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Blessing or Evil? Contract Farming, Smallholder Poultry Production and Household Welfare in Kenya

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Abstract

There is lack of consensus in the literature on the impact of contract farming on the welfare of smallholder farmers. Some authors argue that contract farming improves access to markets hence income, while others view contract farming as an avenue by which large corporations exploit smallholder farmers. It is hence seen as a blessing to some but a necessary evil to others. This study examines the factors influencing participation in poultry contract farming in Kenya. It then uses propensity score matching technique to assess the impact of contract poultry production. The study finds, among others, that farmer-specific factors, transaction costs and financial asset endowment affect participation in contract farming. It also finds that contracted farmers earned more net income per bird than their counterparts. It concludes that participation in contract farming practice improves the welfare smallholder poultry farmers in Kenya. The study discusses the policy implications of the findings.

Keywords: contract farming, poultry production, smallholder farmers, impact, propensity score matching, Kenya

JEL: Q10, Q12, Q13

1 Introduction

Contract farming is an agreement between farmers and processing and/or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices (EATON and SHEPHERD, 2001). The arrangement often involves the buyer providing a degree of production support through, for example, the supply of inputs and the provision of technical advice. Some contracts entail some level of management by the buyer (MINOT, 1986; OKELLO and SWINTON,

2007). The farmers, on the other hand, commit to providing a specific (prescribed) quantity and quality of the commodity often at a specified time to the buyer. A fundamental feature of contract farming is the shifting of risk from producers to processors since it is a form of futures market. Production and price risks are important features of poultry farming. Risk sharing is one of the widely cited reasons for contracting. Numerous studies of contract farming emphasize risk reduction as a principal incentive for producers to enter in to contracts (COVEY and STENNIS, 1985). Much of the price risk is reduced, in contract farming, by the use of a predetermined price rather than the market price (MARTINETZ, 2005).

STROHM and HOEFFLER (2006) indicate that contract farming has been gaining popularity in developing countries. Some of the enterprises where contract farming is widely used are French beans and other horticultural crops (Kenya and Ethiopia), fruits such as pineapples mangoes and passion fruits (Ghana), cotton (Zimbabwe) and poultry (Kenya). Indeed, much of the success in the horticulture industry in Kenya, Zambia and Ethiopia has been attributed to contract farming (OKELLO and SWINTON, 2007; NARROD et al., 2009). Supermarkets particularly in Kenya are also increasingly switching from spot market transactions to contractual arrangements with the farmers (RAO and QAIM, 2011).

Contract farming arrangements in Kenya falls under the four models of contract farming arrangements explained by EATON and SHEPHERD (2001) namely centralized model, multipartite model, intermediary model and the informal model. The centralized model involves a centralized processor and/or buyer procuring from a large number of small-scale farmers. The cooperation is vertically integrated and, in most cases, involves the provision of several services such as pre-financing of inputs, extension and transportation of produce from the farmer(s) to the buyers' processing plant. Multipartite contract farming model arises when a combination of two or more organizations (state, private agribusiness firms, international aid agencies or non-governmental organizations) work together to coordinate and manage the cooperation between buyers and farmers. An intermediary model, on the other hand, shows many characteristics of a centralized model with the difference that they act as an intermediary on behalf of another firm. Normally, the intermediaries organize everything on behalf of the final buyer starting with input supply, extension service, payment of the farmers and final product transport. Indeed, handling several thousands of out growers involves significant management effort and therefore it might be economically attractive for a buyer to outsource this task to an intermediary. Lastly, informal arrangements involve casual oral agreements between contracting parties and regularly repeated marketing transactions, but are characterized by the absence of written contracts or equally binding and specifying documents.

While contract farming is widespread in Africa and many other developing countries, there are different views on its impact on the welfare of smallholder farmers. Some authors argue that contract farming is beneficial to the small holder farmers since it enables farmers to access ready markets and to also access global markets (MINOT, 1986; KEY and RUSTEN, 1999; WARNINGS and KEY, 2002; GULATI et al., 2005; MINOT and ROY, 2006; MIYATA et al., 2009; RAO and QAIM, 2011; SCHIPMANN and QAIM, 2011). Such authors also argue that contract farming enhances the income of farmers which they attribute to the economies of scale enjoyed in contract farming and still others such as FLEMING and ABLER (2013) argue that once farmers access international markets they achieve gains in productivity arising from knowledge spillovers and product specialization. On the other hand, other authors argue that contract farming is a means of exploiting farmers by the large agribusiness firms due to the unequal bargaining power (LITTLE and WATTS, 1994; SINGH, 2002). They criticize contract farming on the basis that most of the contractual terms are too costly for smallholder farmers to comply with and that most large firms break the contractual terms at the expense of the smallholder due to unequal market power. Some other critics of contract farming (e.g. GUO et al., 2005) argue that contract farming is only beneficial for large scale farmers and that it only serves to push smallholder farmers out of the market and could even lead to rural inequality and entrench poverty among the rural smallholder farmers.

