Welfare effects of farmer's participation in supermarket supply chain

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Abstract

Empirical evidences on supply relationship between farmers and agribusiness or supermarket driven supply chains show both farmer experiencing positive income gains on an average and exiting, possibly, because of diverse effects on individual farmers. Against this backdrop, this paper examines the extent of welfare benefits to farmers participating in Aditya Birla More collection centre (ABM CC) supply chain, one of the leading supermarkets chains in India. Using survey data on 543 farmers, the chapter shows that supply relationship yields positive income effects to participant farmers on average. Comparing just the suppliers and non-suppliers, 1% increase in the likelihood of participation in ABM CC chain entails a 23% increase in household annual crop income. However, when the experiences of the discontinued suppliers are accounted, 1% increase in the likelihood of participation in ABM CC chain entails a 33% increase in household annual crop income. This evidence shows that there exists heterogeneity in farmer experiences, which is of interest from a public policy perspective, implying some suppliers might be better off opting out, while some suppliers might fare better by continuing in the supply chain.

The study also finds evidence of spatial selection of procurement region, within region selection of easily accessible vegetable growing belts and cropping pattern change. Also, it shows evidence of strict grading driving farmers to exit and retained suppliers of ABM CC are more likely to grow more horticulture crops

Key words: supermarkets, disintermediation, supply relationship, High value commodity

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Introduction

Supply relationship between an agro-processing or supermarket led supply chain and farmer has attracted considerable academic interest. In the recent times, has remained one of the contested subjects within the context of FDI in multi-brand retail and agricultural policy to promote rural development and poverty alleviation in India. Empirical narratives on contractual schemes argue that it has potential to resolve some of the market imperfections in credit, extension services, input market, price insurance, and provide new technology and reliable output market to rural resource poor farmers (Minot, 1986; 2008; da Silva, 2005; Eaton and Shepherd, 2005). Also, it is articulated in the literature that small farmers can be integrated into the dynamic contractual schemes, as they can draw upon their self-supervising cheap family labour, required for the production of labour intensive and perishable high value commodities (Key and Runsten, 1999).

While recognising the benefits, so far, literature has probed whether small farmers are subjected to exclusion or the 'social performance' of contractual schemes (Warning and Key, 2002) and how small farmers can be incorporated into a supply relationship. There is no denial of the fact that farmer's participation in general and small farmers in particular is important, nevertheless inadequate, when there is widespread collapse of contractual arrangements. Barrette et al. (2012) points out the difficulty of sustaining supply relationship in the face of risky export market, weak enforcement mechanism and intense competition from both foreign and domestic firms. Accordingly, farmers drop out voluntarily or involuntarily, so do expansion and contraction of procurement regions. From public policy perspective, it is critical to understand the dynamic effects of supply relationship between firms and farmers to support sustained participation of farmers in general and small farmers in particular to obtain maximum benefits.

Recent policy measures have been conducive for supermarkets to invest in private markets in India. One such policy measures was Model Agriculture Produce Market Committee (APMC) Act 2003; a legal framework facilitates supermarkets to have direct transactions with farmers outside the ambit of regulated APMC market. Following the amendment to APMC, recently Foreign Direct Investment (FDI) in multi-brand retailing was liberalized in September, 2012 to augment investment in back end infrastructure facilities, such as cold storage, logistics and processing industries. Also, it was envisioned that the improvements in back end infrastructure would bring about stable food prices for the consumers (even producers are consumers) in the long run. FDI norms have a mandatory rule that foreign

players should procure 30% of their produce from the domestic market; thus, supply relationship between farmers and supermarkets are expected to amplify.

Several existing research has documented *supermarket revolution*, transformed procurement system, drivers of participation and welfare effects of farmer's participation in the supermarket retail chain in both developed and developing countries. Empirical evidence on income effects have found that participants experience higher and stable incomes on average (Hernandez et al, 2007; Michelson, 2012; Bellemare, 2012; Miyata et al., 2009; Maertens and Swinnen, 2009) and heterogeneity in income gains both within and across schemes (Narayanan, 2014). Still, it is a most pressing question to study whether suppliers to supermarket do better than the non-suppliers, in the context of widespread farmer exiting and failure of schemes in developing countries (Narayanan, 2014; Michelson, 2012). Likewise, this study has also identified discontinued suppliers in the field area, out which 40% and 26% of the farmers, reported that high rates of rejection and loss in income were the reasons for them to exit the ABM CC chain. Comparing just the suppliers and non-suppliers without including the discontinued suppliers might not result in true expected gains to participants.

Against this back drop, this study intents to analyse welfare gains to suppliers of ABM CC using survey data on 543 farmers from Pune district, Maharashtra, India. Some of the specific questions are what is the average treatment effect (ATE) for the suppliers relative to non-suppliers? Does the ATE change after controlling for the experiences of the discontinued suppliers, if so in which direction?

The empirical assessment of the welfare gains to suppliers from the direct comparison of welfare measure, would be biased if the unobserved factors driving participation is not controlled. For instance, increased welfare gains, possibly because of omitted variables like entrepreneurial ability, might be wrongly attributed to participation. If the underlying factors of selection of participation is transparent and observable, then propensity score matching is one of the common approaches (Dehejia and Wahba, 2002; Angrist and Pischke, 2009). However, if there is self-selection into contractual relationship, then, some of the drivers might be unobservable such as entrepreneurial ability and risk preferences. Hence, the identification of causal impact is a challenge and is hugely dependent on the choice of the instrument, which should be correlated with participation but not with the outcome variable.

Bellemare, (2012) discuss how some of the instruments used in the literature might potentially be endogenous to outcome variable.

To overcome the bias due to unobserved factors, an instrumental variable was constructed by capturing the difference in perceived prices across ABM CC and traditional market. And also another instrument was constructed by obtaining the perception on percentage of produce that is expected to get rejected at the CC gate. Since, there exists diversity in crops that is being supplied to ABM CC across farmers, a common crop was identified. Tomato crop is very popular in the study area and it was grown by most of the farmers in 2010-11, if not, it was replaced by cabbage or cauliflower. The respondents were asked the following question

What do you think (now) the price, ABM CC would have offered for tomatoes/cabbage/cauliflower/bottle gourd of grade A per crate, if you were to sell to ABM CC? What is the minimum, maximum and modal value?

