Contract breaching in agricultural markets: An experiment on double moral hazard

Abstract: Contract farming is increasingly used to coordinate transactions between farmers and buyers downstream in food chains. However, the potential gains of contracts are often undermined by contract breaches from both buyers and sellers. In this paper we develop a simple buyer-seller contract model where we introduce the option of buyers to choose whether or not to offer a binding price to sellers. We assume agents are rational and self-interested, and that in single or double moral hazard settings there should not be differences in profits between buyers and sellers. We test our model in a laboratory experiment where we vary whether: (i) only the seller can renege on the initial agreement (single moral hazard), (ii) both the buyer and the seller can renege (double moral hazard), (iii) buyers can choose whether they are bound by their initial contract offer or not when the contract is determined. In contrast to theoretical predictions, we find that the single moral hazard setting is Pareto superior to the double moral hazard one, as it increases total profits and reduces income inequality. In the third treatment, we find that buyers opt to retain the right to renege on the initial contract offer and use it as a substitute for a lower price offer.

Keywords: Double moral hazard, contract breaching, agricultural contracts, laboratory experiments

JEL codes: C91, D02, L14, Q13

1. Introduction

In the last couple of decades, buyers downstream in food chains have shifted from purchasing agricultural products in spot markets to direct contractual agreements with farmers (MacDonald 2015; Bellemare 2015). These agreements have improved farmers' welfare by reducing price and income uncertainty (Minten et al., 2009; Barrett et al., 2012; Kunte et al. 2016; Bellemare and Bloem 2018; Meenken and Bellemare 2020) and enabled buyers to improve vertical coordination in high-value quality markets (Eaton and Sheppard 2001; Reardon et al. 2009).

However, several studies have highlighted that agricultural contracts in developing countries are often plagued by double moral hazard, as farmers often renege on output delivery when better prices can be found in spot markets, while buyers often strategically default on agreed prices after product delivery (Fafchamps 1996, 2004; The Pew Charitable Trust, 2013; Wu and MacDonald 2015; Casaburi and Macchiavello 2019).[1] As contract breaching is often driven by the lack of verifiability of the farmer's total output and the private nature of contractual agreements, gathering empirical evidence on the magnitude of contract breaching in settings with double moral hazard is anything but trivial (Blouin and Macchiavello 2019). A reason why agricultural contracts fail is that they are often informal, and it is too costly to, at least one of, the parties to settled disputes in a court of law. Thus, if one of the parties commits to comply with the terms of the contract the other will have more incentives to accept the contract. Here we formalize such possibility by giving the buyer the chance to offer a binding contract offer and abstains from changing the contract price offered.

Building on the work by Barrett et al. (2012) and Kunte et al. (2016), we develop a simple buyer seller model and show that, if agents are rational and self-interested, single and double moral hazard should lead to an identical distribution of profits between buyers and sellers. However, recognizing that double moral hazard can reduce Pareto efficiency, we introduce the case where the buyer can choose to do binding offer a contract to the seller. To evaluate this model, we conducted a lab experiment where we varied whether only the seller could breach the initial contract, both buyers and sellers could breach the contractual agreement. Specifically, in our single moral hazard (SMH) treatment, sellers can partially breach the contract by side-selling a proportion of their production to

[1] A recent notable example of such a case of alleged buyers' strategic default in the food industry in Poland occurred where Biedronka, a leading food retailer, was fined by anti-trust authorities for notifying their suppliers of a required discount after contracts were signed and products delivered (Reuters 2020).

a spot market, whereas, in the double moral hazard (DMH) treatment, we allow buyers to partially default on the initial contract price after output delivery. Finally, we consider the case where the buyer, at the time of the contract offer, can choose to forego a reduction of the contract price once output has been delivered. As the buyer can decide whether the contract offer is biding or not, we refer to this treatment as the endogenous treatment (E).

We opted to use an economic experiment to test our model for it allows researchers to observe the choices of both parties and exogenously vary the institutional environment, thus allowing analysis of the impact of single and double moral hazard on social welfare[2] (Plott, 1987; Just and Wu, 2009; Mischler and Wu, 2020).

In contrast to theoretical predictions, our experimental results suggest that single moral hazard treatments were Pareto superior in terms of aggregate profitability and income inequality relative to the double moral hazard treatments. Furthermore, in the endogenous treatment, we find that buyers trade off the option to reduce prices upon delivery with the need to offer a higher contract price. Furthermore, we find that most buyers opt to retain their right to breach the contract after output delivery, resulting in a decrease in equity in the distribution on aggregate profits social welfare relative to the SMH treatment.

The remainder of this article is structured as follows: In Section 2, we introduce our theoretical framework and derive key predictions. In Section 3, we describe the experimental design. Section 4 summarizes our results, while Section 5 discusses the implications of our findings.

2. Theoretical Framework

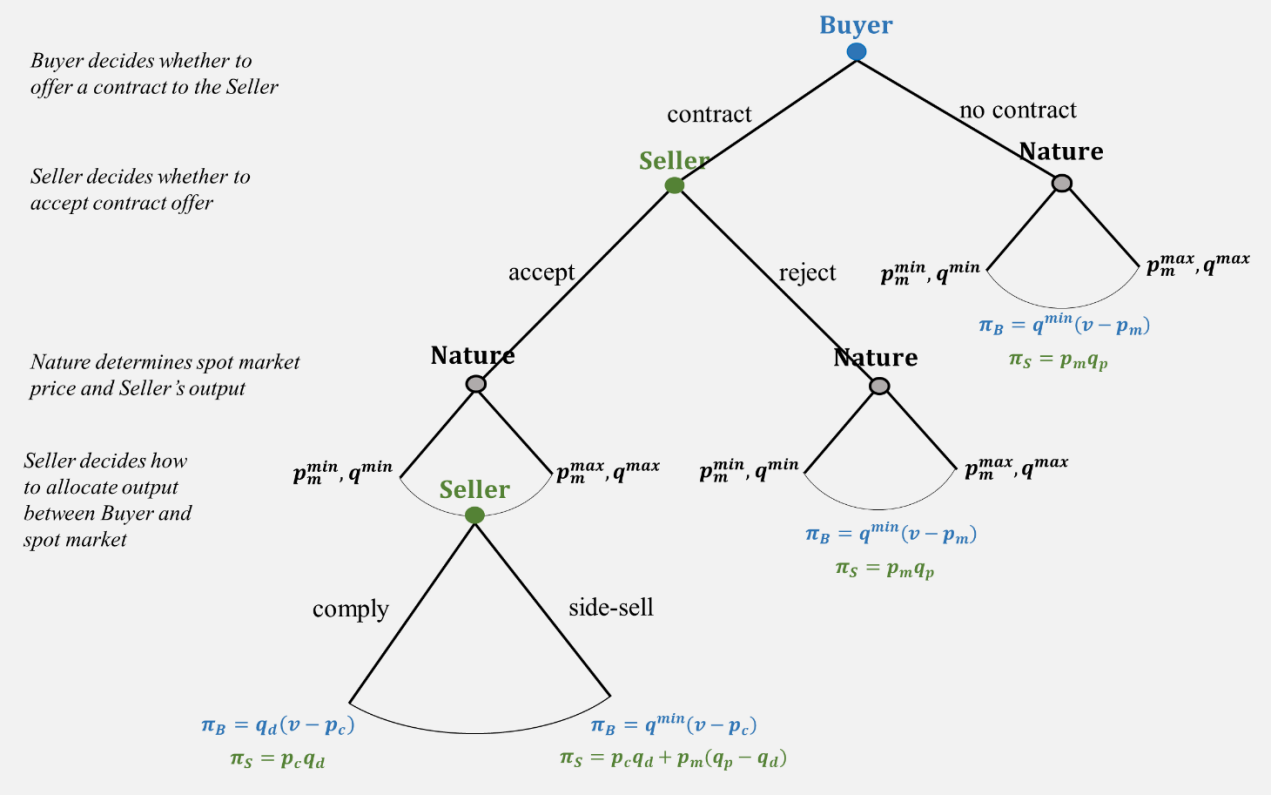
We build our principal-agent model following the framework proposed in Barrett et al. (2012) and Kunte, Wollni and Keser (2016). Throughout the analysis we assume both actors are rational, self-interested, and risk-neutral.

