WPS No. EC-26-83

INDIAN INSTITUTE OF FOREIGN TRADE

WORKING PAPER

Food Insecurity and Contract Farming

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Printed and published by

Indian Institute of Foreign Trade
Delhi Centre: IIFT Bhawan, B-21, Qutab Institutional Area, New Delhi – 110016
Kolkata Centre: 1583 Madurdaha, Chowbagha Road,Ward No 108, Borough XII, Kolkata 700107
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Dr. A K S Chand

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Food Insecurity and Contract Farming

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Abstract: The empirical literature on the effect of Contract Farming (CF) in agriculture is divided on the basic issue of concern for the policymakers: should CF be encouraged, and if so, under what circumstances? Broadly, there are both intermediate (yield, price etc.) and ultimate (mainly household income and food security) benefits. However, the implication of the outcomes of welfare is not unidirectional. For instance, in most cases yield per hectare and household income of farmers increased along with a rise in prices of crops. Also, there is no homogeneity in the sample of crops or the country of occurrence. Since most of these contracts are private in nature with a clear objective of profit maximization, the estimates could have self-section biases, which is rarely controlled for. Additionally, these are mostly in the nature of treatment/control group studies (though not RCTs). A fundamental issue is that spillover effects bias outcomes in these methods and it should be controlled for. This implies that there is virtually no empirical literature on spillover effects. Looked at it differently, these studies conclude that in the absence of spillover effects CF appears to be conditionally beneficial. Given this background, this paper researches: what are the nature of these conditions? To what extent do spillover effects relax them? Constructing a three-sector-four-factors general equilibrium model: agricultural with contract farming, traditional agriculture, and manufacturing, we derive the conditions under which it is conducive for farmers and the country. The model predicts that for CF to be unconditionally beneficial spillover effects have to be strong. The paper then estimates the extent of the spillover effects by taking a sample of 60 countries over a maximum time length of 11 years for which Foreign Direct Investment (FDI) data is available. We find clear evidence of spillovers especially through FDI's influence on the productivities of land and capital. However, the magnitudes of these spillovers are low – much below the predictions of the theoretical model. The paper thus explains the mixed nature of results that have been reported in the literature, while evaluating the impact of CF at the micro-level.

JEL Classification: F22, J31, Q15

Keywords: Land deal, Contract Farming, Vertical Coordination, Wage gap, Self-selection Bias, Spillover.

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Food Insecurity and Contract Farming

1. Introduction

The purpose of this paper is to model the emergence of a cash-crop producing sub-sector in agriculture that entertains contract farming (CF), analyze its consequence in a well-specified general equilibrium model, and explore its social welfare implications with empirical evidence and policy simulations. Bringing all these together under a single umbrella of an analytical study is the novel feature of the paper. We find that analyzing CF through this approach helps us clarify the actual consequences of CF in a developing economy. This clarity is often lost in the plethora of context-dependent theoretical and empirical research in this field. Moreover, we provide suggestions on how to model the emergence of a new sector in general equilibrium, appealing to the technique of finite change. Our analysis demonstrates that while the growth effect of CF is unambiguously positive, the likely negative distribution effect tends to aggravate as an increasing number of countries adopt this policy. We argue that contradictory outcomes reported in empirical research and the political discourse around foreign direct investment in agriculture reflect this growth—equity trade-off associated with CF.

CF is an agricultural production system carried out due to an agreement between the buyer (the foreign contractor) and the seller (the farmer). The contractor is usually a private corporation or a development agency. The sellers can be one or two large farmers or a large group of small farmers. The type of agricultural produce can vary considerably from high-value cash crops to low-value fresh vegetables. The Food and Agricultural Organization (FAO) categorizes these contracts in five broad models, depending on the product, the sponsor's resources, and the intensity of the relationship between the seller and the buyer.[1] The central point in all these diverse systems is that the sponsor or the buyer goes into an arrangement with farmers in foreign countries in return for a margin between the buying price and the international selling price of the concerned product. Many estimates show that CF yields substantially higher profit margins than agricultural marketing through non-contract farming options. For example, Chang et al. (2006) show that the average revenue of a contract farm is about 11% higher than an average non-contract farm for Taiwan. The per hectare cost of production in a contract farm is about 13% lower, and, as a result, the average profit margin under contract is more than 50% above those without a contract. For the farmers who enter into agreements with foreign firms, possibilities of gain are also considerable: it reduces production and marketing risk (Lueck, 1995), and transaction cost (Runsten, 1992), manages supply chains (Swinnen and Maertens (2007), and, as a result, contributes substantially to enhancing income, wealth, and, in general, economic wellbeing of farmers (Bellemare and Lim, 2018) participating in this kind of farming. From the point of view of the recipient country, CF

