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EFFECT OF MARKETING CHANNEL CHOICE ON THE PROFITABILITY OF CITRUS FARMERS: EVIDENCE FORM PUNJAB-PAKISTAN

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Pakistan is the thirteenth largest producer and sixth largest exporter of citrus in the world. Citrus is also the most cultivated and exported among all other fruits in the country. The marketing of citrus in the country is totally in the hands of the private sector partially regulated by the government. Empirical assessment of the links between the participation in the marketing channels and farmers' profitability is characterized by conflicting results. The basic purpose of this paper was to measure the factors contributing to the profitability of citrus growers by taking participation in the marketing channels as the treatment variable. A cross-sectional data of 300 citrus growers were used for this purpose. Multinomial treatment effects model was used to empirically investigate the study objectives. By looking at the dynamics of farmers' profitability by controlling several production and household characteristics, findings of the study showed farmers' profitability was positively affected by the participation in the modern marketing channels, i.e., run by the processors and contractors. These results conveyed two important messages for the policymakers: farmers selling to the modern marketing channels were better off, and the traditional marketing channels (with intermediaries) did not hamper the profitability of the farmers.
Keywords: Citrus growers, marketing channel, multinomial treatment effects.

INTRODUCTION

In the recent years, the importance of cereals and other staple food crops is decreasing in the developing countries relative to the High-Value Agricultural (HVA) products which have an increasing demand (Gogh and Aramyan, 2014). HVA commodities are referred to those commodities which have high economic returns, e.g., fruits, vegetables, milk, meat, eggs, and, fish, etc. The emergence of this agricultural revolution of producing HVA products have deeper effects on agri-food supply chains; providing opportunities for smallholders by participating in these supply chain integrations and the increasing the role of public-private investment activities in the sector. The growth of HVA commodities recommended the ominous need for strong linkages between all agri-food supply chain actors; from farmers to processors and all other intermediaries to the end users, i.e., consumers (Gulati *et al.*, 2007)

In developing countries, these structural changes in the agri-food supply chain; the growth of HVA commodities and the development of institutions for vertical integration present both opportunities and challenges for the smallholders. Opportunities for smallholders to increase their farm income by participating in the modern agri-food supply chains growing markets for HVA commodities and the challenges are in the form of high cost of production, and the risks associated in the production and marketing of these HVA commodities. To overcome the challenges, there is a need for strong vertical linkages between farmers and other stakeholders in the agri-food supply chains. But in most of the cases, smallholders are incapable of encountering the modern supply chain (MSC) demands and measures with respect to food quality and safety.

The limitations faced by the smallholders suggested the exclusion of smallholders from the modern agri-food supply chains from the profitable niche markets because of the fierce competition from different "Modern Supply Chains" to meet the global demand (Heijden and Vink, 2013; Rao and Qaim, 2011; Schuster and Maertens, 2013; Swamy and Dharani, 2016). Conversely, a number of researchers ((Barrett *et al.*, 2012; Minten *et al.*, 2009; Birthal *et al.*, 2017; Montalbano *et al.*, 2018) described the successful cases for smallholder's inclusion in the MSC with the help of innovative institutional roles such as contract farming.

A major proportion of the population in Pakistan like other developing countries are living in rural areas and highly dependent on agriculture to meet their livelihood needs. But due to the dominance of small farmers, i.e., more than 90 percent, they produce crops at subsistence level and in some cases at a commercial level to earn high profits (Naseer *et al.*, 2016). The agricultural marketing system of Pakistan is dominant with the traditional marketing system where commission agents (*Aarthi*) and other market intermediaries interact with growers ranging from the input suppliers to the end customers (Haq *et al.*, 2013).This traditional marketing system of agri-food products and the commercialization by smallholders have some negative impacts that resulted in the market reduction, and smallholders comprise with middlemen, small retailer, the street vendor, and wholesaler at rural level (Chen *et al.*, 2015a; Chen *et al.*, 2015b). However, the agri-food supply chain concept is a very significant approach in the recent world and also for Pakistan. Pakistan has a potential in the production of HVA commodities and for other agricultural commodities in the marketing of farmers' produce at higher returns.

