is resolved, farmers are able to, on their own, address issues of technical efficiency and capital constraints.

A caveat, as with any experimental study, is that the external validity of our results may be limited. Yet, we believe that our experiment provides a context and setting more generalizable than most observational studies of contract farming. Observational studies have frequently focused on high-value of specialty crops, cultivated by a small number of farmers relative to the number cultivating staple crops. In comparison, we study contract farming for a staple grain. Unlike specialty crops, the margins, and therefore the incentives, for staple crop cultivation are small, even given the generous terms of the contracts offered to farmers by ESOP. This suggests that our results should not only be generalizable to contract farming for other staple crops but may be a lower bound on the impacts that contract farming has on specialty crops.

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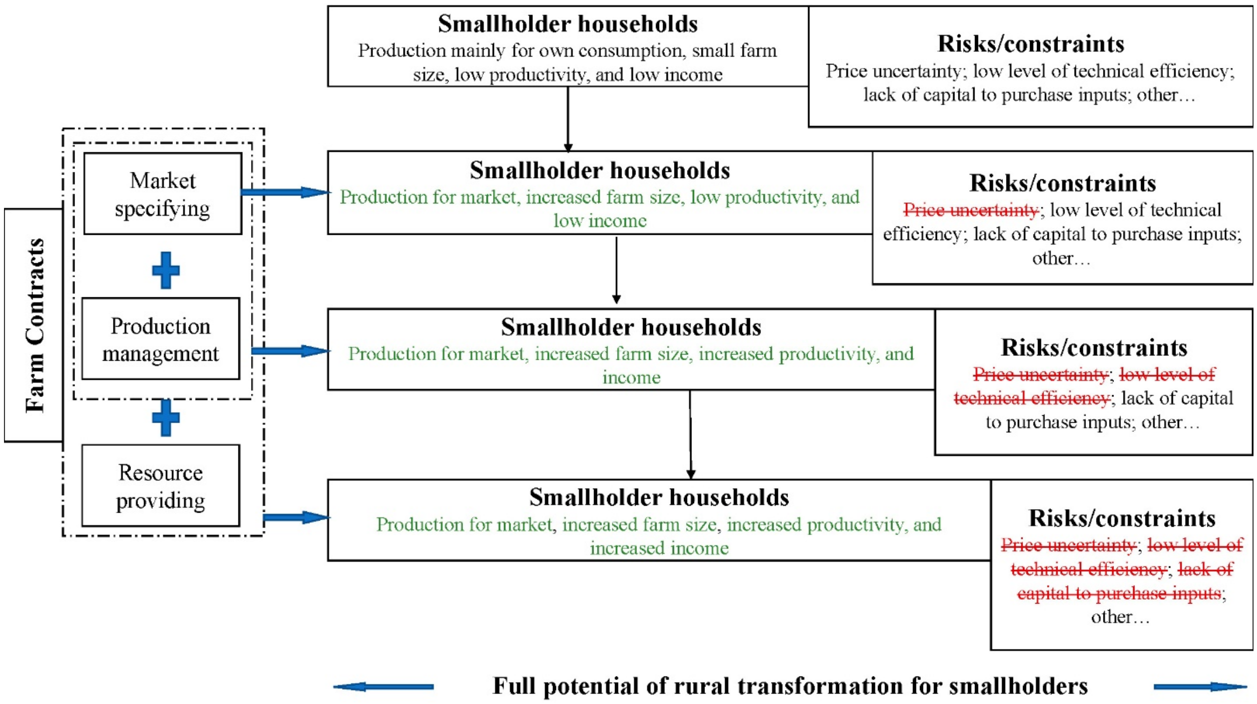

Figure 1: Contract farming and rural transformation

Table 1: Attributes of existing contract farming arrangements

		Number	Percentage
Awareness of existing of contract farming		745	87.13
Experience in contract farming		605	70.75
Type of contract	Oral	779	91.15
	Written	76	8.85
Agreement on price		281	32.86
Agreement on quality		707	82.67
Agreement on quantity		342	40.01
Technical training/backstopping		379	44.29
Credit	In-kind credit	134	15.71
	In-cash credit	98	11.43
	Consumption credit	12	1.43

Note: Table displays number of households and percentage of household in the data set that responded in the affirmative to questions regarding their awareness of and experience with contract farming.

Table 2: Baseline summary statistics and balance test

	Control (n=220)	Price [T1] (n=114)	Extension & price [T2] (n=252)	Input loans, extension, & price [T3] (n=269)	Difference between groups				
					[T1-C]	[T2-T1]	[T3-T2]	[T3-T1]	[T3-C]
Rice area (ha)	0.629	0.645	1.095	0.769	0.017	0.449*	-0.326	0.123	0.140
	(0.751)	(0.822)	(3.035)	(1.173)	(0.091)	(0.226)	(0.238)	(0.128)	(0.121)
Productivity (kg/ha)	819.19	848.61	1,024	922.91	29.41	176.2	-101.9	74.30	103.7
	(1,493)	(1,855)	(1,672)	(1,404)	(290.3)	(338.3)	(280.5)	(310.8)	(221.2)
Market participation (%)	28.82	25.74	45.79	44.36	-3.082	20.05*	-1.437	18.61*	15.53*
	(38.16)	(36.79)	(41.74)	(41.98)	(5.587)	(7.892)	(8.780)	(7.284)	(6.840)
Income (US$/ha)	182.7	217.1	272.8	264.4	34.40	55.68	-8.379	47.30	81.71
	(344.5)	(627.5)	(388.0)	(382.1)	(76.43)	(91.35)	(76.86)	(87.24)	(58.83)
Household size	8.818	7.930	8.452	8.677	-0.888	0.523	0.224	0.747	-0.142
	(4.386)	(4.002)	(5.058)	(5.639)	(0.689)	(0.804)	(0.722)	(0.846)	(0.613)
Age of household head (years)	40.55	42.22	41.52	39.74	1.647	-0.678	-1.784	-2.462	-0.815
	(8.972)	(10.32)	(10.48)	(10.74)	(1.394)	(1.572)	(1.290)	(1.541)	(1.110)
Male headed household (=1)	0.564	0.640	0.488	0.591	0.077	-0.152	0.103	-0.049	0.027
	(0.497)	(0.482)	(0.501)	(0.493)	(0.080)	(0.086)	(0.067)	(0.079)	(0.063)
Experience producing rice (years)	8.195	7.868	9.778	7.981	-0.327	1.909	-1.796	0.113	-0.214
	(3.593)	(5.735)	(6.089)	(4.780)	(1.250)	(1.467)	(0.997)	(1.364)	(0.657)
Primary education (=1)	0.114	0.096	0.123	0.093	-0.017	0.027	-0.030	-0.004	-0.021
	(0.318)	(0.297)	(0.329)	(0.291)	(0.032)	(0.031)	(0.024)	(0.030)	(0.025)
Farming is main activity (=1)	0.918	0.947	0.913	0.918	0.029	-0.035	0.006	-0.029	0.000
	(0.275)	(0.224)	(0.283)	(0.275)	(0.036)	(0.040)	(0.035)	(0.040)	(0.032)
Training in rice production (=1)	0.527	0.193	0.627	0.550	-0.334***	0.434***	-0.077	0.357***	0.023
	(0.500)	(0.396)	(0.485)	(0.498)	(0.063)	(0.091)	(0.111)	(0.095)	(0.090)
Member of farm assoc. (=1)	0.968	0.921	0.976	0.974	-0.047	0.055	-0.002	0.053	0.006
	(0.176)	(0.271)	(0.153)	(0.159)	(0.034)	(0.036)	(0.020)	(0.031)	(0.016)