Figure 1 depicts our principal-agent game with single moral hazard. Consider a buyer sourcing a good to resell on a market downstream at a unit value $v = 10$. The buyer can either obtain $q_m = 11$

[2] Bellemare and Bloem (2018) propose that welfare is a complex and multidimensional concept. When reviewing the literature on the welfare impact of contract farming, they consider dimensions such as incomes, increases in the stock of productive assets, food security and psychological or social dimensions of life. Here, we follow most of the literature and simply define welfare as farmers' and buyers' profits.

units on a spot market at a price $p_m \sim U\left(p_m^{min} = 1, p_m^{max} = 7\right)$ or offer to purchase a seller's output q_p at a contract price $p_c \in [1,7]$.[3] The seller's output is determined stochastically $q_p \sim U\left(q^{min} = 11,\ q^{max} = 20\right)$, and unobservable to the buyer. Thus, only the delivery of the minimum output (q^{min}) is enforceable. Critically, both the seller's output and the spot market prices are determined *after* the buyer and the seller decide whether to enter into a contractual agreement.

Figure 1: Principal-agent game with single moral hazard



If the buyer decides not to offer a contract, or the seller rejects it, the seller sells all production on the spot market. If the seller accepts a contract offer from the buyer, then he is obliged to supply the minimum enforceable amountq^{min} but has the option to side-sell any remaining units to the spot market. Consequently, the payoff functions of the buyer, π_B, and the seller, π_S, can be represented in the following manner:

[3] Where $U(,)$refers to uniform distribution.

$$\pi_B = \begin{cases} q^{min}(v - p_c), & \theta = 1 \; and \; p_m > p_c \\ E[q_p](v - p_c), & \theta = 1 \; and \; p_m \leq p_c \\ q^{min}(v - E[p_m]), & \theta = 0 \end{cases} \quad (1)$$

$$\pi_S = \begin{cases} p_c q^{min} + p_m E[q_p - q^{min}], & \theta = 1 \; and \; p_m > p_c \\ p_c E[q_p], & \theta = 1 \; and \; p_m \leq p_c \\ E[p_m]E[q_p], & \theta = 0 \end{cases} \quad (2)$$

Where, $\theta \in \{0, 1\}$ is an index referring to whether the contract is rejected or accepted, while $E[p_m]$, $E[q_p]$ refer to the expected spot market price and output. Based on the parameters of our experiment $E[p_m] = 4$ and $E[q_p] = 15.5$. As a result, a seller will accept a contract offer if the expected return from accepting a contract is higher than the expected return from selling the output at the spot market. Hence, the *seller's participation constraint* is given by:

$$\lambda\left(p_c q^{min} + \frac{p_m^{high} + p_c + 1}{2} E[q_p - q^{min}]\right) + \; (1 - \lambda)\big(p_c E[q_p]\big) \geq E[p_m]E[q_p] \quad (3)$$

The right-hand side of eq. 3 captures the seller's outside option, while the left-hand side of the equation captures the expected return from accepting a contract offer. λ is the probability $p_m > p_c$, and as p_m is uniformly distributed, $\lambda = \frac{p_m^{high} - p_c}{p_m^{high}}$.[4] Consequently, the mean price the seller receives from selling any excess surplus to the spot market, is given by $\frac{p_m^{high} + p_c + 1}{2}$.[5]

Similarly, the buyer will offer a contract price to the seller's if it satisfies the *buyer's participation constraint*:

$$\lambda\big(q_{min}(v - p_c)\big) + \; (1 - \lambda)\left(E[q_p](v - p_c)\right) \geq q_{min}(v - E[p_m]) \quad (4)$$

[4] For example, suppose $p_c = 1$, then the likelihood the spot market price to be higher than the contract price is $\lambda = \frac{6}{7}$. In contrast, if $p_c = 7$, then the likelihood the market price to be higher than the contract price is $\lambda = \frac{0}{7} = 0$.

[5] Suppose $p_c = 4$, then the seller would sell her goods at the spot market price if $p_m = \{5,6,7\}$. The mean price he would then sell her goods at the spot market is 6.

Solving equation 3, for the parameters of our experiment yields the minimum contract price the sellers would be willing to accept $p_c = 3.706$.[6] As in our experiment only integers were allowed, we assume the seller would accept any contract offer where $p_c \geq 4$.

A contract price of $p_c = 4$, would yield to the buyer the same expected cost as sourcing q_m units of the good from the spot market. However, 43% of the time he will be able to purchase the seller's additional output, which would yield him a net gain $\frac{7-p_c}{7}\big(E[q_p] - q_{min}\big)\big)(v - p_c) = 11.57$.

Lemma 1*: With single moral hazard, the game has a unique Nash equilibrium where, the buyer offers the participating constraint contract price $p_c^* = 4$, and the seller accepts the contract offer. When $p_m \leq p_c$, the seller sells all the units of the good to the buyer. Alternatively, when $p_m > p_c$, the seller delivers q_{min} to the buyer and sells any remaining units at the spot market.*

Figure 2: Principal-agent game with Double moral hazard

[6] Notice that the seller's minimum acceptable contract price offer is below $E[p_m]$ as the seller in our setting can sell all her goods to the buyer when the market price is below the contract price but he is legally obliged to sell only 11 units to the buyer when the market price exceeds the contract price.