[1] See http://www.fao.org/3/y0937e/y0937e05.htm.

increases the scope of either technology dissemination (Deininger, 2016) and factor accumulation (occurring exogenously), improving productivity as well as factor supply within agriculture (Chang et al., 2006). It, thus, opens up the possibility of significant potential gains in the aggregate agricultural output of developing countries. As a result, we see that CF has been quite popular in less developed countries, with many governments recommending its use as a possible alternative to traditional agricultural practices.

However, these favorable outcomes of CF are context-dependent. Wang et al. (2014) review this literature and conclude that more than 75% of the studies show an increase in farmer incomes from CF, resulting in the increasing popularity of CF in many underdeveloped countries (Martin, 2015). Another review by Ton et al. (2018) reports several caveats to this encouraging finding by micro studies: both farms and farmers face risk; hence, income increase for participants must be adjusted to this risk factor. Additionally, the contracts exclude the most impoverished farmers; the majority of the farmers have significantly more extensive landholdings or more assets than the average farmers in the region, adding to indebtedness and income inequality (Little and Watts, 1994) in rural areas. A recent study by Chen and Chen (2021) sheds more light on the inequality issue: income inequality in rural areas increases if more efficient farmers self-select themselves into CF and decrease if the opposite happens. Inequality also depends on whether CF encourages the production of substitutable traditional products. Such a thing can, for instance, can happen if there are spillover effects of CF. However, another recent paper (Meemken and Belmare. 2020) finds no such evidence. Many authors argue that contracting farmers need unique characteristics for a particular scheme to succeed (Minot and Ronchi, 2015; Barrett et al., 2012).[2] Michelson (2013) reports these as irrigation facilities, farm size and human capital, and others.[3] Most theoretical and empirical works on the issue, therefore, take the diversity of effects as given. Many theoretical models have viewed CF as an attempt by firms towards vertical coordination. Reasons for doing this include transaction cost (Williamson, 1975), optimal allocation of property rights (Grossman and Hart, 1983), risk-sharing (Goodhue et al., 2000), and information asymmetry (Hennessy, 1996)—all of which generate context-dependent results. The empirical studies arrive at similarly context-dependent impacts on outcomes from the implementation of this type of farming methods in (a) diverse countries with vastly different institutional frameworks, socio-political environments, and economic conditions; (b) diverse types of contractual agreements, the exact implications of which are not clear to economists (see Wu, 2013); (c) diverse types of buyers and sellers; (d) diverse types of crops; and finally (e) differing roles of governments at the central level and the regional level. These results are so diverse that meta-analysis can identify only a limited number of empirically robust consequences of CF (see, for example, Ton et al., 2018).

[2] https://www.future-agricultures.org/blog/designs-on-the-range-corridors-grabs-and-extractions-at-the-pastoral-margins/
[3] https://www.future-agricultures.org/blog/ethiopia-commercial-farming-investment-and-policy/

Given these diversities both in theoretical approaches and empirical findings, one obvious objective can be followed to try and match the two to understand the intuitions behind the success or failure of schemes in generating specific outcomes. Some researchers have attempted this method (for example, Warning et al., 2002). The matching helps design optimal contracts, given the exact circumstances of the scheme.

However, at the micro-level, these works, especially the empirical literature, fail to address more significant issues with aggregative outcomes that help governments enact laws regarding CF. Essential questions in this respect are: does contract farming improve the aggregate welfare of a country? If so, does it benefit all individuals (participants in the contract and non-participants)? To what extent should contract farming be encouraged by governments? Is there, in some sense, an optimum rule for allocating land to this type of farming method? Analyzing field studies and developing theoretical intuitions for specific situations contributes to but cannot fully tackle such questions.

The objective of this paper is, therefore, to address the issue from the opposite angle. This paper uses the aggregate country-level data on foreign direct investment (FDI) in agriculture and other variables provided by FAO that appear to be relevant in evaluating aggregative outcomes of this phenomenon. Drawing conclusions from this data, we construct a highly stylized general equilibrium model under perfect competition to generate some of the casual observations that this data reveals. Finally, the model is used as a benchmark to address policy issues through empirical analysis and model simulations.