These differing views make contract farming appear as a necessary evil in the production and marketing of certain agricultural commodities in Kenya. It is necessary (and beneficial) to proponents because it resolves the problem of endemic market failures in developing countries thus allowing farmers access to lucrative domestic and international markets. Yet, opponents see contract farming as an evil because it is an avenue for some large agribusiness firms to exploit the smallholder farmers. Theoretically, farmers participate in contract production if the benefits of hedging against risk and resolving other idiosyncratic risks and acquiring technical services that such contracts provide (REHBER, 1998; MARTINETZ, 2005; OKELLO and SWINTON, 2007) outweigh the costs. The nature of market failure and provision of technical services however varies by geographical location and the nature of the market and are exacerbated by the presences high transaction costs and asset poverty (BARRETT, 2008). This study addresses two objectives. First, it examines the factors affecting participation in commercial contract production of poultry by smallholder farmers in Kenya, after controlling for risk. Second, it examines the impact of contract farming on the incomes of smallholder poultry farmers in Kenya. The study focuses on smallholder farmers producing poultry products for Kims Poultry Care Center (KPCC), a large poultry firm in Kenya, under contract. KPCC is the only large poultry firm that worked with smallholder farmers in Kenya at the time of this study.

The rest of this paper is organized as follows. Section 2 provides a brief review of commercial poultry production in Kenya to provide context for the study. This is followed by a presentation of the study approach in Section 3. Section 4 presents the results of the paper. Finally, Section 5 concludes and discusses policy implications.

2 Study Context

Commercial poultry production in developing countries tends to be concentrated in the urban and peri-urban areas of major cities/towns where ready urban markets are available (OKELLO et al., 2010). This has led to the concentration of commercial hatcheries that sell hybrid broiler and layer chicks to commercial farmers in the peri-urban areas (NYAGA, 2007). Kenya has one of the most well-developed commercial poultry industries in Africa (NYAGA, 2007). The industry supplies most of the eastern Africa region with poultry and poultry products including eggs, day-old chicks, and sausages (OKELLO et al., 2010). Thus, the demand for poultry products is high. Some commercial hatcheries have, therefore, developed production schemes that involve outgrowers producing poultry under contract. To date these schemes have targeted Kiambu and Nakuru counties, mainly due to their proximity to large urban populations (hence ready market). The contracting firm in Kiambu is Kenchic Limited which deals exclusively with medium and large scale farmers. On the other hand, the Nakuru county firm, known as Kims Poultry Care Centre, works with smallholder as well as medium and large scale farmers.

Nakuru county is a cosmopolitan region in the Rift Valley province with a population of 471,514 people. The major drivers of the economy in the county are agriculture and tourism. According to REPUBLIC OF KENYA (RoK) (2005) and NYAGA (2007) the county has high poverty levels (ranging from 41 percent in the urban areas to 45 percent in the rural areas) and high unemployment levels. Poultry production is one of the leading agricultural enterprises in the county. The processed chicken and eggs produced in the county feed into the tourist hotels with the rest being sold to other cities in Kenya and in the East Africa region (OKELLO et al., 2010).

3 Study Approach

3.1 Theoretical Framework

Impact assessment establishes with as much certainty as possible, whether or not an intervention produces its intended effects (AIEI, 2010). There are two approaches to study the impact of a given project. These are the ‘before and after’ and the ‘with and without’ approaches. ‘Before and after’ analysis compares the performance of key

variables during and after the program, with those prior to the implementation of the program. This approach uses statistical methods to evaluate whether there is a significant change in some essential variables over time. The approach often gives biased results because it does not take in to account the effect of the confounding factors on the change. With and without comparisons compares the behavior in the key variables in a sample of program beneficiaries, with their behavior in non-program group (a comparison group). This approach uses the experiences of the comparison group as a proxy for what would otherwise have happened in the program beneficiaries.

Impact evaluations typically rely on econometric and statistical models. There are three main kinds of impact evaluation designs. These are experimental, quasi-experimental and non-experimental which are respectively associated with control groups, comparison groups, and non-participants. In Experimental or Randomized Control Design method selection into the treatment and control groups is random within some well-defined set of people. In this case there should be no difference (in expectation) between the two groups besides the fact that the treatment group had access to the program. Non-experimental or Quasi-Experimental Design methods are used to carry out an evaluation when it is not possible to construct treatment and comparison/control groups through experimental design. These techniques generate comparison groups that resemble the treatment group, at least in observed characteristics, through econometric methodologies, which include difference in difference methods, reflexive comparisons, instrumental variables methods and matching methods (BAKER, 2000).

According to HECKMAN (1979) the impact of an intervention is essentially an estimation of a treatment effect in policy analysis. However, change in an outcome of a treatment is often a function of multiple endogenous and exogenous factors. Often, the problem arises in identifying part of the change in the outcome variable for the target population due to treatment. This problem arises due to the difficulty of observing the counterfactual corresponding to any change induced by a treatment yet it is necessary to observe the counterfactual if the impact is to be assessed. Given that the decision of households to participate or not to participate in the treatment may be associated with the net benefits from participation, the issue of self-selection becomes extremely crucial.

Following HECKMAN (1979) the impact of participation in contract farming on household income (Y) can be expressed as a function of explanatory variables (X_i) and a participation dummy variable (R) specified as;

$$Y = \beta X_i + AR_i + \mu_i \quad (1)$$

Where $R_i = 1$ for contracted farmers and 0 for independent farmers. μ_i is the error term, β and A are coefficients of the parameters to be estimated.