Note: The first four columns report means of the data at baseline with standard deviations in parenthesis. The final five columns report coefficients and standard errors on treatment status from an OLS regressions comparing households in each treatment with the other treatments as well as the control groups at baseline. Regressions include treatment status, arrondissement fixed effects, and standard errors clustered at the farmer-group-level. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 3: Baseline differences between attrited and returning households

	Returning (n=855)	Attrited (n=98)	Difference between groups
Rice area (ha)	0.812	0.723	-0.089
	(1.847)	(0.767)	(0.107)
Productivity (kg/ha)	916.3	599.0	-317.2**
	(1,573)	(821.0)	(122.7)
Market participation (%)	38.30	38.14	-0.162
	(41.11)	(42.41)	(5.141)
Income (US$/ha)	239.5	176.8	-62.69
	(417.2)	(249.1)	(36.20)
Household size	8.547	8.480	-0.068
	(4.963)	(4.263)	(0.583)
Age of household head (years)	40.80	44.49	3.686**
	(10.20)	(11.20)	(1.230)
Male headed household (=1)	0.560	0.571	0.011
	(0.497)	(0.497)	(0.059)
Experience producing rice (years)	8.551	9.378	0.827
	(5.135)	(5.979)	(0.666)
Primary education (=1)	0.108	0.051	-0.057*
	(0.310)	(0.221)	(0.025)
Farming is main activity (=1)	0.920	0.969	0.049**
	(0.271)	(0.173)	(0.017)
Training in rice production (=1)	0.519	0.429	-0.091
	(0.500)	(0.497)	(0.062)
Member of farm assoc. (=1)	0.966	0.959	-0.007
	(0.181)	(0.199)	(0.023)

Note: The first two columns report means of the data at baseline with standard deviations in parenthesis. The third column reports coefficients and standard errors on treatment status from an OLS regressions comparing returning and attriting households. Regressions include treatment status, arrondissement fixed effects. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 4: Treatment effects of farming contract [T-C]

	SMD (1)	SMD (2)	DID (3)	DID (4)	FE (5)	FE (6)
Panel A: rice area (ha)						
Treatment effect	0.204***	0.178***	-0.043	-0.043	-0.043	-0.044
	(0.026)	(0.057)	(0.118)	(0.118)	(0.116)	(0.117)
Observations	855	855	1,710	1,710	1,710	1,710
R-squared	0.046	0.072	0.033	0.043	0.004	0.004
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel B: productivity (kg/ha)						
Treatment effect	466.8***	481.3***	348.5*	348.6*	348.5*	345.5*
	(98.08)	(108.1)	(190.1)	(190.6)	(188.2)	(188.4)
Observations	855	855	1,710	1,710	1,710	1,710
R-squared	0.086	0.099	0.236	0.239	0.268	0.269
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel C: market participation (%)						
Treatment effect	32.94***	34.73***	22.62***	22.62***	22.62***	22.53***
	(2.634)	(2.411)	(5.117)	(5.129)	(5.067)	(5.061)
Observations	855	855	1,710	1,710	1,710	1,710
R-squared	0.487	0.498	0.273	0.278	0.123	0.125
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel D: rice income (USD$)						
Treatment effect	730.4***	787.2***	693.0***	693.1***	693.0***	691.8***
	(86.36)	(99.64)	(65.28)	(65.44)	(64.65)	(64.92)
Observations	855	855	1,710	1,710	1,710	1,710
R-squared	0.177	0.195	0.379	0.385	0.475	0.476
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes

Note: For simplicity, coefficient estimates are only reported for the ITT. Household covariates include household size, age and gender of household head, number of years growing rice, and indicators for if the household head had at least primary education, if farming is the household's main activity, if they have received extension training previously, and if they are a member of a farmer association. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 5: Treatment effects of price guarantee [T1-C]

	SMD (1)	SMD (2)	DID (3)	DID (4)	FE (5)	FE (6)
Panel A: rice area (ha)						
Treatment effect	0.236***	0.038	0.219*	0.219*	0.219*	0.212*
	(0.044)	(0.095)	(0.112)	(0.113)	(0.110)	(0.113)
Observations	334	334	668	668	668	668
R-squared	0.080	0.151	0.086	0.102	0.073	0.075
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel B: productivity (kg/ha)						
Treatment effect	603.8***	456.8***	451.3	451.1	451.3	435.2
	(145.0)	(164.8)	(319.8)	(321.8)	(312.7)	(311.7)
Observations	334	334	668	668	668	668
R-squared	0.157	0.184	0.232	0.247	0.242	0.245
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel C: market participation (%)						
Treatment effect	20.355***	20.008***	29.254***	29.258***	29.254***	29.080***
	(2.413)	(2.879)	(5.378)	(5.413)	(5.260)	(5.300)
Observations	334	334	668	668	668	668
R-squared	0.490	0.499	0.195	0.202	0.124	0.124
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel D: rice income (USD$)						
Treatment effect	460.3***	422.8***	538.6***	538.7***	538.6***	532.3***
	(138.1)	(153.1)	(123.0)	(123.8)	(120.3)	(119.4)
Observations	334	334	668	668	668	668
R-squared	0.337	0.353	0.369	0.379	0.429	0.621
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes

Note: For simplicity, coefficient estimates are only reported for the ITT. Household covariates include household size, age and gender of household head, number of years growing rice, and indicators for if the household head had at least primary education, if farming is the household's main activity, if they have received extension training previously, and if they are a member of a farmer association. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 6: Treatment effects of extension training and price guarantee [T2-C]

	SMD	SMD	DID	DID	FE	FE
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: rice area (ha)						
Treatment effect	0.131***	0.111**	-0.335	-0.335	-0.335	-0.335
	(0.030)	(0.043)	(0.224)	(0.225)	(0.220)	(0.221)
Observations	472	472	944	944	944	944
R-squared	0.029	0.069	0.049	0.056	0.006	0.006
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel B: productivity (kg/ha)						
Treatment effect	443.8***	474.1***	178.4	178.5	178.4	177.2
	(97.45)	(79.17)	(269.4)	(270.6)	(265.2)	(265.5)
Observations	472	472	944	944	944	944
R-squared	0.10	0.12	0.21	0.22	0.21	0.21
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel C: market participation (%)						
Treatment effect	32.31***	32.10***	15.32**	15.31**	15.32**	15.30**
	(2.395)	(2.364)	(7.632)	(7.667)	(7.513)	(7.533)
Observations	472	472	944	944	944	944
R-squared	0.578	0.590	0.277	0.283	0.039	0.039
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel D: rice income (USD$)						
Treatment effect	630.3***	631.3***	460.8***	460.8***	460.8***	459.5***
	(77.60)	(78.74)	(79.38)	(79.72)	(78.15)	(78.53)
Observations	472	472	944	944	944	944
R-squared	0.23	0.24	0.38	0.38	0.44	0.44
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes

Note: For simplicity, coefficient estimates are only reported for the ITT. Household covariates include household size, age and gender of household head, number of years growing rice, and indicators for if the household head had at least primary education, if farming is the household's main activity, if they have received extension training previously, and if they are a member of a farmer association. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 7: Treatment effects of input loans, extension training, and price guarantee [T3-C]

	SMD (1)	SMD (2)	DID (3)	DID (4)	FE (5)	FE (6)
Panel A: rice area (ha)						
Treatment effect	0.258***	0.279***	0.118	0.118	0.118	0.117
	(0.033)	(0.088)	(0.125)	(0.125)	(0.123)	(0.123)
Observations	489	489	978	978	978	978
R-squared	0.092	0.130	0.081	0.100	0.038	0.038
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel B: productivity (kg/ha)						
Treatment effect	509.1***	513.5***	464.3*	464.6*	464.3**	457.4*
	(143.6)	(169.8)	(236.2)	(237.4)	(232.3)	(232.5)
Observations	489	489	978	978	978	978
R-squared	0.1	0.2	0.3	0.3	0.3	0.3
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel C: market participation (%)						
Treatment effect	37.75***	38.78***	26.66***	26.67***	26.66***	26.50***
	(2.902)	(2.773)	(7.144)	(7.177)	(7.026)	(7.023)
Observations	489	489	978	978	978	978
R-squared	0.675	0.685	0.327	0.336	0.136	0.141
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel D: rice income (USD$)						
Treatment effect	1,008***	1,045***	976.0***	976.3***	976.0***	974.2***
	(103.52)	(123.74)	(86.40)	(86.77)	(84.97)	(86.03)
Observations	489	489	978	978	978	978
R-squared	0.32	0.34	0.46	0.47	0.53	0.54
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes

Note: For simplicity, coefficient estimates are only reported for the ITT. Household covariates include household size, age and gender of household head, number of years growing rice, and indicators for if the household head had at least primary education, if farming is the household's main activity, if they have received extension training previously, and if they are a member of a farmer association. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 8: Treatment effects of each contract characteristic [T3-T2-T1-C]

	SMD (1)	SMD (2)	DID (3)	DID (4)	FE (5)	FE (6)
Panel A: rice area (ha)						
Treatment effect of T1	0.236***	0.222***	0.219**	0.219*	0.219**	0.219**
	(0.044)	(0.067)	(0.110)	(0.111)	(0.109)	(0.109)
Treatment effect of T2	0.131***	0.117**	-0.335	-0.335	-0.335	-0.335
	(0.030)	(0.050)	(0.222)	(0.223)	(0.220)	(0.220)
Treatment effect of T3	0.258***	0.241***	0.118	0.118	0.118	0.117
	(0.033)	(0.066)	(0.124)	(0.124)	(0.122)	(0.123)
Observations	855	855	1,710	1,710	1,710	1,710
R-squared	0.061	0.084	0.040	0.051	0.016	0.016
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel B: productivity (kg/ha)						
Treatment effect of T1	507.3***	489.7***	451.3	451.2	451.3	451.9
	(127.5)	(147.4)	(314.2)	(315.0)	(311.0)	(311.3)
Treatment effect of T2	393.3***	420.8***	178.4	178.6	178.4	177.7
	(102.8)	(114.1)	(267.2)	(267.9)	(264.4)	(264.7)
Treatment effect of T3	550.0***	553.2***	464.2**	464.4*	464.2**	457.9*
	(112.3)	(121.9)	(234.1)	(234.8)	(231.7)	(231.8)
Observations	855	855	1,710	1,710	1,710	1,710
R-squared	0.09	0.10	0.24	0.24	0.27	0.27
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel C: market participation (%)						
Treatment effect of T1	22.26***	23.66***	29.25***	29.25***	29.25***	29.23***
	(2.755)	(2.587)	(5.285)	(5.298)	(5.231)	(5.235)
Treatment effect of T2	30.59***	31.25***	15.32**	15.31**	15.32**	15.33**
	(2.325)	(2.147)	(7.570)	(7.589)	(7.492)	(7.493)
Treatment effect of T3	40.11***	41.58***	26.66***	26.66***	26.66***	26.44***
	(2.363)	(2.129)	(7.082)	(7.099)	(7.009)	(6.992)
Observations	855	855	1,710	1,710	1,710	1,710
R-squared	0.539	0.552	0.291	0.295	0.135	0.137
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes

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Panel D: rice income (USD$)						
Treatment effect of T1	527.2***	563.4***	313.9***	313.9***	538.6***	539.9***
	(100.9)	(122.2)	(29.63)	(29.71)	(119.6)	(120.1)
Treatment effect of T2	563.4***	595.9***	538.6***	538.5***	460.8***	459.4***
	(75.49)	(92.88)	(120.8)	(121.1)	(77.93)	(78.34)
Treatment effect of T3	1,030***	1,073***	460.8***	460.9***	976.0***	975.1***
	(88.22)	(100.18)	(78.74)	(78.91)	(84.76)	(85.55)
Observations	855	855	1,710	1,710	1,710	1,710
R-squared	0.22	0.24	0.41	0.42	0.50	0.50
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes

Note: For simplicity, coefficient estimates are only reported for the ITT. Household covariates include household size, age and gender of household head, number of years growing rice, and indicators for if the household head had at least primary education, if farming is the household's main activity, if they have received extension training previously, and if they are a member of a farmer association. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 9: Wald tests for differences between coefficients

	SMD (1)	SMD (2)	DID (3)	DID (4)	FE (5)	FE (6)
Panel A: rice area (ha)						
Difference between T2 & T1	0.072*	0.126	0.054*	0.055*	0.051*	0.051*
Difference between T3 & T2	0.002***	0.008***	0.172	0.173	0.164	0.166
Difference between T3 & T1	1.000	1.000	1.000	1.000	1.000	1.000
All pairwise comparisons	0.001***	0.008***	0.060*	0.061*	0.057*	0.057*
Panel B: productivity (kg/ha)						
Difference between T2 & T1	1.000	1.000	1.000	1.000	1.000	1.000
Difference between T3 & T2	1.000	1.000	1.000	1.000	1.000	1.000
Difference between T3 & T1	1.000	1.000	1.000	1.000	1.000	1.000
All pairwise comparisons	0.593	0.601	0.599	0.601	0.593	0.601
Panel C: market participation (%)						
Difference between T2 & T1	0.001***	0.001***	0.240	0.242	0.230	0.233
Difference between T3 & T2	0.000***	0.000***	0.661	0.664	0.647	0.672
Difference between T3 & T1	0.000***	0.000***	1.000	1.000	1.000	1.000
All pairwise comparisons	0.000***	0.000***	0.211	0.213	0.204	0.207
Panel D: rice income (USD$)						
Difference between T2 & T1	1.000	1.000	1.000	1.000	1.000	1.000
Difference between T3 & T2	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***
Difference between T3 & T1	0.000***	0.000***	0.008***	0.008***	0.007***	0.008***
All pairwise comparisons	0.000***	0.000***	0.000***	0.000***	0.000***	0.000***

Note: Each cell contains the Bonferroni-adjusted p-values for Wald tests between coefficient estimates reported in Table 8. Significance of the test is reported as *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table 10: Treatment effects of extension training [T2-T1]

	SMD (1)	SMD (2)	DID (3)	DID (4)	FE (5)	FE (6)
Panel A: rice area (ha)						
Treatment effect	-0.104**	-0.104*	-0.553**	-0.554**	-0.553**	-0.553**
	(0.046)	(0.056)	(0.232)	(0.233)	(0.230)	(0.230)
Observations	366	366	732	732	732	732
R-squared	0.014	0.047	0.041	0.061	0.010	0.010
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel B: productivity (kg/ha)						
Treatment effect	-164.9	-83.4	-273.0	-272.9	-273.0	-273.8
	(100.0)	(110.4)	(367.5)	(369.6)	(363.7)	(364.1)
Observations	366	366	732	732	732	732
R-squared	0.0	0.1	0.2	0.2	0.2	0.2
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel C: market participation (%)						
Treatment effect	10.41***	9.114***	-13.93*	-13.94*	-13.93*	-13.95*
	(2.161)	(2.125)	(7.931)	(7.975)	(7.849)	(7.873)
Observations	366	366	732	732	732	732
R-squared	0.086	0.120	0.250	0.257	0.134	0.134
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel D: rice income (USD$)						
Treatment effect	35.71	29.23	-77.80	-77.70	-77.80	-79.64
	(82.48)	(89.46)	(138.4)	(139.5)	(137.4)	(137.8)
Observations	366	366	732	732	732	732
R-squared	0.04	0.07	0.33	0.33	0.45	0.45
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes

Note: For simplicity, coefficient estimates are only reported for the ITT. Household covariates include household size, age and gender of household head, number of years growing rice, and indicators for if the household head had at least primary education, if farming is the household's main activity, if they have received extension training previously, and if they are a member of a farmer association. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 11: Treatment effects of input loans [T3-T2]

	SMD	SMD	DID	DID	FE	FE
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: rice area (ha)						
Treatment effect	0.127***	0.129***	0.453*	0.453*	0.453*	0.452*
	(0.037)	(0.039)	(0.236)	(0.237)	(0.234)	(0.234)
Observations	521	521	1,042	1,042	1,042	1,042
R-squared	0.023	0.053	0.035	0.056	0.010	0.010
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel B: productivity (kg/ha)						
Treatment effect	166.9**	159.2**	285.9	285.9	285.9	280.1
	(79.7)	(79.1)	(297.7)	(298.9)	(295.2)	(295.3)
Observations	521	521	1,042	1,042	1,042	1,042
R-squared	0.0	0.1	0.2	0.3	0.3	0.3
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel C: market participation (%)						
Treatment effect	9.794***	10.85***	11.34	11.35	11.34	11.10
	(1.502)	(1.634)	(9.213)	(9.250)	(9.137)	(9.119)
Observations	521	521	1,042	1,042	1,042	1,042
R-squared	0.123	0.162	0.234	0.247	0.141	0.144
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel D: rice income (USD$)						
Treatment effect	487.4***	504.0***	515.5***	515.5***	515.1***	515.7***
	(75.20)	(72.2)	(107.2)	(107.7)	(106.3)	(107.1)
Observations	521	521	1,042	1,042	1,042	1,042
R-squared	0.09	0.14	0.39	0.40	0.52	0.52
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes

Note: For simplicity, coefficient estimates are only reported for the ITT. Household covariates include household size, age and gender of household head, number of years growing rice, and indicators for if the household head had at least primary education, if farming is the household's main activity, if they have received extension training previously, and if they are a member of a farmer association. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Table 12: Treatment effects of input loans and extension training [T3-T1]

	SMD (1)	SMD (2)	DID (3)	DID (4)	FE (5)	FE (6)
Panel A: rice area (ha)						
Treatment effect	0.023	0.025	-0.101	-0.101	-0.101	-0.101
	(0.049)	(0.048)	(0.140)	(0.141)	(0.139)	(0.140)
Observations	383	383	766	766	766	766
R-squared	0.001	0.038	0.072	0.128	0.061	0.061
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel B: productivity (kg/ha)						
Treatment effect	120.96	114.86	12.91	12.95	12.91	7.81
	(101.28)	(108.93)	(343.32)	(345.12)	(339.70)	(339.95)
Observations	383	383	766	766	766	766
R-squared	0.04	0.07	0.28	0.29	0.33	0.33
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel C: market participation (%)						
Treatment effect	17.045***	16.894***	-2.590	-2.576	-2.590	-2.677
	(2.030)	(2.060)	(7.544)	(7.585)	(7.465)	(7.478)
Observations	383	383	766	766	766	766
R-squared	0.206	0.227	0.303	0.318	0.235	0.240
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes
Panel D: rice income (USD$)						
Treatment effect	551.50***	552.62***	437.35***	437.91***	437.35***	434.88***
	(96.20)	(101.22)	(142.90)	(143.55)	(141.40)	(142.47)
Observations	383	383	766	766	766	766
R-squared	0.09	0.12	0.39	0.40	0.52	0.52
Arrondissement FE	Yes	Yes	Yes	Yes	No	No
Household Covariates	No	Yes	No	Yes	No	Yes
Household FE	No	No	No	No	Yes	Yes
Year FE	No	No	Yes	Yes	Yes	Yes

Note: For simplicity, coefficient estimates are only reported for the ITT. Household covariates include household size, age and gender of household head, number of years growing rice, and indicators for if the household head had at least primary education, if farming is the household's main activity, if they have received extension training previously, and if they are a member of a farmer association. Robust standard errors, clustered at the farmer-group level, in parentheses (*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$).

Appendix A: Translations of farming contracts

The following are English translations of the three contracts ESOP offered, at random, to farmers in the study. The first contract only provides a price guarantee. The second contract combines the price guarantee with extension training. The third contract adds the provision of seed and fertilizer to the price guarantee and extension training.

CONTRACT

Object of Contract: Production of rice paddy by …………………………………
for the delivery to …………………………………

Contract Partners:

Partner 1: Last and First Names: …………………………………

Residence / Location …………………………………

Contact Number: …………………………………

Function: …………………………………

Partner 2: Last and First Names: …………………………………

Residence / Location: …………………………………

Contact Number: …………………………………

Function: …………………………………

Both parties agree to undertake (respect) the following clauses:

Clause 1: Partner 1 is the initiator of the present contract
Clause 2: Both parties must respect the contract
Clause 3: Partner 1 agrees to buy ……………kilograms of rice paddy produced by Partner 2

Clause 4: Partner 1 will not provide any input to the production by Partner 2

Clause 5: Partner 1 will not provide any technical or training assistance to Partner 2

Clause 6: Partner 2 commits to providing rice of the variety ***IR841*** to Partner 1

Clause 7: Partner 2 is committed to providing rice of ……… percent of impurities to Partner 1

Clause 8: Partner 2 agrees to sell paddy rice at ……………..….FCFA/kilogram to Partner 1. Partner 1 agrees to buy rice paddy at …………..………….FCFA/kilogram

Clause 9: Partner 2 agrees to deliver the rice paddy in the month of …………..…………. in the year of ……………………..
Clause 10: Both partners commit to be faithful to their commitments.
Clause 11: The present contract will last ……......….months from ..…/…../……

Clause 12: Delivery of the rice will be in the village group.

Clause 13: The packaging of rice paddy are lost or recoverable.

Clause 14: Paddy rice will be delivered in 100 kilogram bags for packaging of 80 kilogram.

Clause 15: the present contract is a contract: (fixed period/duration undetermined)

Clause 16: Payment for rice for Mr./Mrs. ……………… will……………… (*in kind* / in cash)

Clause 17: In case of conflict, the regulation will be in ………………………………… (friendly / court)

Partner 1 ***Signature*** ***Partner 2*** ***Signature***

First and last name ***First and last name***

Witnesses

First and last name ***First and last name***

Made in …………………the

…/……/201……..

CONTRACT

Object of Contract: Production of rice paddy by …………………………………
for the delivery to …………………………………

Contract Partners:

Partner 1: Last and First Names: …………………………………

Residence / Location …………………………………

Contact Number: …………………………………

Function: …………………………………

Partner 2: Last and First Names: …………………………………

Residence / Location: …………………………………

Contact Number: …………………………………

Function: …………………………………

Both parties agree to undertake (respect) the following clauses:

Clause 1: Partner 1 is the initiator of the present contract
Clause 2: Both parties must respect the contract
Clause 3: Partner 1 agrees to buy ……………kilograms of rice paddy produced by Partner 2

Clause 4: Partner 1 will not provide any input to the production by Partner 2

Clause 5: Partner 1 is committed to training Partner 2 on the following topics: agricultural contracts, rice production techniques, farm management, and calculating the cost of rice production

Clause 6: Partner 2 commits to providing rice of the variety ***IR841*** to Partner 1

Clause 7: Partner 2 is committed to providing rice of ……… percent of impurities to Partner 1

Clause 8: Partner 2 agrees to sell paddy rice at ……………..….FCFA/kilogram to Partner 1. Partner 1 agrees to buy rice paddy at ………….………….FCFA/kilogram

Clause 9: Partner 2 agrees to deliver the rice paddy in the month of ……….…………. in the year of ……………………..

