World Development 137 (2021) 105202

Contents lists available at ScienceDirect

World Development

journal homepage: www.elsevier.com/locate/worlddev

Can institutional innovations in agri-marketing channels alleviate distress selling? Evidence from India

Disha Bhanot [a,*], Vinish Kathuria [b], Debabrata Das [c]

[a] SP Jain Institute of Management and Research (SPJIMR), Bhavan's Campus, Andheri (West), Mumbai 400 058, India
[b] Shailesh J. Mehta School of Management, Indian Institute of Technology (IIT) Bombay, Powai, Mumbai 400 076, India
[c] National Institute of Industrial Engineering (NITIE), Powai, Mumbai 400 087, India

ARTICLE INFO

Article history:
Accepted 11 September 2020

JEL classification:
Q13
Q18

Keywords:
Distress selling
Agri-marketing
Contract farming
Farmer producer companies
India

ABSTRACT

Distress selling of agri-produce is a common phenomenon in Indian agriculture, and is especially true for horticulture crops, given their highly perishable nature and not being covered under minimum support prices. This study focusses on uncovering the role of institutional innovations in agri-marketing channels in addressing the issue of distress selling. Using primary survey of 108 tomato grower farmers from the Western state Maharashtra in India, the study compares the likelihood of distress selling for farmers selling through the alternative channels of Contract Farming (CF) and Farmer Producer Companies (FPCs), as against selling through the conventional marketing channel of Agriculture Produce Marketing Committees (APMCs). Building on the insights from prospect theory, where a farmer would react more severely to losses than to gains, we develop a mathematical model to compare the utility derived from selling in alternate channels (that is, CF and FPC) vis-à-vis selling through the APMC channel. Subsequently, using econometric analysis, we find that opting to sell through alternative marketing channels helps farmers minimize losses and shields them from distress selling. Finally, a probability function is developed to determine the likelihood of a farmer opting to sell in an alternate marketing channel (CF/FPC) as against the conventional APMC channel. The findings aid in framing optimal pricing strategies that could be used by the contracting firms and FPCs.

1. Introduction

The agrarian crisis and distress of farmers is a leading policy issue in India, given that agriculture sector provides livelihood to about 50 percent of India's population, yet contributes merely 17 percent to the country's Gross Domestic Product (GDP) (Al Shriaan & Hassan, 2018; OECD, 2018). One distinct facet of this crisis is often seen in the form of farmers resorting to panic selling (also termed as distress selling) of their produce. Farmers, especially the small and marginal farmers, in many developing countries including India, grapple with having limited choices for selling their produce, besides facing constraints such as limited irrigation, high input costs, inadequate storage and processing facilities (Chand et al., 2007; Poulton et al., 2010; Dev, 2014). This forces them to sell their produce in distress[1]. Market access remains a major impediment for most small-scale farmers in developing countries, and providing alternate marketing infrastructure[2] is widely seen as an effective strategy for improving their income (Chand, 2012; Chamberlin & Jayne, 2013; Kherallah et al., 2002). This study focusses on studying the linkage between the nature of institutional marketing infrastructure/channels, and the occurrence of distress selling by small and marginal farmers.

The phenomenon of distress selling is more pronounced for horticulture crops, given their highly perishable nature and not being

[1] Distress selling can be defined as an urgent sale of goods at deeply discounted prices, typically characterized by unfavourable conditions for the seller.

[2] Sengupta (2010) classifies marketing infrastructure in two categories – physical and institutional. While the former is concerned with access to roads, transport, grading, storage, packaging, and processing facilities, the latter consists of institutions meant to facilitate the marketing process. Though these two appear distinct, there is an overlap in the sense that provision of institutional infrastructure through innovations like farmer cooperatives or contract farming facilitates the provision of the physical infrastructure of varying degrees (as we shall see later).

* Corresponding author.
E-mail addresses: disha.bhanot@spjimr.org (D. Bhanot), vinish@iitb.ac.in (V. Kathuria), debabrataiitb@gmail.com (D. Das).

https://doi.org/10.1016/j.worlddev.2020.105202
0305-750X/

covered under the minimum support prices (MSP)[3] (Chatterjee & Kapur, 2016). While the horticulture sector offers much higher returns and quicker cash flows to small and marginal farmers,[4] it also makes them more vulnerable to distress selling given the constraints in which they operate. Some of these constraints are their inability to create scale economies, having low bargaining power because of low quantities of marketable surplus, limited access to formal credit, scarcity of capital, lack of market access, shortage of information, and poor infrastructure (Barham & Chitemi, 2009; Biénabe & Sautier, 2005; Chand et al., 2007). Past studies have documented multiple factors as plausible triggers of distress selling. These include – i) bumper crop which causes excess supply in the market thereby leading to fall in prices (Murthy, 2011), ii) insufficient infrastructure facilities, like lack of storage and processing wherein farmer can stock the produce and sell when the price is good (Trebbin & Hassler, 2012), iii) poor implementation of price support schemes which offer an assured price to the farmer (Suri, 2006), iv) interlocked credit markets, where the farmer is forced to sell the post-harvest produce to the lender at a pre-determined (and invariably lower) price *in lieu* of the credit advanced during the cultivation season (Sahu et al., 2004), and v) lack of access to alternate markets (Markelova et al., 2009).

In this study, we mainly focus on the issue of lack of access to alternate markets for Indian farmers. Given that limited literature is available on whether or not, and to what extent, the choice of marketing channel affects farmers' likelihood of distress selling, this study makes an important contribution to literature. We address this research gap for a key horticulture crop – tomato, which is a pantry staple. However, being highly perishable, tomatoes cannot be stored beyond 2–3 days (at the producer's end), and consequently, when there is surplus production, prices fall very quickly.[5] In response, farmers exhibit increased urgency to sell, which negatively impacts their payoffs and makes them vulnerable to taking less than optimal production and investment decisions, eventually leading to welfare losses for market participants (Sekhar, 2004; Apergis & Rezitis, 2003). Such a phenomenon is particularly true for highly perishable commodities that are marketed at conventional Agriculture Produce Marketing Committee (APMC) market yards. Focussing on two institutional innovations in the agri-marketing channel – the Contract Farming (CF) and Farmer Producer Company (FPC), this study compares the likelihood of distress selling by tomato farmers selling through the conventional marketing channel of APMC vis-à-vis the CF and FPC channel.

APMC market yards are state governments' set-up spot markets (commonly called *mandis*) formed to regulate agriculture transactions traded between buyers and sellers and ensure that farmers are offered fair prices for their produce in a transparent manner. However, evidence exists suggesting that when marketing their produce at APMCs, farmers often end-up being exploited by the monopolistic practices of these markets, resulting in their reduced bargaining power, which is further constrained by poor infrastructure facilities and inadequate access to market information (Chand & Singh, 2016; Kapur & Krishnamurthy, 2014; Reardon & Minten, 2011). Unlike the APMC system, CF is a system for the production and supply of agri-produce under forward-contracts. The essence of such contracts being a commitment to sell the pre-agreed quantity of a particular quality, at a pre-decided time and price to the buyer (usually a large-scale buyer, such as exporter or food-processor). In exchange, the contracting firm provides inputs, various equipment, pre- and post-harvest infrastructure, and technical advice/guidance to the farmers (da Silva et al., 2013; Bellemare, 2012; Simmons et al., 2005). For the farmer, the CF option often mitigates the risk associated with downward price fluctuations.

The other institutional innovation, FPC, is a legal form of a farmers' organization.[6] While in the case of APMCs and CF, the agri-produce is individually marketed by the farmer, the FPC model collectivizes the farmers and provides them forward and backward linkages to improve their bargaining power (Bernard & Spielman, 2009; Hellin et al., 2009; Trebbin & Hassler, 2012; Trebbin, 2014).[7] The FPCs came into existence with the amendment of The Indian Companies Act 1956 in 2003. Thus, they operate under the same regulatory framework that applies to Indian companies. The basic tenet of FPCs is to blend the strength of traditional cooperatives with the efficiency of a company (Bernard & Spielman, 2009; Hellin et al., 2009; Trebbin & Hassler, 2012; Trebbin, 2014).

Given this background, this study uncovers the role of institutional innovations in marketing channels in addressing the problem of distress selling. Based on Kahneman and Tversky's (1979) pioneering work on prospect theory, we develop an analytical model that captures farmer's utility in selling across each of the marketing channels. As per prospect theory, reference thinking plays a critical role when decisions are made under uncertainty. Contextually, a farmer's decision to sell through a particular marketing channel is primarily driven by the price deviation experienced by the farmer from an internal reference price.[8] For a similar amount of deviation, individuals react more strongly to losses than to gains. Building on this premise, we compute farmers' utility when selling through different channels and hypothesize that selling through alternate marketing channels offers greater utility to the farmer, because of loss aversion characteristic. To test the hypothesis, we carry out a primary survey of 108 farmers. The results suggest a favourable effect of institutional innovations in alleviating distress selling. Since multiple selling options are available to farmers (i.e., APMC, CF, and FPC), we take into account the various factors affecting the farmer's decision to sell through a particular marketing channel, and subsequently develop a probability function that identifies the situations under which farmers show greater willingness to sell to the alternate channel(s).

In summary, this paper addresses two research questions. First, what is the effect of institutional innovations of CF and FPC, on the likelihood of distress selling by the farmer? Second, how does the farmer's choice of a specific marketing channel vary depending upon the price deviation experienced from an internal reference price? While the first question helped quantify the favourable effect of institutional innovations in alleviating distress selling,

[3] MSP is the price fixed by the respective governments in several countries including India, at which they purchase crop(s) from farmers to insure them against sharp fall in farm prices. Several grains, pulses, and cash crops, but not horticulture crops, are usually covered under MSP.

[4] In India, nearly 85 percent of the total farm households are small (with landholding 1 to 2 ha) and marginal (<1 ha), and they make a significant contribution to the production of horticulture crops, as around 60 percent of vegetable production and 55 percent of fruit comes from them (GoI, 2019). In this paper, wherever we have used the term small-scale farmers, it also includes marginal farmers.

[5] For instance, in the Narayangoan wholesale market in Maharashtra, India, accounting for 30 percent of trade in the state, tomatoes were selling in the range of INR 40 to 70 (1 US $ ~ INR 76) /kg in August 2017. However, the prices plunged to INR 2 /kg in August 2018 due to the sudden jump in production and fall in demand in some markets (Source: https://economictimes.indiatimes.com/industry/cons-products/food/prices-of-tomatoes-plunges-to-rs-2-per-kg/articleshow/65605440.cms).

[6] In India, other legal forms of organizations into which farmers can organize themselves in, include Cooperative Society and Mutually Aided Cooperative Societies.

[7] Figures A1-A3 in Appendix A depict the flow of agri-produce from farmer to consumer across the three channels.

[8] To understand the concept, consider a representative farmer who has a reference price of fetching at least INR 5 (≈7 cents) for one kg of tomatoes. There are two possible scenarios in terms of the actual price received by the farmer. In scenario 1, the actual price (say INR 6/ kg) is more than the reference price (case of positive deviation). In scenario 2, it is lower (say INR 4/kg) than the reference price (case of negative deviation). In the first case, the farmer experiences a psychological gain, and when the deviation is negative, the farmer experiences a psychological loss. The prospect theory suggests that farmer would react more severely to losses than to gains (for the same amount of deviation).

Table 1
APMC, CF and FPC – A comparison.

	APMC	CF	FPC
Price Determination	Open Auction	Pre-determined	Negotiation
Transaction Cost	Relatively High	Medium	Medium
Cost of Production	High	Medium	Relatively Low
Quality Standards	Relaxed	High	Medium to High
Bargaining power of Farmers	Low	Low	High
Risk Mitigation	Low	Relatively High	Medium
Balance of Power with	Middlemen	Contracting Firm	FPC
Value Addition	No	Yes	No
Type of Farmers	All	Mostly medium and large	Mostly marginal and small
Price Spread between Producer & Consumer	Large	Large	Relatively Small
Nature of Market	Regulated	More towards Monopsony	Bilateral
Market Catered	Domestic & Export	Domestic & Export	Mostly Domestic

Notes: Above table holds true across most types of CFs and FPCs. Some variability may exist with respect to parameters like Value Addition, Types of Farmers and Market Catered - depending on the location and specific nature of CF and FPC.
Source: Own compilation

the second question provided insights into the significant role of loss aversion in explaining the farmer's choice of marketing channel. The remaining paper is structured as follows: Section 2 describes the nature of CF and FPC interventions, their implications on farmer's income and then reviews empirical literature. Section 3 presents the model that incorporates the concept of prospect theory into farmer's utility. Section 4 elaborates on the data, field-study context, research methodology, and the proposed hypothesis. Section 5 reports the results, and Section 6 gives the concluding comments and policy implications.

2. Literature review

In this section, we first discuss the institutional differences across different marketing channels – APMC vs. CF vs. FPC. The marketing aspect is important from distress selling point of view. It is now well recognized that the prospect for small farmers to raise their incomes depends on their ability to successfully participate in markets (Markelova et al., 2009; Shepherd, 2007). We then review studies that look into the impact of these alternate institutional innovations in agri-marketing channels on farmer's income.

Regarding CF, literature has discussed broadly two types of contracts – production contract and marketing contract (MacDonald et al., 2004; Otsuka et al., 2016). Under the production contract, the contracting firm provides vital inputs such as credit, technical assistance, information services to the farmers in return for the delivery of an agreed quantity and quality of the product, at a pre-determined price. Unlike the production contract, the marketing contract gives more autonomy to the farmer in production decisions and is primarily concerned with the conditions governing the sale of the produce (Otsuka et al., 2016). By design, the contracts between agribusiness firms and farmers typically differ across a set of parameters (Simmons et al., 2005). These are - i) *nature of contracting party*, ii) *crops contracted* – cereal vs. cash vs. horticulture, iii) *contract details* - extent of assistance provided and the price-setting mechanism, iv) *degree of formality* ranging from signed contracts to verbal agreements, and lastly, v) *the extent of participation by small farmers*.