Whether farmers participate in contract farming or not is dependent on the characteristics of farmers and farms, hence the decision of a farmer to participate is based on each farmer's self-selection instead of random assignment. Assuming a risk-neutral farmer, the index function to estimate participation in contract farming can be expressed as:

$$R_i^* = \gamma X_i + e_i \quad (2)$$

Where R_i^* is a latent variable denoting the difference between utility from participating in contract farming U_{iA} and the utility from not participating (U_{iN}). The farmer will participate in contract farming if $R_i^* = U_{iA} - U_{iN} > 0$. The term γX_i provides an estimate of the difference in utility from participating in contract farming ($U_{iA} - U_{iN}$), using the household and farm-level characteristics, X_i as explanatory variables, while e_i is an error term. In estimating Equations (1) and (2), it should be noted that the relationship between participating in contract farming and the outcome (such as income) could be interdependent. Thus, participating in contract farming can increase output and as such richer households may be better disposed toward participating in contract farming. Thus, treatment assignment is not random, with the group of farmers being systematically different. Specifically, selection bias occurs if unobservable factors influence both the error terms of the income equation, μ_i , and that of the participation choice equation, e_i thus resulting in correlation of the error terms of the outcome and participation choice specifications (GREENE, 2003). In that case, estimating Equation (1) with ordinary least squares will lead to biased estimates.

Several strategies have been employed in addressing the problem of selection bias above. Some studies have employed the Heckman two-step method to address selection bias, when the correlation between the two error terms is greater than zero. However, the approach depends on the restrictive assumption of normally distributed errors. Another way of controlling for selection bias is to employ instrumental variable approach (IV). However, the instrumental variable approach suffers from a major limitation relating to the difficulty in finding and identifying instruments in the estimation (KIRUI et al., 2013). In addition, both OLS and IV procedures tend to impose a linear functional form assumption implying that the coefficients on the control variables are similar for adopters and non-adopters (ALI and ABDULAI, 2010). Unlike the parametric methods mentioned above, propensity score-matching requires no assumption about the functional form in specifying the relationship between outcomes and predictors of outcome. Due to the shortcomings of the two methods discussed above, propensity score matching which is a non-parametric method, first proposed by ROSENBAUM and RUBIN (1983) is used in this paper as a treatment effect correction model to reduce self selection bias.

To evaluate the impact of participation in poultry contract farming on income, all observable characteristics have to be the same between the contract farmers which in this case is the treatment and the non-contract farmers which will be the control. The expected treatment effect of contract participation or Average Treatment Effect on Treatment (ATT) is the difference between the actual income and the income if they did not participate in contract farming. Following DEHEJIA and WAHBA (2002), the ATT is given as;

$$ATT = E(Y_{1i} - Y_{0i} | P_i = 1) \quad (3)$$

where Y_{1i} denotes income when the i -th farmer participates in contract, Y_{0i} is the income of i -th farmer when he does not participate in contract, and P_i denotes the contract participation, 1=participate, 0= otherwise. The mean difference between observable and control is written as;

$$D = E(Y_1 | P_i = 1) - E(Y_0 | P_i = 0) = ATT + \varepsilon \quad (4)$$

where ε is the bias, also given by:

$$\varepsilon = E(Y_0 | P_i = 1) - E(Y_0 | P_i = 0) \quad (5)$$

The true parameter of ATT is only identified if the outcome of treatment and control under the absence of contract are the same. This is written as:

$$E(Y_0 | P_i = 1) = E(Y_0 | P_i = 0) \quad (6)$$

As such estimation of the average treatment effects on the treated (ATT) group using matching methods such as propensity score matching relies on two key assumptions: the conditional independence assumption (CIA) (also known as confoundedness assumption and the common support or overlap assumption. The unconfoundedness assumption requires that the analyst should observe all variables influencing the participation decision and outcome variables simultaneously. It implies that selection into the treatment group is solely based on observable characteristics. This is a strong identifying assumption but has to be met for the results of the PSM to be valid and reliable. The overlap condition ensures a common support which is the area where the balancing score has positive density for both treatment and the control units.

3.2 Empirical Methods

The dependent variable in the model estimated to assess the determinants of participating in contract farming is binary taking the value of 1 if a farmer participated and 0 otherwise. Consequently, a Logit regression model was used. Other authors have used

Probit regression model to estimate such binary dependent variable regression models. Both the Logit and Probit models estimate parameters using maximum likelihood. However, while Probit assumes normally distributed error term, the Logit model assumes a logistic distribution of the error term. The Logit model is often preferred due to the consistency of parameter estimates associated with the assumption that error term in the equation has a logistic distribution (RAVALLION, 2001; BAKER, 2000). Therefore, the Logit regression model was used to estimate the probability of contract participation assigned to socio- economic characteristics in this study.

The dependent variable in model estimated to examine the drivers of participation in poultry production contract is *Kims* which is a dummy variable equal to 1 if a farmer is contracted by KPCC, 0 otherwise. The independent variables were: *Experience* = experience of the farmer in contract farming in years; *Education* = number of formal years of education of the farmer; *Gender* = dummy variable equal 1 if farmer is male, 0 otherwise; *Age composition* = number of household members aged 15 years and above; *Occupation* = Dummy variable for main occupation of the farmer, equal to 1 if farming, 0 otherwise; *Risk attitude* = farmer's risk perception given as 0 if risk-loving, 1 if risk neutral, and 2 if risk-averse, and computed as described below; *Farm size* = size of the farm land in acres; *Total assets* = Natural log of total asset value of the farm in Kenya Shillings; *Brooder capacity* = number of chicks that the farm's brooders can hold when completely full; *Credit* = Dummy variable equal to 1 if the farmer received credit for poultry production, 0 otherwise; *Group membership* = Dummy variable equal to 1 if farmer is a member of a farmers' association, 0 otherwise; *Farm income* = natural log of household farm income during 2010; *Non-farm income* = natural log of non-farm income earned by the household in 2010; *Distance* = distance to the main road in kilometers; *Extension* = Dummy equal to 1 if farmer received technical advice during last cycle, 0 otherwise. Natural logs of asset value and income were used due to the high standard deviation in the variables (caused by wide variation in the income in the sample) so we took the natural logs to normalize the distribution of income in the sample.