In its bare essential core, the model considers a small open economy where the cash crop producing CF sector is not remunerative at the current international price of cash crops. To focus sharply on the differential impact of CF compared to traditional agriculture, we make two assumptions: (1) CF only produces cash crops, leaving the production of food crops to traditional agriculture, and (2) the CF sector exports its entire production. The first assumption is not crucial. It simply acts as an identifier of the CF sub-sector within the agricultural sector and can be removed without affecting the results. The second assumption is essential and opens up land shortages for food production for domestic consumption. We then analyze the consequences of two exogenous changes that can induce the CF sector to enter such an economy: (1) an increase in the world price of cash crops shifting the terms of trade towards the cash crop sector and (2) an improvement in the productivity of the CF sector. In either case, the value of the marginal productivity of land can rise enough for CF to pay a competitive rent that can attract at least some landowners away from the food-producing traditional agricultural sector, thus making CF possible in the economy. Assuming CF is more land-intensive than conventional agriculture, land transfer from food to cash crops reduces the demand for agricultural labor and wages. Immediately, therefore, we have a situation where the entry of CF has raised the rent of land and, as long as CF production is positive in equilibrium, the gross domestic product (GDP)[4] of the country but at the cost of labor income. Assuming that landowners, on average, earn more than agricultural laborers, inequality turns out to be an inevitable consequence of CF. Many micro-level empirical observations have highlighted the relative increase in income of participants in CF schemes. Additionally, they report self-selection bias—relatively more immense, more fertile farmland belonging to wealthier landowners chosen for CF contributing to a rise in inequality in rural areas (see Ton et al., 2018). The aggregate country-level data reported by FAO and descriptively analyzed below also find evidence towards this. Additionally, assuming that the CF sector exports its entire production of cash crops, food scarcity from domestic production also follows immediately, though the trade balance improves due to higher exports.

The assumption of perfect competition generates two even more disturbing consequences of the entry of CF, which have hardly ever been discussed in literature. First, a continuous increase in international price in cash crops or technological up-gradation in the CF sector can technically wipe out traditional agriculture from this small open economy. Suppose we continue to assume that this conventional agricultural sector produces food crops, and all CF production is shipped out. In that case, a problematic consequence of CF will be that the county might be growing too few food crops, making it entirely dependent on food import. Secondly, if world food production is an aggregate of a large number of such small open economies, an inevitable short-run consequence of a rising CF in all countries will be world food shortages and a rise in food prices worldwide.

These points become relevant only when international terms of trade remain sufficiently high to support transferring large tracts of land to the CF sector. Suppose this is not the case, or institutional hurdles limit CF's rapid short-run entry in less developed countries. In that case, the proportion of the land going to CF will be relatively low (see the next section for some evidence). A natural question to ask under such circumstances is, will such low amounts of CF relative to total agricultural production be enough to influence the country's GDP sufficiently? This question is empirical, and FAO data can, to an extent, tackle it a bit more rigorously. Suppose the answer to this turns out to be no. In that case, the only possible remaining effect of CF, as revealed by the above-mentioned kind of perfectly competitive general equilibrium model, will influence inequality in the wrong direction. Whether or not this is so (another empirical question) will decide whether governments should fundamentally oppose CF or remain indifferent towards it.

Section 3 develops the model after offering empirical evidence in Section 2. Section 4 extends the benchmark model and Section 5 discusses the food security impacts. Section 6 concludes.

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[4] Through the application of the envelop theorem on the optimized GDP function.

2. Emergence of Contract Farming in a Competitive Economy

In the model that follows, we consider a small open economy and its 'structural change' in terms of the evolution or disappearance of a sector in response to external stimuli causing changes in production.[5] First, we consider two sectors, viz., Agriculture (A) and Manufacturing (M) (*composite non-agricultural*). However, the former sector is of immediate interest, as the transformation happens there. The CF sector (C) requires land to set up its activity. The entry of CF brings about a structural change within the agricultural sector. Some land moves from the traditional food-producing agricultural sector to non-food cash crops, which it exports entirely.[6] CF, therefore, brings in a *discrete change in the output baskets* as a new separate sector splits out. Theoretically, the situation is similar to problems analyzed by a *class of models called the "finite change" models* (Beladi et al., 2006; Marjit and Kar, 2013; Marjit, Kar, and Beladi, 2013; Marjit and Mandal, 2014). In these models, new traded sectors *appear and disappear* due to changes in competitive forces brought about by policy intervention. As the number of sectors in the model changes, a new equilibrium is qualitatively different from the pre-change situation.