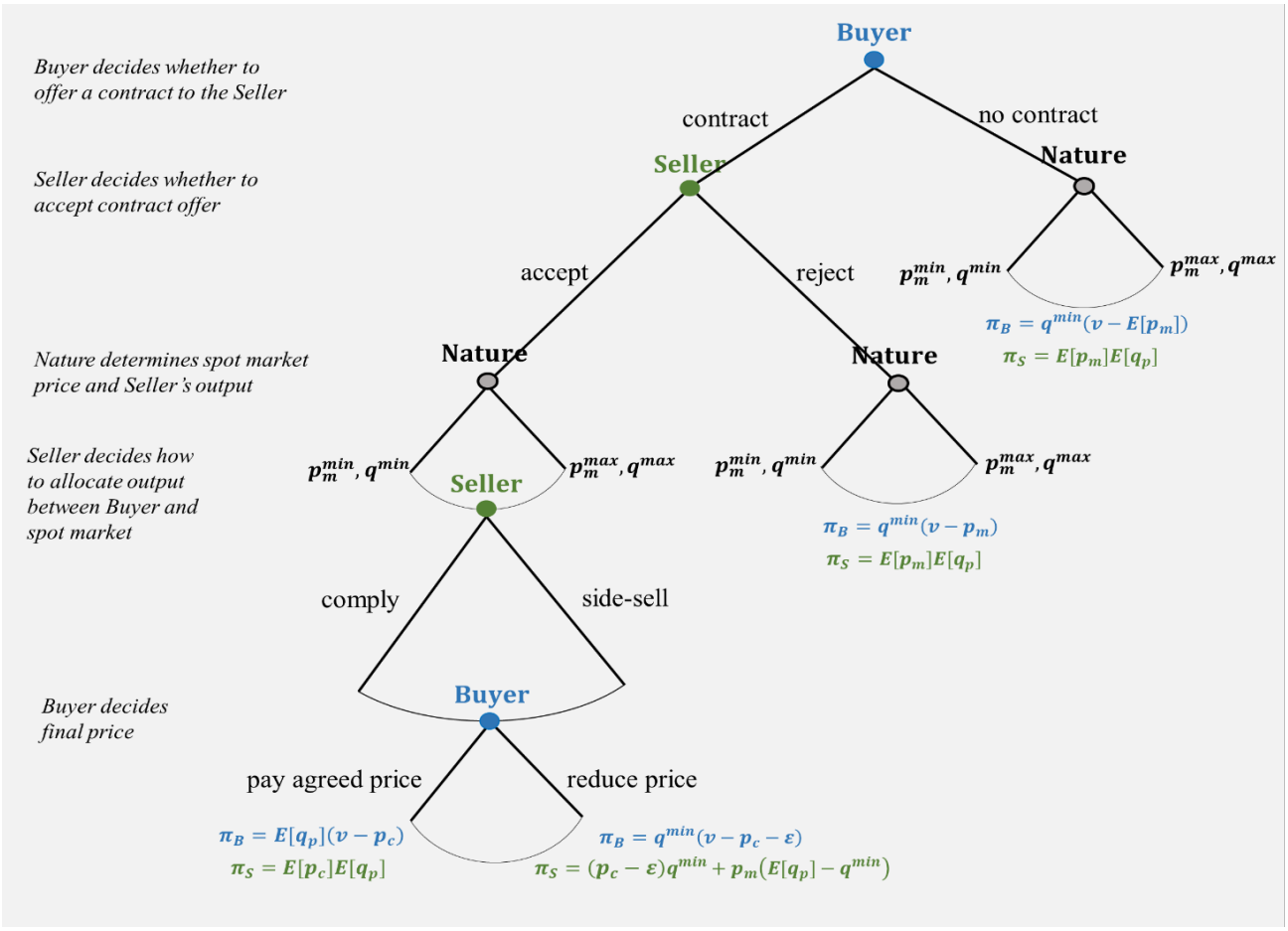


Figure 2 depicts our principal-agent game with double moral hazard. In this case the buyer can reduce the initially agreed contract price by $\varepsilon \in [\varepsilon^{min} = 0, \varepsilon^{max} = 2]$ after the seller has delivered the output. Trivially, since the buyer is self-interested and this is common knowledge, the seller anticipates that the buyer will always reduce the final contract price by ε^{max} at the final stage. As a result, the minimum acceptable contract price she would be willing to accept would be $p_c^* + \varepsilon^{max} = 6$. Even though the offered contract price now increases, the expected earnings for both buyer and seller are identical to those obtained in the case with unilateral moral hazard.

***Lemma 2**: With double moral hazard, the game has a unique Nash equilibrium where, the buyer offers the participating constraint contract price $p_c^* = 6$, and the seller accepts the contract offer. When $p_m \leq p_c$, the seller sells all the units of the good to the buyer. Alternatively, when $p_m > p_c$, the seller delivers q_{min} to the buyer and sells any remaining units at the spot market. At the final stage the buyer reduces the contract price by $\varepsilon^{higgn} = 2$, resulting to the same distribution of profits as in the single moral hazard case.*

Finally, in the case where the buyer has the option to offer a binding contract price, the seller will know whether there is a single or a double moral hazard setting as the buyer's choice is common knowledge.[7] From a game-theoretic perspective the introduction of this option is equivalent to an initial stage. After the buyer made her choice the behaviour and outcomes of this setting will be akin to predictions describes in lemma 1 and 2 above. From our previous analysis it follows that the buyer would be indifferent between either setting, as the earnings would be identical for him and the seller.

Lemma 3*: As both SMH and DMH yield identical payoffs for buyers and sellers, buyers would be indifferent regarding foregoing the right to reduce the contract price.*

3. Experimental Design

The experiment comprises three treatments: *Single Moral Hazard* (SMH), *Double Moral Hazard* (DMH), and *Endogenous* moral hazard (E). In SMH, if the buyer offers a contract to the seller, and the latter accepts it, the game finishes after the seller decides how many units of the good, to allocate between the buyer and the spot market. In DMH, if the buyer offers a contract to the seller, and the latter accepts it, after the seller decides how many goods to deliver to the buyer, the latter may reduce the contract price by ε. In E, the buyer first decides whether the initial contract price offer is binding or not. If the buyer decides to offer a binding contract offer, then the game proceeds as in the single moral hazard case described, otherwise it follows the double moral hazard game. There is perfect information on the choice of the buyer, so seller should expect a price reduction if the buyers does not offer a binding price contract.

We conducted 15 sessions in total; four sessions for SMH and DMH, and seven sessions for E[8]. At the beginning of each session, each subject was randomly assigned the role of *buyer* or *seller*, and roles remained fixed throughout the experiment. Each session comprised of 10 rounds. At the start of each round, buyers and sellers were randomly re-matched, following a perfect stranger matching protocol. At the beginning of each session, and after every subject read the instructions, they were asked to answer six unincentivized multiple-choice questions. These aimed to test and reinforce subjects' understanding of the instructions. Then the subjects participated in two practice rounds to

[7] For example, the buyer could enrol a third party to act as an intermediary and accept a deposit on some percentage of the value of the contract.

[8] We had 7 seven sessions on treatment E to assure we had enough observations for our analysis.

familiarize themselves with the user interface of the experimental software. At the end of the practice rounds, the supervisor of the experiment answered any remaining questions in private. At the end of the experiment, every subject completed a multiple choice questionnaire to collect demographic characteristics questions which include a 16-item variant of the social desirability scale (Stober, 2001). This is an independent measure of sensitivity to social pressure and demand effects (Zizzo, 2010; Zizzo and Fleming, 2011). Copies of the instructions can be found in the online appendix.

To minimize hedging, and wealth effects, earnings were determined using a random lottery payment mechanism (Charness et al., 2016). The experiment was conducted at the experimental economics laboratory of a British University. It was programmed in zTree (Fischbacher, 2007) and participants were recruited via ORSEE (Greiner, 2015).

Each session lasted approximately 120 minutes. The average earnings were £16.86, including £3 show-up fee. We had 300 subjects in our experiment, of which 58% were enrolled in an undergraduate degree, 56% were female, 50% reported English as their native language, and 28% reported economics as their main field of study[9]. There were participants from 37 different nationalities, while the first and second most observed nationalities were British (32%) and Chinese (26%). The mean age was 23.31 (SD:5.98) years old.

Hypotheses

Based on the lemmas described in our conceptual framework and the parameterization of our experiment we draw the following hypotheses:

[9] A recent concern with laboratory experiments is the extent to which experimental findings involving volunteered university students are generalizable to representative samples (Levitt and List, 2006). Concerns about the representativeness of student samples can be separated into two potential effects: (i) student bias, which exists if students behave differently than the general population, after controlling for socio-demographics, and (ii) volunteer bias, which exists if participants who self-select to voluntarily participate in laboratory experiments behave systematically different from non-volunteers. With regards to student bias, there are a number of studies which find that students tend to behave more selfishly than non-students (e.g. Exadaktylos et al, 2013; Falk et al. 2013; Cappelen et al. 2015; Belot et al., 2015). However, such differences are rather small in the majority of cases (e.g. Exadaktylos et al, 2013; Falk et al. 2013; Snowberg and Yariv, 2018; Frigau et al. 2019), disappear when one controls for socioeconomic characteristics (e.g. Carpenter et al. 2008), and always follow the same behavioural patterns. In relation to volunteering bias, a number of studies report no statistically significant differences between volunteers and non-volunteers (e.g., Falk et al, 2013; Bellemare and Kroger, 2008; Anderson et al. 2013). Nevertheless, in interpreting our results, one should be cautious in drawing generalizable inferences and keep in mind that university students tend on average to behave more selfishly relative to representative samples.

Hypothesis 1: *In SMH, buyers offered contract price will be* $p_c \geq 4$.

Hypothesis 1 is a consequence of Lemma 1.

Hypothesis 2: *In DMH, buyers offered contract price will be* $p_c \geq 6$.

Hypothesis 2 is a consequence of Lemma 2.

Hypothesis 3: *The distribution of buyers and sellers' profits is the same across treatments.*

Hypothesis 3 is a consequence of Lemmas 1 and 2.

Hypothesis 4: *buyers are indifferent between offering a binding contract price or not in the Endogenous (E) treatment.*

Hypothesis 4 is a consequence of Lemmas 3.

4. Results

We first present the effects on profit distributions between the buyer and the seller. We then report the results on the sellers' side selling, and buyers' strategic price default

4.1 The impact of doubled moral hazard on the distribution of profits

Table 2 presents summary statistics for our main variables by experimental treatment. For the endogenous treatment (E), we disaggregate the data depending on whether the buyer chose to forego the option to reduce the contract price in the final stage, in which case we have a setup akin to the SMH (labelled E-SMH) or not, in which case we have a double moral hazard (E-DMH).

The first observation that stems from the summary statistics is that the distribution of profits between buyers and sellers differs substantially across SMH and DMH. Sellers earn approximately 20% more on average in SMH (70.438) relative to DMH (61.946) (Mann-Whitney test, p=0.02).[10] While buyers earn approximately the same in SMH (71.678) and DMH (75.026) (Mann-Whitney test, p=0.248).

[10] All non-parametric tests are two-sided and with the session level as the unit of observation.