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What do you think (now) the percentage of rejection would have been for your produce, if you were to sell to ABM CC?

Since the number of high value crops and present and pre-participation (2005) area under horticulture crops grown by farmers reveal that there is significant difference by supplier status. Hence, operational area would capture the cropping pattern change; however it would create a potential endogeneity issue. In other words, acreage or the number of horticulture crops for cultivation and the decision to supply to ABM CC is simultaneous decided. Limited capacity of ABM CC makes it to procure diverse HVC in few quantities only. Hence, instead of constructing a composite index to capture cropping pattern change; just the area under horticulture crop was used as one of the dependent variables. Simultaneous equations model framework was followed and three stage least square models were built.

The organization of the paper is such that the next section deals with description of field area and ABM procurement practices. The third section deals with empirical framework, metric used and the identification strategy. This is followed by results and discussion and the final section concludes.

Empirical context

Junnar and Ambegaon blocks of Pune district, Maharashtra, India were selected for the study, where some supermarkets have active presence through their collection centres (CC). It functions as an outlet for suppliers to sell vegetables. Historically, these two blocks are horticulture zone, endowed with relatively fertile and irrigated land holdings. Sources of irrigation in this area are diverse; such as network of publicly provided canals, small rivers, open wells and tube wells are available. They also have well connected road networks, linking major urban markets such as Mumbai, Thane, Pune and Nashik. These features make it highly attractive for the supermarkets to invest. The field area is also served by two traditional markets Manchaar and Othur, one in each block and a regional market, Pune.

Crops grown in this region include all vegetables and greens. Seasonal fruits such as mangoes, grapes, custard apple and pomegranate are also grown widely. Even cultivation of cash crops like sugarcane is widely prevalent. Wheat and Pearl millet is grown for consumption. Junnar block is also well known for tomato production during the monsoon months, June to September and supplies more than 60% of tomatoes to all parts of the country during this season. Interviews with the farmer and traders reveal that area under exotic vegetables like baby corn; sweet corn, lettuce, and red cabbage have increased in the last five years after the entry of some supermarkets. The field area has multiple marketing channels, comprising of farm gate traders, commission agents, transportation service providers, CC's of supermarkets and *dedicated traders*. Where, *dedicated traders* have only supermarkets as their clienteles.

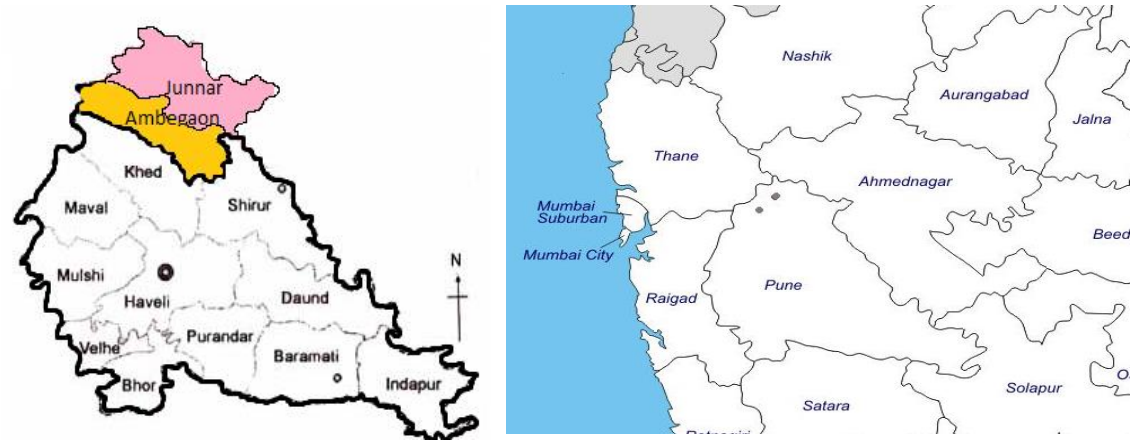

Figure 1: Map of Pune district and Maharashtra

There is no cold storage available for vegetables and even farmers do not store vegetables. However, private exporting firms have cold storages for grapes.

At the same time, the major challenge facing farmers in these blocks are scarcity of labour for agricultural work. Since, agriculture labourers have secured employment opportunities in neighbouring industrial clusters and in booming informal hospitality service sector, due to nearby tourist spots. This has resulted in more dependency on weedicides and soaring up of agricultural wages pushing the cost of cultivation upwards.

ABM CC supply chain and contracts

Two methods of sourcing strategies were observed in the study area; supermarkets such as *Aditya Birla More, Spencers* and *Reliance Fresh* procure directly from the farmers through their CC, while *Bharti-Walmart, Food bazaar, Godrej Adhaar* and *Metro* procure through *dedicated traders*. ABM collection centre was established in 2006. ABM CC is proximate to the highway between Pune and Nashik, hence easily accessible by farmers. ABM procures all type of vegetables and seasonal fruits grown in the region through its verbal contract with the farmers. Its daily indent is around 12 to 15 tons for all commodities and procures only portion of farmer's harvest, which is of only premier quality. However, the daily demand for certain commodities such as cauliflower, cabbage, bottle gourd, eggplant and tomato are slightly over a ton, relatively higher compared to other commodities. The supermarket manager is informed about the requirement a day before; accordingly the manager communicates the same to the farmers over the phone the same night. Hence, possession of cell phone is a necessary factor for participation.

ABM benchmarks its price 30% less against the regional market Pune, since it is a big market and happens to be representative of the available supply in the region. ABM follows product specific quality standards, defined on colour, size, freshness and volume. For instance, cauliflower and cabbage weighing more than 450 grams and crooked vegetables are weeded out at the time of procurement. Recently, ABM has started building a preferred list of 200 farmers primarily because of the quality issue; similar to what was observed in other developed and developing countries such as Thailand and Malaysia (Shepherd, 2005). It is also to reduce leakages at the ground level, by transferring payments directly to suppliers, instead of weekly cheques. Cultivation methods for ABM CC and spot markets are not very

different; farmers sell proportion of their produce which is of good quality to ABM CC and the rest to alterative markets.