Following notations are used to describe the model structure:

P_j: exogenously given prices for j^{th} final good output, $\forall j \in \{X_M, X_A, X_C\}$ where,
X_M: Import-competing manufacturing sector.
X_A: Agricultural sector
X_C: Contract Farming sector
w: labor's wage
r: Return to capital (generic)
V: inter-sectorally mobile land (in general) in broader terms of the agriculture sector.
V_F: Land under CF (i.e., acquisition of land under deal irrespective of modes of acquirement)
V_A: Land for Agriculture.
R: return to V (generic land types)
a_{ij} = i^{th} input required to produce 1 unit of the j^{th} final good, i =K, L, V;
$\frac{da_{ij}}{a_{ij}} = -t(t > 0)$ is the uniform rate of technical progress. A negative sign indicates that unit factor requirement shrinks thanks to boons of technological advancement.
$\theta_{ij} = wa_{lj}/P_j$ is the distributive share of l^{th} labor-types in $j \in \{ X_M, X_A, X_C \}$, $\forall l$;

[5] Typically, new changes via CF *create shocks* of 'finite size' (finite price changes or technology or endowments), causing changes to new equilibria (Jones 2013) that could change entire production pattern endogenously.
[6] In typical model of inter-industry trade (Heckscher-Ohlin and its variants), Jones (2013) considers this kind of possibility. In case of *intra-industry* trade, Krugman (1979) and others show increasing variety because of trade and more variety improving welfare. Melitz (2003) considers the case of heterogeneity of firms and their productivities where unproductive firms within the industry drop out with no effect on shutting down of the sector. What we consider here is the complete elimination or vanishing of a sector and/or the emergence of a new sector (i.e., contract farming) at the expense of the existing ones. Ours is more akin to inter-industry and specific factor types a la Jones (1971) and its extensions.

$\theta_{kj} = r_{kj}a_{kj}/P_j$ is the distributive share of the owner of specific capital types K for j =C, M;

$\theta_{vj} = R_j a_{vj}/P_j$ is the distributive share of the owner of V^{th} specific land for $j \in \{A, F\}, \forall v \in \{V_F, V_A\}$;

$\lambda_{ij} = a_{ij}Y_j/f_j$ is j^{th} commodity's input share in i^{th} factor's endowment, where Y is generic output and f is generic endowment;

"∧"= proportional changes for a variable, *say x*, such that generically $\hat{x} = \frac{dx}{x}$

The production structure of the economy before rthe entry of CF is as follows:

$$X_M = X_M(L, K); X_A = X_A(L, V), \quad (1)$$

where L (labor), K(Capital), and V (Land) are the factors of production. The economy, thus, represents a standard more factors than goods or specific factor model of production (see Feenstra [2007], chapter 3). Since the equation structure of this model is well known, we relegate them to the appendix (see Appendix A).

The introduction of CF as a separate sector, producing a distinct set of homogenous goods but *nested* within the agricultural sector, is equivalent to splitting the 'broad generic' agricultural sector into two different sectors: producing say food (as before) and the other say cash crops. Such CF activities in the farming sector introduce new technology in selected tracks of land (in terms of different unit factor requirements). Let us suppose that the payment for this technology transfer accrues to its (*foreign*) introducers in terms of *a fixed margin of unit prices,* where $\rho < 1$ is the proportion of unit prices accruing to the domestic economy and $(1-\rho)$ is the proportion of unit prices that is repatriated. We can then immediately write:

Lemma 1: CF will be feasible if only if $\rho P_C > P_A \Rightarrow P_C > (1/\rho)P_A$ where $(\frac{1}{\rho}) > 1$.

Necessary: Suppose *total factor income (Wl + rK + RV)* before and after the introduction of CF be respectively Ω^0 and Ω^*. With zero profits, $\rho P_C > P_A$ implies $\Omega^0 < \Omega^*$, implying that the *non-CF equilibrium* becomes suboptimal as soon as CF opens up.