Clause 10: Both partners commit to be faithful to their commitments.
Clause 11: The present contract will last …….......…..months from ...…/…../……
Clause 12: Delivery of the rice will be in the village group.

Clause 13: The packaging of rice paddy are lost or recoverable.

Clause 14: Paddy rice will be delivered in 100 kilogram bags for packaging of 80 kilogram.

Clause 15: the present contract is a contract: (fixed period/duration undetermined)

Clause 16: Payment for rice for Mr./Mrs. ……………… will……………… (*in kind* / in cash)

Clause 17: In case of conflict, the regulation will be in ……………………………… (friendly / court)

Partner 1 ***Signature*** ***Partner 2*** ***Signature***

First and last name ***First and last name***

Witnesses

First and last name ***First and last name***

Made in …………………the

…/……/201……..

CONTRACT

Object of Contract: Production of rice paddy by …………………………………
for the delivery to …………………………………

Contract Partners:

Partner 1: Last and First Names: …………………………………

Residence / Location …………………………………

Contact Number: …………………………………

Function: …………………………………

Partner 2: Last and First Names: …………………………………

Residence / Location: …………………………………

Contact Number: …………………………………

Function: …………………………………

Both parties agree to undertake (respect) the following clauses:

Clause 1: Partner 1 is the initiator of the present contract
Clause 2: Both parties must respect the contract
Clause 3: Partner 1 agrees to buy ……………kilograms of rice paddy produced by Partner 2

Clause 4: Partner 1 is committed to providing seed (……..………kilograms) and fertilizer (……..………kilograms) for Partner 2

Clause 5: Partner 1 is committed to training Partner 2 on the following topics: agricultural contracts, rice production techniques, farm management, and calculating the cost of rice production

Clause 6: Partner 2 commits to providing rice of the variety ***IR841*** to Partner 1

Clause 7: Partner 2 is committed to providing rice of ……… percent of impurities to Partner 1

Clause 8: Partner 2 agrees to sell paddy rice at ……………..….FCFA/kilogram to Partner 1. Partner 1 agrees to buy rice paddy at ………….………….FCFA/kilogram

Clause 9: Partner 2 agrees to deliver the rice paddy in the month of …………………… in the year of ……………………..
Clause 10: Both partners commit to be faithful to their commitments.
Clause 11: The present contract will last …….......…..months from ...…/…../……
Clause 12: Delivery of the rice will be in the village group.

Clause 13: The packaging of rice paddy are lost or recoverable.

Clause 14: Paddy rice will be delivered in 100 kilogram bags for packaging of 80 kilogram.

Clause 15: the present contract is a contract: (fixed period/duration undetermined)

Clause 16: Payment for rice for Mr./Mrs. ……………… will……………… (*in kind* / in cash)

Clause 17: In case of conflict, the regulation will be in ………………………………… (friendly / court)

Partner 1 ***Signature*** ***Partner 2*** ***Signature***

First and last name ***First and last name***

Witnesses

First and last name ***First and last name***

Made in …………………the

…/……/201……..

Appendix B: Corrections for multiple hypothesis tests

Table 13: Correction for multiple inference of the treatment effects of farming contract [T-C]

	SMD (1)	SMD (2)	DID (3)	DID (4)	FE (5)	FE (6)
Panel A: rice area (ha)						
Unadjusted *p*-value	0.0001	0.0023	0.7130	0.7131	0.7103	0.7072
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0003					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0010	0.2170	0.2170	0.2160	0.2150
Panel B: productivity (kg/ha)						
Unadjusted *p*-value	0.0001	0.0001	0.0696	0.0703	0.0670	0.0695
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0007					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0010	0.0490	0.0500	0.0470	0.0490
Panel C: market participation (%)						
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0013					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Panel D: rice income (USD$)						
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0010					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010

Note: Each cell contains *p*- or *q*-values for the multiple regressions presented in Table 4. Bonferroni, Holm, and List et al. adjusted p-values are calculated using the Stata code from List et al. (2018). The sharpened q-values are calcualted using the Stata code from Anderson (2008). Note that the code in List et al. (2018) only makes adjustments for SMD estimates of the treatment effect. Additionally, the code cannot accommodate the presence of covariates.

Table 14: Correction for multiple inference of the treatment effects of price guarantee [T1-C]

	SMD (1)	SMD (2)	DID (3)	DID (4)	FE (5)	FE (6)
Panel A: rice area (ha)						
Unadjusted *p*-value	0.0001	0.6904	0.0569	0.0583	0.0518	0.0662
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0013					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.2090	0.0400	0.0410	0.0360	0.0470
Panel B: productivity (kg/ha)						
Unadjusted *p*-value	0.0001	0.0078	0.1643	0.1672	0.1552	0.1688
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0007					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0090	0.0830	0.0850	0.0750	0.0930
Panel C: market participation (%)						
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0003					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Panel D: rice income (USD$)						
Unadjusted *p*-value	0.0016	0.0080	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0010					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0090	0.0010	0.0010	0.0010	0.0010

Note: Each cell contains *p*- or *q*-values for the multiple regressions presented in Table 4. Bonferroni, Holm, and List et al. adjusted p-values are calculated using the Stata code from List et al. (2018). The sharpened q-values are calcualted using the Stata code from Anderson (2008). Note that the code in List et al. (2018) only makes adjustments for SMD estimates of the treatment effect. Additionally, the code cannot accommodate the presence of covariates.