Table 2: Summary statistics

	SMH	DMH	E-SMH	E-DMH
Profit of buyer	71.678	75.026	69.238	77.834
	(20.795)	(23.495)	(20.039)	(24.674)
Profit of seller	70.438	61.946	72.090	59.871
	(27.123)	(28.189)	(23.419)	(27.508)
Contract Price	4.218	5.083	4.238	4.782
	(1.093)	(0.919)	(1.376)	(1.016)
Price default	-	1.785	-	1.719
		(0.567)		(0.642)
Quantity Side-Sold	1.699	2.383	1.733	2.432
	(2.761)	(3.068)	(2.628)	(2.991)
Contract acceptance rate	.695	.544	.704	.591
	(.498)	(.460)	(.492)	(.457)
Contract Choice	1	1	0.19	0.81

Note: standard deviations are given in parentheses.

In Table 3, we report panel regressions on seller's profit levels clustered at the session level. In model 1 we see that profits are lower overall when there is DMH. Importantly, we find that sellers earn significantly less than buyers. In model 2, we disaggregate the impact of treatment on sellers' profits through interaction variables. By disentangling the impact of each setting on sellers' profits, we find they earn significantly less in DMH and E-DMH relative to buyers but not in SMH or E-SMH. This result suggest that not only overall profits are higher in SMH, but that they are also more equitably distributed. Model 3 tests the robustness of the results in Model 2 by controlling for demographic characteristics and the subjects' score on the social desirability scale (Strober, 2001). We find qualitatively similar results using standard OLS with robust standard errors and hierarchical linear models with random effects at both session and subject level.

From this analysis we state our first result as:

Result 1: *SMH leads to a Pareto improvement in earnings and a more equitable wealth distribution compared to DMH.*

Table 3: Panel Regressions on seller's profit

Profit	(1)	(2)	(3)
DMH	-5.239***	1.563	1.508
	(-8.72)	(-0.81)	(-0.75)
E-DMH	-4.741***	4.184*	4.120*
	(-7.13)	(-2.19)	(-2.21)
E-SMH	0.352	-1.468	-1.487
	(-0.44)	(-0.80)	(-0.89)
Contract price	2.980***	2.884***	2.832***
	(-10.02)	(-10.34)	(-10.23)
Output	3.273***	3.272***	3.268***
	(-27.94)	(-28.44)	(-28.60)
Seller	-10.29***	-0.344	-0.511
	(-4.46)	(-0.37)	(-0.60)
Seller # DMH		-13.46***	-13.02***
		(-3.79)	(-3.63)
Seller # E-DMH		-17.49***	-17.12***
		(-5.25)	(-5.29)
Seller # E-SMH		2.600	2.879
		(-0.60)	(-0.70)
Controls	No	No	Yes
Constant	23.480***	8.652***	12.400***
	(-4.86)	(-3.50)	(-4.13)
N	3000	3000	3000
Wald χ^2	1252.37	1091.6	1780.31

Notes: *** Significant at 1% level; ** significant at 5% level; * significant at 10% level. Robust standard errors in parentheses. Qualitatively similar results are observed with standard OLS with robust standard errors and hierarchical linear models with random effects at both session and subject level. In controls we include whether the participant is a native english speaker, an economics student and gender. **DMH= Double Moral hazard; E-SMH= Endogenous Single Moral hazard; E-DMH= Endogenous Double Moral hazard.**

A key contributing factor to result 1 is that, as reported in table 1, while on average the offered a contract price in SMH was not statistically significant different from 4 (One-sample proportions test, p=0.76), it was significantly lower than 6 in the DMH case, in contrast to our Lemma 2 (One-sample proportions test, p=0.03). Thus, this result provides evidence to support our Lemma1, but not Lemma 2.

Result 2: *While in SMH, buyers contract prices do not differ significantly from 4, in DMH the contract price offered is significantly lower than 6, which is contrary to theoretical predictions.*

As a result, sellers were much more likely to reach a contractual agreement in SMH (.695) relative to DMH (.544) (Mann-Whitney test, p=0.04).

Result 3: *Buyers and sellers come more often to contractual agreement in SMH relative DMH.*

We now turn our attention to profit distributions in the endogenous treatment. Similar to SMH and DMH, there are no significant differences in profits between buyers (69.238) and sellers (72.090) in E-SMH (Mann-Whitney test, p=0.56), while buyers (77.834) earn significantly more than the sellers (59.871) in E-DMH (Mann-Whitney test, p=0.02). Thus, we conclude that earnings are more equitably distributed when buyers opt to forego the option to price default. However, while sellers earn significantly more in E-SMH (72.090) relative to E-DMH (59.871) (Mann-Whitney test, p=0.01) buyers earn significantly less (E-SMH: 69.238, E-DMH: 77.834; Mann-Whitney test, p=0.01). Further inspection, of average profits for both buyers and sellers in E-SMH relative to E-DMH reveals that there are no statistically significant differences (Mann-Whitney test, p=0.65).

Result 4: *In the E treatment, when buyers choose to forgo the right to price default, profits are more equitable distributed. However, there is no difference in aggregate profits, when comparing buyers choose not to forego their option to price default.*

As buyers earn significantly more in E-DMH relative to E-SMH, it should not be surprising that they are significantly less likely (0.81 relative to 0.19) to forego the right to deduct contract prices. The buyers' preference for E-DMH is statistically significant different from 0.5, which is the appropriate benchmark under the assumptions that buyers are indifferent between the two contract types (One-sample proportions test, p<0.001).

Result 5: *In the Endogenous (E) treatment, buyers are more likely to maintain the right to reduce the contract price, contrary to theoretical predictions.*

Both results 4 and 5 are in striking contrast to predictions under narrow self-interest, and theories of social preferences, where agents are concerned about equality of payoffs (e.g., Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000).

4.2 Side-selling

We now turn our attention to side-selling. On average, sellers' side-sell significantly less in SMH (1.699) relative to DMH (2.383) (Mann-Whitney test, p=0.04). Table 4 reports Panel Tobit

regressions clustered at zero and nine.[11] In model 1, we find that side-selling is significantly higher with DMH, even after quantity produced, spot market prices, and contract prices are considered. The results in model 2 corroborate the results of model 1 after controlling for demographic characteristics.

Table 4: Panel Tobit Regressions on side-selling

Quantity side-sold	(1)	(2)
DMH	2.761***	2.807***
	(0.476)	(0.489)
E-DMH	2.684***	2.679***
	(0.421)	(0.426)
E-SMH	-0.346	0.344
	(0.563)	(0.565)
Contract Price	-1.135***	-1.124***
	(0.164)	(0.165)
Market Price	1.879***	1.879***
	(0.087)	(0.087)
Quantity Produced	0.912***	0.912***
	(0.053)	(0.053)
Controls	No	Yes
Constant	-17.859***	-18.625***
	(1.259)	(1.476)
Wald χ^2	612.28	614.36
N	842	842

Notes: *** Significant at 1% level; ** significant at 5% level; * significant at 10% level. Robust standard errors in parentheses. Note only the cases where a contract was accepted and side-selling was possible are included in the regressions Qualitatively similar results are observed with standard OLS with robust standard errors and hierarchical linear models with random effects at both session and subject level. In controls we include whether the participant is a native English speaker, an economics student and gender.
DMH= Double Moral hazard; E-SMH= Endogenous Single Moral hazard; E-DMH= Endogenous Double Moral hazard.

Result 6: *Side-selling is significantly higher under double-sided moral hazard.*

4.3 Strategic price default

Table 5 reports Panel Tobit regressions on buyers' decision to reduce the contract price clustered at zero and two. In model 1, we find a positive relationship between quantity delivered and strategic price default. Even though we elicited buyers' beliefs on the amount side-sold by the sellers we do not find a significant relationship. In model 2, we control for demographic characteristics. In line with previous studies where a higher score in SDS tend to be associated with prosocial behaviour

[11] We used a panel Tobit model because the seller can only side sell quantities between 0 and 9 units, note that in our experiment the output quantity varied between 11 and 20, but the sellers were obliged to provide 11 units if he accepted the buyer's contract offer.

(Karakostas and Zizzo 2016; Karakostas et al. 2017), we find that buyers who score higher in SDS are less likely to reduce the contract price.