Sufficiency: A sufficient condition for CF to occur is that at least one factor of production can gain due to CF. If $\rho P_C > P_A$, then the mobile factor (land) will get a higher return in CF than in the 'A' sector. Therefore, landowners will be incentivized to reallocate land *to CF, giving the endogenous production structure* modeled below.

Essentially this transforms the above 2x3 Specific Factor model in equation (1) to a *3x3-mixed* Specific-Factor-Heckscher Ohlin model: (Agricultural and CF sectors are HOV production technology, and Manufacturing is Specific Factor Technology). Thus, the model becomes:

$$a_{VA}X_A + a_{VC}X_C = \bar{V} \quad (2)$$

$$a_{KM}X_M = \bar{K} \quad (3)$$

$$a_{LA}X_A + a_{LM}X_M + a_{LC}X_C = \bar{L} \tag{4}$$

$$a_{VA}R + a_{LA}w = \bar{P}_A \tag{5}$$

$$a_{KM}r + a_{LM}w = \bar{P}_M \tag{6}$$

$$a_{VC}R + a_{LC}w = \rho\bar{P}_C \tag{7}$$

$$a_{ij} = a_{ij}(R, r, w) \tag{8}$$

These are *six independent equations in six variables*: the three-factor prices and the three outputs of the three sectors. Note that the system is now decomposable into (2) to (4) and (5) to (7), where the three latter equations determine the factor prices. Unlike the previous model, now there are two mobile factors: labor and land (with restricted mobility between the two subsectors under agriculture).

Now we report a series of 'magnification effects' resulting from the above class of perfectly competitive general equilibrium open small economy models (see the appendix for the proofs) that progressively introduce complexities in implementation of CF in a small open underpeopled country. We begin by assuming a closed economy with an agricultural and manufacturing sector. The consequence of a price rise on the return to labour depends on the configuration of factors used in these sectors. If capital and labour are the only factors of production and these are used in both the sectors then the normal magnification effect holds and the return to factor more intensive to the sector whose relative price has increased (due say, to a exogenous increase in demand, an exogenous increase in share of income going to the agricultural sector in a standard H-O-V model) gains while the other factor loses. Thus for real wage to increase agriculture has to be labour intensive and the price of the agricultural sector needs to increase more than the manufacturing sector. This result also generalizes to the case where both labour and capital are mobile, as in the above case, but there is an additional factor land specific to the agricultural sector. Continuing to assume that agriculture is relatively more intensive in labour relative to capital than the manufacturing sector and land is specific to agriculture, if the price of the agricultural good rises with no rise in the price of the manufacturing good then labour as well as landowners gain in terms of both goods.

Our story begins with the opening up of the economy to trade but not to foreign investments. To make things simple we consider a small open economy so that prices can be considered as exogenous. With the full employment conditions and zero profit conditions being identical to the closed economy model and prices exogenous the above results continue to hold:

$$\hat{R} > \hat{w} > \widehat{P_A} > \widehat{P_M} = 0 > \hat{r} \tag{9}$$

Also taking account of the response of the technological coefficients to changes in factor prices we can conclude that production of the agricultural sector increase at the cost of the manufacturing sector:

$$\widehat{X_A} > 0 \; and \; \widehat{X_M} < 0 \tag{10}$$

Next, relaxing the assumption of no international investments (FDI), capital can flow into A from three sources: (a) exclusively domestic (capital moving from manufacturing to industry) and (b) exclusively foreign (FDI in agriculture) (c) a mix of both. Since our intention is to look at the effects of CF (a) is ruled out. (b) implies that new farms are all foreign – a bad assumption to make as there is equal incentive for domestic capital to move to the agricultural sector from the manufacturing sector. We therefore proceed with assumption (c) where new firms can both be domestic and foreign.

FDI in agriculture coupled with an exogenous rise in price of agricultural goods lead to an increase in the capital stock of the country and a Rybczynski effect follows leading to an increase in the agricultural output at the cost of manufacturing sector *along with* the normal Stolper Samuelson effect in (9). The net result will be that both (9) and (10) will be magnified.

Thus FDI in agriculture is unambiguously better for farmers and landowners (and worse for capitalists) in underdeveloped countries as the Rybczynski effect magnifies the Stolper Samuelson effect that would occur if exogenous prices of agricultural goods had increased with capital stock in the country remaining the same[7].