It appears that operations of supermarkets and other organised retailers have created new opportunities for the farmers. A farmer who is supplying to ABM CC from its inception stated that "little packaging cost, absence of participation fee, electronic weighing machines and often, very low transportation cost are some of the attractive features of ABM supply chain, however, initial rejection rates were hurting us, but, eventually we learnt the requirements of CC, accordingly we sort and supply only premium quality produce, which saves our transaction cost". Several farmers said that they had increased the area allocation for horticulture crops and few others stated that they have increased the number of horticulture crops after the establishment of ABM CC. A supplier stated that "earlier I used to grow tomato and staples such as wheat and pearl millet, however, now I grow bottle gourd, sponge gourd, bitter gourd and tomato one after the other in my 2.5 acres of land. I sell the A grade quality to ABM CC and rest in the village daily market. I do not waste time growing staples anymore, when there is lucrative market for vegetables".

At the same time, discontinued farmers and non-suppliers were unhappy about the quality standards and rejection rates. Also, suppliers and ABM CC does not seem to have moral obligation towards each other. Instances of both farmers and ABM CC reneging on their oral agreement have been observed. Farmer side-sell their produce to alternative markets and ABM CC on many instances has rejected the produce of the farmers, if, its indent has been met for the day. One of the discontinued supplier said that "it was difficult to find a buyer for the rejected produce at the open market and increased our transportation cost, so I stopped supplying". Observing the experiences of the suppliers and discontinued suppliers, few non-suppliers stated that "CC would manhandle our produce and would make it a trash, so we would never supply to ABM CC or for that matter not to any other supermarket supply chain". These anecdotes shows that perception about risks associated with supplying to ABM CC would be key factor driving participation or exiting.

Numerous empirical evidences indicate that contractual relationship exposes farmers to high risk and uncertainty in some factors, while simultaneously reducing risks on other fronts and, also, coexistence of both risk reducing and aggravating elements (Narayanan, 2012). Some of the often cited issues faced by farmers were firms reneging on their commitment to buy back contracted quantities, rejecting produce based on arbitrary quality standards, stringent quality

standards when prices in open market crashes, poor quality of technical services and delay or deliberate default on payments (Echanove and Steffen, 2005; Glover, 1987; Mannon, 2005; Ramaswami et al., 2005).

Similar to other empirical studies, I found set of risks factors associated with the supply relationship between farmers and ABM CC. It was revealed that ABM CC, more often than not, used to contract more than the required quantity of produce to reduce the risk of farmer default and often had reneged on its commitment to buy back the produce increasing the transportation costs. Another major risk associated with the supply relationship is that of the quantity that is being rejected. On many instances, it is very little to be sold, so farmers dispose it off or use for their own consumption. However, on other occasions were the quantity is more, not a mix of all grades, but just low quality produce, finding a buyer in the open market becomes troublesome. Repeated instances of a farmer left with only low quality produce, brands the farmer as low productive farmer among the traders in the open market, hence, finding a buyer becomes very problematic. And the quality standards become incomprehensibly stringent when the open market prices crash. It was also observed that when a particular commodity is contracted more than required and if it happens to have a very thin local market, the required quantity is bought on the same day, however, the rest is retained at the ABM CC with the consent of the farmer without refrigeration, on the commitment that it would be bought for the next day. Nevertheless, the risk of reduction in the weight loss is passed on to the farmers. These observations reveal even though, contractual relationship between ABM CC and farmers bring reduction in transaction costs, creates new set of risks, triggering farmer exits.

Data

A total of 10 villages were chosen for the study, 8 villages from the supermarket data and 2 non participant villages, 5 from each block. The sample size is 543 out of which 198 are suppliers, 277 are non-suppliers and 68 are discontinued suppliers, considering cost and time constraint. We sampled participant farmers and discontinued suppliers from the supermarket data of total registered suppliers and supplier for the survey year, while non-suppliers were surveyed from the village census list collected from the village agriculture office. We conducted survey in two phases; in the first phase village level data was collected from the village panchayats and block level offices. And detailed household survey for the reference period 2010-11, using well tested questionnaire was collected in the second phase. The

questionnaire was first tested in the pilot survey one month prior to final survey. While surveying we made sure that we did not include current suppliers of the survey year 2011-12 and farmers supplying to other super market collection centre.

Descriptive statistics

Mean comparisons by supplier status for the variables included in the regression analysis and t-test of difference in means for each variable has been presented in table 1. The average net crop income per annum of supplier households are significantly higher than both the discontinued and non-suppliers. The average participant household size in the data is 6 individuals, out of which two thirds are adult which is significantly higher than either non-suppliers or discontinued suppliers and the rest are dependents. Nearly, 11% of the participant belongs to SC/ST social group significantly different from discontinued suppliers. The average participant household head is 46 years old and has completed an average of 9 years of education and had accumulated 29 years of farming experience. The average participant household head tend to have significantly higher years of schooling and lower years of farming experience than non-suppliers, but cannot reject the equivalence of means for suppliers and discontinued suppliers. About 11% of the supplier household head is a member of one or more voluntary organization other than contracting which is significantly higher than non-suppliers. The percentage of suppliers growing exotic crops are significantly lower than compared to non-suppliers, however, cannot reject the equivalence of means for suppliers and discontinued suppliers.

Surprisingly, in terms of pre-participation wealth, suppliers have lower ranking in the household asset index than non-suppliers or discontinued suppliers, but cannot reject the equivalence of means. Nevertheless, farm asset index ranking was significantly higher and access to drip irrigation was significantly lower than non-suppliers, but cannot reject the equivalence of means for suppliers and discontinued suppliers. As far as pre-participation landholdings are concerned, the average participant household had 5.63 acres, significantly higher than non-suppliers, but cannot reject the equivalence of means for suppliers and discontinued suppliers, but these groups had significantly higher 2007 landholding than non-suppliers.