To obtain information on the risk perception (attitude) of the farmers, a proxy for risk tolerance based on individual's response to hypothetical risky choices was applied, following KIMBALL et al. (2008). The questions were addressed as a hypothetical gamble. In particular, farmers were asked to choose between a crop/livestock with a certain lifetime income and a crop/livestock with uncertain but higher income. The uncertain income was made to change from a higher amount to a lower amount and the farmer's choice (depending on how much risk he/she was willing to take) based on the expected changes in income. After obtaining the farmers' responses to the hypothetical question, risk attitude was categorized into risk-averse, risk neutral and risk-loving.

This study, unlike some studies on risk, did not proceed to translate the ordinal responses to cardinal proxies of risk.

To address the second objective which is to assess the impact of contract participation on income, propensity score matching was used. BAKER (2000) gives the steps involved in applying propensity score matching. First the propensity scores are estimated using a discrete choice model. A Logit regression model is often preferred in estimating the scores due to the consistency of parameter estimates (BAKER, 2000; RAVALLION 2001). CALIENDO and KOPEINIG (2008) also note that the Logit model which has more density mass in the bounds could be used to estimate the propensity score $p(X)$.

In the second step matching algorithm is selected based on the data at hand after undertaking matching quality test. Matching is a common technique used to select control subjects who are matched with the treated subjects on background covariates that the investigator believes need to be controlled. In this study, the nearest neighbor matching (NNM), radius matching (RM) and kernel based matching (KBM) methods were used. Basically, these methods numerically search for “neighbours” that have a propensity score for non-treated individuals that is very close to the propensity score of treated individuals. NNM method is the most straight forward matching method. It involves finding, for each individual in the treatment sample, the observation in the non-participant sample that has the closest propensity score, as measured by the absolute difference in scores (BAKER, 2000; CALIENDO and KOPEINIG, 2008). In this study we match each treated household with the five nearest neighbors (with replacement) in terms of propensity score distances. To avoid the possibility of bad matches, we impose a maximum caliper restriction of 0.3.

The KBM method is also a non-parametric matching method that uses the weighted average of the outcome variable for all individuals in the group of non-participants to construct the counterfactual outcome, giving more importance to those observations that provide a better match. This weighted average is then compared with the outcome for the group of participants. The difference between the two terms provides an estimate of the treatment effect for the treated case. For the KBM, we specified a bandwidth of 0.3. Radius matching (RM) is a variant of caliper matching suggested by DEHEJIA and WAHBA (2002). Applying caliper matching means that an individual from the comparison group is chosen as a matching partner for a treated individual that lies within the caliper (propensity range) and is closest in terms of propensity score (CALIENDO and KOPEINIG, 2008). The basic idea of RM as a variant of caliper matching is to use not only the nearest neighbour within each caliper but all of the comparison members within the caliper. A benefit of this approach is that it uses only as many comparison units as are available within the caliper and therefore allows for

usage of extra (fewer) units when good matches are (not) available. For RM we impose a radius caliper of 0.3.

In the third stage, overlap condition or common support condition is identified. The common support or the overlap condition is an important condition while applying PSM. The common support is the area where the balancing score has positive density for both treatment and comparison units. No matches can be made to estimate the average treatment effects on the ATT parameter when there is no overlap between the treatment and non-treatment groups. In the fourth stage, the treatment effect is estimated based on the matching estimator selected on the common support region. In this study, the treatment effects were computed by matching the net income per bird based on the propensity scores and using the three matching algorithms explained above. The standard errors were computed using variance approximation method as proposed by LECHNER (2011) which takes into account that matching is performed with replacement.

Finally, sensitivity analysis is undertaken to check the strength of the conditional independence assumption. The propensity score matching model assumes that the differences between the participants and the non-participants is just because they differ in observable variables in the data set. Since it is not possible to estimate the magnitude of selection bias while using PSM (non-experimental model) AAKVIX (2001) suggests the use of Rosenbaum bounds (rbounds) test which tests the null hypothesis that there is no change on the treatment effect for different values of unobserved selection bias. This study therefore conducted the sensitivity analysis for the presence of hidden bias using the Rosenbaum bounds (rbounds test) in STATA. This sensitivity test shows how hidden biases might alter inferences about treatment effects but does not indicate whether biases are present or what magnitudes are plausible.

In addition to these, a major objective of propensity score estimation is to balance the observed distribution of covariates across the groups of participants and non-participants. The balancing test is normally required after matching to ascertain whether the differences in the covariates in the two groups in the matched sample have been eliminated, in which case the matched comparison group can be considered as a credible counterfactual (CALIENDO and KOPEINIG, 2008).