Table 5: Panel Tobit regressions on strategic price default

Price default	(1)	(2)
E-SMH	-0.742	-0.996
	(0.826)	(0.823)
Quantity Delivered	0.383**	0.388**
	(0.179)	(0.177)
Belief	0.243	0.264*
	(0.158)	(0.157)
Controls	No	Yes
Constant	-0.453	1.210
	(2.491)	(2.961)
Wald χ^2	10.73	15.65
N	670	670

Notes: *** Significant at 1% level; ** significant at 5% level; * significant at 10% level. Robust standard errors in parentheses. Note that only the observations were a contract was accepted are included in the analysis. Qualitatively similar results are observed with standard OLS with robust standard errors and hierarchical linear models with random effects at both session and subject level. In controls we include whether the participant is a native English speaker, an economics student and gender.
E-SMH= Endogenous Single Moral hazard.

Result 7: *Buyers are more likely to reduce the final price paid to the seller the higher the quantity delivered.*

5. Discussion and Conclusion

Contract farming has been recognised for improving the livelihoods of smallholder farmers in developing countries and for the benefits to buyers in optimising supply chain coordination. Despite evidence that contracts have raised agricultural productivity, there is increasing concern over the impact of double moral hazard, on farmers' welfare.

To evaluate this problem, we conducted an experiment where we varied whether: (i) only sellers can breach the initial contract, (ii) both sellers and buyers can breach the initial contract and, (iii) the buyers can voluntarily forego their option to breach the contract.

In contrast to theoretical predictions in our setting, we find that, single moral hazard leads to an increase in social welfare a more equitable profit distribution between buyers and sellers. This result seems to be driven by opportunistic buyers who, in the DMH setting, offer an initial contract price that is below the seller's participation constraint, and over-optimistic sellers who hope that buyers will not fully default at the final stage. Furthermore, in the third treatment we find that buyers show a strong preference for retaining the option to strategically default. Notably, our results cannot be explained by self-interest, nor theories of social preferences, where agents are concerned about the equality of payoffs (e.g., Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000).

However, our findings are in line with the concerns raised by Sexton (2013), Wu (2014), Bellemare (2015), and Wu and McDonald (2015) of how, in the absence of strong institutions, buyers may opportunistically renege on initial contracts. They also align with the findings of Casaburi and Macchiavello (2019), who report that dairy farmers in Kenya preferred monthly payments from a large cooperative than daily payments from transient buyers because they feared that the latter would not pay the agreed price after delivery. Finally, our results also echo the findings in Karakostas et al. (2017), who find that when principals are given the option to pay agents using revenue-sharing, bonus or fixed-wage contracts, those principals who opt for bonus contracts tend to act opportunistically, promising large bonuses but rarely acting on those promises, regardless of the agent's effort.

From a policy perspective, our results suggest great caution in investing in the promotion of voluntary systems where buyers are invited to defer their right to default on contract prices. Even if such systems come at no cost to the contracting parties, our findings suggest buyers would be unwilling to opt in. Future research could explore whether reputation or competition between buyers could help promote contract compliance.

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Online Appendix

Contents

A.1: Instructions

Instructions

Welcome and thank you for attending this session of our experiment

This is an experiment on decision-making, and you will earn money for your participation. The amount of money you will earn depends on both your and, partly on, decisions of other participants. The experiment is expected to last about 2 hour 30 minutes.

Please read the following instructions carefully. These instructions will help you make your decisions. If you face any difficulty understanding any part of the instructions, please raise your hand and we will come and assist you. All the money you earn during this experiment will be paid to you in cash at the end of the experiment. You are not allowed to communicate with any other participants or talk throughout the experiment. Please switch off your mobile phones to avoid any distractions.

You will be given a show up fee of £3 for coming today. In addition, you can earn more based on your decisions. We will be using an experimental currency unit called ECU. In the end, the total ECU you have earned during the experiment will be converted to GBP at the exchange rate of: **1 ECU = £0.20.** For example, 10 ECU=£2.0, 50ECU= £10, 100 ECU=£20, 156ECU= £31.2.

Summary of Experiment

In this session, you will have three tasks to perform in parts. The first part consists of an experiment and in the second part you will be asked to complete two questionnaires. The experiment has 12 rounds. The first 2 rounds are practice rounds and your choices will not affect your earnings. The purpose of the practice rounds is to help you understand the tasks involved. Your earnings will be chosen randomly from one of the ten rounds and paid to you together with your show up fee at the end of the session.

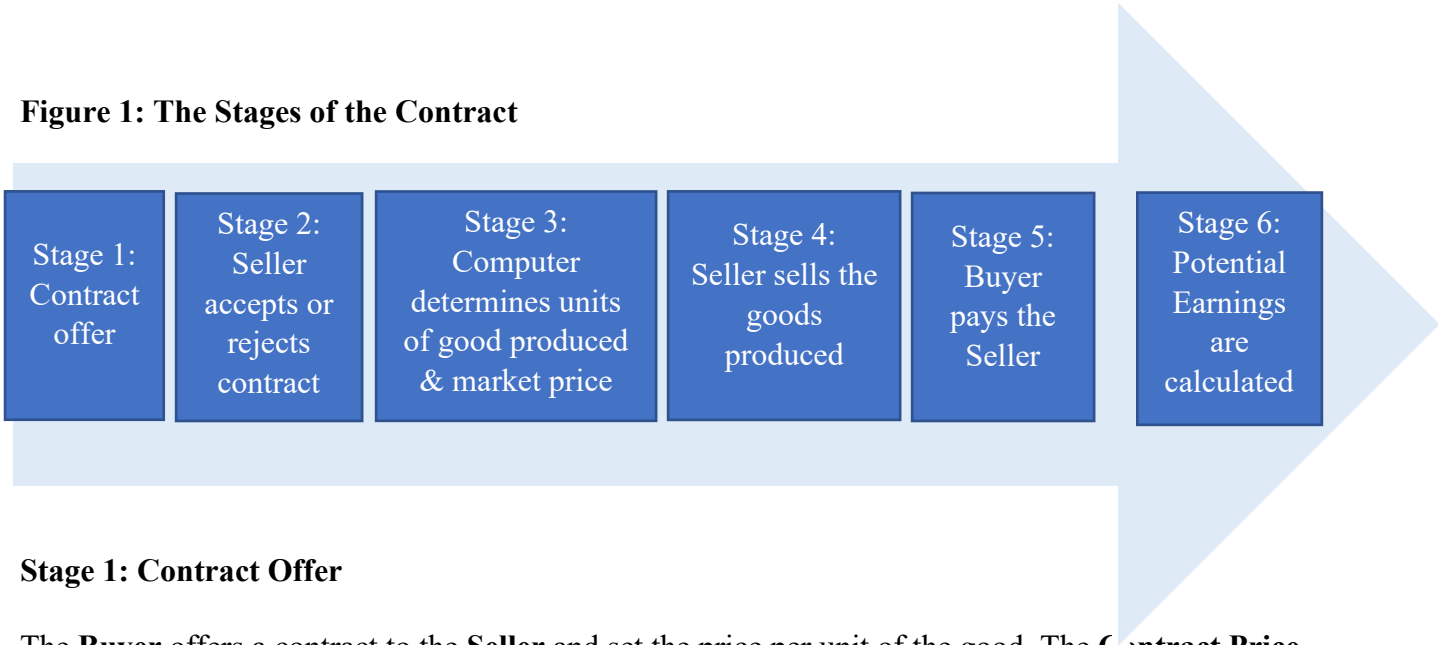
You will be randomly assigned the role of either a **Buyer** or a **Seller** and will remain in this role throughout the experiment. Communication between the two roles will be via the computer. Your identity is **anonymous to other participants in this session**; in other words, neither you nor the person you are matched with will know the identity of the other participant. In each round of this session you will be randomly matched with a *different participant of the opposite role.*

Part 1: The Experiment

The **Buyer** and the **Seller** could trade a given Good by setting a contract or using the external market. The value of the good to the buyer is 10 ECU per unit. If a contract is used, the buyer choses the price per unit of the good. If Buyer decides to use the market, he/she takes the market price as given.

There are 6 stages involved in each round as shown in figure 1 below.

Figure 1: The Stages of the Contract



Stage 1: Contract Offer

The **Buyer** offers a contract to the **Seller** and set the price per unit of the good. The **Contract Price** takes any value ranging from **1 – 7 ECU**.