With regard to FPCs, they share the same principles of functioning as the farmer producer organizations (FPOs) in other countries. Farmers' organizations provide a range of services that are crucial for farmers to compete more effectively in markets (Hellin et al.,2009; Markelova et al., 2009; Trebbin & Hassler, 2012, Fischer & Qaim, 2012). These include *organizational services* (organizing farmers into collective action), *production services* (bulk buying of input, etc.), *marketing services* (arranging for transport, storage, branding, and certification), *financial services* (providing loans), *technology and education services* (sharing information on good cultivation practices) and, *management of resources and policy advocacy* (developing soil and water conservation practices). However, FPOs' sustenance is contingent on the nature of external support they receive from NGOs, government agencies, private businesses, or other partner institutions (Cherukuri & Reddy, 2014; Fischer & Qaim, 2012).

Based on the above discussion, Table 1 compares CF and FPC with APMC marketing channel across a set of parameters.[9]

There exist several studies in developing countries context, covering various horticulture crops, that attempt to ascertain the impact of CF on farmers' income. See for example, studies by Kaur & Singla (2018) for Sugar Beet for India, Bellemare & Novak (2017) for Green beans and Snow peas for Madagascar, Andersson et al. (2015) and Chege et al. (2015) for several vegetables for Kenya, Narayanan (2014) for Marigold, Papaya and Gherkins for India, Ito et al. (2012) for watermelon for China, Schipmann & Qaim (2011) for Sweet pepper for Thailand among others. Most of these studies have found income enhancing effect of CF on participating farmers.

Studies have also found positive effect of FPOs on farmers' income for crops such as Banana, Grapes, Mango, Potato and Tomato in countries like India, Kenya, Tanzania, Uganda etc. (see for example, Fischer & Qaim, 2012; Trebbin & Hassler, 2012; Barham & Chitemi, 2009; Kaganzi et al., 2009 among others). In Table 2 we summarize those studies that have focussed on the institutional innovations in the horticulture sector, preferably vegetables and for countries in lower and lower-middle income group.

Interestingly, despite having unanimity in their impacts on farmers' income, various studies have expressed concerns regarding contracting firm favouring large farmers, contracted production squeezing out local food production, farmers becoming over-dependent on their contracted crops eventually leading to a loss in bargaining power and poor grievance handling by contracting foreign firms in developing countries (Clapp, 1988; Wilson, 1990; Little & Watts, 1994; Singh, 2000). Likewise for FPCs/FPOs, while such interventions have shown enhanced market access for small farmers, improved bargaining power and net incomes (Table 2), some studies have also flagged issues related to small farmers lacking basic education, management, and entrepreneurial skills which are key to ensuring financially sustainable partnerships (Hellin et al., 2009; Pingali et al., 2005).

[9] Table 1 is not specific to India per se but indicates differences across the three channels which are generic in nature. Similar institutional arrangements for marketing of agri-produce exist in other countries, even though they are known by different names across countries.

Table 2
Studies estimating impact of CF and FPO/FPC – A summary of literature review.

Author (s)	Part A: CF Related Studies								
	Country	Crop/Commodity	Market Served (Domestic/Export)	Contract Type (Production, P/ Marketing, M)	Farmers' Type (Small, S /Medium, M/Large, L)	Sample Size*	Study Design (Model)	Outcome Variable	Effect (+/−)
Kaur & Singla (2018)	India	Chicory, Sugar Beet	Domestic	P	S, M	400 (200 CF)	Heckman Two-stage (Heckman)	Farm Income	+
Anderson et al. (2015)	Kenya	Various vegetables	Domestic (Supermarkets)	M	S	336 - panel data (77–115 HVM, 259–221 TC) #	Difference in difference (DID)	Household Income	+
Briones (2015)	Philippines	Tobacco	Both	P	S	316 (243 CF)	Heckman	Farm Income	+
Chege et al (2015)	Kenya	Various vegetables	Domestic (Supermarkets)	M	S	384 (85 SM; 299 TC)	Instrument Variable (IV) Approach	Household Nutrition	+
Narayanan (2014)	India	Marigold, Papaya, Broiler Chicken, Gherkins	Both	P	M	474 (266 CF)	Switching Regression	Crop Income	+
Wang et al (2014)	Vietnam	Various vegetables	Domestic	M	S	137 (41 CF)	Propensity Score Matching (PSM)	Household Income	+
Bellemare (2012)	Madagascar	Green beans, leek, snow peas, rice, barley	Export & Domestic (processing firms)	Both	S	1178 (579 CF)	IV	Household Income	+
Escobal & Cavero (2012)	Peru	Potato	Both	P	M	360 (43 CF)	Switching	Farm Income	+
Ito et al (2012)	China	Watermelon	Mix (CF & Cooperative) – Domestic	P	S	318 (160 CF)	PSM	Farm Income	+
Jones & Gibbon (2011)	Uganda	Cocoa	Export	P	S,M	222 (all CF)	IV	Crop Income	+
Rao & Qaim (2011)	Kenya	Various vegetables	Domestic (Supermarkets)	M	S	402 (133 SM; 269 TC)	Switching	Household Income	+
Schipmann & Qaim (2011)	Thailand	Sweet pepper	Both	Both	S	244 (112 CF)	Mixed Logit	Household Income	+
Bolwig et al (2009)	Uganda	Coffee	Export	P	S	160 (112 CF)	Heckman	Crop Income	+
Maertens & Swinnen (2009)	Senegal	French Beans	Export	P	M	300 (59 CF)	PSM	Household Income	+
Miyata et al (2009)	China	Apples, Green Onions	Both	P	S	162 (98 CF)	Heckman	Household Income	+
Neven et al (2009)	Kenya	Tomato, Kale, Banana	Domestic (Supermarkets)	M	M, L	115 (49 SM; 66 TC)	Descriptive Analysis	Net Income	+
Hernandez et al (2007)	Guatemala	Tomato	Domestic (Supermarkets)	P	M	164 (112 SM; 52 TC)	Heckman	Crop Income	No Impact
Winters et al (2005)	Indonesia	Seed corn, corn, rice, sugarcane	Both	P	S	289 (145 CF)	Probit	Farm Income	+
Warning & Key (2002)	Senegal	Peanuts	Export	P	M	26 (15 CF)	Heckman	Farm Income	+
Singh (2002)	India	Chilli, Potato, Tomato	Both	P	M, L	Case Study of Pepsico, Hindustan Liver & Nijjer Agro foods			+

Table 2 (*continued*)

Author	Part B: FPC Related Studies								
	Country	Product/Crop	Market Served	Services (Production, P/ Marketing, M/Financial, F/ Education, E)	Farmers' Type (Small/ Medium/Large)	Sample Size	Study Design	Outcome Variable	Effect (+/−)
Fischer & Qaim (2012)	Kenya	Banana	Domestic	P, M	S	444 (201 members)	PSM	Household Income	+
Trebbin & Hassler (2012)	India	Mango, Cashew Nuts	Domestic	M	S	Case Study of Vasundhra Agri-Horti Producers' Company			+
Barham & Chitemi (2009)	Tanzania	Vegetables, Cereals	Domestic	M, E	S	34 groups (mean size 35 member)	Regression	Group Marketing Performance	+
Hellin et al (2009)	Honduras, El Salvador, Mexico	Tomato, Bell Pepper, Potato, Broccoli, Lettuce, Carrots, Maize	Domestic (Supermarkets)	M	S	Case Study of 3 FPOs in El Salvador and 2 in Honduras			+
Kaganzi et al (2009)	Uganda	Potato	Domestic	P, F, M	S	Case Study of Nyabyumba Farmer Group			+
Narrod et al (2009)	India, Kenya	Grapes, Green Beans	Export	P, M	S	Case Study of Mahagrapes (India) and Public-Private Partnerships (Kenya)			+
Roy & Thorat (2008)	India	Grapes	Export	M	S,M,L	183 (88 members)	IV	Crop Income	+
Wollni & Zeller (2007)	Costa Rica	Coffee	Domestic	M	M	216 households (106 members)	Heckman	Crop Income	+

Notes: SM -Supermarket Channel, TC – Traditional Channel, HVM - High Value Market; * – In sample size, only CF or FPOs members are given – remaining are non-CF or non-FPO members; #For panel data we have given the range of value across the years; None of the studies talked about marginal farmers.
Source: Own compilation.

Most of the existing studies (including the ones in Table 2) use the transaction cost economics (TCE) framework to explain the reasons behind farmers opting to sell in alternate marketing channels. From the perspective of small farmers, participation in contracts and/or FPCs, entails benefits on multiple fronts, including i) accessing timely credit, ii) obtaining market information, iii) getting technical know-how on good cultivation practices, iv) achieving economies of scale in accessing markets, v) tapping into high-value markets, and vi) adoption of new technologies (Otsuka et al., 2016; Markelova et al., 2009; Winters et al., 2005). This results in reduced transaction costs as against when they sell through open/spot markets. Likewise, for the contracting firms, transaction costs may be extremely high if they source the agri-produce from spot markets, especially in situations where desired quality and assured quantities are key to their operations (Otsuka et al., 2016; Simmons et al., 2005; Winters et al., 2005).

While TCE assumes that the decision-makers are risk-neutral, in reality, farmers are risk-averse. We incorporate this loss aversion characteristic of farmers to realistically explain their choice of attaching themselves to a particular marketing channel. To the best of our knowledge, none of the studies in the past have captured the loss aversion characteristic of farmers while determining their utility when they sell across different channels. Besides, the present study focusses on a key horticulture crop, tomato, which being highly perishable, is more prone to distress selling. As seen from Table 2, there are only a handful of studies (one each from India and Kenya, and two from Central America) concerning the impact on farmers' income from participation in CF and FPC channels. However, none of these studies have looked at the impact from the distress selling point of view. In light of these research gaps, this study makes a significant contribution.

In the next section, we provide an analytical basis, using the loss-aversion characteristic of farmers, to build the hypothesis regarding two institutional innovations (CF and FPC channel) and how they alleviate the likelihood of distress selling.

3. Model

To fathom the role of agri-marketing channels in addressing distress selling issue, we incorporate the notion of reference price in modelling farmer's value function. As per prospect theory (Kahneman & Tversky, 1979), reference thinking plays a critical role when decisions are made under uncertainty. Since farmers experience price uncertainty, reference thinking allows farmers to evaluate actual prices by comparing them with an internal reference price (the expected price) and use their price expectations to judge whether the actual received price is high or low. Given the three marketing channels, with the APMC channel serving as the default option, the idea is to compare the farmer's overall utility when selling in alternate channels (that is, CF and FPC) *vis-à-vis* selling through the APMC.

3.1. Modelling Farmer's utility across marketing channels

Consider a farmer who decides to go to the *mandi* (APMC) with a reference price $p_r > 0$. At the APMC, the farmer gets to know the actual price, p_a, such that $p_a = p_r + d$, where "d" denotes the deviation of actual price from the reference price. If $d > 0$, then the produce would sell at a higher-than-expected price at the *mandi* and *vice versa*.

The farmer's overall utility has two parts: consumption utility and reference utility. While the former comprises of the utility associated with the selling of farm produce and the (dis)utility associated with farm expenses, reference utility, on the contrary, captures the deviation of actual price from the internal expected price.

The consumption utility, $c(u)$ consists of three parts:

$$c(u) = (p_r + d)^{\alpha} - (CC + FEE + TRAN)^{\beta} \pm C \quad (1)$$

The first part is the utility obtained from sales proceeds of produce (captured by $(p_r + d)^{\alpha}$), the second part $(CC + FEE + TRAN)^{\beta}$), is the dis(utility) associated with farm expenses and the third part, C is the additional utility/disutility associated with attaching to a particular marketing channel (captured by $\pm C$). The physical significance of the third component in Eq. (1) is as follows. When the farmer sells the produce to licensed middlemen in the APMC, it is the responsibility of the *mandi* for ensuring payment for agriculture produce, which is captured as gain in utility experienced by the farmer. On the contrary, when the farmer decides to sell the produce in the CF channel, a loss in utility is experienced on account of the absence of provision for the regulation of the contract signed between the farmer and the firm. Likewise, lack of a grievance redressal mechanism for farmers to report irregularities in the implementation of contract/functioning of FPCs results in the loss in utility for the farmer. In Eq. (1), *CC* is the cost of cultivation, *FEE* is the fees associated with availing the service of a particular marketing channel, *TRAN* is the transportation costs associated with the respective marketing channel, and,α and β are the parameters $(0 < \alpha \leq \beta < 1)$ capturing the diminishing sensitivity associated with the utility function.

Regarding reference utility, $r(d)$, it incorporates the reference thinking properties of prospect theory value function and can be written as:

$$r(d) = \begin{cases} (|d|)^{\alpha} for\ d > 0 \\ -\lambda(|d|)^{\beta} for\ d < 0 \end{cases} \quad (2)$$

In the above equation, $d > 0$ implies that $p_a > p_r$ and is thus coded as a gain, while $d < 0$ implies that $p_a < p_r$ and is coded as a loss. Further, $\lambda > 1$ is the loss aversion coefficient. Prior research suggests that the parameters, α and β, take similar values in Eqs. (1) and (2) (Thaler, 1980; Saini et al., 2010). In the first scenario, when $p_a > p_r$, the farmer experiences a psychological gain, as the actual price is more than the reference price. In the second scenario, the deviation is negative, and the farmer experiences a loss.