There are a plethora of research studies which focused on the factors of farmers' inclusiveness and allied issues within the framework of existing supply chains; little research has been carried out regarding the participation effect on the productive efficiencies in the presence of all related variables. In Pakistan, the citrus supply chain studies are limited to the marketing margins, citrus supply chain constraints analysis, factors impeding the supply chain development, and post-harvest losses in citrus production (Iqbal *et al.*, 2018; Siddique *et al.*, 2018; Naseer *et al.*, 2019a). Therefore, in this study, an attempt will be made to fill the existing research gap to study the agri-food supply chain of citrus fruit with the farmer's perspective by using acomprehensive and inclusive survey approach, similar approach which was also narrated by Reardon *et al.* (2009). This study places particular emphasis on the farmers' participation in the citrus supply chain. Especially study will be aimed to analyze the determinants of farmers' participation in the agri-food supply chains, for their inclusiveness and efficiency.

This paper used a case study methodology by taking mandarin (Kinnow) from the citrus family in the HVA products in Pakistan. Pakistan is the 13th largest producer of citrus (FAO, 2018), and citrus is the leading fruit in term of production, i.e., 2.36 million tons is produced from an area of 206.6 thousand hectares (Memon, 2017; Naseer *et al.*, 2019b). There are several varieties of citrus fruit grown in Pakistan, and the most popular among these varieties are known as mandarin (Kinnow). In Pakistan, mandarin is produced about 90.6 percent of the total citrus growing area (GOP, 2018c), and application of modern techniques at all stages of growth and during the post-harvest phase add value to the fruit to attract premium price and also increase export volume to fetch much needed foreign exchange to the country (Memon, 2017).

The citrus market in Pakistan is broadly segmented in traditional or informal and modern or formal supply chains (Siddique, 2015). The traditional supply chains (TSC) include direct sales as village retailers, sales to local intermediaries and sales at traditional fruit and vegetable markets. The modern supply chains (MSC) include the sales to the traders or contractors and local processors or juice manufacturing factories, from where it is processed in different juices or exported after waxing and processing by increasing its shelf life. This paper aims to measure the factor affecting the choice of supply chain participation in the profitability of citrus growers. The paper is built on the four sections. In the first section, the importance of the study is presented. Section two describes the methodology used in this paper. Results and discussion are described in section three, and finally the paper is concluded in the fourth section.

METHODOLOGY

***Description of the study area*:** The study was carried out in the Punjab Province of Pakistan that can be traced from the study area map in Figure 1. Punjab is the largest province in terms of population and second largest in term of the area (Naseer *et al.*, 2016; GOP, 2018d). Punjab's share in agricultural GDP is also the highest among all other provinces (GOP, 2018b). Similarly, Punjab is the largest producer of mandarin, i.e., more than 98 percent of mandarin is produced in the province (Memon, 2017). During 2017-18, total production of citrus in Punjab was 2.12 million tons out of which 1.12 million tons, i.e., about 53 percent only came from Sargodha district out of 37 districts of Punjab (GOP, 2018a). Therefore, district Sargodha was purposely chosen for this study.

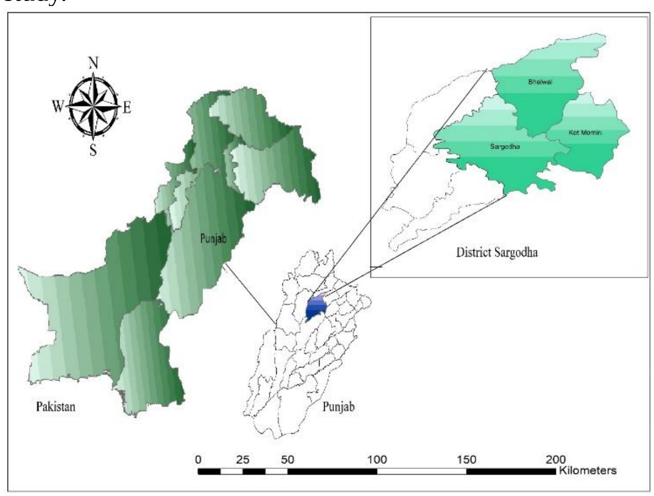

Figure 1. Map of the study area.

***Sampling technique*:** A multistage sampling technique was used for better representation of the study area as shown in Figure 2. In the first stage, district Sargodha was purposely selected due to the most significant district in terms of production, in the second stage three Tehsils, i.e., Bhalwal, Kotmomin, and Sargodha were randomly selected. In the third stage, ten villages from each tehsil were randomly the chosen, and in the final stage at least 10 respondents from each village were randomly interviewed through a well-structured questionnaire. Thus, the study used a sample size of 300 respondents including a mix of traditional and modern supply chain participants representing all farm size categories of the small, medium, and large.