3.3 Estimating Net Revenues

Total revenues earned by farmers were estimated in this study by revenue from sale of full grown birds (which is equal to the total number of chicks kept by the farmer less the approximate number of chicks that died during the production cycle multiplied by

the selling price per bird) and revenue from sale of manure and empty feed bags. Costs incurred during the cycle were categorized into production and transaction costs. Production costs were categorized into feed costs (broiler starter, broiler finisher and pellets), cost of vaccines and medication (new castle, gumboro, fowl typhoid, vitamin supplements, deworming drugs and any other medication that the farmer may have used), labor costs and other costs which includes electricity, charcoal, litter (wood shavings), water and any other cost the farmer may have incurred. Labor costs were estimated from the number of hours spent on poultry production and included monetary value of both family and hired. Family labor was valued at the on-going wage rate applicable in the area. In addition, the transaction costs of production and marketing of poultry was included as a cost item. Transaction cost considered included phone call costs and transport cost incurred in search of markets as well as the costs negotiating and enforcing the contracts (i.e., following up on the terms of contract in cases of delayed or defaulted payment agreements). However in this study, most of the transaction costs incurred by the farmers were in search of markets and in enforcement of contracts. The net income value obtained therefore equals total revenue net of all production and transaction costs.

3.4 Data and Sampling

The data used in this study was collected from poultry farmers in Nakuru County stratified by participation in contract farming. The list of farmers and their location was obtained from the day old chick suppliers in Nakuru which include Kenchic, Muguku and Sigma. A list of the contracted farmers was also obtained from KPCC. Based on these lists the farmers were placed into various administrative divisions and six divisions were purposively selected since they had a considerably higher number of contract poultry farmers compared to the other divisions. The selected divisions were Bahati, Njoro, Dundori, Nakuru Municipality, Nakuru North and Elburgon. A complete list of all the villages in the divisions was then drawn and due to budgetary constraints only 39 villages were randomly selected. And from the 39 villages a random sample of 180 households stratified by participation in contract production was randomly selected. Of the 180 households, 111 were independent (non-contracted) growers and 69 were contracted farmers.

The survey was conducted during April and May 2011. However, the data on production was for the period November 2010 to February 2011 and was based on the farmer's latest complete production cycle. Information collected included demographic characteristics of the household, land, financial and physical asset endowments, access to infrastructure (roads, electricity, water, and telephone), information on revenue earned and cost incurred in poultry production, transaction costs and information on the household farm and nonfarm income.

4 Results

4.1 Factors Influencing Farmers' Participation in Contract Poultry Production

Table 1 presents summary statistics for the key variables in the data collected. As shown by the t-test of differences in means, contract farmers have, on average, significantly higher levels of farm and non-farm incomes compared to the independent growers. They also have, on average, significantly shorter production cycles. The t-tests also show that the contract farmers and independent farmers differ significantly with respect to distance to the main road (a proxy for transaction costs), asset value and also the average weight of full grown birds.

Table 1. Summary statistics of various contracted and independent poultry farmers

Variable	Independent farmers (N=111)		Contract farmers (N=69)		P-value
	Mean	std dev	Mean	std dev	
Distance to the main road	2.98	2.75	2.02	1.54	0.08*
Distance to town (Nakuru)	14.35	7.21	15.84	8.64	0.212
Distance to the vet clinic	5.16	2.35	4.62	3.33	0.207
Distance to the credit society	7.08	3.35	7.68	4.65	0.315
Distance to nearest animal feed	2.30	2.19	2.07	1.66	0.468
Distance to nearest processor	2.62	1.46	2.29	1.10	0.106
Household size	4.21	1.51	4.33	1.35	0.571
Farmers' age	46.69	10.45	46.83	9.44	0.918
Years of farmers' education	12.23	3.08	12.64	2.75	0.365
Land size in acres	1.11	1.00	1.27	1.18	0.349
Full brooder capacity	624.77	550.99	684.2	627.36	0.506
Natural log of total asset value	11.22	1.49	11.62	1.55	0.084*
Average weight per bird (Kg)	1.45	0.1	1.38	0.06	0.000***
No of birds kept by farmers	362.16	112.66	389.9	122.97	0.127
Natural log of farm income	3.56	5.51	5.28	6.08	0.05**
Natural log of non farm income	6.02	6.34	8.41	6.22	0.014**
Length of production cycle (week)	6.01	0.46	5.88	0.4	0.049
Number of feeders	14.45	7.46	15.51	5.89	0.319
Number of drinkers	12.14	6.8	12.91	5.35	0.426
Household member >15 years	3.62	1.48	3.56	1.54	0.896

*significant at 10%; **significant at 5% and *** significant at 1%

Source: authors' estimations (2014)

Table 2 presents the maximum likelihood estimates and the marginal effects from the Logit regression. The model diagnostics indicate that it fits the data well (p value= 0.000). Further, the Hosmer and Lemeshow's test yields a large p-value (0.993) indicating the model fits the data well. Among the exogenous variables considered, age, education, farm income, off-farm income, gender, distance to the main road, risk attitude and education significantly influence the probability of participation in poultry contract farming at least at the 10 percent level.