However the simplistic scenario assumed above is far from the actual reality in underdeveloped countries. The main point here is that the foreign entrants are somehow different from their domestic counterparts. The empirical literature on CF (as we will call the foreign entrants) suggests three basic differences: first the foreign entrants come in with their own 'technology' that is superior to the technology of the domestic farms. Secondly, they often choose better lands in terms of fertility and irrigation facilities for setting up their ventures. Third, they produce goods with a superior 'quality' in the sense that their goods are more compliant to the sanitary standards of developed countries than traditional agricultural goods. The second point is referred to as the self-selection bias in CF. For the moment let us assume away this possibility. However we allow for different 'technology' in the CF and traditional agricultural sectors in the country. One way of formalizing this is to assume that the physical capital required for CF is qualitatively different from domestic capital.

We have already assumed that land is not used in manufacturing, to account for difference in capital, in addition to that let us now assume that capital is specific in each sector. The model then becomes a three good (traditional agriculture (A), CF agriculture (F) and manufacturing (M)) five factor (capital in the three sectors (r_A, r_F , r_M) labour (w) and land (R)) model. Finally, with CF goods assumed to be of better quality than traditional agricultural goods they can be treated as separate goods altogether. To focus exclusively on the effect of the CF sector, in what follows we assume that all subsequent price rise after the initial one that results in the influx of FDI in agriculture pertain only to the CF sector (say, due to rise in exogenous food

[7] Note the result is qualitatively independent of the assumption of specificity of land to agriculture, without that assumption both land and labour would shift from manufacturing to agriculture confirming the expansion of the agricultural sector and the shrinkage of the manufacturing sector

demand in developed countries) and prices of traditional agricultural produce remain unaffected.

With the change in model structure post price rise of CF agricultural goods, simple comparisons of factor returns done above become impossible as a single agricultural price is now replaced by two different agricultural prices and different rates of return to capital appears in the economy. Assuming CF to be more labour intensive than manufacturing but less labour intensive than traditional agriculture (unit labour requirements is smaller in CF than traditional agriculture) and only the price of the CF good rises. Then (1) and (2) changes here to:

$$\widehat{r_F} > \widehat{P_F} > \widehat{w} > \widehat{P_M} = \widehat{P_A} = 0 > \widehat{R} > \widehat{r_A} > \widehat{r_M} \quad (11)$$

$$\widehat{X_F} > 0, \widehat{X_A} < 0, \widehat{X_M} < 0, \widehat{X_A} + \widehat{X_F} > 0 \quad (12)$$

In terms of equation (3) real wage falls in terms of the CF output but increases in terms of the traditional agricultural output so that farmers' household income increase but entitlement in terms of the good produced by the CF sector falls. In terms of equation (4), agricultural output in the traditional sector falls, but output in the CF sector as well as combined output of agriculture rises. So food deficit apparently declines. However that is not the case as the entire amount of CF output is exported. Hence food deficit actually rises and the resultant excess demand in food leads to increase in the price of food. This is clearly borne out by the casual data analysis of the previous section where we have noted that (1) food deficit has intensified (2) food inflation has been positive and often severe and (3) net export of food has been on the rise in the poorest countries of the world where FDI in agriculture has been rampant[8]. Real wage however increases as the output of the traditional agricultural sector is the only output that is consumed by workers (CF output is totally exported).

What is the consequence of future price rises in agricultural commodities? To focus once more exclusively on the CF sector we assume that this price rise once more has its source in DCs and hence only the price of the good produced by the CF sector increase. Is it possible for workers to gain in this situation? To make wage rise in (3) to be greater than the rise with the no FDI case, we need relative increase in wage (value of marginal product) to be more in (3) than in (1) for the same relative increase in P_F. This requires some structure on the technology prevalent in the traditional agricultural sector as well as the manufacturing sector.

In particular if technology is such that the marginal productivity of labour is convex to the origin (like an indifference curve) for these industries then the wage increase with FDI is guaranteed. Assuming lower labour coefficients for the CF sector in the presence of FDI (henceforth simply denoted by CF as we continue to assume this for the rest of the analysis) the marginal productivity curve for CF is higher than non-CF and price rise is constant in both cases. Figure 1 demonstrates the case for a two good specific factor framework with labour as the mobile factor.

[8] Note that the positive second order effect of this food inflation on output of traditional agriculture will be dominated by the negative first order effect in (3) due to the stability of the equilibrium condition.