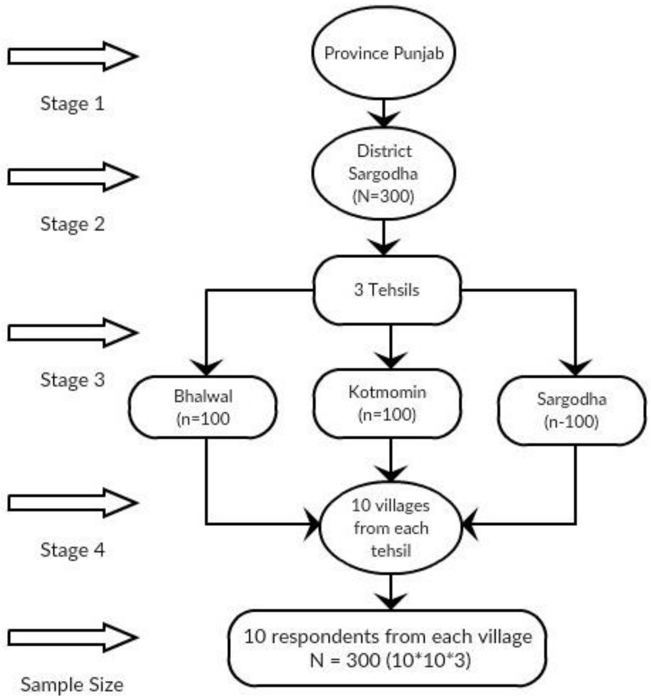

Figure 2. Sample selection criteria.

Profitability analysis**:** Cost and revenue theories suggested the following formula to calculate the profit (Mankiw, 2014; McConnell and Brue, 2005).

$$\pi_i = TR_i - TC_i \quad (1)$$

Where π_i denoted the profit in mandarin farmers participating in the ith supply chain, TRi represented the total revenue and TCi represented the total cost incurred by the farmers participating in that chain, which was calculated as following:

$$TC = TFC + TVC \quad (2)$$

Where TFC and TVC represented the total variable and fixed costs respectively. And the total revenue was calculated as:

$$TR = Q * P \quad (3)$$

Where Q is the total sale of the mandarin product and P is the respective price of the mandarin. Following the Mehdi et al. (2016), study did not use the fixed cost incurred in the production of the mandarin, e.g., the machinery purchased by the farmer, cost incurred in the establishment of the mandarin orchard including land, time, and plantation etc. which were covered overtime and remain constant for traditional and modern supply chain participants. The total variable cost was divided into four major portions which are the pre-harvest cost, post-harvest cost, logistic cost, and the opportunity cost of the farmer. These were described as follow:

$$TVC = PRHC + POHC + LOGC + WCOC \quad (4)$$

Where PRHC was the pre-harvest costs and the POHC was the post-harvest costs, logistics costs incurred by growers was denoted by LOGC and the working capital defined as the opportunity costs were denoted by WCOC. These costs were derived as follow:

$$PRHC = PLC + IRC + FRC + FYM + PSC + PRC + LBC \quad (5)$$

Where PLC denoted ploughing cost, IRC represented the irrigation cost, FRC and FYM represented cost of fertilizer and farmyard manure, PSC represented the pesticides/chemical cost, PRC denoted the pruning practices cost, and LBC represented the labor cost.

Post-harvest costs are calculated depending upon the practices undertaken by the citrus farmers participating in different supply chains. Detailed components of these activities are illustrated below.

$$POHC = HPC + GRC + WAC + PKC + PMC \quad (6)$$

Where HPC represented the cost of harvesting and pruning, GRC denoted the grading cost of citrus, WAC represented the washing and waxing cost if any, PKC and PMC represented the packaging labor cost and packaging material cost respectively.

After these, all calculations the benefit-cost ratio of the farmers participating in different supply chains were calculated by the following formula.

$$BCR = \frac{TR_i}{TC_i} \quad (7)$$

In this way, the efficiency indicators like profitability, yield, and price were also categorized across different supply chains. Further, the analysis would be enhanced to characterize and map the citrus supply chain.