Table 15: Correction for multiple inference of the treatment effects of extension training and price guarantee [T2-C]

	SMD (1)	SMD (2)	DID (3)	DID (4)	FE (5)	FE (6)
Panel A: rice area (ha)						
Unadjusted *p*-value	0.0001	0.0126	0.1400	0.1416	0.1339	0.1340
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0007					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0040	0.1090	0.1110	0.1010	0.1030
Panel B: productivity (kg/ha)						
Unadjusted *p*-value	0.0001	0.0001	0.5102	0.5118	0.5036	0.5069
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0010					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0010	0.2300	0.2330	0.2180	0.2180
Panel C: market participation (%)						
Unadjusted *p*-value	0.0001	0.0001	0.0489	0.0499	0.0455	0.0463
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0013					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0010	0.0800	0.0810	0.0740	0.0750
Panel D: rice income (USD$)						
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0003					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010

Note: Each cell contains *p*- or *q*-values for the multiple regressions presented in Table 4. Bonferroni, Holm, and List et al. adjusted p-values are calculated using the Stata code from List et al. (2018). The sharpened q-values are calcualted using the Stata code from Anderson (2008). Note that the code in List et al. (2018) only makes adjustments for SMD estimates of the treatment effect. Additionally, the code cannot accommodate the presence of covariates.

Table 16: Correction for multiple inference of the treatment effects of input loans, extension training, and price guarantee [T3-C]

	SMD (1)	SMD (2)	DID (3)	DID (4)	FE (5)	FE (6)
Panel A: rice area (ha)						
Unadjusted *p*-value	0.0001	0.0023	0.3459	0.3483	0.3379	0.3457
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0003					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0020	0.0950	0.0960	0.0930	0.0950
Panel B: productivity (kg/ha)						
Unadjusted *p*-value	0.0007	0.0035	0.0535	0.0544	0.0497	0.0533
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0013					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0020	0.0370	0.0380	0.0350	0.0370
Panel C: market participation (%)						
Unadjusted *p*-value	0.0001	0.0001	0.0004	0.0004	0.0003	0.0003
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0007					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Panel D: rice income (USD$)						
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0010					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010

Note: Each cell contains *p*- or *q*-values for the multiple regressions presented in Table 4. Bonferroni, Holm, and List et al. adjusted p-values are calculated using the Stata code from List et al. (2018). The sharpened q-values are calcualted using the Stata code from Anderson (2008). Note that the code in List et al. (2018) only makes adjustments for SMD estimates of the treatment effect. Additionally, the code cannot accommodate the presence of covariates.

Table 17: Treatment effects of each contract characteristic [T3-T2-T1-C]

		SMD (1)	SMD (2)	DID (3)	DID (4)	FE (5)	FE (6)
Panel A: rice area (ha)							
Treatment effect of T1	Unadjusted *p*-value	0.0001	0.0013	0.0499	0.0502	0.0476	0.0477
	Bonferroni adjusted *p*-value	0.0040					
	Holm adjusted *p*-value	0.0017					
	List et al. adjusted *p*-value	0.0003					
	Sharpened *q*-value	0.0010	0.0010	0.0460	0.0470	0.0440	0.0470
Treatment effect of T2	Unadjusted *p*-value	0.0001	0.0213	0.1349	0.1356	0.1310	0.1311
	Bonferroni adjusted *p*-value	0.0040					
	Holm adjusted *p*-value	0.0033					
	List et al. adjusted *p*-value	0.0003					
	Sharpened *q*-value	0.0010	0.0020	0.0820	0.0830	0.0780	0.0830
Treatment effect of T3	Unadjusted *p*-value	0.0001	0.0004	0.3404	0.3424	0.3354	0.3404
	Bonferroni adjusted *p*-value	0.0040					
	Holm adjusted *p*-value	0.0033					
	List et al. adjusted *p*-value	0.0003					
	Sharpened *q*-value	0.0010	0.0010	0.1420	0.1430	0.1390	0.1420
Panel B: productivity (kg/ha)							
Treatment effect of T1	Unadjusted *p*-value	0.0001	0.0012	0.1539	0.1550	0.1497	0.1496
	Bonferroni adjusted *p*-value	0.0040					
	Holm adjusted *p*-value	0.0023					
	List et al. adjusted *p*-value	0.0003					
	Sharpened *q*-value	0.0010	0.0010	0.0820	0.0830	0.0780	0.0830
Treatment effect of T2	Unadjusted *p*-value	0.0002	0.0004	0.5058	0.5064	0.5014	0.5034
	Bonferroni adjusted *p*-value	0.0040					
	Holm adjusted *p*-value	0.0010					
	List et al. adjusted *p*-value	0.0003					
	Sharpened *q*-value	0.0010	0.0010	0.2030	0.2040	0.2010	0.2020
Treatment effect of T3	Unadjusted *p*-value	0.0001	0.0001	0.0500	0.0506	0.0477	0.0508
	Bonferroni adjusted *p*-value	0.0040					
	Holm adjusted *p*-value	0.0030					
	List et al. adjusted *p*-value	0.0003					
	Sharpened *q*-value	0.0010	0.0010	0.0460	0.0470	0.0440	0.0470

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Panel C: market participation (%)							
Treatment effect of T1	Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	Bonferroni adjusted *p*-value	0.0040					
	Holm adjusted *p*-value	0.0020					
	List et al. adjusted *p*-value	0.0003					
	Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Treatment effect of T2	Unadjusted *p*-value	0.0001	0.0001	0.0455	0.0460	0.0433	0.0431
	Bonferroni adjusted *p*-value	0.0040					
	Holm adjusted *p*-value	0.0007					
	List et al. adjusted *p*-value	0.0003					
	Sharpened *q*-value	0.0010	0.0010	0.0460	0.0470	0.0440	0.0470
Treatment effect of T3	Unadjusted *p*-value	0.0001	0.0001	0.0003	0.0003	0.0002	0.0003
	Bonferroni adjusted *p*-value	0.0040					
	Holm adjusted *p*-value	0.0013					
	List et al. adjusted *p*-value	0.0003					
	Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Panel D: rice income (USD$)							
Treatment effect of T1	Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	Bonferroni adjusted *p*-value	0.0040					
	Holm adjusted *p*-value	0.0027					
	List et al. adjusted *p*-value	0.0003					
	Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Treatment effect of T2	Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	Bonferroni adjusted *p*-value	0.0040					
	Holm adjusted *p*-value	0.0037					
	List et al. adjusted *p*-value	0.0003					
	Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010
Treatment effect of T3	Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	Bonferroni adjusted *p*-value	0.0040					
	Holm adjusted *p*-value	0.0040					
	List et al. adjusted *p*-value	0.0003					
	Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010

Note: Each cell contains *p*- or *q*-values for the multiple regressions presented in Table 4. Bonferroni, Holm, and List et al. adjusted p-values are calculated using the Stata code from List et al. (2018). The sharpened q-values are calcualted using the Stata code from Anderson (2008). Note that the code in List et al. (2018) only makes adjustments for SMD estimates of the treatment effect. Additionally, the code cannot accommodate the presence of covariates.