Table 1: Descriptive statistics by supplier status

Dependent variable	Participants (n=198)		Non-Participants (n=277)		Discontinued farmers (n=68)	
	Mean	Std deviation	Mean	Std deviation	Mean	Std deviation
Net annual income per acre (000'rupees)	125.69*#	95.86	64.67	61.63	84.63	7.06
Landholdings 2006 (acres)	5.63*	5.55	4.18	3.75	5.20	4.49
Age of the head of the household (years)	46.55	9.54	46.9	9.74	45	9.46
Household size	6.14*#	3.32	5.56	2.52	5.44	1.84
Number of adult members	4.1*#	2.04	3.75	1.34	3.71	1.32
Number of dependents	2.04	2.16	1.82	1.97	1.91	1.75
Household belonging to SC/ST (D)	0.11#	N.A	0.07	N.A	0.00	N.A
Farming experience (years)	29.46*	12.61	33.39	11.12	29.24	12.68
Education of the household head (years)	9.32*	3.52	7.98	3.79	8.78	3.14
Member of a voluntary organisation (D)	0.11*	N.A	0.04	N.A	0.09	N.A
Grow exotic vegetables (D)	0.29*	N.A	0.36	N.A	0.31	N.A
Household asset index (2006)	-0.03	1.66	0.07	1.72	0.01	1.66
Farm asset index (2006)	0.29*	1.36	-0.24	1.2	0.16	0.84
Relationship with a trader (years)	22.2*	8.97	25.07	8.71	23.62	9.36
Drip irrigation 2006 (D)	0.16*	N.A	0.21	N.A	0.12	N.A
Mean well depth (meters)	47.75*#	5.62	56.79	16.59	45.75	6.15
Distance to highway (Kilo metres)	4.75*#	5.72	9.44	8.46	3.07	4.31
Distance to market (Kilo metres)	13.02*#	4.25	11.55	5.99	11.53	4.49
Distance to Supermarket CC (Kilo metres)	9.91*#	4.31	16.54	11.53	8.45	4.59
Non-farm employment (D)	0.09	N.A	0.08	N.A	0.1	N.A
Possess cell phone (D)	0.8*	N.A	0.6	N.A	0.78	N.A
Perception of price difference between CC and traditional market	3.09*#	3.32	-1.48	2.59	-0.05	3.11
Perception of percentage of Produce rejected (%)	9.47*#	5.24	11.68	3.88	12.76	6.73

Participants statistically significantly different at least the 10% level from: *Non-participants #Discontinued suppliers

All the spatial characteristics related to accessibility and potential for steady crop production, supplier communities differ significantly from non-suppliers and discontinued suppliers. One interesting fact is that the supplier communities were significantly farther from the traditional market than both non-suppliers and discontinued suppliers.

Other geographical characteristics such as mean well depth, distance to ABM supermarket CC and distance to highway were significantly lower than non-suppliers but higher than discontinued suppliers. Majority of suppliers, 80% had access to cell phones in 2007, which

is significantly higher than non-suppliers and discontinued suppliers. On average suppliers have perceived to obtain significantly higher income gains and prices by supplying to ABM CC than compared to non-suppliers and discontinued suppliers, if they were to supply to ABM CC. Finally, suppliers had perceived 9.5% of the produce would be rejected on an average, which was significantly lower than both non-suppliers (11.68%) and discontinued suppliers (12.8%).

Table 2: Total number of crops grown and supplied to CC

Crops sold to CC	n	Mean total crops grown	Mean total vegetable crops grown
Supplied one crop in 2010-11	167	3.892216	2.928144
Supplied two crops in 2010-11	54	4.12963	3.074074
Supplied three crops in 2010-11	23	4.956522	3.695652
Supplied four crops in 2010-11	12	6.083333	4.583333
Discontinued farmers	68	4.4	3.0
Non participant	277	4.0	2.6

The table 2 presents the total number of crops and vegetable crop grown by farmers by their participation status. There is systematic difference in cropping pattern between the farmers by their contracting status.

Table 3: Cropping pattern change

Table 3 presents past and present acreage decision for suppliers and discontinued suppliers.

Cropping pattern change	Participants		Discontinued supplier	
	Mean	standard deviation	Mean	standard deviation
Average proportion of area under horticulture crop 2011	3.8***	3.5	3.6***	3.0
Average proportion of area under horticulture crop 2005	2.5	2.2	2.3	2.0
Percentage of farmers increased land allocation to horticulture crops post CC	59.6		38	
Average proportion of area under horticulture crop among those who allocated more land (2011)	4.9***	4.1	4.7***	3.6
Average proportion of area under horticulture crop among those who allocated more land (2005)	2.8	2.5	2.3	1.8

Statistically significantly different at 1% level from

The average proportion of area under horticulture crop 2005 for supplier was 2.5 acres and it increased to 3.8 acres in 2011, similarly the figures for discontinued suppliers were 2.3 and 3.6 acres respectively. Nearly 60% of the suppliers stated that they had increased land allocation to horticulture crops after supplying to ABM CC. Among the suppliers, who responded positively to cropping pattern change had increased their average proportion of area under horticulture crop from 2.8 acres in 2007 to 4.9 acres in 2011; similarly the figures for discontinued suppliers were 2.3 and 4.7 acres respectively. The difference between the two years for both suppliers and discontinued suppliers are statistically significant at 1% level of significance.

Estimation Framework

$$y_i = \alpha_1 + \alpha_2 HVC_i + \alpha_3 P_i + \alpha_4 X_i + \alpha_5 C_i + \varepsilon_i \qquad (1)$$

The objective of this paper is to estimate α_3 of equation 1, which represents the effect of participation in AMB CC on household welfare. Also, α_3 is otherwise known as average treatment effect of participation in ABM supermarket supply chain, given as

$$ATE = E(y_1 - y_0)$$

Where $y_1$is the household welfare if a household supplies to ABM CC and y_0 is the household welfare if the same household does not supply to ABM CC. However, one cannot observe the y_0 for a participant household and y_1 for non-suppliers. Since, supply chain participation is not random, driven by unobservable factors, implying, the direct estimation of equation 1 would lead to a biased estimate of ATE. In order to correct for the endogeneity issue and also to identify causal impact of participation in supermarket supply chain on household welfare, this paper uses a set of instrumental variables correlated with participation in supermarket supply but not with the outcome variable.