In light of the above discussion, the utility function for the three marketing channels – APMC, CF and FPC, are as follows:

APMC farmers

$$u_{APMC} = \begin{cases} (RP + |d_{RPAPMC}|)^{\alpha} - (CC_{APMC} + FEE_{APMC} + TRAN_{APMC})^{\beta} + (|d_{RPAPMC}|)^{\alpha} + Cifd_{RPAPMC} \geq 0 \\ (RP - |d_{RPAPMC}|)^{\alpha} - (CC_{APMC} + FEE_{APMC} + TRAN_{APMC})^{\beta} - \lambda(|d_{RPAPMC}|)^{\beta} + Cifd_{RPAPMC} < 0 \end{cases} \quad (3)$$

CF farmers

$$u_{CF} = \begin{cases} (RP + |d_{RPCF}|)^{\alpha} - (CC_{CF} + TRAN_{CF})^{\beta} + (|d_{RPCF}|)^{\alpha} - Cifd_{RPCF} \geq 0 \\ (RP - |d_{RPCF}|)^{\alpha} - (CC_{CF} + TRAN_{CF})^{\beta} - \lambda(|d_{RPCF}|)^{\beta} - Cifd_{RPCF} < 0 \end{cases} \quad (4)$$

FPC farmers

$$u_{FPC} = \begin{cases} (RP + |d_{RPFPC}|)^{\alpha} - (CC_{FPC} + TRAN_{FPC} + FEE_{FPC})^{\beta} + (|d_{RPFPC}|)^{\alpha} - Cifd_{RPFPC} \geq 0 \\ (RP - |d_{RPFPC}|)^{\alpha} - (CC_{FPC} + TRAN_{FPC} + FEE_{FPC})^{\beta} - \lambda(|d_{RPFPC}|)^{\beta} - Cifd_{RPFPC} < 0 \end{cases} \quad (5)$$

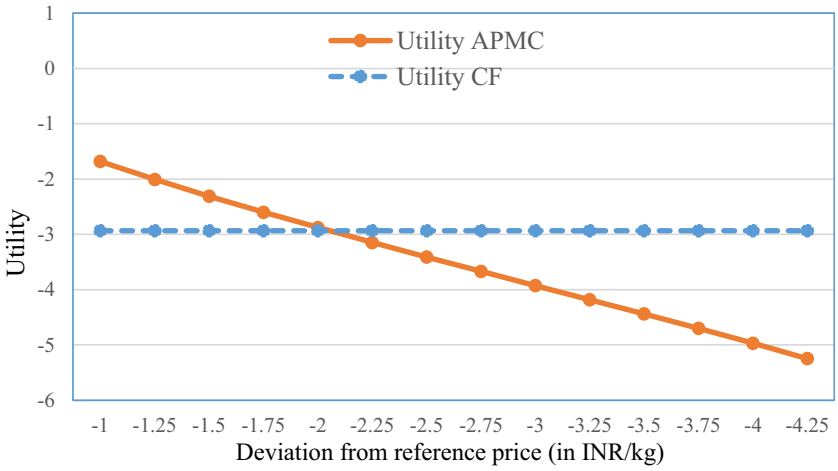

Fig. 1. Comparing utility for APMC vs. CF channel. *Note:* Reference Price is INR 5/kg and Price under CF is INR 2.5/kg.

where, *RP* denotes the internal reference price and d_{RPAPMC}, d_{RPCF} and d_{RPFPC} denote the deviation from reference price observed across each of the three marketing channels.

Based on the deviation from reference price, multiple scenarios are possible for each marketing channel. For instance, when comparing APMC with CF channel, the four possible scenarios are: Scenario 1:$d_{RPAPMC} \geq 0$ and $d_{RPCF} \geq 0$, Scenario 2: $d_{RPAPMC} \geq 0$ and $d_{RPCF} < 0$, Scenario 3: $d_{RPAPMC} < 0$ and $d_{RPCF} \geq 0$, and Scenario 4: $d_{RPAPMC} < 0$ and $d_{RPCF} < 0$.[10] Similarly, four such scenarios are possible for APMC versus the FPC channel. Given these multiple scenarios, when the farmer experiences a negative deviation from an internal reference price across the channels (i.e., $d_{RPAPMC} < 0$ and $d_{RPCF} < 0$ and $d_{RPAPMC} < 0$ and $d_{RPFPC} < 0$), it potentially results in distress selling like condition. We thus specifically focus on the loss domain scenario and compare the overall utility experienced by the farmer from selling through APMC vis-à-vis CF (/ FPC) channel. Figs. 1 and 2 present the simulated graphs for APMC versus CF and APMC versus FPC for a reference price of INR 5/Kg tomato (≈ 6.5 cents/kg).[11]

It is evident from Fig. 1 that overall utility for the farmer is higher under the CF channel when the price at APMC crashes, whereas it is monotonically higher when selling through the FPC channel (Fig. 2). In the case of the CF channel, which offers an assured price to the farmer, when the *mandi* prices crash, being registered with the contracting firm would help minimize farmer's losses. Likewise, as a member of an FPC, the farmer can better negotiate the produce price (as against the *mandi*). Also, FPCs, by advising farmers about the good cultivation practices, helps in reducing cultivation costs for the farmer. While membership in FPC does not offer an assured price, it helps in protecting farmer's losses by lowering costs. Thus, institutional innovations such as CF and FPC are hypothesized to be effective in shielding the farmer from distress selling.

4. Data and research methodology

4.1. Sample data and Field-study location

The data used in this study was collected from a field survey of 108 tomato farmers, in the Western Indian state of Maharashtra, conducted between July 2016 and September 2017. The survey was carried out in Nasik division. Of the eight administrative divisions in Maharashtra, Nasik division accounted for nearly 51 percent of the total arrivals of tomato in 2016–17.[12] Fig. 3 gives the location of the study area in India's map.

Since the purpose of this study is to capture the institutional differences in marketing channels, we wanted to carry out the survey in a region with either CF or (active) FPC, but not both, and a region that did not have either. In Nasik division, Varun Agro Processing Foods Pvt. Ltd. and Devnadi Valley Agricultural Farmer Producer Company Ltd. are the two active CF and FPC marketing channels, respectively. We selected them for the present study.

4.2. CF intervention – Varun Agro processing Foods Pvt. Ltd

Incorporated in the year 2010, Varun Agro Processing Foods Pvt. Ltd. (VA) is a tomato processing plant in the Umrale block[13] of Nasik district in the state of Maharashtra, which supplies tomato paste to Hindustan Unilever Limited (HUL), under contract system of production. HUL, a subsidiary of Unilever Plc, processes one-tenth of the world's tomato production and is the largest food processing and marketing company in India. The plant is biggest in Maharashtra (and the second-largest in India) with an installed capacity of processing 450 metric tonnes of tomato/day and caters to both domestic and export demand for tomato paste. The company works with about 650 tomato growers who, as per the contract, commit to providing good quality tomato produce at a predetermined price. The price is typically decided based on the APMC (*mandi*) rates and is announced to the farmer at the time of sowing the crop. On average, the price set by the company varies between INR 2.5–5.5/kg (≈ 4–7.5 cents/kg), corresponding to glut and supply shortage in the market. At the time of this study, the farmers attached with VA were offered the fixed price of INR 2.5/kg of tomatoes (reflecting glut in the market). While the contract requires the farmers to sell at least 50 percent of their produce to the company, the contract is not strictly enforced and the farmer has the discretion to decide the quantity to be sold. However, the balance of power to determine the price remains with the VA. The company insists on

[10] Three more sub-scenarios are possible under scenario 1 (i.e. $d_{RPAPMC} > d_{RPCF} \geq 0$, $d_{RPCF} > d_{RPAPMC} \geq 0$, and $d_{RPAPMC} = d_{RPCF} \geq 0$) and scenario 4 (i.e. $d_{RPAPMC} < d_{RPCF} \leq 0$, $d_{RPCF} < d_{RPAPMC} \leq 0$, and$d_{RPAPMC} = d_{RPCF} \leq 0$). When calculating the overall utility, we have captured the explicit interrelationships as well.

[11] This price is based on what we have found in our fieldwork.

[12] As on March 2017, of 305 APMCs in Maharashtra, tomato is traded in 74 APMCs spread across eight divisions – Amravati (3), Aurangabad (2), Kolhapur (12), Latur (2), Nagpur (9), Nasik (20), Pune (19) and Ratnagiri (7). Figures in parenthesis indicate the number of APMCs reporting tomato trade from the respective division.

[13] Block refers to the district sub-division in India and is commonly known as *tehsil*/*taluka*/*mandal*. Blocks are in the rural areas, while in urban areas, they are termed as wards.

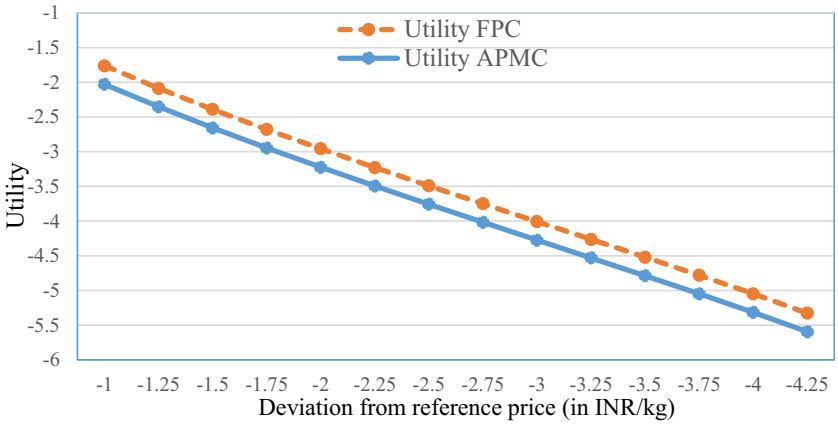

Fig. 2. Comparing utility for APMC vs. FPC channel. *Note:* Reference Price is INR 5/kg.

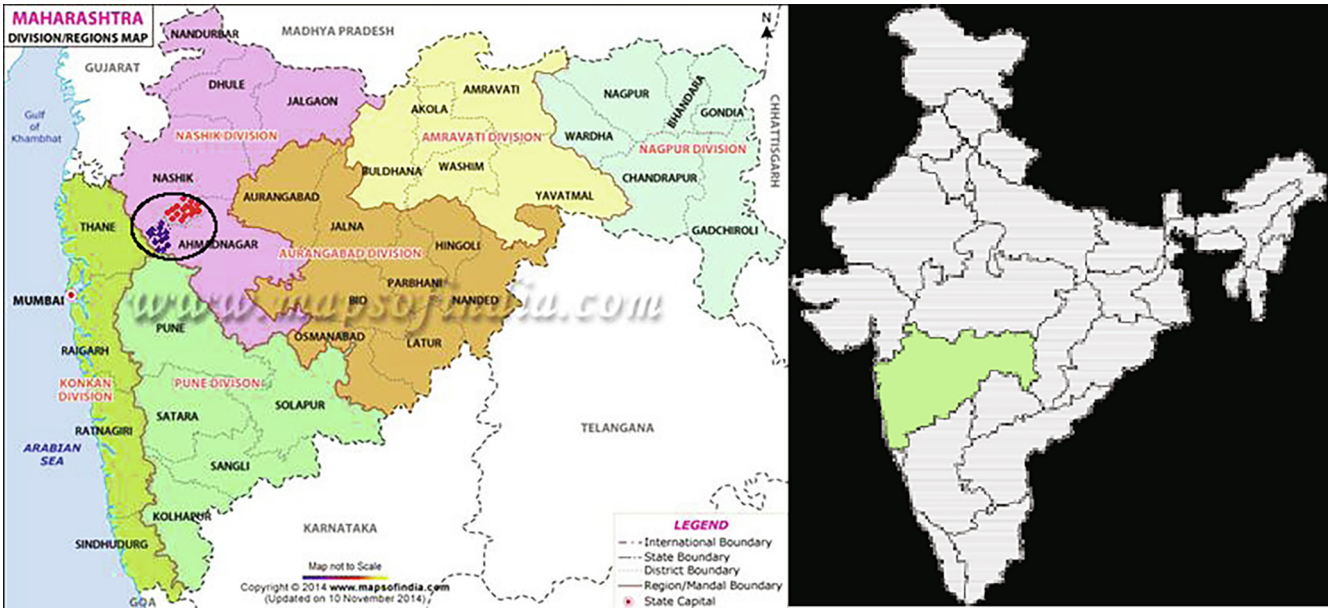

Fig. 3. Map showing the study area. *Note:* The specific location of the study area is encircled.

stringent quality requirements with tomatoes required to be bright red of a specific size. Typically, 10 percent of farmer's produce gets rejected on quality grounds.[14]

Besides training the farmers on good cultivation practices, the company also provides agro-inputs (such as seeds, fertilizers, pesticides) on a credit basis, primarily to needy farmers. Farmers can bring their produce to a few designated sites, known as collection centers, saving them the cost of transporting. In case if the village does not have a collection centre, then the farmer bears the cost of transportation. At the time of payment, the cost of the inputs is deducted, and the balance amount is paid to the farmer's bank account. The presence of VA has benefited farmers by providing them with an alternate sales outlet, besides offering an assured price.

4.3. FPC intervention – Devnadi Valley agricultural farmer Producer company Ltd

Devnadi Valley Agri FPC Ltd. (henceforth, *Devnadi*) is an NGO promoted FPC in the Sinnar block of Nasik district. The company was set-up in 2011 by local NGO, *Yuva Mitra*, which had been working on the restoration of traditional water management systems surrounding the area (since 2000). As of March 2017, *Devnadi* FPC had 839 members (from 16 villages) with a shareholding of INR 1500 (≈US$ 20) each. The average landholding of farmers associated with *Devnadi* is though, 1.6 ha, the distribution is skewed towards small farmers, as there are only ten farmers with landholding more than four hectares. As support, *Devnadi* first set-up Agri-Mall – a shop that sold all kinds of agriculture-related inputs such as seeds, fertilizers, pesticides, etc. and agricultural equipment including tractors, harvesters to its members at a reasonable price.[15] Consequently, the farmers' cultivation costs have significantly reduced as the farmers in our field survey reported savings of nearly 22 percent on their input costs.