Multinomial treatment effects model**:** Field surveys showed that mandarin producers sell their produce to the pre-harvest contractors; village retailers, vendors or consumers; middlemen or commission agents; fruit and vegetable markets; processors, factories or exporters. The impact of the farmer's choice of the supply chain on their efficiency and performance was assessed by using the following form of the linear regression model:

$$Y_i = \alpha_1 + \alpha_2 T_{2i} + \alpha_3 T_{3i} + \alpha_4 T_{4i} + \alpha_5 T_{5i} + X_i \beta_i + \mu_i \quad (8)$$

Here Yi represents the profit of mandarin producers. Profit or the yield is considered as the important indicators of efficiency in supply chain studies (Birthal et al., 2017). In equation (9), Xi is a set of independent variables used in the study, i.e., farmer's and locational characteristics and Ti (i = 1 to 5) is the supply chain to which farmer is associated. The first three channels (T1 to T3) categorized in TSC and the last two channels (T4 and T5) categorized in MSC. Farmer's choice of participation in a particular supply chain may be based on several unobservable characteristics, i.e., a partnership with other farmer's group or self-selection of the supply chain may be influenced due to the skills of the supply chain management affecting farmer's choice and efficiency. These unobservable characteristics caused the biased results of our estimate, i.e., α's would be biased. To capture this bias study by following several studies (Deb and Trivedi, 2006a; Deb and Trivedi, 2006b; Birthal *et al.*, 2017), multinomial treatment effects model was used which estimate the multinomial choice selection equation in the first stage. The predicted values of the first stage was used as regressors in the second stage outcome equation. The advantage of multinomial over the ordinary least square is the explicitly model farmer's choice of a supply chain.

***Model specification*:** Each farmer *i* participates in the one supply chain (treatment) from a set of five choices, which typically includes a control group, implying a multinomial choice model. Let EV_{ij}^* denotes the indirect utility that farmers would obtain by selecting jth treatment, j = 0, 1, 2, …, J and

$$EV_{ij}^* = z_i'\alpha_j + \delta_i' l_{ij} + \eta_{ij} \qquad (9)$$

Where z_i denotes the exogenous covariate with associated parameters α_j and η_{ij}, which are independently and indirectly distributed error terms. Also EV_{ij}^* includes latent factors l_{ij} that incorporates unobserved characteristics common to farmers j's treatment choice and outcome. The l_{ij} are assumed to be independent of η_{ij}. Without loss of generality, let j = 0 denotes the control group and $EV_{i0}^* = 0$.Let d_i be binary variables representing the observed treatment choice and $d_i = (d_{i1}, d_{i2}, \ldots, d_{ij})$, and let $l_i = (l_{i1}, l_{i2}, \ldots, l_{ij})$. Then the probability of treatment can be represented as

$$\Pr(d_i|z_i, l_i) = g(z_i'\alpha_1 + \delta_1 l_{i1}, z_i'\alpha_2 + \delta_2 l_{i2}, \ldots, z_i'\alpha_j + \delta_j l_{ij}) \quad (10)$$

Where g is an appropriate multinomial probability distribution. Specifically, it was assumed that g has a mixed multinomial logit (MMNL) structure, and is defined as;

$$\Pr(d_i|z_i, l_i) = \frac{exp(z_i'\alpha_j + \delta_j l_{ij})}{1 + \sum_{k=1}^{j}(z_i'\alpha_k + \delta_k l_{ik})} \qquad (11)$$

The outcome (profit) is a count variable, i.e., $y_i = 0, 1, 2, \ldots, N$. the expected outcome equation is formulated as;

$$E(y_i|d_i, x_i, l_i) = x_i'\beta + \sum_{j=1}^{j}\gamma_j d_{ij} + \sum_{j=1}^{j}\lambda_j l_{ij} \qquad (12)$$

Where, x_i is a set of exogenous covariates with associated parameter vectors β and γ_j denoting the treatment effects relative to the control. $E(y_i|d_i, x_i, l_i)$ is a function of the each of the latent factors l_{ij}; i.e., the outcome (profit) is affected by unobserved characteristics that also effect selection into treatment (participation in the supply chain). When λ_j, the factor loading parameter is positive, the treatment and outcome positively correlated through unobserved characteristics, i.e., there is a positive selection and vice versa, with γ and λ the associated parameter vectors respectively. It assumes that f is the negative binomial-2 density,

$$f(y_i|d_i, x_i, l_i) = \frac{\Gamma(y_i+\psi)}{\Gamma(\psi)\Gamma(y_i+1)}\left(\frac{\psi}{\mu_i+\psi}\right)^{\psi}\left(\frac{\mu_i}{\mu_i+\psi}\right)^{y_i} \quad (13)$$

Where;

$$\mu_i = E(y_i|d_i, x_i, l_i) = exp(x_i'\beta + d_i'\gamma + l_i'\lambda) \quad (14)$$

and $\psi \equiv {}^{1}/_{\alpha}\ (\alpha > 0)$ is the overdispersion parameter.