E treatment:{ The **Buyer** also decides whether or not to forgo the chance to review the contract price when the **Seller** has delivered the good. }

Stage 2: Seller Accepts or Rejects Contract Offer

The **Seller** observes the price and decides whether or not to accept the contract. If the **Seller** rejects the contract, he/she needs to sell all the units produced in the market. In this case the **Buyer** can buy 11 units in the market, and earnings determined. If the **Seller** accepts the contract, he/she can *either deliver all units produced to the buyer or sell part in the market.*

Stage 3: Computer Determines Units of Goods Produced and Market Price

The computer randomly determines the number of units produced, which ranges from 11 to 20 with equal probability. Also, the **Market Price** is randomly determined by the computer ranging from **1 to 7 ECU** with equal probability.

Stage 4: Seller Sells the Goods Produced

The **Seller** observes the market price and then decides whether to deliver to the **Buyer** all units produced or sell part in the market. If the contract was accepted, the seller must deliver a minimum of 11 units.

Stage 5: Buyer Pays the Seller

In this stage, the **Buyer** observes how many units are delivered by the **Seller**.

DMH treatment:{ He/she then decides the **Final Price**. The Buyer can reduce the **Contract Price** by up to 2 ECU. **}**

SMH treatment:{ He/she then pays the **Contract Price**. **}**

E treatment:{ If he/she decided to forgo the chance to review the **Final Price** in Stage 1, he/she then pays the **Contract Price**. Otherwise, he/she decides the **Final Price**. In this case, the Buyer can reduce the **Contract Price** by up to 2 ECU. **}**

Stage 6: Potential Earnings are Calculated.

The computer calculates potential earnings from this round and displays your potential earnings on your screen.

We will now show you how you can calculate your earnings

Earnings when a contract is accepted

- **Buyer's Earnings** = 10 * Units Delivered (by the Seller) – Price paid to Seller * Units Delivered
- ***Sellers Earnings*** = Units Delivered (to Buyer) * Price (set by the Buyer) + Units Sold in the Market * Market Price

Earnings when a contract is rejected

- ***Buyer's Earnings*** = 10 * 11 Units Bought in the Market – Market Price * 11 Units Bought in the Market
- ***Sellers Earnings*** = Units Produced * Market Price

Examples

Please note that all examples are aimed to solely illustrate how earnings are calculated.

DMH treatment:{

Example 1: Assuming the **Buyer** offers a contract price of 5 ECU. The **Seller** accepts the contract and produces 18 units of Good and the market price was 6 ECU. The **Seller** delivered all 18 units to the **Buyer**. The **Buyer** paid a final price of 5 ECU. What are the earnings of the **Buyer** and the **Seller**?

Answer:

$$Buyer's\ Earnings\ =\ 10 * 18 - 5 * 18\ =\ 90\ ECU$$

$$Seller's\ Earnings\ =\ 5*\ 18\ +\ 6*\ 0\ =\ 90\ ECU$$

Example 2: Assuming the **Buyer** offers a contract price of 5 ECU. The **Seller** accepts the price and produces 18 units of Good and the market price was 6 ECU. The **Seller** delivered 11 units to the **Buyer** and sold 7 units in the market. The **Buyer** paid a final price of 5 ECU. What are the earnings of the **Buyer** and the **Seller**?

Answer:

$$Buyer's\ Earnings\ =\ 10*\ 11\ -\ 5*\ 11\ =\ 55\ ECU$$

$$Seller's\ Earnings\ =\ 5*\ 11\ +\ 6*\ 7\ =\ 97\ ECU$$

Example 3: Assuming the **Buyer** offered a contract price of 5 ECU. The **Seller** accepts the contract and produces 16 units of Good and the market price was 4 ECU. The **Seller** delivered all 16 units to the **Buyer**. The **Buyer** paid a final price of 3 ECU. What are the earnings of the **Buyer** and the **Seller**?

Answer:

$$Buyer's\ Earnings\ =\ 10*\ 16\ -\ 3*\ 16\ =\ 112\ ECU$$

$$Seller's\ Earnings\ =\ 3*\ 16\ +\ 4*\ 0\ =\ 48\ ECU$$

Example 4: Assuming the **Seller** did not accept contract from the **Buyer**. He produced 14 units of Goods and the market price was 3 ECU. What are the earnings of the **Buyer** and the **Seller**?

Answer:

$$Buyer's\ Earnings\ =\ 10*\ 11\ -\ 3*\ 11\ =\ 77\ ECU$$

$$Seller's\ Earnings\ =\ 3*\ 14\ =\ 42\ ECU$$

Example 5: Assuming the **Seller** did not accept contract from the **Buyer**. He/she produced 14 units of Goods and the market price was 7 ECU. What are the earnings of the **Buyer** and the **Seller**?

Answer:

$$Buyer's\ Earnings\ =\ 10 * 11 - 7 * 11\ =\ 33\ ECU$$

$$Seller's\ Earnings\ =\ 7\ x\ 14\ =\ 98\ ECU$$

}

SMH treatment:{

Example 1: Assuming the **Buyer** offered a contract price of 5 ECU. The **Seller** accepts the contract and produced 18 units of Good and the market price was 6 ECU. The **Seller** delivered all 18 units to the **Buyer**. What are the earnings of the **Buyer** and the **Seller**?

Answer

$$Buyer's\ Earnings\ =\ 10\ x\ 18 - 5\ x\ 18\ =\ 90\ ECU$$

$$Seller's\ Earnings\ =\ 5\ x\ 18\ +\ 6\ x\ 0\ =\ 90\ ECU$$

Example 2: Assuming the **Buyer** offered a contract price of 4 ECU. The **Seller** obtained 18 units of Good and the market price was 6 ECU. The **Seller** delivered 11 units to the **Buyer** and sold 7 units in the market. What are the earnings for the **Buyer** and the **Seller**?

Answer:

$$Buyer's\ Earnings\ =\ 10\ x\ 11 - 4\ x\ 11\ =\ 66\ ECU$$

$$Seller's\ Earnings\ =\ 4\ x\ 11\ +\ 6\ x\ 7\ =\ 86\ ECU$$

Example 3: Assuming the **Buyer** offered a contract price of 4 ECU. The **Seller** accepted the contract produced 15 units of Good and the market price was 3 ECU. The **Seller** delivered all units to the **Buyer**. What are the earnings of the **Buyer** and the **Seller**?

Answer:

$$Buyer's\ Earnings\ =\ 10\ x\ 15 - 4\ x\ 15\ =\ 90\ ECU$$

$$Seller's\ Earnings\ =\ 4\ x\ 15\ +\ 3\ x\ 0\ =\ 60\ ECU$$

Example 4: Assuming the **Seller** did not accept contract from the **Buyer**. He/she produced 14 units of the Good and the market price was 3 ECU. What are the earnings of the **Buyer** and the **Seller**?

Answer:

$$Buyer's\ Earnings\ =\ 10\ x\ 11\ -\ 3\ x\ 11\ =\ 77\ ECU$$

$$Seller's\ Earnings\ =\ 3\ x\ 14\ =\ 42\ ECU$$

Example 5: Assuming the **Seller** did not accept contract from the **Buyer**. He/she produced 14 units of Goods and the market price was 7 ECU. What are the earnings of the **Buyer** and the **Seller**?

Answer:

$$Buyer's\ earnings\ =\ 10\ x\ 11\ -\ 7\ x\ 11\ =\ 33\ ECU$$

$$Seller's\ Earnings\ =\ 7\ x\ 14\ =\ 98\ ECU$$

}

E treatment:{

Example 1: Assuming the **Buyer** offered a contract price of 5 ECU and decided not to forgo the chance to review it. The **Seller** accept the contract and obtained 18 units of good and the market price was 6 ECU. The **Seller** delivered all 18 units to the **Buyer** and the **Buyer** paid the final price of 5 ECU. What are the earnings of the **Buyer** and the **Seller**?