Besides providing information on government schemes and subsidies, and improved farm practices, *Devnadi* has encouraged farmers to take up intensive cultivation of horticultural crops so that the farmers could fetch high prices in up-end nearby markets of Mumbai and Nasik. Besides directly selling the produce to resi-

[14] Source: Interview with the firm's officials and also corroborated by contracted farmers.

[15] Initially, the Agri-mall was for FPC members only. Of late, it is open for non-members too with the bulk of the business coming from them.

dential societies and hotel industry, it also sells the produce to Indian supermarkets. Farmers, however, are not involved in marketing their produce as they sell to *Devandi*, which further sells on commission[16] basis. The existing market linkages of *Devnadi* do not permit it to procure all produce from farmers; presently, around 25 percent of the farmer's produce is sold through it (the rest being sold through the APMC channel). As *Devnadi* does not offer an assured price to its members, the quantity sold is mostly decided on the given day price, which is typically higher than the prevailing price at the APMC.

As can be seen from Table 1 and above discussion, CF does well in mitigating the risk associated with downward price fluctuation by having a prior agreement on prices. Likewise, the FPC mobilizes mostly marginal and small farmers and helps in reducing their cultivation cost. It is important to note that there is huge heterogeneity in terms of how different CFs/FPCs operate in practice. A whole spectrum of FPCs exist – some homogenous in terms of operations, but more successful, and some with varied activities but with less success. Likewise, the contracting firms differ depending on the extent of vertical coordination being done, the terms and conditions of the contractual agreements, and the extent of participation of small farmers, among other factors. Despite the heterogeneity in how different CF or FPCs operate, the broad premise regarding their role as institutional innovations to provide support to the farmers holds.

4.4. Sample distribution

Of the surveyed 108 farmers, 35 farmers (32 percent) were selling their produce only through APMC channel, 40 farmers (37 percent) were selling to VA (CF channel) along with APMC channel, and the remaining 33 farmers (31 percent) were selling to *Devnadi*, along with selling to APMC channel.[17] In all the locations where we carried out our survey, the farmer had only two options to sell – either APMC and CF or APMC and FPC, but not all the three options.

4.5. Operationalizing distress selling

The issue of distress selling of horticulture crops is under-researched, and the limited number of studies that explicitly model the likelihood of distress selling have focussed on non-horticulture crops only (Murthy, 2011; Nadkarni, 1980; Sahu et al., 2004). For non-horticulture crops, it is relatively straightforward to quantify distress sales by benchmarking the average selling price against the pre-defined MSP. While there is no MSP for tomato, we define a hypothetical MSP (MSP*), on similar lines as is done for non-horticulture crops (Swaminathan, 2006). According to this, the sale price should be at least 50 percent more than the average cost of production. This implies that if the farmer's average selling price is less than MSP*, then the farmer is said to be making a distress sale.

Since this is a dichotomous outcome, where a farmer either makes a distress sale or not, the logistic (or logit) model is an appropriate analysis tool. The logistic model models the relationship between a binary dependent variable (farmer selling in distress or not) and a set of independent variables, binary or continuous. The following equation gives the logistic model for '*p*' independent variables ($X_1, X_2, X_3 \cdots ..X_p$):

$$L_i = \ln\left(\frac{P_i}{1-P_i}\right) = \alpha + \sum_{j=1}^{j=p} \beta_j X_j + \epsilon_i \quad (6)$$

The above equation (Eq. (6)) can be rewritten as follows:

$$\frac{P_i}{(1-P_i)} = e^{\alpha + \sum_{j=1}^{j=p} \beta_j X_j}, i = 1, 2, \cdots, n;\ j = 1, 2, \cdots, p \quad (7)$$

where, $\exp(\beta_j)$ indicates the odds ratio for a farmer having characteristic *j* versus not having *j*, while β_j is the regression coefficient, and α is constant.

Using a logistic regression model, we quantify the effect of factors influencing the distress selling of tomato produce. A dummy variable for each of the marketing channel ascertains the effect of the type of marketing channel (i.e., APMC/FPC/CF) on the likelihood of the farmer distress selling the produce.

As discussed in Section 3, and in line with prospect theory, it is hypothesized that odds of distress selling for farmers selling through CF and FPC channel would be less as compared to those selling through the APMC channel (APMC being the reference category).

4.6. Other factors influencing distress sale

There are several potential determinants of distress selling – such as farming experience, area under tomato cultivation, loan taken, etc. which needs to be controlled if we want to ascertain the effect of marketing channel on distress selling. The significance of these potential determinants of distress selling is explained below.

Land under tomato cultivation (Land_Tomato): We hypothesize that a farmer devoting a higher percentage of area under tomato cultivation can lower the cost of production (by achieving economies of scale) and also ensure better crop planning, management and cultivation practices, leading to a reduced likelihood of distress selling (Singh, 2002). However, at the same time, dedicating more area under a particular crop (tomato in this case) can make the farmer vulnerable to distress selling, especially in the event of a crash in market prices. So, *a priori*, the impact of the variable is not clear, and we will ascertain which of the above hypothesis would hold in this study.

Farming Experience (Tomato_Exp): We posit that for more years of tomato farming experience, the likelihood of distress selling would be less. This is so because as farming experience increases, the farmer would have built heuristics around do's and don'ts of tomato farming, thereby making them adept in preventing distress selling like condition (Briones, 2015).

Loan amount for Capital Assets (Loan_CA): Loan for capital assets are meant to finance the purchase of farm equipment such as tractors, bore-well, drip-irrigation systems, etc. Typically, in the absence of modern production technologies, farmers end-up operating at sub-optimal levels, leading to low productivity and farm income. Increased loan uptake by the farmer to finance private investment in agriculture can have favourable impact on productivity and incomes and thereby reduce the likelihood of distress selling (Akudugu, 2016). At the same time, availing more loans (to finance the purchase of capital assets) is a sign of increased indebtedness. In the event of a fall in prices, higher indebtedness can increase the likelihood of distress selling. Thus, the impact of this variable is not *a priori* clear.

Farmer Type (FT): We also ascertain the effect of land holding, captured by the farmer type – marginal farmer ($\leq$2.5 acres), small farmer (2.5 < land $\leq$ 5 acres), medium and large farmer (>5 acres). It is hypothesized that likelihood of distress selling will be more for

[16] The commission varies between 2.5 and 5 percent, subject to the prevailing market price. If the produce gets sold at a higher price, then *Devnadi* charges a higher commission and *vice versa* (Source: Telephonic discussion with *Devnadi*, Jan 2020). Singh & Singh (2014) have also reported a 3 percent commission charged by *Devandi*.

[17] In all, we surveyed 154 tomato farmers spanning two monsoonal years – 2016 and 2017. For the final analysis, we could use data of 108 farmers that were surveyed in 2017. This is because of significantly different agro-climatic conditions prevailing in the two years. Besides, the 46 left-out surveyed farmers were in an area where there was no CF and active FPC. We believed that their inclusion would have skewed the distribution of our sample in favour of APMC.

Table 3
Potential factors affecting distress selling of agri-produce.

S. No.	Variables	Description of Variable	Mean Values#	Hypothesized Relation
1.	Land_Tomato (%)	Percentage of Land under Tomato	25 (9.83)	(−)
2.	Tomato_Exp (years)	No. of years since engaged in tomato farming	6.58 (2.18)	(−)
3.	Edu (years)	Years of education of the farmer	9.33 (3.11)	(−/+)
4.	Age (years)	Age of the farmer	47.86 (7.50)	(−/+)
5.	Ln (Loan_CA)	Loan Amount for Capital Assets (in log)	11.58 (2.05)	(−/+)
6.	Farmer_Type (FT) (%)	FT1 (Marginal Farmer; Land $\leq$ 2.5 acres)	7	(+)
		FT2 (Small Farmer; Land > 2.5 & $\leq$5 acres)	62	(+)
		FT3 (Medium and Large Farmer; Land > 5 acres) (**reference category**)	31	(−)
7.	Marketing Channel (%)	1 = APMC (**reference category**)	35	(+)
		2 = CF	40	(−)
		3 = FPC	33	(−)
	Distress Selling (Dependent Variable)	1 = Farmer making a distress sale	52%	
		0, otherwise	48%	

Note: # – Figures in parenthesis are the standard deviations.

small and marginal farmers, given their low bargaining power and increased vulnerability due to scarcity of capital, limited access to formal credit, low quantities of marketable surplus and access to poor infrastructure facilities (Trebbin, 2014).

Age and Education: Finally, we also control for the effect of age of the farmer and farmer's education level. We hypothesize that with age (*Age*), the likelihood of distress selling reduces due to a better ability to manage risk. However, at the same time, with age, the farmer may not be able to keep pace with technological advances and improvements in cultivation practices, which may be crucial to alleviate the likelihood of distress selling (Cawley et al., 2018). Thus, *a priori* the effect of the age variable is inconclusive. However, the effect of education (*Edu*) on distress selling should be negative. As education captures the human capital aspect, so we hypothesize that it will have a positive effect on farmer's productivity, thereby improving income and reducing the likelihood of distress selling. However, existing studies in literature subscribe to mixed results of education on farm productivity (Paltasingh & Goyari, 2018).

Few other factors like transport infrastructure and storage availability can also have an impact on distress selling. The transport infrastructure is important, but in most cases, especially when the farmers are small, it is not owned by the farmer. Instead, a group of five to six farmers collectively hire a transport provider (a private operator). The provider charges a fixed amount (depending upon the distance) per crate for transporting the produce to the APMC/CF/FPC as the case may be. And with regards to storage, the role is limited for tomato as once harvested, the crop must be sold. While having storage infrastructure can reduce some post-harvest losses, having such infrastructure at the farmer level is not a feasible option. During our field survey, some farmers strongly put forth the need to access affordable cold storage facilities at the village level.

Thus, the final model between the set of independent variables and the logit of the dependent variable is represented as:

$$\begin{aligned}\text{logit}(\text{DistressSelling}) = a &+ b_1 * \text{Land\_Tomato} + b_2 * \text{Tomato\_Exp} \\ &+ b_3 * \text{Edu} + b_4 * \text{Age} + b_5 * \text{Ln(Loan\_CA)} \\ &+ b_6 * \text{Farmer\_Type} \\ &+ b_{7-8} * \text{MarketingChannel}_i + \epsilon_i \end{aligned} \quad (8)$$

The mean values and hypothesized relationships between the dependent and proposed explanatory variables are presented in Table 3.

4.7. Econometric issue

One key issue with the present analysis is self-selection, that is, relatively large farmers with more experience in tomato cultivation may be opting for CF or marginal farmers may be opting for FPC. We feel that our data does not suffer from self-selection bias for two reasons. First, the selling to CF or FPC channel is not dedicated, these farmers are simultaneously selling to the APMC channel also.[18] Second, the identified survey regions are such that the farmers from the region had either CF or FPC, but not both and a region which had only APMC (and did not have either CF or active FPC). Still, there is a possibility that in a region, certain kinds of farmers (having some unobservable characteristics) may be self-selecting to CF or FPC. To rule this out, we also performed the Wu-Hausman test of endogeneity and found that channel choice is exogenous.

5. Results

This section begins by describing the key differences between APMC and non-APMC farmers. Subsequently, we present the econometric analysis of the impact of alternate marketing channels on the likelihood of distress selling.

5.1. Characteristic differences between APMC farmers vs. CF/FPC farmers

Table 4 compares the characteristics of APMC and non-APMC farmers. A simple *t*-test is carried out to see whether the differences are statistically significant or not.

On average, the APMC farmers reported higher household income than CF and FPC farmers (row 9). However, annual income from tomato cultivation is highest for CF farmers (row 10), followed by FPC and APMC farmers. While there is considerable variability in the cost of tomato cultivation across farmers (row 8) (costs being highest for APMC farmers and lowest for CF farmers with differences statistically significant), the area under tomato cultivation across APMC and FPC marketing channels is similar (row 5) and quite small – <1 acre, whereas it is nearly 1.5 acres for CF farmers.

Since there is a considerable difference in cultivation cost across the three marketing channels, in Table 5, we provide its breakup across the channels. It is apparent from the table that CF farmers have a significantly lower cost of cultivation than APMC farmers. In contrast, there is hardly any difference in the cost of cultivation between FPC and APMC farmers.

As part of the survey, we asked the farmers the average, minimum, and maximum price they received for their produce from each marketing channel. It is seen (Table 6) that the price realized by the farmer is not only the highest in the case of CF channel, there is considerably less variation vis-a-vis FPC and APMC channel. Also, the maximum price that the CF farmers received on an

[18] Farmers attached to CF sell nearly 20 percent of their produce to VA and remaining to the APMC, whereas this percentage is 25 in the case of farmers selling to *Devnadi*.

Table 4
Characteristics of APMC and non-APMC tomato farmers.

		APMC farmers	CF farmers	FPC farmers	Test of Difference	
					APMC vs. CF	APMC vs. FPC
1	Household Size (persons)	5	4.38	4.48	2.44***	1.69**
2	Age of the household head (years)	49.43	43.95	50.94	3.81***	−0.79
3	Education of the household head (in years)	10.31	9.28	8.36	1.90**	2.37**
4	Owned Land (acres)	5.29	5.35	4.18	−0.10	1.62*
5	Land under Tomato (acres)	0.91	1.49	0.89	−5.56***	0.34
6	Tomato Farming Experience	8.17	5.05	6.73	7.86***	2.81***
7	No. of crops cultivated (Average in a year)	6.17	5.33	5.36	5.22***	4.47***
8	Cost of tomato cultivation (in INR per acre)	128,725	93,803	113,320	6.06***	2.88***
9	Annual household income (in INR)	458,292	270,636	255,000	4.42***	4.24***
10	Annual Income from tomato cultivation (in INR)	30,863	44,101	39,700	−4.48***	−2.47***

Data Source: Field survey.
Note: *, **, *** denotes significance at 10%, 5% and 1% level.

Table 5
Tomato Cultivation Costs and Returns across the three marketing channels.