Table 18: Correction for multiple inference of the treatment effects of extension training [T2-T1]

	SMD (1)	SMD (2)	DID (3)	DID (4)	FE (5)	FE (6)
Panel A: rice area (ha)						
Unadjusted *p*-value	0.0274	0.0685	0.0212	0.0218	0.0200	0.0202
Bonferroni adjusted *p*-value	0.1240					
Holm adjusted *p*-value	0.0930					
List et al. adjusted *p*-value	0.0810					
Sharpened *q*-value	0.0430	0.1150	0.0930	0.0960	0.0870	0.0880
Panel B: productivity (kg/ha)						
Unadjusted *p*-value	0.1057	0.4539	0.4614	0.4640	0.4567	0.4559
Bonferroni adjusted *p*-value	1.0000					
Holm adjusted *p*-value	0.6107					
List et al. adjusted *p*-value	0.4830					
Sharpened *q*-value	0.0760	0.4340	0.4070	0.4090	0.4030	0.3950
Panel C: market participation (%)						
Unadjusted *p*-value	0.0001	0.0001	0.0854	0.0871	0.0823	0.0829
Bonferroni adjusted *p*-value	0.0093					
Holm adjusted *p*-value	0.0093					
List et al. adjusted *p*-value	0.0083					
Sharpened *q*-value	0.0010	0.0010	0.1470	0.1510	0.1410	0.1430
Panel D: rice income (USD$)						
Unadjusted *p*-value	0.6670	0.7453	0.5779	0.5804	0.5740	0.5662
Bonferroni adjusted *p*-value	1.0000					
Holm adjusted *p*-value	0.7973					
List et al. adjusted *p*-value	0.7973					
Sharpened *q*-value	0.2010	0.5950	0.4070	0.4090	0.4030	0.3950

Note: Each cell contains *p*- or *q*-values for the multiple regressions presented in Table 4. Bonferroni, Holm, and List et al. adjusted p-values are calculated using the Stata code from List et al. (2018). The sharpened q-values are calcualted using the Stata code from Anderson (2008). Note that the code in List et al. (2018) only makes adjustments for SMD estimates of the treatment effect. Additionally, the code cannot accommodate the presence of covariates.

Table 19: Correction for multiple inference of the treatment effects of input loans [T3-T2]

	SMD (1)	SMD (2)	DID (3)	DID (4)	FE (5)	FE (6)
Panel A: rice area (ha)						
Unadjusted *p*-value	0.0010	0.0018	0.0597	0.0606	0.0577	0.0585
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0010					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0020	0.0990	0.1000	0.0950	0.0970
Panel B: productivity (kg/ha)						
Unadjusted *p*-value	0.0404	0.0485	0.3407	0.3427	0.3368	0.3467
Bonferroni adjusted *p*-value	0.1107					
Holm adjusted *p*-value	0.0277					
List et al. adjusted *p*-value	0.0277					
Sharpened *q*-value	0.0110	0.0130	0.2060	0.2070	0.2030	0.2100
Panel C: market participation (%)						
Unadjusted *p*-value	0.0001	0.0001	0.2230	0.2245	0.2193	0.2281
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0007					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0010	0.1750	0.1770	0.1720	0.1800
Panel D: rice income (USD$)						
Unadjusted *p*-value	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0013					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010

Note: Each cell contains *p*- or *q*-values for the multiple regressions presented in Table 4. Bonferroni, Holm, and List et al. adjusted p-values are calculated using the Stata code from List et al. (2018). The sharpened q-values are calcualted using the Stata code from Anderson (2008). Note that the code in List et al. (2018) only makes adjustments for SMD estimates of the treatment effect. Additionally, the code cannot accommodate the presence of covariates.

Table 20: Correction for multiple inference of the treatment effects of input loans and extension training [T3-T1]

	SMD (1)	SMD (2)	DID (3)	DID (4)	FE (5)	FE (6)
Panel A: rice area (ha)						
Unadjusted *p*-value	0.6464	0.6056	0.4761	0.4755	0.4714	0.4725
Bonferroni adjusted *p*-value	1.0000					
Holm adjusted *p*-value	0.6393					
List et al. adjusted *p*-value	0.6393					
Sharpened *q*-value	0.4650	0.4350	1.0000	1.0000	1.0000	1.0000
Panel B: productivity (kg/ha)						
Unadjusted *p*-value	0.2380	0.2968	0.9701	0.9702	0.9698	0.9818
Bonferroni adjusted *p*-value	1.0000					
Holm adjusted *p*-value	0.7527					
List et al. adjusted *p*-value	0.6083					
Sharpened *q*-value	0.1890	0.2470	1.0000	1.0000	1.0000	1.0000
Panel C: market participation (%)						
Unadjusted *p*-value	0.0001	0.0001	0.7328	0.7356	0.7300	0.7219
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0010					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0010	1.0000	1.0000	1.0000	1.0000
Panel D: rice income (USD$)						
Unadjusted *p*-value	0.0001	0.0001	0.0035	0.0036	0.0032	0.0036
Bonferroni adjusted *p*-value	0.0013					
Holm adjusted *p*-value	0.0013					
List et al. adjusted *p*-value	0.0003					
Sharpened *q*-value	0.0010	0.0010	0.0150	0.0150	0.0130	0.0150

Note: Each cell contains *p*- or *q*-values for the multiple regressions presented in Table 4. Bonferroni, Holm, and List et al. adjusted p-values are calculated using the Stata code from List et al. (2018). The sharpened q-values are calcualted using the Stata code from Anderson (2008). Note that the code in List et al. (2018) only makes adjustments for SMD estimates of the treatment effect. Additionally, the code cannot accommodate the presence of covariates.