Often, participation reduces exposure to risk and could induce farmers to grow more crops or increase the area allocated to contract crops (Bellemare et al., 2011). In the study area, nearly 60% of farmers said that they had increased the area allocation for horticulture crops and few others stated that they have increased the number of horticulture crops after the establishment of ABM CC. To capture this effect, area under horticulture crops were employed, nevertheless, it is endogenous. Several factors which are expected to influence cropping pattern but not participation were introduced. For instance, cost factors such as seed cost, pesticide cost, labour cost and fertilizer costs were included along with length of the growing

period of crops. These variables affect participation only through cropping pattern but not otherwise. Interviews with farmers suggest that cost of cultivation is same for both ABM CC and traditional market. Since ABM CC procures only *A* grade produce, the rest is any ways sold in traditional market. The length of growing period of crops was averaged across crops a supplier grew, lesser the length of growing period, more the cultivation of horticulture crops. Instead of land holdings owned, operational landholdings were incorporated to capture the decision of renting in land for cultivation.

The sample has selection bias, the common approach is to use Heckman selection's model, which controls for selection bias. In the present context, since acreage decision, participation decision and impact on income is simultaneously determined, I employ three stage least square methodology to model cropping pattern change, selection into supply chain and impact on income in simultaneous equations model framework. Rank and order conditions were verified on the set of equations before modelling.

Model specification

$$HVC_i = \alpha_1 + \alpha_2 P_i + \boldsymbol{\alpha_3} \boldsymbol{X_i} + \boldsymbol{\alpha_4} \boldsymbol{C_i} + \varepsilon_{1i} \quad (2)$$

$$P_i = \beta_1 + \beta_2 HVC_i + \boldsymbol{\beta_3} \boldsymbol{X_i} + \boldsymbol{\beta_4} \boldsymbol{C_i} + \varepsilon_{2i} \quad (3)$$

$$Y_i = \gamma_1 + \gamma_2 P_i + \gamma_3 HVC_i + \boldsymbol{\gamma_4} \boldsymbol{X_i} + \boldsymbol{\gamma_5} \boldsymbol{C_i} + \varepsilon_{3i} \quad (4)$$

The following model describes the behaviour of the agent choice of number of crops, decision to sell to ABM CC and impact on income. Where HVC_i is the number of high value crop grown by a farmer, P_i is the indicator of participation variable and Y_i is the annual net income per acre and these are the three dependent variables. $\boldsymbol{X_i}$, $\boldsymbol{C_i}$, are vectors of exogenous variables of farmer characteristics and community characteristics respectively. $\boldsymbol{\alpha_3}$, $\boldsymbol{\alpha_4}$, $\boldsymbol{\beta_3}$, $\boldsymbol{\beta_4}$, $\boldsymbol{\gamma_4}$ and $\boldsymbol{\gamma_5}$ are vectors of parameters.

The above model describes the behaviour of the agent choice of area under horticulture crops, and decision to sell to ABM CC, where HVC_i is area under horticulture crops grown by a farmer and P_i is the indicator of participation variable and these are the two dependent variables. $\boldsymbol{X_i}$,$\boldsymbol{C_i}$, are vectors of exogenous variables of farmer characteristics and community characteristics respectively. $\boldsymbol{\alpha_3}$, $\boldsymbol{\alpha_4}$, $\boldsymbol{\beta_3}$ ad $\boldsymbol{\beta_4}$ are vectors of parameters.

These above mentioned equations form a simultaneous equation model (SEM) which can be expressed in the following generalized form;

$$B \times y + \Gamma \times x = \in$$

Here $\in$ is a vector of error terms which is assumed to be normally distributed as N (0,Ω) with the variance covariance matrix Ω given as

$$\begin{bmatrix} \sigma_{11} & \sigma_{12} & \sigma_{13} & \sigma_{14} \\ \sigma_{21} & \sigma_{22} & \sigma_{23} & \sigma_{24} \\ \sigma_{31} & \sigma_{32} & \sigma_{33} & \sigma_{34} \\ \sigma_{41} & \sigma_{42} & \sigma_{43} & \sigma_{44} \end{bmatrix}$$

y is a vector of endogenous variables, x is a vector of exogenous variables. As the matrix of coefficients of the model, B is triangular. Then we have utilized the estimated cropping patter equation in the three stage least squares (3SLS) technique to allow for cross-equation correlation between the error terms to obtain consistent and efficient estimates of the selection equation.

Variables

The welfare measure is net crop income per annum from all the crops including cash crops such as sugar cane and cereals such as wheat, millet and sorghum. Incomes from rent on own land, rental incomes from farm assets and cost of family labour were not accounted. However, savings on transaction cost such as transportation, packaging and marketing cost were accounted to obtain the net income. Farmers were asked about the delivered quantity and prices market wise. There is no difference in production technology across the two channels for a supplier, so the cost of production remains same for both channels. All farmers grade their produce according to the quality and suppliers retain the premier quality for the ABM CC and the rest are sold to the traditional market.

Given the empirical context, restricting to net returns per acre from the crop supplied to ABM CC is not possible, because of the existence of diversity in the crop that is being supplied. For instance, farmer A would have supplied a crop say tomato, while, farmer B would have supplied a crop say grapes or water melon. And also supply relationship with ABM CC affects the household decision on acreage as well as the crop portfolio. These factors makes infeasible to just compare the net returns from the supplied crop to ABM CC. Data on all

crops were collected for each season and was aggregated over the season to obtain the annual net crop income per annum.

Given the context of the study, if a farmer had supplied once to the ABM CC is considered to be participant farmer, irrespective of the quantity supplied. Like other empirical studies on modern supply chain, there is clear distinction between treatment (supplying to modern supply chains) and counterfactual group (supply the same produce but to traditional channel). Use of the produce is also the same. Since the capacity of the ABM CC is limited to 2 tons per day, which is miniscule, compared to the transaction at the traditional market. Hence the possible effect of the presence of ABM CC operation on traditional market is almost negligible.