	APMC (n = 35)		CF (n = 40)		FPC (n = 33)		Test of Difference	
	Average	S.D.	Average	S.D.	Average	S.D.	(APMC v/s CF)	(APMC v/s FPC)
Cultivation Costs (in INR per acre)	81,389 **(65)**	17,574	56,180 **(65)**	15,874	80,744 **(75)**	15,074	6.53***	0.16
• Raw Material Cost	11,763	2,238	12,693	3516	12,350	2653	−1.34*	−0.98
• Seed Cost	9,814	1,863	6,444	1,920	9,564	1,815	7.68***	0.56
• Machine Cost	5,374	2,397	4,593	1,460	5,921	1,482	1.73**	−1.12
• Manure Cost	4,886	4,886	3,220	1,261	4,788	1,521	4.78***	0.25
• Fertilizer Cost	16,466	3,794	9,821	3,397	17,455	5,056	8.00***	−0.92
• Plant Protection Cost	33,086	9,936	19,410	6,504	30,667	8,002	4.69***	1.10
Labour Cost (in INR per acre)	31,913 **(25)**	6,408	24,097 **(22)**	7,830	29,717 **(23)**	4,645	4.69***	1.61*
Transportation Charges (in INR per acre)	15,413 **(10)**	3,930	13,515 **(13)**	3,370	2,848 **(2)**	4,606	2.25**	12.12***
Total Costs Incurred (in INR per acre)	128,725	23,974	93,803	25,702	113,320	19,770	6.06***	2.88***
No. of Crates Harvested (per acre)	574	149	541	135	572	70	1.01	0.07
Yield (in kg per acre)	11,489	2974	10,812	2696	11,448	1410	1.03	0.07

Notes: (i) Figures in parenthesis (and in bold) represent percentage to the total cost; (ii) 1 crate of tomato weighs approximately 20 kg; *, **, *** denotes significance at 10%, 5% and 1% level.
Data Source: Field survey.

Table 6
Price fetched by farmers across three marketing channels.

	Price Realized by Farmer (in INR/kg)		
	Average price	Minimum price	Maximum price
APMC	2.94 (1.17)	1.29 (0.66)	4.94 (1.79)
CF	4.28 (0.45)	2.5 (0)	6.26 (0.33)
FPC	4 (0.97)	1.56 (0.51)	5.71 (1.39)
All farmers (overall average)	*3.76 (1.06)*	*1.81 (0.70)*	*5.67 (1.39)*

Note: Standard deviation figures are in parentheses.

average from selling their produce in the *mandi* (INR 6.26/kg) is higher than that of the APMC farmers. This difference could be attributed to the high-quality produce of CF farmers. Column 2 of the table gives the minimum price received by farmers across the channels, which is higher for the CF farmer and is fixed. This suggests the cushioning role played by the CF channel while prices crash in APMC.

5.2. Regression results – Impact of marketing channel on distress selling

Table 7 provides econometric estimates for the role of marketing channel in influencing distress selling by farmers. We report two sets of results – Model M1 is the independent effect of different explanatory variables (Eq. (8)) and Model M2 is M1 with an interaction term, where we have interaction between 'land under tomato' and 'farmer type', and posit that a marginal and small farmer with more land under tomato is more likely to fall in distress selling and *vice versa*.

As reported in Table 7, the effect of institutional innovations is as hypothesized. Selling agri-produce through CF (row 8) and FPC (row 9) channels has a significant negative impact on the likelihood of distress selling by farmers (across both the models). In terms of the odds ratio, vis-à-vis the APMC farmers, the odds of distress selling are 97 percent less for CF farmers and 91 percent less for FPC farmers (M1) (the corresponding figures for model M2 are 97 and 89 percent respectively). Further, the odds of distress selling fall by nine percent (32 percent for the model with interaction term) for farmers who dedicate a higher percentage of land for tomato farming (row 1). However, when the interaction effect (row 7) is considered, then the marginal and small farmers who dedicate a higher percentage of area under tomato cultivation are more prone to selling in distress. This is because tomato cultivation being a labour-intensive process, small and marginal farmers prefer to use their family labour to cut down on labour costs. However, if they dedicate a higher percentage of area under tomato cultivation (more than what their family labour can attend to), their costs increase significantly, making them more vulnerable to make a distress sale.

The positive coefficient for small and marginal farmers (row 6) (M1) suggests a greater likelihood of distress selling – odds being 380 percent higher for them *vis-a-vis* medium and large farmers. However, once we account for the interaction term with land under tomato (M2), the effect gets nullified as it is primarily those marginal and small farmers who rely more on tomato farming are

Table 7
Logistic Regression model parameter estimates and odds ratio.

	Variables	Model 1 (M1)		Model 2 (M2)	
		Parameter Estimates	Odds Ratio	Parameter Estimates (with interaction term)	Odds Ratio
1	Land_Tomato	−0.0984 (0.03)	0.91***	−0.3793 (0.21)	0.68**
2	Education	−0.089 (0.09)	0.91	−0.1057 (0.09)	0.90
3	Age	0.0023 (0.04)	1.01	−0.0016 (0.04)	1.01
4	Tomato_Exp	−0.1381 (0.15)	0.98	−0.0289 (0.15)	0.97
5	Ln(Loan_CA)	−0.0438 (0.17)	0.96	−0.0663 (0.18)	0.94
6	FT1 (Marginal & Small Farmer)#	1.5706 (0.78)	4.80**	−3.30 (3.33)	0.03
7	Land_Tomato*FT1	–	–	0.3024 (0.21)	1.35*
8	MktgType (CF)	−3.3832 (0.93)	0.03***	−3.4991 (0.94)	0.03***
9	MktgType (FPC)	−2.1435 (0.80)	0.09**	−2.2413 (0.80)	0.11**
10	Constant	4.86 (3.48)		9.76 (4.79)	
	PseudoR^2	0.3727		0.3958	
	Observations	108			
	Model significance tests				
	Likelihood Ratio	55.75 (dof: 8; prob > chi2 = 0.0000)		59.20 (dof: 9; prob > chi2 = 0.0000)	
	Wald Chi-sq	43.99 (dof: 8; prob > chi2 = 0.0000)		35.11 (dof: 9; prob > chi2 = 0.0000)	

Notes: Standard errors have been mentioned in parenthesis. # Since there were only seven 'marginal' farmers in our sample, for analysis purpose, they have been merged with 'small' farmer category. *, **, *** denotes significance at 10%, 5% and 1% level.

more likely to fall in distress. The effect of farmer specific factors such as farmer's age (row 3), education (row 2), farming experience (row 4) are not statistically significant. Though a literate farmer is less likely to fall in distress, the effect is not statistically significant.

The last two rows of Table 7 report test statistics - likelihood ratio and Wald test - both the test statistics follow chi-square distribution. They indicate how the independent variables together contribute to explain the outcome variable. The p-value for both the tests (<0.0001) indicates the significance of the models.

We also conduct the Hosmer and Lemeshow goodness of fit test to assess the fitted model (Mennard, 2010). For model M2, the statistic value is 7.51 (with corresponding p-value, 0.04825). Sensitivity, Specificity, and Area under the Receiver Operating Characteristic curve (AUC) values are also computed. Sensitivity describes the probability of the model predicting distress sale when the farmer has actually made one, and specificity is the probability that the model has correctly identified farmers who are not making a distress sale. AUC measures the association of predicted probabilities and observed responses. The optimum sensitivity and specificity values are 82.14 percent and 76.92 percent, respectively (at 0.50 cut-off probability), and the AUC value is 0.88, with all three indicators suggestive of good model performance.

5.3. Probability of selling in alternate marketing channels

The above analysis thus suggests that creating alternative markets for farmers alleviates the likelihood of distress selling. From a farmer's perspective, having access to more marketing channels apart from the conventional APMCs provides them the benefit of making an informed decision of selling their produce through their preferred channel.

As mentioned, sample farmers associated with CF/FPC channel sell a fixed percentage of their produce to these channels and the remainder to the APMC channel. In this section, we find the likelihood of the farmer selling additional portions to CF/FPC. As discussed in Section 3, this decision to sell the produce through a particular marketing channel depends on utility derived by the farmer, which in turn depends on multiple factors such as – price across the channel, deviation from reference price, cultivation costs, membership fees for a specific marketing channel, transportation cost and the additional utility/disutility (referred as C in the utility function) associated with attaching to a particular channel.

When harvesting, the farmer needs to decide the marketing channel where the produce would be sold. Since reference thinking assumes importance when choices are made under uncertainty (price uncertainty in our context), and the negative deviations are valued more than the positive deviations, while computing the probability for a CF/FPC farmer to sell additional produce to these alternate channels, we consider different scenarios of deviation of actual price from the reference price. Herein, we specifically discuss two scenarios – first, positive deviation from reference price in case of APMC and CF channels, and second, a case of negative deviation from reference price for both the channels.[19]

5.3.1. Scenario 1: Positive deviation from reference price for both APMC and CF channels

If there is a positive deviation from the reference price for both APMC and CF channels, i.e., both d_{RPAPMC} and $d_{RPCF} \geq 0$, under this scenario, the farmer will sell through the CF channel, when the utility derived by selling to CF is more than the APMC channel. This implies that,

$$(RP + |d_{RPCF}|)^{\alpha} - (CC_{CF} + TRAN_{CF})^{\beta} + (|d_{RPCF}|)^{\alpha} - C > (RP + |d_{RPAPMC}|)^{\alpha} - (CC_{APMC} + FEE_{APMC} + TRAN_{APMC})^{\beta} + (|d_{RPAPMC}|)^{\alpha} + C$$

On rearranging, we get:

$$C < \Big[(RP + |d_{RPCF}|)^{\alpha} - (CC_{CF} + TRAN_{CF})^{\beta} + (|d_{RPCF}|)^{\alpha} - (RP + |d_{RPAPMC}|)^{\alpha} + (CC_{APMC} + FEE_{APMC} + TRAN_{APMC})^{\beta} - (|d_{RPAPMC}|)^{\alpha}\Big]/2$$

Thus, the probability of opting for CF over APMC is:

$$F\Big(\Big[(RP + |d_{RPCF}|)^{\alpha} - (CC_{CF} + TRAN_{CF})^{\beta} + (|d_{RPCF}|)^{\alpha} - (RP + |d_{RPAPMC}|)^{\alpha} + (CC_{APMC} + FEE_{APMC} + TRAN_{APMC})^{\beta} - (|d_{RPAPMC}|)^{\alpha}\Big]/2\Big). \quad (9)$$

where F is the cumulative probability distribution of C.

Fig. 4 shows the probability of the CF farmer opting to sell additional quantity to the contracting firm for a reference price of INR 5/kg. If the price prevailing at APMC is INR 6.5/kg (corresponding to orange line in the graph), while the price offered by CF is INR 7.5/kg, still nearly 70 percent of the farmers would opt for APMC

[19] We do not discuss the positive price deviation for APMC and the negative deviation for CF (or FPC) channels. This is because, in such a scenario, everything will be sold through the APMC channel. The computations for APMC versus FPC channel are discussed in Appendix B.

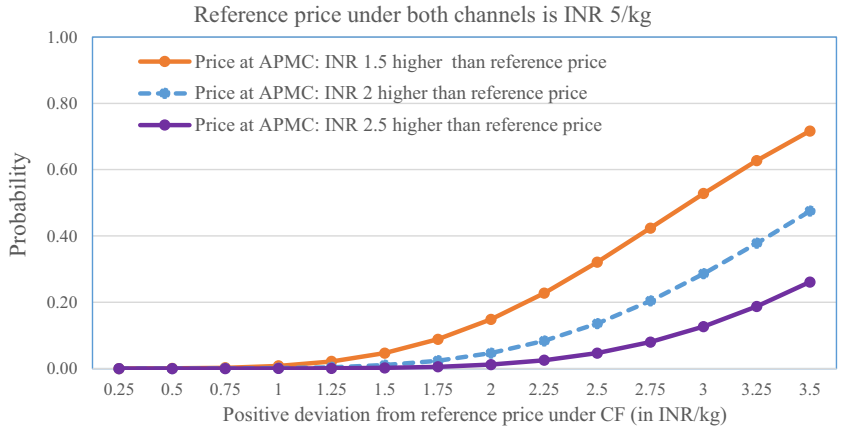

Fig. 4. Probability of farmer opting for CF channel over APMC: Case of Positive deviation from reference price.

channel. Imperfections in the functioning of CF channel could be the possible reasons for this behaviour. Inordinate delay in the settlement is one such imperfection, excessive emphasis on a particular type of tomato could be another. Both these issues came forth in our field survey also, as the average payment settlement cycle is 7–10 days (extended to 3–4 months in disputed cases) in CF, whereas it is 2–3 days in APMC. Regarding quality, a 10 percent rejection is a norm in CF, whereas all kinds of tomato, irrespective of quality, have a market in APMC.

Besides capturing the farmer's willingness to sell to CF channel, the above probability function (Eq. (9)), can also help the CF firm to determine the optimal price to get the desired number of farmers on board. Fig. 4 shows that for an APMC price of INR 6.5/kg (the orange line in the below graph), the CF firm has to offer 20 percent more (around INR 8/kg) to attract 50 percent farmers. Further, if the price at APMC rises to INR 8.5/kg (corresponding to the purple coloured line in the graph), then not even 20 percent of farmers would sell to CF at this price.

At this point, it is worthwhile to know the situation under which such a scenario can manifest. Typically, in the event of a supply shortfall, *mandi* prices go beyond the farmer's internal reference price (i.e., $d_{RPAPMC} \geq 0$). In such a situation, CF firm has two options - either to close the plant for not being able to pay such a price or pay farmers a higher price that ensures optimal use of their processing capacity. Since CF firms typically benchmark their prices based on the APMC prices, the likelihood of offering prices higher than the APMC prices is remote, unless there is increased competition among the firms. Having only one CF (or FPC) in fact works against the farmer also, as the farmer has limited bargaining power in the situation. Had there been two or more CF firms, farmers would have negotiated well, unless there is collusion (Bellemare, 2012).