As the standard multinomial logit model, the parameters in the MMNL are identified only up to the scale. Therefore, normalization for the scale of the latent factors without loss of generality is required. It assumes $\delta_j = 1$ for each j but allow the researcher to change this constant. Also, although the model is identified when $z_i = x_i$, including some variables in z_i that are not included in x_i is usually preferable, identification via exclusion restrictions is the preferred approach (Deb and Trivedi, 2006a; Deb and Trivedi, 2006b). For identification, the study used the distance of farmer's village from the fruit & vegetable market and the location dummies as instruments in the selection equation. In both equations, i.e., selection and outcome, the study used the orchard size and total land size as the indicators of the scale of mandarin production which also capture the farmer's endowments of resources in the choice of supply chain participation. A list of several other variables, including personal characteristics, e.g., age, education, information, awareness, etc., and household characteristics such as family size, total family income, labor availability, etc. used as independent variables.

RESULTS AND DISCUSSION

Descriptive statistics of the important variables that potentially influence farmer's choice of supply chain participation and subsequently the mandarin yield and profit are presented in Table 1. In general, the farmers associated with the modern supply chains (i.e., processors and contractors) have larger farm size, a higher level of education, higher mandarin orchard size, having more employed labor and near to the processing areas.

At the upstream of a supply chain product yield, profits and output prices are considered as the important indicators of supply chain efficiency. Yield represents the production efficiency indicator while profit and prices represent the economic and marketing efficiency indicators (Birthal *et al.*, 2017). A comparison of these indicators associated with different supply chain participation was made in Table 2. Profit margins are estimated by deducting the per unit cost of production from the per unit revenues of the mandarin production. The average mandarin yield of 558.6 maund (40 kg) per ha is estimated of the farmers that were associated with the processors. It is also evident from the Table 2 that difference in mandarin yield across different farm size categories is very little, suggesting that mandarin yield is invariant to the scale of production perhaps due to little difference in the management practices. Similar results were also described by Birthal *et al*. (2017). But some studies (Sharma, 2015) found inverse productivity to size relationship in a similar type of studies.

The second part of Table 2 represents the mandarin sale price across different supply chains. The average price received across all supply chain within all farm size categories was 8.64 USD per mounds. If we talk about the different farm size categories, it is evident from Table 2 that large farmers receive the highest price as compared with small and medium farmers. Across different supply chains, farmers associated with the processors receive the highest prices. An interesting

Table 1. Descriptive statistics of the variables used in the model.

Variable	Mean	Std. Dev.	Min	Max
Small Farmers (< 5 ha) = 1, 0 otherwise	0.327	0.470	0	1
Medium farmers (5 to 10 ha) = 1, 0 otherwise	0.410	0.493	0	1
Large farmers (> 10) = 1, 0	0.263	0.441	0	1
Farmer's education (years)	8.027	3.742	0	18
Family size (No.)	9.760	3.505	4	25
Mandarin area (ha)	4.966	2.082	0.80	12.14
Main occupation (farming) = 1, 0 otherwise	0.640	0.481	0	1
Permanent farm worker (Yes) = 1, 0 otherwise	0.420	0.494	0	1
Extension information (Yes) = 1, 0 otherwise	0.523	0.500	0	1
Distance from the market (Km)	13.02	4.299	2	23
Agri Finance (Yes) = 1, 0 otherwise	0.393	0.489	0	1
Participation (1= modern, 0 = traditional)	0.586	0.475	0	1
Local consumers = 1, 0 otherwise	0.040	0.196	0	1
Local middlemen = 1, 0 otherwise	0.193	0.396	0	1
Fruits & vegetable markets = 1, 0 otherwise	0.180	0.385	0	1
Contractor = 1, 0 otherwise	0.543	0.499	0	1
Processors = 1, 0 otherwise	0.043	0.204	0	1
Sargodha = 1, 0 otherwise	0.333	0.472	0	1
Bhalwal = 1, 0 otherwise	0.333	0.472	0	1
Kotmomin = 1, 0 otherwise	0.333	0.472	0	1

Table 2. Efficiency indicators at the upstream of the mandarin supply chain.