There are cases of farmers selling their entire harvest of a single or multiple crops and also cases of suppliers selling a portion of single or multiple crops. As mentioned earlier, the capacity of the ABM CC is limited, so participant farmers supply both to ABM CC and alternative traditional market simultaneously. Therefore a supplier farmer is one who supplied at least once to ABM CC irrespective of the quantity and number of crops. A non-supplier farmer is one who supply to spot market or farm gate trader.

The non-random spatial selection of the procurement region might bias the welfare estimate. Literature on spatial selection and interviews with the supermarket manager reveal that the selection on procurement region is based on the observable characteristics such as year round growing potential, water supply for irrigation, transportation and communication facility. A community having potential to produce and supply horticulture crops year-round, are more likely to be included in supermarket procurement basin. The variables capturing agro-climatic factors necessary for year round cultivation includes the altitude, depth of ground water and higher access to water for irrigation all-round the year (Michelson, 2012). In addition, infrastructural factors such as access to all weather roads, regulated markets and communication facilities matter a great deal for better coordination to maintain a flexible relationship and to reduce transaction costs to both the parties. Since the procurement shed is located near the national highway, ABM CC prefers villages proximate to highway than farther villages captured by distance of village from highway. In addition to spatial selection on procurement region, with in region selection of villages and placement of collection centre is captured by using the number of procurement villages in the block where the respondent is located (Narayanan, 2013).

Given the cost associated to adhere to stringent quality standards, access to irrigation facility all throughout the year, possession of cell phone required by CC for coordination and delay in payments makes us believe that pre participation (2005) wealth would positively influence participation (Michelson, 2012; Hernandez et al., 2007). Pre-participation (2005) landholdings could positively or negatively affect participation. Since the volume requirements of CC is very little on a daily basis, gives credible opportunity for both small and large farmers to participate. Pre-participation (2005) household and farm assets and access to drip irrigation are expected to positively affect participation.

Variables to account for labour availability at the household level, household size was employed. Since it is a vegetable growing belt and farmers depend on traders for marketing the produce, hence, expect the relationship with trader to negatively influence participation. And also, the volume requirements of CC are low and to market the rest of the produce in traditional markets, farmers depend on traders.

Other demographic variables age of the head of the household and education of the head were employed, it was expected that education of the household head to positively affect participation. Membership in voluntary organization is anticipated to positively influence participation and similarly is the production of exotic vegetables.

Identification strategy

As mentioned earlier, farmer's participation in supermarket supply chain is driven by unobserved factors, which would bias the estimated average treatment effect if not accounted for. For instance, risk preference, entrepreneurial ability or attitude towards price fluctuations are few examples of omitted variables, when not accounted would bias the average treatment effect.

To overcome the bias due to unobserved factors, an instrumental variable was constructed by capturing the difference in perceived prices across ABM CC and traditional market. There has been increased articulation of how perceived risks and not the actual risks shape economic behaviour (Narayanan, 2012; Delavande et al., 2011; De Weeedt, 2005; Manski, 2004). Doss et al., (2008) argue that subjective risk perceptions depend not just on objective risks but also on other multiple sources of risks facing individuals. Further, expressed perception of risks incorporates individual's expectations of exposure to risk as well as their ability to mitigate (ex-ante) or cope (ex-post) if the adverse events were to occur. Recently, a

number of studies have employed different metrics of risk perceptions and subjective expectations to examine economic decisions in the context of agriculture (Narayanan, 2012; Doss et al., 2008; Bellmare, 2011; Delavande et al., 2011; Smith et al., 2001).

Also, another variable was constructed by obtaining the perception on percentage of produce that is expected to get rejected at the CC gate. Since, there exists diversity in crops that is being supplied to ABM CC across farmers, a common crop was identified. Tomato crop is very popular in the study area and it is grown by most of the farmers, if not, it was replaced by cabbage or cauliflower. The respondents were asked the following question

What do you think (now) the price, ABM CC would have offered for tomatoes/cabbage/cauliflower/bottle gourd of grade A per crate? What is the minimum, maximum and modal value?

What do you think (now) the price, mandi would have offered for tomatoes/cabbage/cauliflower/bottle gourd of grade A per crate? What is the minimum, maximum and modal value?

What do you think (now) the percentage of rejection would have been for your produce with your own efforts if you were to sell to CC?

The instrumental variable used in this study is the difference of perceived prices across ABM CC and traditional market. Another variable used is the perceived rates of rejection. These variables control for much of the unobserved heterogeneity between respondents because it reflects the expected direct benefits to farmers from supplying to ABM CC. A risk averse farmers may perceive higher prices in the ABM CC supply chain where the transaction cost is low, is different from an otherwise identical risk neutral respondent who does not mind to bear risk. This difference in risk preference is captured by the different price perception between individuals. Similarly, a respondent with high level of farming experience, ability and has economic means to adhere to a given level of quality standards, may perceive low rates of rejection from an otherwise identical but low level of farming and ability respondent. In other words, these instrumental variables capture the different perceived benefits due to unobserved characteristics for otherwise observationally identical respondents (Bellemare, 2012).

On the other hand, these variables could be faulted for potential endogeneity, that the actual participation in ABM supply chain could affect the perception when analysing the impact of supply relationship on income because they have a thorough knowledge of the institution. However, even the non-suppliers have full information regarding the procurement operations of ABM CC by virtue of living in the same neighbourhood or hamlets as the suppliers. Further, non-suppliers hamlets did have information regarding the operations of ABM CC but the distance factor discouraged them to supply to ABM CC.

This paper is not focused on the determinants of participation per se, however, on the welfare impacts of the supply relationship. Two 3SLS models were run, in the first model suppliers and non-suppliers were compared, while in the second model the comparison was between the supplier and the non-suppliers (including discontinued suppliers). Similar procedure was repeated for OLS model.

Results and discussions

In this section, a nonparametric approach is employed to map the distribution of annual net crop income per annum for suppliers, non-suppliers and discontinued farmers. Figure 2 displays the kernel density estimates of annual net income per acre by participation status. The figure suggests that the unconditional distribution of the welfare metric is different between the participation regimes.

Results from the Kolmogorov-Smirnov tests for comparing the distributions in table 4 shows that the distributions of annual net income are statistically significantly different across the different participant regimes.