5.3.2. Scenario 2: Negative deviation from reference price for both APMC and CF channels

For negative deviation from the reference price for both APMC and CF channels, i.e., $d_{RPAPMC}$and$d_{RPCF} < 0$,in such scenario, the farmer will choose the CF channel when,

‘

$$(RP - |d_{RPCF}|)^{\alpha} - (CC_{CF} + TRAN_{CF})^{\beta} - \lambda(|d_{RPCF}|)^{\beta} - C > (RP - |d_{RPAPMC}|)^{\alpha} - (CC_{APMC} + FEE_{APMC} + TRAN_{APMC})^{\beta} - \lambda(|d_{RPAPMC}|)^{\beta} + C$$

On rearranging, we get

$$C < \Big[(RP - |d_{RPCF}|)^{\alpha} - (CC_{CF} + TRAN_{CF})^{\beta} - \lambda(|d_{RPCF}|)^{\beta} - (RP - |d_{RPAPMC}|)^{\alpha} + (CC_{APMC} + FEE_{APMC} + TRAN_{APMC})^{\beta} + \lambda(|d_{RPAPMC}|)^{\beta}\Big]/2$$

Thus, the probability of opting for CF over APMC channel is:

$$F\Big(\Big[(RP - |d_{RPCF}|)^{\alpha} - (CC_{CF} + TRAN_{CF})^{\beta} - \lambda(|d_{RPCF}|)^{\beta} - (RP - |d_{RPAPMC}|)^{\alpha} + (CC_{APMC} + FEE_{APMC} + TRAN_{APMC})^{\beta} + \lambda(|d_{RPAPMC}|)^{\beta}\Big]/2\Big) \quad (10)$$

where F is the cumulative probability distribution of *C*.

In this scenario, when the actual price received by the farmer is below the internal reference price, it serves as a fertile ground for distress selling like condition. Fig. 5 plots the probability of farmer selling additional produce to CF channel given such a scenario. Since the farmer is in the loss domain, the probability distribution curve is steep (because of the high value of loss aversion coefficient, λ, as losses loom larger than gains).

For example, if the APMC price is INR 3.5/kg (corresponding to the orange line in the graph) and the CF price is nearly 15 percent more (i.e., INR 4/kg), then the probability of CF farmer opting to sell additional produce to the CF channel is 50 percent. Further, if the APMC prices decline to INR 2.5/kg, over 90 percent of CF farmers would prefer to sell the remaining output to the CF channel at this offered price (corresponding to the purple coloured line in the graph). Despite being offered only a marginal increment in price by the CF channel, farmers show increased willingness to sell to CF over APMC. The utility gained by fetching INR 0.5/kg extra is much more in the loss domain than the gain domain scenario. This is in line with the loss aversion characteristic of the farmer. From CF firm's perspective, if the APMC price is INR 3.5/kg, then for the firm to attract about half of the farmers from a given area, it would need to offer merely a 15 percent increase. Further, if the APMC prices decline to INR 2.5/kg, then over 90 percent of farmers would switch to CF. This suggests that in the loss domain, a little reward (to the farmer) could lead to substantial gain (for the firm).

Figures B1 and B2 in Appendix B plot the probability of the FPC farmer to sell additional quantity to FPC channel for positive and negative deviation, respectively. In the case of negative deviation, FPC, primarily being a farmers' body, is in a better position to negotiate a better price (as against individual farmers) with the bulk buyers and, hence, the increased probability of farmers selling to the FPC channel against APMC channel. And as previously

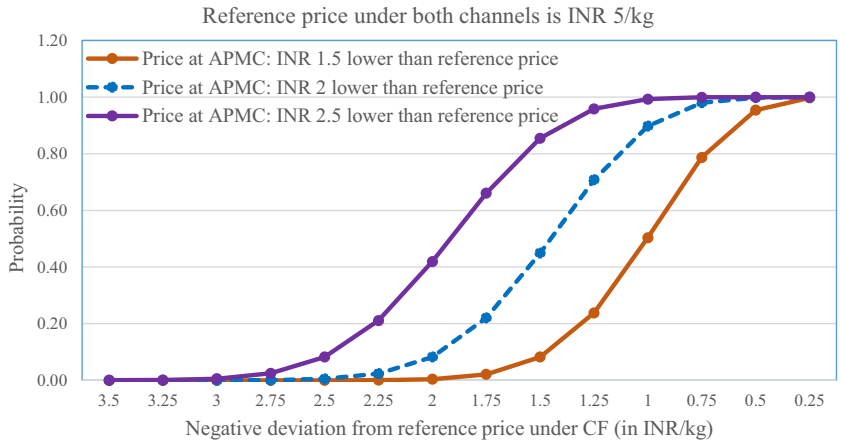

Fig. 5. Probability of farmer opting for CF channel over APMC: Case of Negative deviation from the reference price.

mentioned, the additional utility of fetching marginally more price is much more in the loss domain than the gain domain scenario.

6. Discussion and conclusions

This study highlighted the role of institutional innovations in agricultural marketing that reduces the likelihood of distress selling for small and marginal farmers. In India, while the conventional marketing channel (i.e., APMCs) was set up with the best of intentions, through the Adoption of APMC Act in the 1960 s and 1970 s, to address the village trader dominated exploitative system, evidence exists that it failed to serve the objective of achieving price discovery fairly and transparently (Kapur & Krishnamurthy, 2014; Reardon & Minten, 2011). On the contrary, the APMCs got captured by the special interest groups that they were meant to control.

Of late, there has been increased interest in alternate agri-food marketing systems (such as contract farming, CF and farmer producer companies, FPCs) that not only provide for better price discovery but also help in building capacity of small farmers to facilitate their participation in globalized market environments (Trebbin, 2014; World Bank, 2007). The recent period has also witnessed a focal shift of government policy from production enhancement to agricultural marketing reforms. These reforms have been implemented through the model APMC Act of 2003, the Model Agricultural Produce and Livestock Marketing (APLM) Act of 2017, and the most recent Contract Farming Act, 2018. The spirit behind these Acts is to reduce intermediaries between farmers and buyers and boost farm incomes.

In this paper, we posited that institutional innovations through CF and FPC could serve as an effective strategy to alleviate distress selling by small and marginal farmers in India. We build on Kahneman & Tversky's (1979) pioneering work on prospect theory, as per which a farmer reacts more severely to losses than to gains. We use this insight to compare the farmer's overall utility in selling the produce through CF or FPC channel vis-à-vis the APMC channel. Logit analysis of a primary survey of 108 tomato farmers in the Western state of India, Maharashtra suggests that selling through these alternate marketing channels alleviates the likelihood of distress selling. The study also finds that while the odds of distress selling are more for marginal and small farmers, they reduce once their attachments with alternate marketing channels are accounted for.

By design, the CF and FPC institutions reduce the multiple intermediaries, thereby reducing the transaction costs for the small farmers (Mugwagwa et al., 2020; Simmons et al., 2005). The findings establish the loss aversion characteristic of the farmer as the assured price offered under CF protects them against losses in the event of downward spiral in spot-market prices. Likewise, assured savings in cultivation cost and collective marketing through FPC improve the farmer's bargaining power, thereby fetching a better price for their produce.

It is well acknowledged that market access is a major impediment for most small-scale farmers, and they get little protection against a glut when they sell in the conventional marketing channel. The study's findings highlighted the need to implement enabling reforms to expand small farmers' marketing choices. The study also provided insights into the role of loss aversion in explaining the farmers' choice of marketing channel. The simulation exercise showed that when farmers experience positive price deviation for both CF and APMC channels (i.e., in the gain domain), they value selling to spot markets, as they prefer immediate cash vis-a-vis choosing an option that though offers competitive price, yet increases the payment-cycle. In contrast, in case of negative deviation, the farmers stick to the option which shields them from extreme losses. Thus, the findings are helpful in understanding farmers' behaviour, on the basis of which the contracting firms and FPCs could frame pricing strategies to attract more farmers.

As this study calls for implementing reforms in the agricultural marketing sector, it is essential to understand the existing ecosystem in which the institutional innovations of CF and FPC operate. Though the first known CF example in India was in the late 1980s, yet until recently, significant entry barriers existed to set up contracting firms (/private markets yards).[20] As a consequence of such barriers, the CF firm often becomes the sole buyer and farmers turn into price-takers resulting in monopsony like condition, which contracting firms exploit to their advantage. Singh (2013) finds that one key reason for the success of CF in gherkins in Karnataka, India is the existence of over two-dozen CF companies in the state. This implies that entry barriers to setting up new contracting firms need to be lowered. The Contract Farming Act, 2018, is a step in that direction as it proposes a state-level agency, the Contract Farming (Development and Facilitation) Authority, which would put the CF outside the ambit of the APMCs. While policies like these serve to address the imperfections in agricultural markets, it is equally important to regulate (and not merely facilitate) the CF

[20] Under the Model APMC Act 2003, a direct marketing license could be given to bulk buyers and CF ventures. However, the Act could not address the monopoly of APMCs, for as per the Act, setting up a CF firm (or private market yard) in an area under a particular APMC's jurisdiction required obtaining a license from the concerned APMC, which acted as a deterrent to setting up agribusiness firms.

firms' contracts with farmers, so that they do not end-up accepting unfair terms. Studies in the past have documented concerns regarding non-transparent pricing, contract-breaching - especially violation of agreed price, and the issue of delayed payments (da Silva et al., 2013). One way to safeguard the interest of farmers is to implement responsible CF agreements (Singh, 2018).

Regarding FPCs, they are unique as they strive to combine cooperative principles with professional business management practices (Bernard & Spielman, 2009; Trebbin, 2014). However, there are concerns regarding how FPCs are being promoted – typically by NGOs, who have very little business acumen. The strength of these NGOs is community mobilization, but they have no insights on the market, creating a value chain, and making a business plan. The FPCs are also known to face operational problems like low equity base, poor marketing[21] and value addition expertise, lack of vision, and inept leadership (Shah, 2016; Singh & Singh, 2014; Trebbin & Hassler, 2012),[22] which has severely affected their ability to offer competitive prices to members.

In cognizance of these concerns, there is a dire need to create a conducive ecosystem. This can happen by way of lowering entry barriers for CF firms, providing subsidy on capital cost for CF firms (and FPCs, if they venture into processing), enabling access to low-cost working capital funds to FPCs from banks, and training and capacity building of FPC members on running the organisation and business planning. And from the farmers' point of view, it is vital to have a mechanism for conflict resolution, grievance redressal and monitoring and regulation of CF/FPC projects.

While increasing farmers' marketing choice is important, their ability to exercise control over the price they receive is also vital to alleviate distress selling. For instance, strengthening the negotiating power of farmers by making them capable of defending their interests could be achieved by encouraging CFs/FPCs to take up group contracts rather than individual farmers signing contracts with firms, as has been practiced in state of Gujarat (India) for potato crop. Group contracts are found to be instrumental in curbing opportunistic behaviour by firms, reducing transaction costs for farmers, while ensuring consistent supply by the farmers to the firm (Mugwagwa et al., 2020; Singh, 2018).

To conclude, this study has shown the role of institutional innovations in addressing the issue of distress selling by farmers. However, at the same time, the need to strengthen the existing institutions of APMCs is paramount. This is because a substantial share of agri-trade (around 60–70 percent in our study area, Nasik District) happens through APMCs. In this regard, successful implementation of the e-NAM (electronic National Agriculture Market) platform for APMC markets is critical as it will provide more options to farmers to sell their produce, especially at the time of bumper crop, while helping in doing away with the constraint of farmers selling their produce to nearby APMCs only.

The study, though, gives valuable policy insights, has a few limitations. The study's findings are limited in scope since we were able to survey only a small number of farmers and focus only on one particular crop, tomato. Besides, the farmers surveyed were associated with only one CF/FPC intervention. The results will have far-reaching implications if similar kind of studies is carried out elsewhere for other crops, for other regions and covering regions which have multiple CFs/FPCs. Another limitation of the present study is that it could not segregate small and marginal farmers due to the small sample size. It would be important to see in future work whether marginal farmers also benefit from these interventions or not. Finally, the probability functions developed to ascertain the likelihood of farmers opting for alternate marketing channels needs to be validated with real-life data captured from field experiments with farmers.

[21] For instance, farmers associated with *Devnadi* reported that it has been unable to procure the entire produce from them, due to lack of adequate institutional linkages.

[22] For these reasons, nearly 1000 FPCs in Maharashtra (of the total 1700 registered) have either reported no business or are non-functional (Source: https://indianexpress.com/article/cities/pune/over-1000-fpcs-in-maharashtra-non-functional-or-report-zero-business-5753624/).

Author Contribution

All authors discussed the results among themselves and contributed to the final manuscript. This Authorship statement is approved by all the three authors. Thank you.

CRediT authorship contribution statement

Disha Bhanot: Conceptualization, Funding acquisition, Methodology, Data Curation, Formal Analysis, Writing- Original draft preparation, Visualization. **Vinish Kathuria:** Conceptualization, Funding acquisition, Methodology, Formal Analysis, Writing - Review & Editing, Visualization, Data Curation, Supervision, Project administration. **Debabrata Das:** Methodology, Formal Analysis, Visualization, Writing - Review & Editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgments

This research work has been funded by Sir Dorabji Tata Trust through Tata Centre for Technology and Design, IIT Bombay. We acknowledge with thanks the support. We would like to extend sincere thanks to the farmers from the state of Maharashtra, India, who whole-heartedly participated in this study. Also, we are grateful to members of farmer producer companies and contract farming in Maharashtra, with whom we closely interacted throughout this study. An earlier version of the paper was presented in the first Sustainable Development Conference (SDC) held at the University of Michigan, Ann Arbor, during Nov. 2018. We are thankful to conference participants for useful comments and suggestions. The usual disclaimers apply.