Table 2. Logit regression results of factors affecting participation in poultry production contract

Variables	Maximum likelihood estimates			Marginal effects	
	Coefficient	std error	P-value	Coefficient	P-value
Distance to the main road	-0.232**	0.091	0.010	-0.049***	0.009
Education	-0.148*	0.080	0.064	-0.031**	0.060
Experience	-0.0582	0.054	0.289	-0.012	0.288
Occupation	0.158	0.535	0.768	0.033	0.765
Gender of farmer	1.024**	0.441	0.020	0.207**	0.019
Age composition	-0.0665	0.123	0.589	-0.014	0.590
Land size	-0.208	0.183	0.256	-0.044	0.262
Risk attitude	1.697***	0.375	0.000	0.359***	0.000
Brooder capacity	2.49E-04	4.59E-04	0.587	5.28E-05	0.587
Extension	-1.096*	0.571	0.055	-0.195**	0.021
Credit	0.435	0.611	0.477	0.097	0.496
Asset value	0.0724	0.152	0.633	0.015	0.629
Farm income	0.115***	0.041	0.004	0.024***	0.006
Nonfarm income	0.131***	0.041	0.001	0.028***	0.002
Constant	-2.922	2.005	0.145		

*significant at 10%; **significant at 5% and *** significant at 1%

Overall P-value = 0.000; Pseudo R² = 0.301; Hosmer-Lemeshow's test (p-value) = 0.9929

Source: authors' estimations (2014)

As expected, the proxy for risk attitude is positive and highly significant (p-value = 0.000) indicating that risk attitude influences the likelihood of participating in contract production. Specifically, it means that risk-averse farmers are more likely to participate in contract farming than their counterparts. In theory, contract farming is viewed as a means of hedging against risks. Hence risk-averse farmers will tend to participate in marketing arrangements such as contracting that help diversify (reduce) risks. Indeed risk reduction is usually a major objective of contract farming (MARTIN, 1997). The

computed marginal effects indicate that farmers who have higher risk-rating also have higher likelihood of participating in contract farming. Hence our finding is line with theory.

Results also indicated that distance to the main road negatively influenced farmers' participation. A 10 percentage increase in the distance from the main road will reduce the probability of participating in contract farming by 0.5, other things constant. The finding implies that the further away the farm is from the main road, the less likely the farmer will participate in contract production. The findings corroborate past studies that indicate that long distances to the main road (and hence markets) increases the transaction costs of sourcing products from smallholder (FAFCHAMPS and HILL, 2005; FAFCHAMPS and GABRE MADHIN, 2006).

The levels of farm and non-farm incomes also positively and significantly influence the decision to participate in poultry contract farming. A percentage increase in the farm income and also in non-farm incomes of a farmer will increase the likelihood of the farmer to participate in contract farming by 2 and 3 percent, respectively, other things constant. These findings suggest that farmer's financial endowment increases the probability of participating in contract farming. They further suggest that contract farming can exclude poor farmers.

Results further indicate that gender of the respondent also positively affects the likelihood of participation in contract production. In particular, the results show that male farmers have a higher probability of participating in contract farming than their female counterparts. The computed marginal effects indicate that for male farmers the probability of participating in contract farming is higher than for the female farmers by 0.21. This finding could be attributed to the fact that male farmers tend to have greater access to productive assets such as land than their female counterparts.

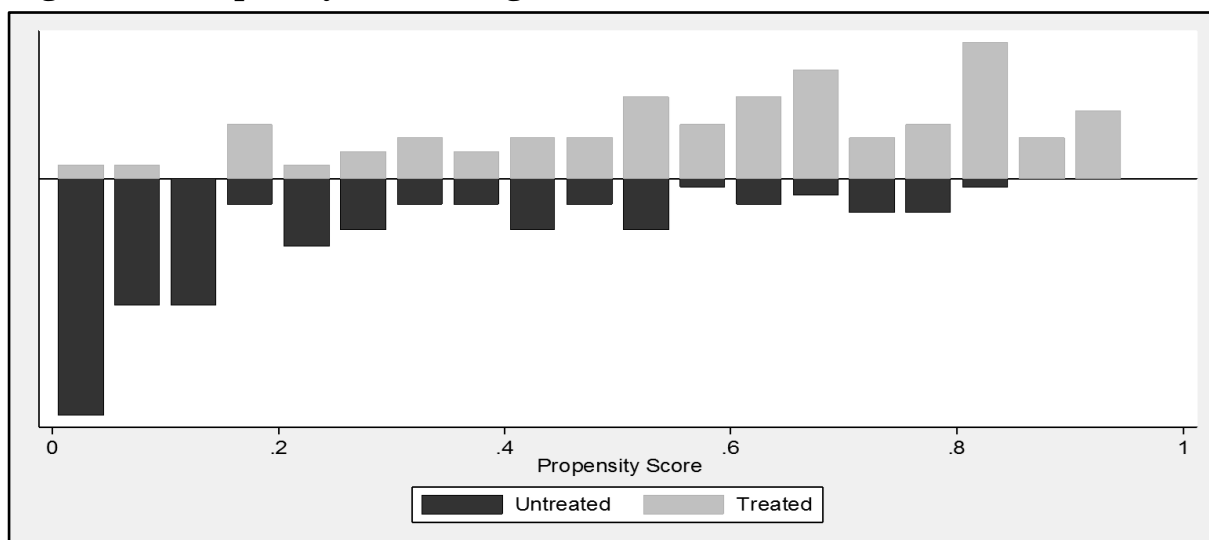
Contrary to our expectation, households which received technical advice from extension agents were less likely to participate in contract farming. Results indicate that the probability of participating in contract farming for those farmers who have access to technical advice is lower by 0.20 compared to those farmers who have no access to these services. This may be due to the fact that farmers who obtain technical advice from government extension agents are likely to be more aware and informed of alternative marketing channels and also production methods. Similarly, the level of education of the farmer has a negative effect on the farmers' likelihood of participating in contract farming. Results show that an increase in years of education by 1 year will reduce the likelihood of participating in contract farming by 0.14, other things equal. The finding suggests that more educated farmers prefer to use alternative marketing arrangements, probably because they are able to seek information on other marketing channels.