Figure 2: Distribution of annual net income per acre for suppliers and non-suppliers.

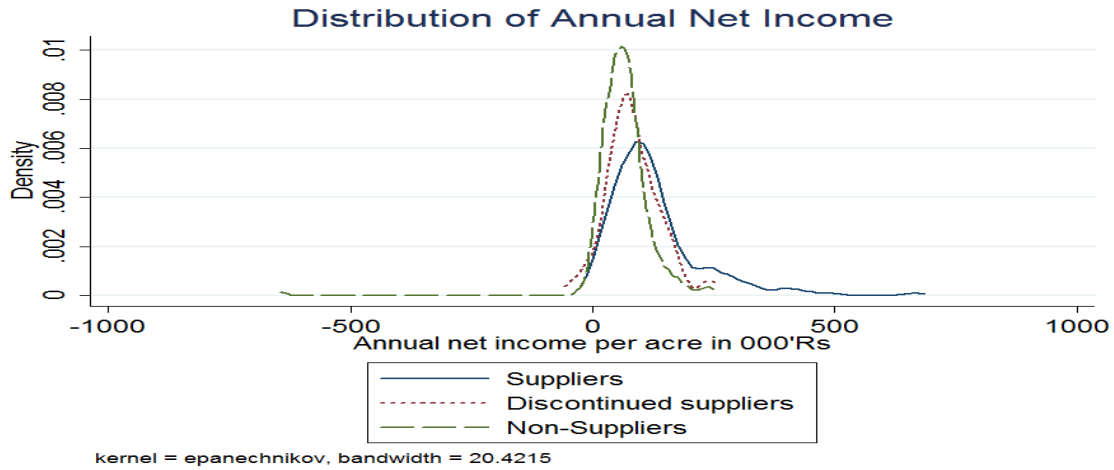

Table 4: Two-sample Kolmogorov-Smirnov test for equality of net income distribution functions

Participation status	D	p-value
Suppliers versus Discontinued Suppliers	0.238	0.006***
Supplier versus Non-suppliers	0.389	0.000***

Significance levels: *: 10% **: 5% ***: 1%

In model 1, the supplier status includes only the current supplies and non-suppliers, displays the estimation results of 3SLS regression of household crop income per annum after modelling the cropping pattern change and participation in ABM CC supply chain. In model 2, the supplier status includes current suppliers, discontinued suppliers and non-suppliers, where discontinued suppliers are grouped along with non-suppliers, presents the estimation results of 3SLS regression of household crop income per annum.

The results of 3SLS model 1 for participation in ABM CC supply chain shows that farmers growing more horticulture crops having positive perception about income increase, prices and farmers perceiving low rates of rejection are more likely to participate. Communities with characteristics such as low underground water table, proximity to highway, farther from traditional markets and access to canal irrigation are more likely to be ABM CC supplier villages. Moreover in model 2, I found that farmers perceiving low rejection rates, lower years of relationship with trader/commission agent and if a block has more suppliers villages in which the participant resides are more likely to get retained in ABM CC supply chain.

The results of 3SLS estimation approach yields nearly similar results for cropping pattern change and participation in ABM CC supply chain in models 1 and 2. The only significant difference is that the participation in ABM supply chain positively affects cropping pattern change in model 2. In other words, retained suppliers of ABM CC are more likely to grow more horticulture crops. This effect would have been unnoticed if we had considered only suppliers and non-suppliers and not the experiences of discontinued suppliers.

The results of 3SLS estimation approach for participation in ABMCC supply chain in model 1 shows that farmers growing more horticulture crops and having positive perception about

income and price increase, and also, farmers perceiving low rates of rejection are more likely to participate. Communities with characteristics such as low underground water table, proximity to highway, farther from traditional markets and access to canal irrigation are more likely to become ABM CC supplier villages. This finding is consistent with evidences from other developing countries, where some communities with relative comparative advantage get included, while others tend to get excluded from supermarket procurement basin (Barrett et al., 2011; Michelson, 2012; Narayanan, 2013). Moreover in model 2, I found that farmers perceiving low rejection rates, lower years of relationship with trader /commission agent and if a block has more suppliers villages in which the participant resides are more likely to get retained in ABM CC supply chain.

Finally, the results of 3SLS regression of the impact of participation on household annual income show that supplying to ABM CC positively significantly influence income. Moreover, considering only the suppliers and non-suppliers, I find the ATE is nearly 23838 rupees per annum, however if the experiences of the discontinued suppliers are accounted for, then the ATE increases to nearly 33746 rupees per annum this result is consistent with the observation made by Barrett et al., (2011) that higher the economic gains to parties involved in contracting, then more likely it is to observe a supply relationship between them. Further, this is consistent with the revealed preference theory suggesting that the farmers agree to supply or continue to supply, if they expect, on an average, to gain out of the supply relationship. This is actually the gains to current suppliers, who had had the opportunity to stay in the chain to reap the benefits in terms of higher prices and incomes. As the farmers exit, the limited capacity of the ABM CC gives credible opportunity for the rest of the farmers in the supply chain to continuously supply and experience high income through both higher prices and low transaction cost (Suganthi, 2013). Out of the farmers who quit, 43% and 18% reported that high rates of rejection and poor income were the reasons for them to exit the ABM CC supply chain. This evidence shows that there exists heterogeneity in farmer experiences, which is of interest from a public policy perspective, implying some suppliers might be better off opting out, while other suppliers might fare better by continuing in the supply chain.