Answer

$$Buyer's\ Earnings\ =\ 10 * 18\ -\ 5 * 18\ =\ 90\ ECU$$

$$Seller's\ Earnings\ =\ 5 * 18\ +\ 6 * 0\ =\ 90\ ECU$$

Example 2: Assuming the **Buyer** offered a contract price of 4 ECU and decided not to forgo the chance to review it. The **Seller** accepted the contract and obtained 15 units of goods and the market

price was 2 ECU. The seller delivered all units to the **Buyer**. The **Buyer** reviewed the contract price to 3 ECU. What are the earnings of the **Buyer** and the **Seller**?

Answer:

$$Buyer's\ Earnings\ =\ 10 * 15 - 3 * 15\ =\ 105\ ECU$$

$$Seller's\ Earnings\ =\ 3 * 15\ +\ 2 * 0\ =\ 45\ ECU$$

Example 3: Assuming the **Buyer** offered a contract price of 5 ECU and decided to forgo the chance to review it**.** The **Seller** accepted the contract and produced 18 units of Goods and the market price was 6 ECU. The **Seller** delivered 11 units to the **Buyer** and sold 7 units in the market. What are the earnings for the **Buyer** and the **Seller**?

Answer:

$$Buyer's\ Earnings\ =\ 10 * 11 - 5 * 11\ =\ 55\ ECU$$

$$Seller's\ Earnings\ =\ 5 * 11\ +\ 6 * 7\ =\ 97\ ECU$$

Example 4: Assuming the **Buyer** offered a contract price of 5 ECU and decided to forgo the chance to review it. The **Seller** accepted the contract and obtained 15 units of goods and the market price was 3 ECU. The **Seller** delivered all units to the **Buyer**. What are the earnings of the **Buyer** and the **Seller**?

Answer:

$$Buyer's\ Earnings\ =\ 10 * 15 - 5 * 15\ =\ 75\ ECU$$

$$Seller's\ Earnings\ =\ 5 * 15\ +\ 3 * 0\ =\ 75\ ECU$$

Example 5: Assuming the **Seller** did not accept contract from the **Buyer**. He produced 14 units of Goods and the market price was 3 ECU. What are the earnings of the **Buyer** and the **Seller**?

Answer:

$$Buyer's\ Earnings\ =\ 10 * 11 - 3 * 11\ =\ 77\ ECU$$

$$Seller's\ Earnings\ =\ 3 * 14\ =\ 42\ ECU$$

}

A2. Additional Analysis

Figure 1: Contract price and quantity delivered over time

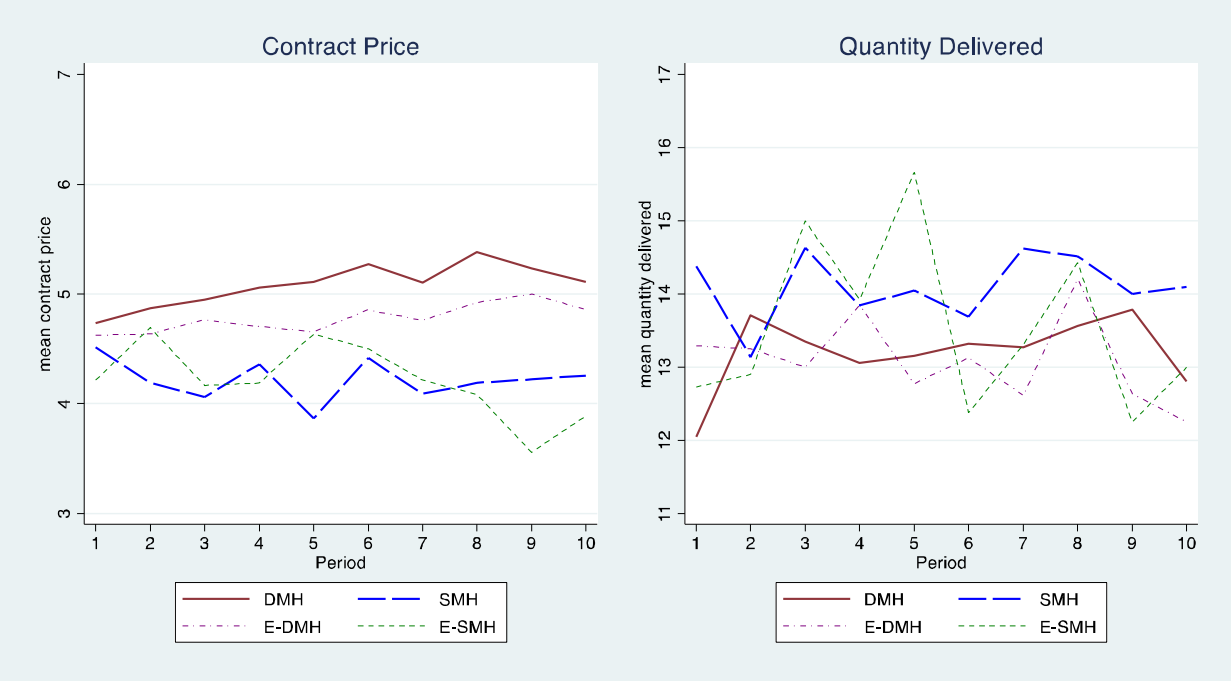


Figure 2: Side-selling & price defaults

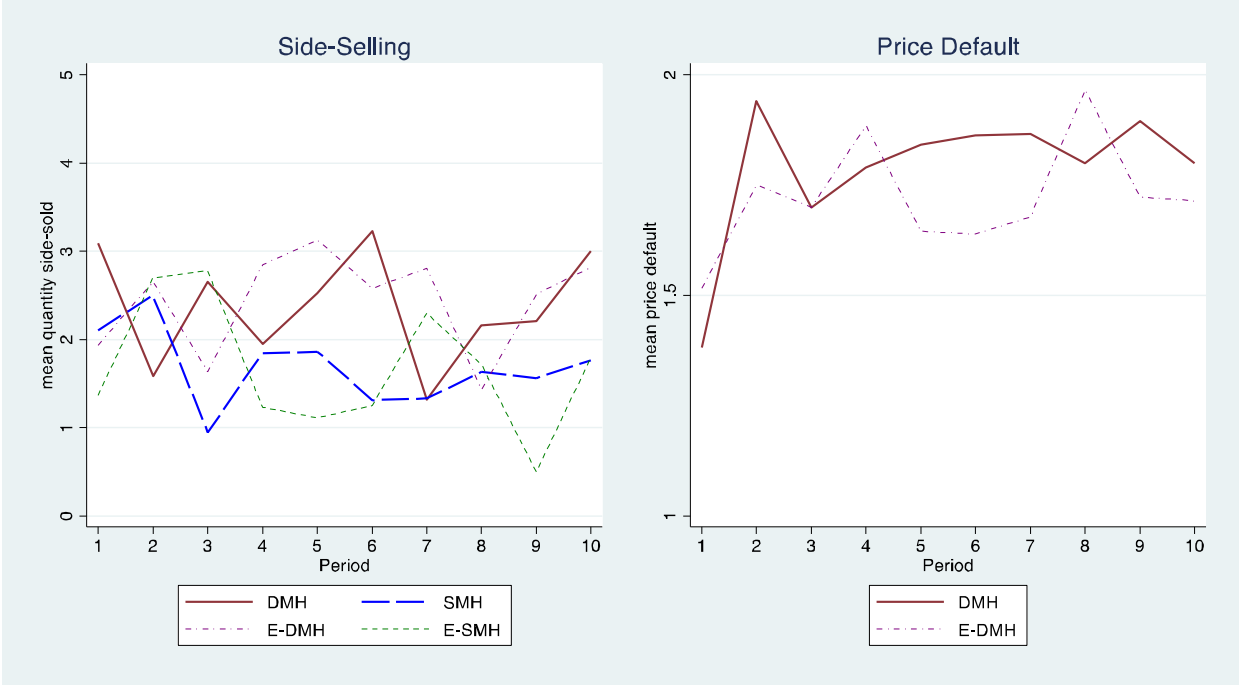


Figure 3: Contract Price relative to contract price promised

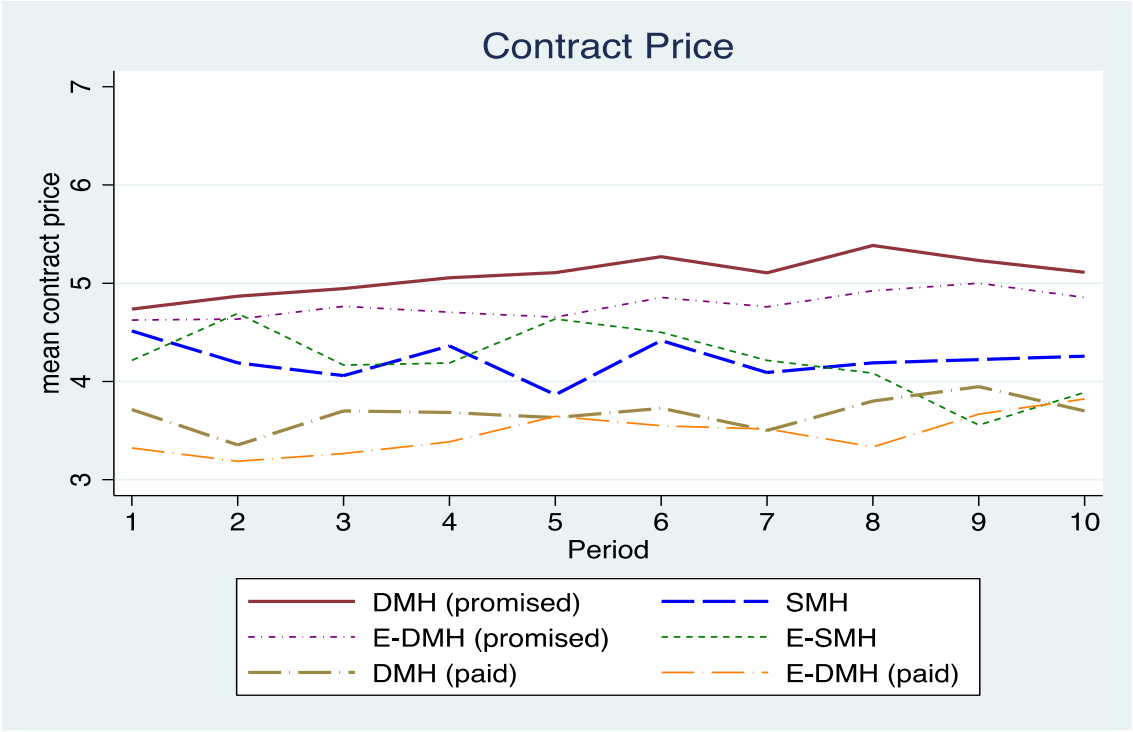


Figure 4: Proportion of buyers who chose to forgo the option the reduce the contract price in E.

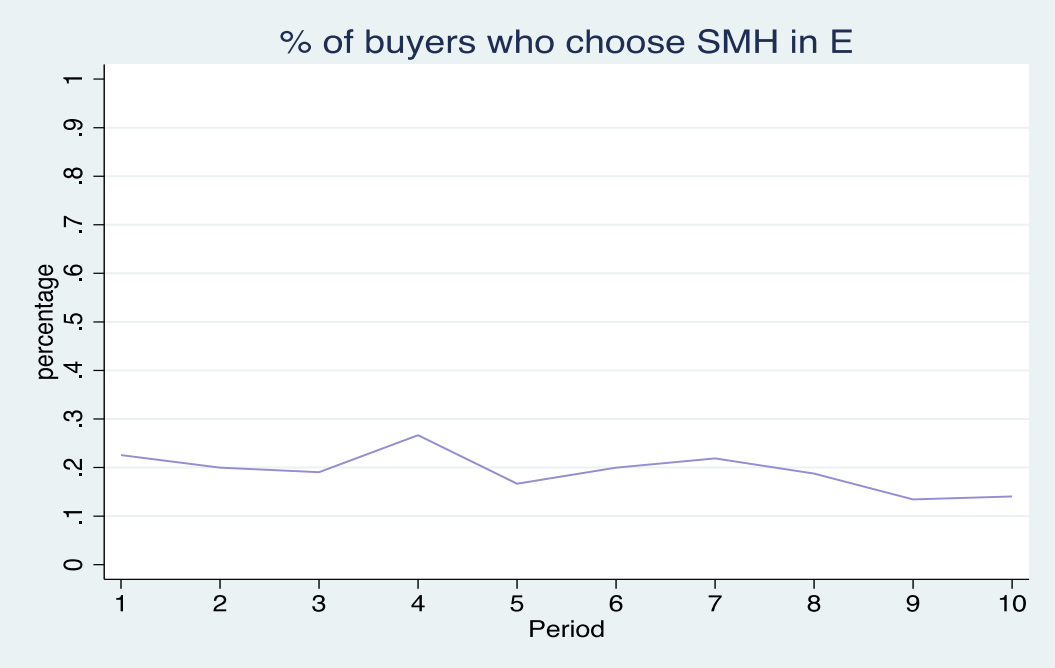


Table 3: Panel Regression on seller's profit with demographic controls displayed

Profit	(1)	(2)	(3)
DMH	-5.239***	1.563	1.508
	(-8.72)	(-0.81)	(-0.75)
E-DMH	-4.741***	4.184*	4.120*
	(-7.13)	(-2.19)	(-2.21)
E-SMH	0.352	-1.468	-1.487
	(-0.44)	(-0.80)	(-0.89)
Contract price	2.980***	2.884***	2.832***
	(-10.02)	(-10.34)	(-10.23)
Output	3.273***	3.272***	3.268***
	(-27.94)	(-28.44)	(-28.60)
seller	-10.29***	-0.344	-0.511
	(-4.46)	(-0.37)	(-0.60)
seller # DMH		-13.46***	-13.02***
		(-3.79)	(-3.63)
seller # E-DMH		-17.49***	-17.12***
		(-5.25)	(-5.29)
seller # E-SMH		2.600	2.879
		(-0.60)	(-0.70)
SDS17_Score			-0.248
			(-1.48)
English			-1.139
			(-1.19)
Economics			-0.253
			(-0.25)
Gender			-0.720
			(-0.85)
Constant	23.480***	8.652***	12.400***
	(-4.86)	(-3.50)	(-4.13)
N	3000	3000	3000
Wald Chi2	1252.37	1091.6	1780.31

Notes: *** Significant at 1% level; ** significant at 5% level; * significant at 10% level. Robust standard errors in parentheses. Qualitatively similar results are observed with standard OLS with robust standard errors and hierarchical linear

Table 4: Panel Tobit Regressions on side-selling with demographic controls displayed

seller side sale	(1)	(2)
DMH	2.761***	2.807***
	(0.476)	(0.489)
E-DMH	2.684***	2.679***
	(0.421)	(0.426)
E-SMH	-0.346	0.344
	(0.563)	(0.565)
Contract Price	-1.135***	-1.124***
	(0.164)	(0.165)
Market Price	1.879***	1.879***
	(0.087)	(0.087)
Quantity Produced	0.912***	0.912***
	(0.053)	(0.053)
SDS17 Score		-0.016
		(0.057)
English		0.227
		(0.340)
Economics		0.133
		(0.365)
Gender		0.681**
		(0.336)
Constant	-17.859***	-18.625***
	(1.259)	(1.476)
Wald χ^2	612.28	614.36
N	842	842

Notes: *** Significant at 1% level; ** significant at 5% level; * significant at 10% level. Robust standard errors in parentheses. Note only the cases where a contract was accepted and side-selling was possible are included in the regressions Qualitatively similar results are observed with standard OLS with robust standard errors and hierarchical linear models with random effects at both session and subject level.

Table 5: Panel Tobit regressions on strategic price default with demographic controls displayed

Price default	(1)	(2)
E-SMH	-0.742	-0.996
	(0.826)	(0.823)
Quantity Delivered	0.383**	0.388**
	(0.179)	(0.177)
Belief	0.243	0.264*
	(0.158)	(0.157)
SDS17 Score	-	-0.121*
		(0.136)
English	-	0.107
		(0.795)
Economics	-	-2.216***
		(0.849)
Gender	-	0.195
		(0.770)
Constant	-0.453	1.210
	(2.491)	(2.961)
Wald χ^2	10.73	15.65
N	670	670

Notes: *** Significant at 1% level; ** significant at 5% level; * significant at 10% level. Robust standard errors in parentheses. Note that only the observations were a contract was accepted are included in the analysis. Qualitatively similar results are observed with standard OLS with robust standard errors and hierarchical linear models with random effects at both session and subject level