	Retailers/ consumers	Middlemen/ beopari	F&V markets	Contractors	Processors	Total
i. Mandarin yield across the different supply chain and farm size (40 kg/hectares/season)						
Farm Size						
Small	461.1	444.6	485.8	465.3	555.8	464.5
	(37.7)	(71.9)	(79.4)	(67.4)	(109.8)	(74.7)
Medium	515.6	456.0	497.4	478.0	559.9	476.9
	(68.2)	(74.8)	(72.5)	(68.9)	(57.8)	(72.7)
Large	494.0	422.8	533.1	491.4	558.8	496.7
		(55.5)	(69.1)	(64.6)	(70.9)	(73.3)
Total	500.2	444.6	505.4	480.5	558.6	489.7
	(61.8)	(69.9)	(75.2)	(67.2)	(68.2)	(73.3)
ii. Sale price across different supply chains (USD/40 kg)						
Small	8.69	8.62	8.59	8.61	8.63	8.60
	(0.21)	(0.19)	(0.30)	(0.25)	(0.24	(0.24)
Medium	8.53	8.54	8.57	8.70	8.54	8.61
	(0.14)	(0.34)	(0.51)	(0.81)	(0.15)	(0.65)
Large	8.52	8.56	8.74	8.63	9.00	8.64
		(0.33)	(0.30	(0.27	(0.50)	(0.31)
Total	8.54	8.55	8.61	8.59	8.78	8.62
	(0.16)	(0.29)	(0.38)	(0.55)	(0.36)	(0.46)
iii. Profit margin across different supply chains (USD/hectares)						
Small	1342	1244	1427	1396	1748	1383.0
	(648.2)	(497.4)	(678.1)	(629.6)	(1313.7)	(686.4)
Medium	1959	1843	1912	1931	2224	1914.4
	(850.1)	(758.4)	(739.3)	(655.8)	(489.5)	(707.5)
Large	2098	1554	2586	2258	2960	2143.6
		(466.1)	(586.8)	(693.2)	(702.4)	(720.6)
Total	1,679.1	1,467.6	1,761.4	2,320.4	2,601.0	2197
	(746.1)	(618.9)	(698.8)	(657.5)	(741.2)	(702.6)

Note: calculations were made at 1 USD = 123.15 PKR | figures in parenthesis are standard errors

result in price table was seen as small farmers associated with the direct sale receive a high price than the average price. This supports the theory of lesser market intermediary with lesser marketing margins (Pokhrel and Thapa, 2007; Fournier, 2018; Agbo *et al.*, 2015).

By looking at the overall price table, there is a little variation

Table 3. Benefit cost analysis of mandarin according supply chain participation.

Activity [unit]	Retailers/ consumers	Middlemen/ beopari	F&V markets	Contractors	Processors
Y [40kg/ha]	500.40	444.80	505.60	480.50	558.80
P [USD/40kg]	8.54	8.55	8.61	8.59	8.78
TR [USD]	4,275.30	3,802.00	4,352.70	4,127.50	4,906.50
GM [USD]	2,566.60	2,319.60	2,596.80	3,150.90	3,477.30
NM [USD]	1,679.10	1,467.60	1,761.40	2,320.40	2,601.00
(BCR)	1.65	1.45	1.68	1.98	2.00

Table 4. Results of the selection equation of multinomial treatment effect model.

	Retailers/ consumers	Middlemen/ beopari	F&V markets	Contractors
Farm size dummies (omitted = large)				
Small (≥ 5 ha) = 1, 0 otherwise	0.0141	-0.6116*	-0.5739	-0.4681
	(2.1413)	(1.4177)	(1.5319)	(1.3546)
Medium (5 to 10 ha) = 1, 0	-0.0706	0.2657	0.0358	-0.1532
otherwise	(1.705)	(0.9822)	(1.0725)	(0.9285)
Farmer's education (years)	0.6353*	0.0288	0.3826*	0.2562*
	(0.6177)	(0.2567)	(0.3372)	(0.2437)
Farmer's education squared	-0.0561**	-0.0032	-0.0221*	-0.0149
	(0.0420)	(0.0163)	(0.0208)	(0.0154)
Family size (No.)	0.086	0.1149	0.0048	0.3226*
	(0.6286)	(0.4167)	(0.4539)	(0.3862)
Family size squared	-0.006	-0.0003	-0.0006	-0.0076
	(0.0257)	(0.0162)	(0.0177)	(0.0146)
Mandarin area (ha)	-1.0579	-0.2672	-0.7548	-0.1754*
	(2.2582)	(0.7752)	(0.9703)	(0.7621)
Mandarin area squared	0.2683*	0.0289	0.0849*	0.0194
	(0.2498)	(0.0578)	(0.0775)	(0.0579)
Main occupation (farming) = 1, 0	0.1924	-1.1137**	-0.8445	0.7741**
otherwise	(1.3863)	(0.913)	(1.1021)	(0.8657)
Permanent farm worker (Yes) = 1,	-1.4974*	-1.2011*	0.8992	1.5693**
0 otherwise	(1.4622)	(1.052)	(1.2613)	(0.9958)
Extension information (Yes) = 1, 0	0.1565	-0.0616*	0.0901	0.2138
otherwise	(0.9286)	(0.6629)	(0.739)	(0.6302)
Agri Finance (Yes) = 1, 0	-0.4450	-0.0125	0.2361	0.2563
otherwise	(0.4442)	(0.3212)	(0.1122)	(1.2691)
Distance from the market (Km)	0.0358* (0.1060)	0.0549**	0.0009***	0.0401*
		(0.0776)	(0.0871)	(0.0733)
Location dummies (omitted Kotmomin)				
Sargodha = 1, 0 otherwise	-1.0939	1.5662***	2.6167	1.7756***
	(2.343)	(0.7599)	(1.105)	(0.8455)
Bhalwal = 1, 0 otherwise	-1.3595***	-1.0656*	-1.19246	-2.2001
	(1.067)	(1.067)	(31.067)	(1.067)
Constant term	-4.203	1.7783**	1.6283*	-0.4749***
	(6.983)	(4.0222)	(4.6932)	(3.8056)