4.2 Impact of Contract Farming on the Net Income per Bird

To assess the impact, Propensity Score Matching (PSM) was applied. The results of the Logit model estimated above indicate that individuals participating in contract farming differ significantly from the non-participants with respect to observable characteristics suggesting that there is self-selection. Therefore, comparing the two groups as they are would result in biased estimates and thus the need to correct for selection bias through the use of propensity score matching.

Propensity scores were estimated (from the logit model in Table 2) for all the 180 farmers; 111 independent growers (control) and 69 contracted farmers (treatment). Among participants, the predicted propensity score ranges from 0.0347 to 0.9311, with a mean of 0.5809. While the predicted propensity score ranges from 0.0068 to 0.8450, with a mean of 0.2543 among non-adopters. The density distribution of the propensity scores for participants and non-participants is shown in Figure 1. The bottom half of each graph shows the propensity score distribution for the non-treated, while the upper-half refers to the treated individuals. The y-axis indicates the frequency of the propensity score distribution. Visual analysis of the density distribution of the propensity scores suggests that there is a high chance of getting good matches. The graph shows that only few treated individuals were off support indicating that most of the individuals that participated in contract farming (treated) found a suitable match among those who did not participate (control).

Figure 1. Propensity score histogram



Source: authors' estimations (2014)

Table 3 presents the results of the covariate balancing test used in this study to test the hypothesis that both groups have the same distribution in covariates x after matching.

Table 3. Propensity scores and tests of covariate balancing

Variable	Sample	Mean		% bias reduction		T test differences in means	
		treated	untreated	% bias	absolute bias	T stat	p- value
Pscore	Unmatched	0.5909	0.2543	145.5		9.42	0.000
	Matched	0.5909	0.5685	9.7	93.4	0.61	0.540
Distance to the main road	Unmatched	2.0232	2.9856	-43.3		-2.66	0.008
	Matched	2.0232	2.198	-7.9	81.8	-0.63	0.529
Education	Unmatched	12.638	12.225	14.1		0.91	0.365
	Matched	12.638	12.937	-10.3	27.4	-0.64	0.525
Experience	Unmatched	5.7391	6.2973	-12.4		-0.81	0.421
	Matched	5.7391	6.1638	-9.4	23.9	-0.57	0.572
Occupation	Unmatched	0.5507	0.6396	-18.1		-1.18	0.238
	Matched	0.5507	0.5391	2.4	87.0	0.14	0.892
Gender	Unmatched	0.6957	0.5225	35.8		2.32	0.022
	Matched	0.6957	0.7232	-5.7	84.1	-0.35	0.724
Age composition	Unmatched	3.6522	3.6216	2.0		0.13	0.896
	Matched	3.6522	3.7406	-5.8	-189.4	-0.34	0.733
Land size	Unmatched	1.2652	1.1108	14.1		0.94	0.349
	Matched	1.2652	1.3334	12.1	14.6	0.74	0.460
Brooder capacity	Unmatched	684.2	624.77	10.1		0.67	0.506
	Matched	684.2	793.91	-18.6	-84.6	-1.00	0.321
Risk attitude	Unmatched	1.8261	1.1802	95.7		5.92	0.000
	Matched	1.8261	1.8116	2.1	97.8	0.18	0.856
Credit	Unmatched	0.1594	0.1171	12.2		0.81	0.420
	Matched	0.1594	0.1551	1.3	89.0	0.07	0.945
Extension	Unmatched	0.1015	0.2172	-29.4		-1.86	0.065
	Matched	0.1015	0.1015	0.0	100.0	0.00	1.000
Asset value	Unmatched	11.623	11.217	26.6		1.74	0.083
	Matched	11.623	11.449	11.4	57.2	0.67	0.506
Farm income	Unmatched	5.2842	3.5614	29.7		1.96	0.051
	Matched	5.2842	5.0663	3.8	87.4	0.21	0.833
Non farm income	Unmatched	8.411	6.0179	38.1		2.48	0.014
	Matched	8.411	7.6693	11.8	69.0	0.70	0.485

Figures in bold show significant covariates. The after covariates are from the nearest neighbor matching algorithm.

Source: authors' estimations (2014)

The table presents the covariates' means, their t-test of differences in means as well as the percentage bias before and after matching. For all the 13 covariates, the matched sample means are almost similar for both the treatment and the control after matching, contrary to the situation prior to matching. Table 3 further shows that covariate balancing was attained in this study. The test results specifically show that covariates whose differences were statistically significant prior to matching become statistically insignificant after matching as required when covariate balancing is attained (ALI and ABDULAI, 2010). The p-values of these variables are in bold. The variables include distance to the main road, risk attitude, gender, farm income, non farm income, total asset value and extension.

Low pseudo-R² and the insignificant likelihood ratio tests (Table 4) further support the hypothesis that both groups have the same distribution in covariates x after matching. These results clearly show that the matching procedure is able to balance the characteristics in the treated and the matched comparison groups. Therefore, these results were used to evaluate the impact of contract farming on the bird's net income among groups of households having similar observed characteristics. Together, the results of these tests indicate absence of hidden bias which implies that the computed average treatment effect on the treated (ATT) is unbiased sample estimate of the outcome variable (i.e., net income). Therefore, the results give unbiased estimates of the impact of contract farming on households.