Appendix A

Appendix B

Scenario 1: Positive deviation from reference price for both APMC and FPC channels

If there is a positive deviation from the reference price for both APMC and FPC channels, i.e., d_{RPAPMC} and $d_{RPFPC} \geq 0$. Under this scenario, the farmer will sell through the FPC channel, when the utility derived by selling to FPC is more than the APMC channel. This implies that,

$$(RP + |d_{RPFPC}|)^{\alpha} - (CC_{FPC} + FEE_{FPC} + TRAN_{FPC})^{\beta} + (|d_{RPFPC}|)^{\alpha} - C > (RP + |d_{RPAPMC}|)^{\alpha} - (CC_{APMC} + FEE_{APMC} + TRAN_{APMC})^{\beta} + (|d_{RPAPMC}|)^{\alpha} + C$$

Appendix A

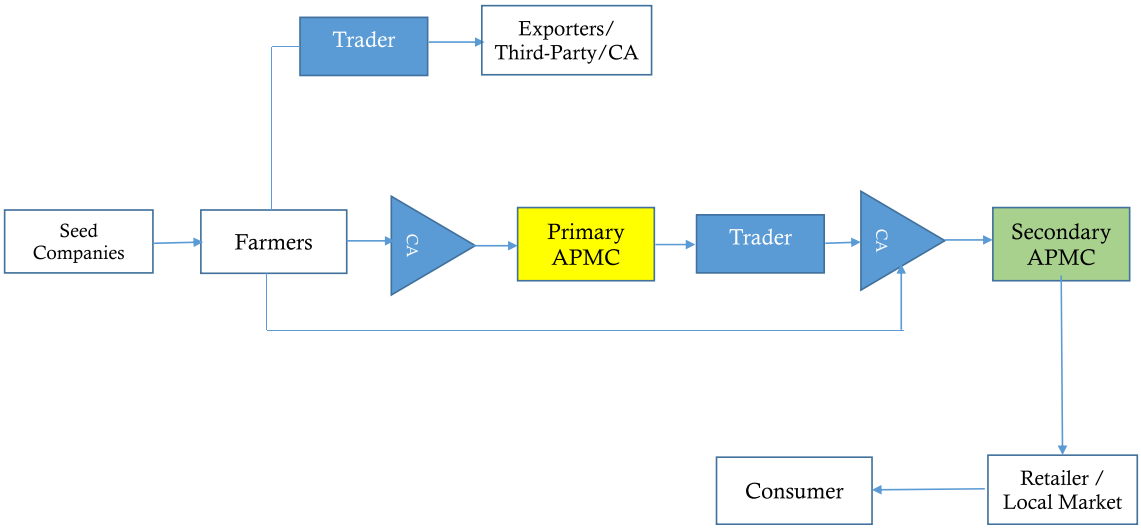

Fig. A1. Agri-supply chain for APMC channel. *Notes*: CA stands for Commission Agent (commonly known as *arthiya*) and acts as a middle-men between the farmer/grower and the buyer. Primary markets are the first place of transaction between the farmers and the buyers of their produce; in secondary markets (/ Secondary APMC) traders or aggregators bring in produce directly from farmers, either from their door-steps or from primary markets and trade happens between them and retailers (Figs. A1-A3).

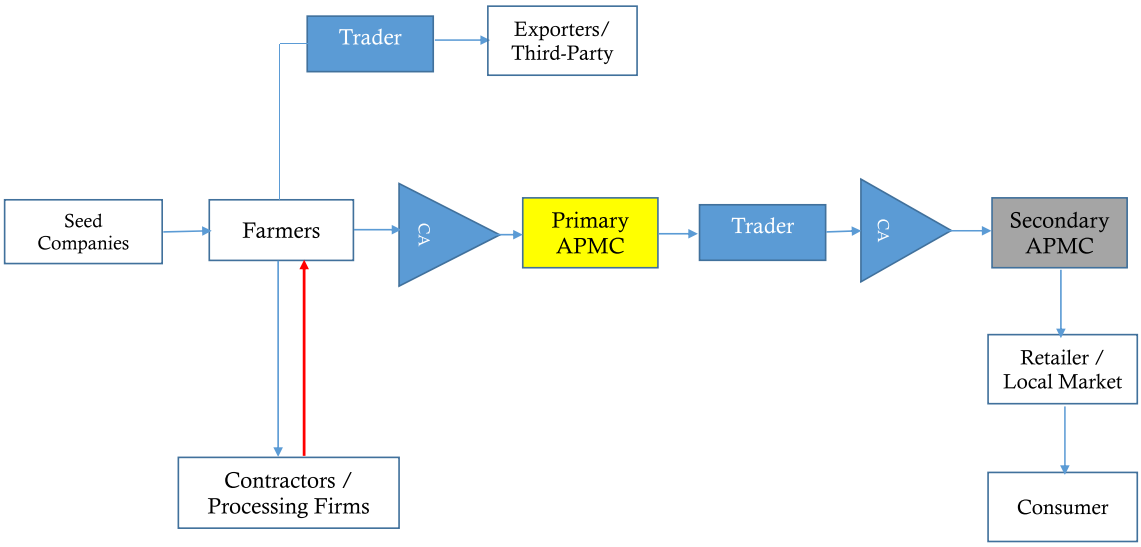

Fig. A2. Agri-supply chain for CF channel. *Note*: Red arrow indicates that CF firms provide farm inputs, technical advice, pre- and post-harvest infrastructure and information to growers.

i.e.,

$$2C < (RP + |d_{RPFPC}|)^{\alpha} - (CC_{FPC} + FEE_{FPC} + TRAN_{FPC})^{\beta} + (|d_{RPFPC}|)^{\alpha} - (RP + |d_{RPAPMC}|)^{\alpha} + (CC_{APMC} + FEE_{APMC} + TRAN_{APMC})^{\beta} - (|d_{RPAPMC}|)^{\alpha}$$

i.e.,

$$C < \left[(RP + |d_{RPFPC}|)^{\alpha} - (CC_{FPC} + FEE_{FPC} + TRAN_{FPC})^{\beta} + (|d_{RPFPC}|)^{\alpha} - (RP + |d_{RPAPMC}|)^{\alpha} + (CC_{APMC} + FEE_{APMC} + TRAN_{APMC})^{\beta} - (|d_{RPAPMC}|)^{\alpha}\right]/2$$

Thus, the probability of opting for FPC over APMC is

$$[(RP + |d_{RPFPC}|)^{\alpha} - (CC_{FPC} + FEE_{FPC} + TRAN_{FPC})^{\beta} + (|d_{RPFPC}|)^{\alpha} - (RP + |d_{RPAPMC}|)^{\alpha} + (CC_{APMC} + FEE_{APMC} + TRAN_{APMC})^{\beta} - (|d_{RPAPMC}|)^{\alpha})]/2)$$

where F is the cumulative probability distribution of C.

Scenario 2: Negative deviation from reference price for both APMC and FPC channels

For negative deviation from the reference price for both APMC and FPC channels, i.e., d_{RPAPMC} and $d_{RPFPC} < 0$. In such scenario, the farmer will choose selling through the FPC channel when,

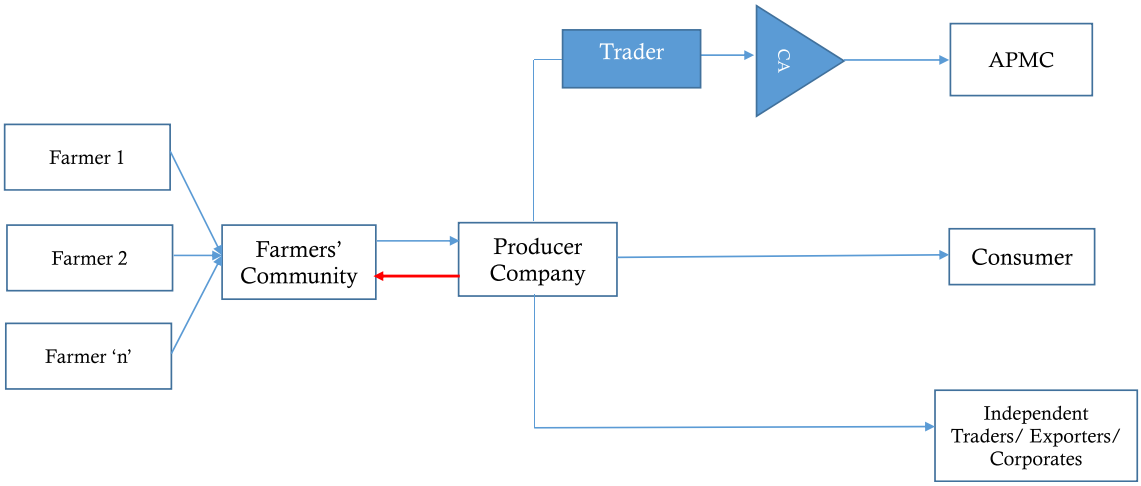

Fig. A3. Agri-supply chain for FPC channel. *Note*: Red arrow indicates the range of services provided by the FPC to farmers, such as Organizational, Production, Marketing, Financial, Technology, Management of resources and Policy advocacy.

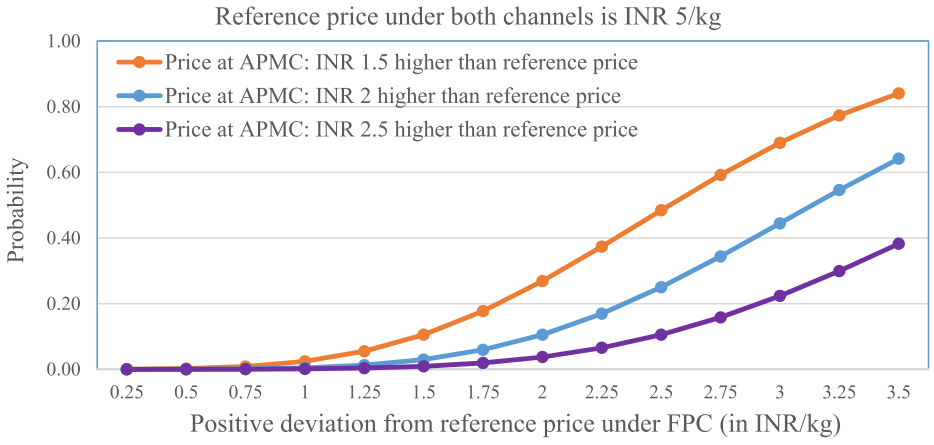

Fig. B1. Probability of farmer opting for FPC channel over APMC: Case of Positive deviation from reference price.

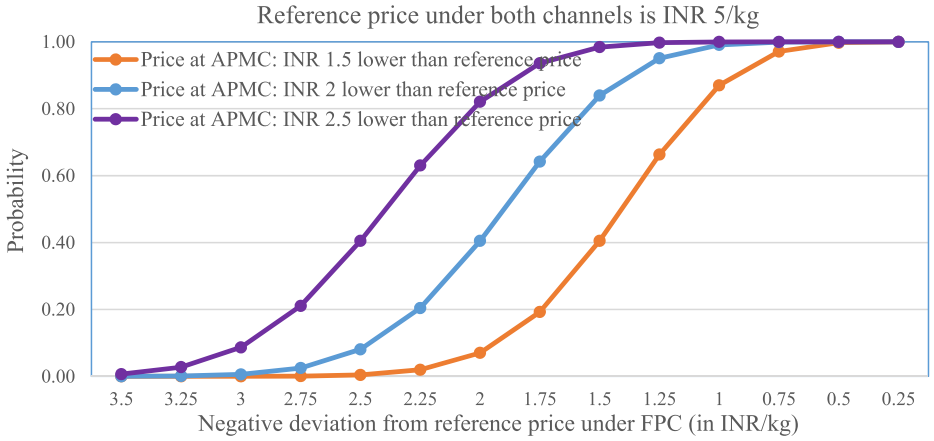

Fig. B2. Probability of farmer opting for FPC channel over APMC: Case of Negative deviation from reference price.

$$(RP - |d_{RPFPC}|)^{\alpha} - (CC_{FPC} + FEE_{FPC} + TRAN_{FPC})^{\beta} - \lambda(|d_{RPFPC}|)^{\beta} - C > (RP - |d_{RPAPMC}|)^{\alpha} - (CC_{APMC} + FEE_{APMC} + TRAN_{APMC})^{\beta} - \lambda(|d_{RPAPMC}|)^{\beta} + C$$

i.e.,

$$2C < (RP - |d_{RPFPC}|)^{\alpha} - (CC_{FPC} + FEE_{FPC} + TRAN_{FPC})^{\beta} - \lambda(|d_{RPFPC}|)^{\beta} - (RP - |d_{RPAPMC}|)^{\alpha} + (CC_{APMC} + FEE_{APMC} + TRAN_{APMC})^{\beta} + \lambda(|d_{RPAPMC}|)^{\beta}$$

i.e.,

$$C < \Big[(RP - |d_{RPFPC}|)^{\alpha} - (CC_{FPC} + FEE_{FPC} + TRAN_{FPC})^{\beta} - \lambda(|d_{RPFPC}|)^{\beta} - (RP - |d_{RPAPMC}|)^{\alpha} + (CC_{APMC} + FEE_{APMC} + TRAN_{APMC})^{\beta} + \lambda(|d_{RPAPMC}|)^{\beta}\Big]/2$$

Thus, the probability of opting for FPC (over APMC channel) is

$$[(RP - |d_{RPFPC}|)^{\alpha} - (CC_{FPC} + FEE_{FPC} + TRAN_{FPC})^{\beta} - \lambda(|d_{RPFPC}|)^{\beta} - (RP - |d_{RPAPMC}|)^{\alpha} + (CC_{APMC} + FEE_{APMC} + TRAN_{APMC})^{\beta} + \lambda(|d_{RPAPMC}|)^{\beta}]/2)$$

where F is the cumulative probability distribution of C.