Note: Base category: processors | Standard errors are written in parenthesis; ***, ** & * represents the level of significance at 1, 5, and 10 percent respectively.

ranging from the 8.52 to 8.70 USD which shows the trade competitiveness of the mandarin market. It supports the basic microeconomic theory of pure competition "there is a minimum variation in the prices when there is the presence of a large number of buyers and sellers in the market" (Friedman, 2017). The third part of Table 2 presented the profit margins calculated extensively the farm survey across different supply chains. It is evident from the results that the modern supply chain gets more profit. In the traditional segment, small farmers sell directly in the villages earn more profits. However, across farm size categories large farmers get more profit.

Table 3 shows the economic analysis of the mandarin farmers according to their participation in the five different supply chains. The lowest yield was seen in middlemen/ beopari's category because farmer's involvement is very less, and they know they have made a pre-mature contract with the middlemen or village beopari. The highest per unit mandarin yield was seen by the farmers who are associated with the processors for the sale of their produce. The reason behind this the association of large farmers with the processors. There were only 4% of farmers who were linked with the processors, and they have better management practices than the other farmers. Similarly, the highest prices get by the farmers who were associated with the processors followed by the farmers associated with fruit and vegetable markets, contractors, middlemen, and direct sale to retailers/consumers. The results of the benefit-cost ratio show that the farmers who were associated with the middlemen get a minimum return, i.e., 45 cents over 1 dollar of cost incurred. Highest returns were seen by the farmers who were associated with processors 1 dollar over 1 dollar of cost incurred.

Table 4 shows the results of the selection equation of the multinomial treatment effect model. These results are interpreted relative to the scale of processors that is considered as the base category in the model. The coefficient of village distance from the market in the nearest city is positive and highly significant in all supply chains, which implies a relatively higher probability to participate in these supply chains as compared with the processor's category. It is also possible that if the processing industries are near to the farmers, they are more likely to participate in this category and vice versa. And the greater competition in the agribusiness processing industries are the main reason to offer better prices for the farmers. These results are consistent with the Birthal *et al.* (2017) in the milk value chain study and justifies the price theory (Friedman, 2017).

The coefficient of medium farm size dummies is negative indicating the higher probability for large farmers to be associated with the processor category in the modern supply chain. The small farmer coefficient in case of direct sales to the village consumers, vendor or village retailer, is positive that means small farmers are more likely to associate with the informal supply chain. Further, the coefficient of the mandarin area (orchard size) is negative though only significant in contractor's category. However, it suggests a higher probability for large orchard size of mandarin fruits being associated with the modern supply chains, i.e., processor or contractor category. Hired labor is also an important indicator of farmers' resource endowment, and the finding of the study suggest that mandarin farmers who have not to hire any labor are more likely to associate with the traditional supply chains and vice versa. These findings revealed that the resource-rich farmers are more likely to associate with the modern supply chains and the resource-poor farmers with the traditional supply chains. It can also be interpreted that modern supply chain buyers prefer to deal with the resource-rich farmers and the traditional sector buyers with the resource-poor farmers. These results are consistent with Slamet *et al.* (2017) and Birthal *et al*. (2017).