Table 4. Other indicators of covariate balancing: before and after matching

Test indicator	
Before matching	
Pseudo R ²	0.301
LR χ^2 (P value)	69.93 (0.000)
After matching using nearest neighbor matching (NNM)	
Pseudo R ²	0.028
LR χ^2 (P value)	5.35 (0.967)
After matching using kernel based matching (KBM)	
Pseudo R ²	0.04
LR χ^2 (P value)	7.67 (0.864)
After matching using radius matching (RM)	
Pseudo R ²	0.051
LR χ^2 (P value)	9.74 (0.715)

*significant at 10%; **significant at 5%; ***significant at 1%

Source: authors' estimations (2014)

The Treatment Effect (Impact)

The impact of participating in contract farming on poultry income computed using the three matching algorithms namely, nearest neighbor matching (NNM), kernel based matching (KBM) and radius matching (RM) are shown below in Table 5. The outcome variable was the net income per bird (net of all production and transaction costs) and measured in Kenya Shillings (Kshs).

The results indicate that participating in contract farming has a positive and significant impact on the incomes of the farmers at the 5 percent level (Table 5). This is achieved through the increment in the net revenues from the sale of birds. Specifically, there is an increment in net revenue per bird of Kshs 7.91, Kshs 6.78 and Kshs 6.93 using NNM, KBM and RM matching algorithms respectively which are significant at 5 percent. That is, participating in contract farming increases net income by Kshs 7-8 per bird. This finding suggests that getting smallholder commercial poultry farmers to participate in contract farming can help improve their welfare by increasing the net incomes.

Table 5. Impact of participation in contract production of poultry (ATT)

Matching algorithm	Sample	Treated	Control	Difference	Std error	t-statistic
Unmatched		33.65	27.76	5.90	2.670	2.21
Nearest Neighbour Matching	ATT**	33.65	25.74	7.91**	3.611	2.19
Kernel-based Matching	ATT**	33.65	26.87	6.78**	3.324	2.04
Radius Matching	ATT**	33.65	26.73	6.93**	3.164	2.19

*significant at 10%; **significant at 5%; ***significant at 1%; as at 30th July 10kshs=0.11 US dollars
Source: authors' estimations (2014)

Sensitivity Analysis for Hidden Bias

Table 6 shows the level of gamma for the three matching algorithms. Both the KBM and the RM approach reported a level of gamma of [2.15, 2.2] while the level of gamma in NNM is [2.3, 2.35]. In all the three matching algorithms the lowest gamma level is 2.15 and the highest level is 2.35. The level of gamma is defined as the odds ratio of differential treatment assignment due to an unobserved covariate. Therefore, for a gamma level of 2.15 it implies that if individuals who have the same characteristics (X vector) differs in their odds ratio of participation by a factor of 115 percent

then the significance of the estimated participation effect on net income may be questionable. Generally, the gamma levels reported for sensitivity analysis compare favourably with those reported in other studies (e.g. FALTERMEIER and ABDULAI, 2009; ALI and ABDULAI, 2010). It can therefore be concluded that even large amounts of unobserved covariates would not alter the conclusion about the estimated effects and that the positive treatment effects reported in Table 6 above can be attributed to participation in contract farming and not due to unobserved variables

Table 6. Results of the sensitivity analysis for the hidden bias

Matching method	ATT	T statistic	Gamma (γ) level
Nearest Neighbour	7.90	2.19	2.3-2.35
Kernel-based	6.78	2.04	2.15- 2.2
Radius Matching	6.93	2.19	2.15- 2.2

The gamma level is reported at the point where 10% level on (sig +) is exceeded.

Source: authors' estimations (2014)

5 Summary, Conclusion and Policy Recommendation

This study examined the factors influencing farmers' participation in contract farming and evaluated the impact of contract farming on the income from contract production of poultry by the smallholder farmers in Kenya. The study used data collected from 180 small farm households stratified by participation in contract production. It used logit regression model to isolate the factors that affect decision to participate in contract production of poultry and propensity score matching to assess the impact of participating in such contracts.

As expected, the study finds that risk-averse farmers were more likely to participate in poultry contract farming. Farm and non-farm income also have positive influence on the likelihood of participating in contract farming while male farmers have a higher likelihood of participating in contract compared to the female farmers. The study further finds that distance to the main road as well as the farmer's level of education negatively influence farmers' likelihood to participate in contract production. Farmers who receive advice from the extension agents are less likely to participate in contract farming. Results of the propensity score matching analysis show that participating in contract farming has a positive and a significant effect on the net income per bird. It specifically increases the net income by Kenya Shillings 7-8/bird. Furthermore, results from the sensitivity (rbounds) test of hidden bias show that even large amounts of unobserved covariates would not alter the conclusion about the estimated impact of participation in contract farming.

The study concludes that participation in contract production indeed improves the welfare of participating farmers. The implication of these findings is that contract farming can reduce rather than entrench rural poverty as some studies have suggested. Policies which will make it easier for smallholder farmers to participate in contract farming should be pursued. These include policies that target improvement of rural infrastructure, especially roads and that facilitate farmer participation in contractual arrangements. Specifically, there is need to ensure that contracts are enforceable and means of third party arbitration clearly defined. The finding that poor farmers are less likely to participate in contract farming, due to lack of financial and assets endowments, calls for policies and strategies that target the inclusion of such farmers in contract production. One such strategy is to help such farmers form producer organizations that will allow them overcome financial barriers and other idiosyncratic market failures.

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