References

Akudugu, M. A. (2016). Agricultural productivity, credit and farm size nexus in Africa: A case study of Ghana. *Agricultural Finance Review, 76*(2), 288–308.

Al Shriaan, A., & Hassan, M. (2018). India's Agriculture Growth: A Critical Review. *European Journal of Social Sciences, 57*(2), 193–201.

Andersson, C. I. M., Chege, C. G. K., Rao, E. J. O., & Qaim, M. (2015). Following Up on Smallholder Farmers and Supermarkets in Kenya. *American Journal of Agricultural Economics, 97*(4), 1247–1266.

Apergis, N., & Rezitis, A. (2003). Agricultural price volatility spillover effects: The case of Greece. *European Review of Agricultural Economics, 30*(3), 389–406.

Barham, J., & Chitemi, C. (2009). Collective action initiatives to improve marketing performance: Lessons from farmer groups in Tanzania. *Food Policy, 34*(1), 53–59.

Bellemare, M. F. (2012). As you sow, so shall you reap: The welfare impacts of contract farming. *World Development, 40*(7), 1418–1434.

Bellemare, M. F., & Novak, L. (2017). Contract farming and food security. *American Journal of Agricultural Economics, 99*(2), 357–378.

Bernard, T., & Spielman, D. J. (2009). Reaching the rural poor through rural producer organizations? A study of agricultural marketing cooperatives in Ethiopia. *Food Policy, 34*(1), 60–69.

Biénabe, E., and Sautier, D. (2005). The role of small scale producers' organizations in addressing market access. Beyond Agriculture: Making Markets Work for the Poor, Eds FR Almond, SD Hainsworth

Bolwig, S., Gibbon, P., & Jones, S. (2009). The economics of smallholder organic contract farming in tropical Africa. *World Development, 37*(6), 1094–1104.

Briones, R. M. (2015). Small farmers in high-value chains: Binding or relaxing constraints to inclusive growth?. *World Development, 72*, 43–52.

Cawley, A., O'Donoghue, C., Heanue, K., Hilliard, R., Sheehan, M., & Stefanou, S. (2018). The impact of extension services on farm-level income: An instrumental variable approach to combat endogeneity concerns. *Applied Economic Perspectives and Policy, 40*(4), 585–612.

Chamberlin, J., & Jayne, T. S. (2013). Unpacking the meaning of 'market access': evidence from rural kenya. *World Development, 41*, 245–264.

Chand, R., Raju, S. S., & Pandey, L. M. (2007). Growth crisis in agriculture: Severity and options at national and state levels. *Economic and Political Weekly, 42*(26), 2528–2533.

Chand, R. (2012). Development Policies and Agricultural Markets. *Economic and Political Weekly, 47*(52), 53–63.

Chand, R., & Singh, J. (2016). Agricultural marketing and farmer friendly reforms across Indian states and UTs. Report by National Institution for Transforming India (NITI) Ayog, New Delhi.

Chatterjee, S., & Kapur, D. (2016). *Understanding Price Variation in Agricultural Commodities in India: MSP, Government Procurement, and Agriculture Markets*. National Council of Applied Economic Research, Delhi: India Policy Forum.

Chege, C. G. K., Andersson, C. I. M., & Qaim, M. (2015). Impacts of supermarkets on farm household nutrition in kenya. *World Development, 72*, 394–407.

Cherukuri, R. R., & Reddy, A. A. (2014). Producer organisations in indian agriculture: their role in improving services and intermediation. *South Asia Research, 34*(3), 209–224.

Clapp, R. A. J. (1988). Representing reciprocity, reproducing domination: Ideology and the labor process in Latin American contract farming. *Journal of Peasant Studies, 16*(1), 5–39.

Dev, S. M. (2014). *Small farmers in India: Challenges and opportunities* WP-2012-014. Mumbai: Indira Gandhi Institute of Development Research.

Escobal, J. A., & Cavero, D. (2012). Transaction costs, institutional arrangements and inequality outcomes: Potato marketing by small producers in Rural Peru. *World Development, 40*(2), 329–341.

Fischer, E., & Qaim, M. (2012). Linking smallholders to markets: Determinants and impacts of farmer collective action in Kenya. *World Development, 40*(6), 1255–1268.

GoI, (2019). *All India Report on Number and Area of Operational Holdings, Agriculture Census 2015–16*. Government of India (GoI): Ministry of Agriculture and Farmers Welfare.

Hellin, J., Lundy, M., & Meijer, M. (2009). Farmer organization, collective action and market access in Meso-America. *Food Policy, 34*(1), 16–22.

Hernández, Ricardo, Reardon, Thomas, & Berdegué, Julio (2007). Supermarkets, wholesalers, and tomato growers in Guatemala. *Agricultural Economics, 36*(3), 281–290.

Ito, Junichi, Bao, Zongshun, & Su, Qun (2012). Distributional effects of agricultural cooperatives in China: Exclusion of smallholders and potential gains on participation. *Food Policy, 37*(6), 700–709.

Jones, Sam, & Gibbon, Peter (2011). Developing agricultural markets in sub-saharan africa: organic cocoa in rural uganda. *Journal of Development Studies, 47*(10), 1595–1618.

Kaganzi, Elly, Ferris, Shaun, Barham, James, Abenakyo, Annet, Sanginga, Pascal, & Njuki, Jemimah (2009). Sustaining linkages to high value markets through collective action in Uganda. *Food Policy, 34*(1), 23–30.

Kahneman, Daniel, & Tversky, Amos (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47*(2), 263. https://doi.org/10.2307/1914185.

Kapur, D., & Krishnamurthy, M. (2014). *Understanding mandis: Market towns and the dynamics of India's rural and urban transformations. Working Paper no.: F-35007-INC-1, International Growth Centre*. London: London School of Economics.

Kaur, P., & Singla, N. (2018). Can contract farming double farmers' Income? *Economic and Political Weekly, 53*(51), 67–75.

Kherallah, M., Delgado, C., Gabre-Madhin, E., Minot, N., & Johnson, M. (2002). *Reforming markets in Africa: Achievements and Challenges*. International Food Policy Research Institute.

Little, P. D., & Watts, M. (Eds.). (1994). *Living under contract: contract farming and agrarian transformation in sub-Saharan Africa*. London, England: University of Wisconsin Press.

MacDonald JM, Perry J, Ahearn M, Banker D, Chambers W, et al. (2004). Contracts, markets, and prices: Organizing the production and use of agricultural commodities. UDA-ERS Agricultural Economic Report 837.

Maertens, Miet, & Swinnen, Johan F. M. (2009). Trade, Standards, and Poverty: Evidence from Senegal. *World Development, 37*(1), 161–178.

Markelova, H., Meinzen-Dick, R., Hellin, J., & Dohrn, S. (2009). Collective action for smallholder market access. *Food Policy, 34*(1), 1–7.

Mennard, S. (2010). *Logistic Regression: From Introductory to Advanced Concepts and Applications*. Thousand Oaks, CA: Sage.

Miyata, Sachiko, Minot, Nicholas, & Hu, Dinghuan (2009). Impact of contract farming on income: Linking small farmers, packers, and supermarkets in China. *World Development, 37*(11), 1781–1790.

Mugwagwa, Innocent, Bijman, Jos, & Trienekens, Jacques (2020). Typology of contract farming arrangements: A transaction cost perspective. *Agrekon, 59*(2), 169–187.

Murthy, R. R. (2011). Paddy glut and farmer distress in andhra pradesh. *Economic and Political Weekly, 46*(29), 27–29.

Nadkarni, M. V. (1980). Marketable surplus and market dependence: A millet region of Maharashtra. *Economic and Political Weekly, 15*(13), A13–A24.

Narayanan, Sudha (2014). Profits from participation in high value agriculture: Evidence of heterogeneous benefits in contract farming schemes in Southern India. *Food Policy, 44*, 142–157.

Narrod, Clare, Roy, Devesh, Okello, Julius, Avendaño, Belem, Rich, Karl, & Thorat, Amit (2009). Public–private partnerships and collective action in high value fruit and vegetable supply chains. *Food Policy, 34*(1), 8–15.

Neven, David, Odera, Michael Makokha, Reardon, Thomas, & Wang, Honglin (2009). Kenyan supermarkets, emerging middle-class horticultural farmers, and employment impacts on the rural poor. *World Development, 37*(11), 1802–1811.

OECD (2018). Agricultural Policies in India. *OECD Food and Agricultural Reviews, OECD Publishing, Paris., 2020*. https://doi.org/10.1787/9789264302334-en (accessed 9 Jan.

Otsuka, Keijiro, Nakano, Yuko, & Takahashi, Kazushi (2016). Contract farming in developed and developing countries. *Annu. Rev. Resour. Econ., 8*(1), 353–376.

Paltasingh, K. R., & Goyari, P. (2018). Impact of farmer education on farm productivity under varying technologies: Case of paddy growers in India. *Agricultural and Food Economics, 6*(7), 1–19.

Pingali, P., Khwaja, Y., & Meijer, M. (2005). Commercializing Small Farms: Reducing Transaction Costs. Agricultural and Development Economics Division, FAO, Rome, Italy (ESA Working Paper No. 05–08).

Poulton, Colin, Dorward, Andrew, & Kydd, Jonathan (2010). The future of small farms: new directions for services, institutions, and intermediation. *World Development, 38*(10), 1413–1428.

Rao, Elizaphan J. O., & Qaim, Matin (2011). Supermarkets, farm household income, and poverty: insights from kenya. *World Development, 39*(5), 784–796.

Reardon, T. A., & Minten, B. (2011). The quiet revolution in India's food supply chains. *International Food Policy Research Institute (IFPRI) Discussion Paper, 01115*.

Roy, Devesh, & Thorat, Amit (2008). Success in high value horticultural export markets for the small farmers: The case of mahagrapes in India. *World Development, 36*(10), 1874–1890.

Sahu, Gagan Bihari, Madheswaran, S, & Rajasekhar, D (2004). Credit constraints and distress sales in rural india: Evidence from kalahandi district, Orissa. *Journal of Peasant Studies, 31*(2), 210–241.

Saini, Ritesh, Rao, Raghunath Singh, & Monga, Ashwani (2010). Is that Deal Worth my Time? The interactive effect of relative and referent thinking on willingness to seek a bargain. *Journal of Marketing, 74*(1), 34–48.

Schipmann, Christin, & Qaim, Matin (2011). Supply chain differentiation, contract agriculture, and farmers' marketing preferences: The case of sweet pepper in Thailand. *Food Policy, 36*(5), 667–677.

Sekhar, C. S. C. (2004). Agricultural price volatility in international and indian Markets. *Economic and Political Weekly, 39*(43), 4729–4736.
Sengupta, K. (2010). *Determinants of Marketed Surplus in a Backward Economy*. A Case Study of Three Districts of South Assam: Concept Publishing Company.
Shah, T. (2016). Farmer producer companies: Fermenting new wines for new bottles. *Economic & Political Weekly, 51*(8), 15.
Shepherd, A. W. (2007). Approaches to Linking Producers to Markets: A Review of Experiences to Date. *Agricultural Management, Marketing and Finance Occasional Paper 13*. Rome: Food and Agriculture Organization of the United Nations.
Simmons, Phil, Winters, Paul, & Patrick, Ian (2005). An analysis of contract farming in East Java, Bali, and Lombok, Indonesia. *Agricultural Economics, 33*(s3), 513–525.
Singh, S. (2000). Theory and practice of contract farming: A review. *Journal of Social and Economic Development., 3*(2), 255–263.
Singh, Sukhpal (2002). Contracting Out Solutions: Political Economy of Contract Farming in the Indian Punjab. *World Development, 30*(9), 1621–1638.
da Silva, Carlos, Shepherd, Andrew, & Singh, Sukhpal (2013). The practice of contract farming in India: Making it inclusive and effective. *Food Chain, 3*(3), 137–154.
Singh, S. (2018). Reforming agricultural markets in India. *Economic and Political Weekly, 53*(51), 15–18.
Singh, S., & Singh, T. (2014). *Producer Companies in India: Organization and Performance* (Vol. 1) New Delhi, India: Allied Publishers.
Suri, K. C. (2006). Political economy of agrarian distress. *Economic and Political Weekly, 41*(16), 1523–1529.
Swaminathan, M.S. (2006). Serving Farmers and Saving Farming, National Commission on Farmers. Available at: http://www.agricoop.nic.in/sites/default/files/NCF3.pdf (accessed on July6, 2020)
Thaler, Richard (1980). Toward a positive theory of consumer choice. *Journal of Economic Behavior & Organization, 1*(1), 39–60.
Trebbin, A. (2014). Linking small farmers to modern retail through producer organizations – Experiences with producer companies in India. *Food Policy, 45*, 35–44.
Trebbin, A., & Hassler, M. (2012). Farmers' Producer Companies in India: A New Concept for Collective Action? *Environ Plan A, 44*(2), 411–427.
Wang, Huaiyu, Moustier, Paule, & Loc, Nguyen Thi Tan (2014). Economic impact of direct marketing and contracts: The case of safe vegetable chains in northern Vietnam. *Food Policy, 47*, 13–23.
Warning, Matthew, & Key, Nigel (2002). The social performance and distributional consequences of contract farming: An equilibrium analysis of the arachide de bouche program in senegal. *World Development, 30*(2), 255–263.
Wilson, John (1990). The political economy of contract farming. *Review of Radical Political Economics, 18*(4), 47–70.
Winters, Paul, Simmons, Phil, & Patrick, Ian (2005). Evaluation of a hybrid seed contract between smallholders and a multinational company in East Java, Indonesia. *Journal of Development Studies, 41*(1), 62–89.
Wollni, M., & Zeller, M. (2007). Do farmers benefit from participating in specialty markets and cooperatives? The case of coffee marketing in Costa Rica1. Agricultural economics, 37(2-3), 243-248.
World Bank (2007). *World Development Report 2008: Agriculture for Development*. Washington: World Bank.