Table 4.6: Results of Simultaneous equation model with HVC, Participation in supply chain and Annual net income as the dependent variables

Proportion of area under horticulture crops	**Model 1: 3SLS**		**Model 2: 3SLS**	
	Coefficient	Standard error	Coefficient	Standard error
Suppliers (D)	0.025	0.038	0.088***	0.031
Operational landholdings (acres)	-0.006*	0.003	-0.005*	0.003
Age of the head of the household (years)	0.001	0.001	0.001	0.001
Household size	-0.005	0.004	-0.005	0.004
Social group	0.104**	0.044	0.104**	0.044
Farm asset index (2006)	0.006	0.008	0.002	0.008
Household asset index (2006)	-0.002	0.006	-0.001	0.005
Education of household head secondary (D)	-0.009	0.021	-0.013	0.020
Drip irrigation in 2006 (D)	-0.053	0.036	-0.051	0.034
Average length of growing period of vegetable crops	-0.001**	0.000	0.000*	0.000
Seed cost (Log)	0.059***	0.013	0.055***	0.013
Labour cost (Log)	0.047***	0.010	0.055***	0.010
Pesticide cost(Log)	0.03***	0.010	0.02***	0.012
Fertilizer cost(Log)	-0.069***	0.019	-0.097***	0.019
Distance to market (Kilo metres)	-0.058***	0.020	-0.069***	0.019

Distance to Supermarket CC (Kilo metres)	0.017	0.012	0.027**	0.011
Access to canal irrigation in 2006 (D)	-0.007	0.026	-0.009	0.023
Intercept	0.602***	0.141	0.785***	0.134
R-squared	0.329		0.308	
Chi square	232.52		242.950	

Suppliers (D)				
Proportion of area under horticulture crops	0.646***	0.181	0.638***	0.176
Landholdings in 2006 (acres)	0.001	0.005	0.000	0.005
Age of the head of the household (years)	-0.001	0.002	0.000	0.002
Household size	0.008	0.007	0.013**	0.007
Social group	-0.079	0.081	-0.016	0.083
Farm asset index (2006)	0.016	0.014	0.019	0.014
Household asset index (2006)	0.011	0.010	0.005	0.010
Education of household head secondary (D)	0.006	0.037	0.027	0.036
Member of a voluntary organization (D)	0.070	0.072	0.055	0.070
Drip irrigation in 2006 (D)	0.002	0.063	0.011	0.062
Perception about income increase	0.129***	0.051	0.043	0.049
Price difference between CC and mandi	0.056***	0.006	0.058***	0.006
Percentage of Produce rejected (%)	-0.011**	0.004	-0.013***	0.003
Possession of cell phone in 2006 (D)	0.076	0.036	0.044	0.035

Number of supplier villages in the block	0.004	0.005	0.009**	0.005
Relationship with a trader (years)	-0.058	0.043	-0.084**	0.041
Mean well depth (Log meters)	-0.186**	0.116	-0.160	0.117
Distance to market (Log kilo metres)	0.118***	0.042	0.108**	0.042
Distance to Supermarket CC (Log kilo metres)	-0.043	0.035	-0.003	0.034
Distance to Highway (Log kilo metres)	-0.034**	0.016	-0.041***	0.016
Access to canal irrigation in 2006 (D)	0.111***	0.044	0.066*	0.042
Intercept	0.230	0.334	-0.099	0.329
R-squared	0.487		0.413	
Chi square	454.20		392.180	

Annual net income (Rs)				
Suppliers (D)	23.838***	14.132	33.746***	10.943
Proportion of area under horticulture crops	34.429	37.263	17.178	21.204
Age of the head of the household (years)	0.620	0.388	0.616	0.352
Landholding in 2006 (acres)	2.45***	0.739	1.741**	0.879
Household size	0.193	1.398	0.094	1.303
Farm asset index (2006)	-0.123	2.927	0.543	2.767
Household asset index (2006)	1.829	2.120	1.345	1.931
Education of household head secondary (D)	12.089*	7.712	10.579	6.979
Drip irrigation in 2006 (D)	1.860	13.142	-10.446	11.999

Member of a voluntary organization (D)	52.526***	15.154	43.674***	13.851
Mean well depth (Log meters)	6.715	21.075	2.712	20.180
Distance to Supermarket CC (Log kilo metres)	4.906	5.715	5.268	5.366
Distance to Highway (Log kilo metres)	-8.142**	3.150	-5.216*	2.886
Distance to market (Log kilo metres)	10.197	8.177	5.312	7.848
Possession of cell phone in 2006 (D)	4.531	7.737	8.526	7.228
Access to canal irrigation in 2006 (D)	19.424***	7.419	24.704***	8.408
Discontinued suppliers (D)			14.647*	10.424
Intercept	-44.016	66.603	-13.013	63.170
R-squared	0.1863		0.182	
Chi square	93.97		127.200	

Significance levels: *: 10% **: 5% ***: 1%

Clearly, results show that participation in ABM supply chain has significant impact on welfare, that it significantly increases household annual crop income and also retained supplies are more likely to cultivate more horticulture crops, but not the initial included farmers. Farmers in villages proximate to highway, pre-participation (2005) access to canal irrigation, membership to voluntary organisation, having more landholding and older household heads are more likely to have higher incomes.

Conclusion

The study shows that supply relationship yields positive income effects to participant farmers on average. Comparing just the suppliers and non-suppliers without including the experiences of discontinued suppliers, 1% increase in the likelihood of participation in ABM CC chain entails a 23% increase in household annual income. However, when the experiences of the discontinued suppliers are accounted, 1% increase in the likelihood of participation in ABM CC chain entails a 33% increase in household annual income. This is actually the gains to current suppliers, who had had the opportunity to stay in the chain to reap the benefits in terms of higher incomes. As the farmers exit, the limited capacity of the ABM CC gives credible opportunity for the rest of the farmers in the supply chain to continuously supply and experience high income through both higher prices and low transaction cost. This evidence shows that there exists heterogeneity in farmer experiences, which is of interest from a public policy perspective, implying some suppliers might be better off opting out, while some non-suppliers might fare better by continuing in the supply chain.

The study also finds evidence of spatial selection of procurement region and within region selection of easily accessible vegetable growing belts and strict grading driving farmers to exit. Retained suppliers of ABM CC are more likely to grow more horticulture crops. These findings have implication for scaling up and promoting contract farming to improve the incomes of rural poor.

Appendix

Table 1: Instrumental Variable (IV) Diagnostic Tests

Diagnostic Tests	Model (dependent variable)	
	Annual net crop income of current suppliers	Annual net crop income of retained adopters
	Statistic (p-value)	Statistic (p-value)
Endogeneity Test (Lagrange Multiplier Test)	36.78 (0.00)	35.66 (0.000)
Over identification Test (Hensen-Sargan statistic)	23.17 (0.219)	25.76 (0.264)

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