The regression coefficient of the farmer who has farming as the main occupation is negative and significant with TSCs, i.e., local middlemen and F&V market; and positive and significant with MSC contractors. But it is also positive but not significant in the case of local consumers which means farmers who are associated with the local consumers might have another source of income and farming may not be there the main source of income. The coefficient of extension information is only significant and negative in case of farmer associated with the local middlemen category, which means farmers who did not have access to the extension information are more likely to be associated with the TSCs. It can be interpreted as the extension information play an important role for the farmer to be associated with the MSCs. Furthermore, the coefficient of education is negative across all supply chains representing a lower probability to participate in these supply chains relative to the processors that are the MSC. These results are consistent with the Sahara *et al.* (2015) and Slamet *et al.* (2017) who used treatment effect model to estimate farmer's income in which both selection and outcome equations are estimated simultaneously. Their results showed that the age of the respondent, education level, irrigated land with several other variables have a statistically significant impact on the farmers' participation in supermarket channels or MSCs.

Table 5. Second stage equation of multinomial treatment effects model.

Independent variables	Ln (Profit)
Choice of supply chain = multinomial (omitted = processors)	
Local consumers = 1, 0 otherwise	-0.2659** (0.1351)
Local middlemen = 1, 0 otherwise	-0.4495*** (0.1015)
Fruits & vegetable markets = 1, 0 otherwise	-0.1855* (0.1103)
Contractor = 1, 0 otherwise	-0.1367 (0.0968)
Farm size dummies (omitted = large)	
Small (≥ 5 ha) = 1, 0 otherwise	-0.0265 (0.0545)
Medium (5 to 10 ha) = 1, 0 otherwise	-0.1295** (0.0753)
Farmer's education (years)	0.0197* (0.0179)
Farmer's education squared	-0.0009 (0.0010)
Family size (No.)	0.0153 (0.0231)
Family size squared	-0.0005 (0.0009)
Mandarin area (ha)	0.0242** (0.0463)
Mandarin area squared	-0.0004 (0.0037)
Main occupation (farming) = 1, 0 otherwise	0.0964* (0.0566)
Permanent farm worker (Yes) = 1, 0 otherwise	0.0342 (0.0626)
Extension information (Yes) = 1, 0 otherwise	0.0831** (0.03833)
Agri Finance (Yes) = 1, 0 otherwise	0.0307 (0.0390)
Ln (sigma)	0.7965* (0.2192)
Lambda (local consumers)	0.0821 (0.2131)
Lambda (local middlemen)	-0.0231* (0.0985)
Lambda (fruit and vegetable market)	-0.0953** (0.0236)
Lambda (contactors)	0.1417* (0.0698)
Chi^2	217.40***

Note: Base category: processors | Standard errors are written in parenthesis; ***, ** & * represents the level of significance at 1, 5, and 10 percent respectively.

Table 5 showed the effects of supply chains on farmers' profit. The Inverse Mills' Ratio is negative and significant in the case of supply chains in the category of local middlemen and fruit and vegetable markets. This indicated that the mandarin profit would have been biased downward without controlling for the selection bias. Study results showed no significant difference in mandarin profit of those associated with local consumers, local middlemen, and fruit and vegetable markets. However, the farmers associated with the processor supply chain realize more profit. These results are consistent with our descriptive results where the farmer who sells their products to the processor or contractors earn more profit relative to the others. Gupta and Roy (2012) and Birthal *et al.* (2017) also found similar results from a comparison of the efficiency of milk value chains. Furthermore, with a significant positive coefficient of independent variable showed that the mandarin profit is found to be increased with large farmers category, higher education level, greater mandarin orchard, with main farming as the main occupation, and having access to extension information. Some other variables have a positive impact on mandarin profit but not found significant in our model, i.e., family size, permanent workers, and agricultural finance.

***Conclusions*:** The relative benefit-cost analysis of marketing channels is not well understood and include many assumptions and lack substantial empirical evidence in literature to support them. To increase in the welfare of the small farmers, it is important to link them with the modern marketing channels, i.e., high-value export chains which offers benefits to decrease rural poverty. However, there are clear differences between the results of the existing literature, i.e., modernization of markets and the real situation in the developing countries where most of the small and medium farmers are still market their farm produce in the wet markets through traditional marketing channels. This study contributed to the existing empirical literature by assessing whether the commercialization of the marketing system has effects on the profitability of citrus growers. The results showed that with the less benefit-cost ratio, traditional marketing channels still exists in citrus marketing system of Pakistan. Findings also revealed that farmers who were selling their produce to the processors and contractors, were better off in terms of the citrus profitability irrespective of their decisions to the specific marketing channel. The major policy implication of the study is to establish marketing linkages in the developing countries to support the integration of farmers with the modern value chains (also termed as integrated supply/value chains). This empirical research floors the way to additional research. Given the relevance of the links between farmers' choice of commercialization and profitability, a more reliable and accurate data for other major fruits and crops will be helpful to empirically investigate the mechanism identified in the exiting theoretical literature.

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