Thus in addition to a fall in real wage relative to CF output, FDI in agriculture together with the greater acceptability of the output from this sector in developed countries makes a gain in returns to labour conditional for any rise in international price of the agricultural good. The results with FDI and specificity of capital are therefore distinctly weaker for workers than without such specificity.

3. Self Selection Bias

We now consider the case of self-section bias in the choice of land. Specifically we assume that CF occurs only in those land that are more productive than the non-CF sector. To block the channel of distortions caused by specificity of capital we can make three assumptions: (a) capital used in agriculture is fully mobile across both types of agriculture but capital used in manufacturing is different (b) capital is mobile across all sectors (c) capital is specific only to the manufacturing sector (this, of course, eliminates the possibility of free entry of domestic farms into the CF sector. Note that these assumptions have no effect on the relative return to labour though the relative return to capital changes in each of these situations. Given this observation we choose (c) as it is the simplest alternative.

Consider then a situation where there are three factors: Land, labour and capital. Labour is fully mobile. Capital is specific to manufacturing. Land is not only specific to agriculture but also to the two types of agricultural practices in the economy. Further, in order to model the higher productivity of land in the CF sector compared to the non-CF sector, we assume that the non-CF sector is more land intensive than the CF sector. If R_F and R_A are the returns to land in the CF and the non-CF sectors then the magnification effects of an increase in the price of the CF sector is:

$$\widehat{R_F} > \widehat{P_F} > \widehat{w} > \widehat{P_M} = \widehat{P_A} = 0 > \widehat{R_A} > \hat{r} \qquad (13)$$

$$\widehat{X_F} > 0, \widehat{X_A} < 0, \widehat{X_M} < 0, \widehat{X_A} + \widehat{X_F} > 0 \qquad (14)$$

Clearly thus there is no change in the condition of workers but as expected, now ownership of land becomes an issue. Since land that would subsequently be chosen by FDI were already more productive, the return for these land owners were higher prior to the arrival of CF (this obvious result is not modelled here). With the arrival of FDI in agriculture, creation of dualism within the agricultural sector and rise in international price of only goods produced by these farms, inequality between the owners of productive and unproductive land increases. Further food deficit clearly rises as the output of the traditional agricultural sector falls and all CF output is exported. It is obvious from (5) that the opposite would happen if CF goes to the unproductive rather than productive land as rate of return of the unproductive land would increase with the rise in international price of the CF farms.

It is thus crucial as to which kind of land is allocated to the CF sector. Government policy should clearly incentivize FDI so that it flows to the less productive farmlands.

The most alarming situation, as far as developmental issues of underdeveloped countries are concerned, arises when we assume farm labourers to be specific to CF and non-CF sectors.

Unlike the other assumptions made above that have at least some empirical support, this assumption is a little more difficult to motivate. The simplest assumption that comes to mind is the case where farms are self-cultivated. However this assumption does not do the job. Note that the logic that drives (5) is as follows: as price of CF sector rises there is entry in the CF sector and labour moves from the non-CF and manufacturing sectors to the CF sector. With self-cultivated lands this cannot occur and the CF and non-CF sectors become virtually independent. The only way to ensure that the transmission mechanism of a price rise in the CF sector occurs through the non-CF sector is to assume that land (or capital) now is mobile across these sectors. In these cases a simple extension of (5) and (6) implies that workers in CF land are better off for any exogenous price rise of the CF sector and workers in non-CF land *are worse off in terms of all goods*. If land is mobile and capital is specific to manufacturing then:

$$\widehat{w_F} > \widehat{P_F} > \hat{R} > \widehat{P_M} = \widehat{P_A} = 0 > \widehat{w_A} > \hat{r} \qquad (15)$$

$$\widehat{X_F} > 0, \widehat{X_A} < 0, \widehat{X_M} < 0, \widehat{X_A} + \widehat{X_F} > 0 \qquad (16)$$

Thus FDI in agriculture not only increases inequality in the rural sector, it actually leads to impoverishment of a class of agricultural workers who are excluded from the CF process (immisereizing growth for them).

4. Modelling Spill-over Effects

Here we consider the case that productivity of labor in the CF sector transmits to those in the non-CF agriculture sector due to sharing common characteristics of production, but not having the same access to better techniques. Similarly, land productivity in CF can also diffuse to the non-CF. Both of this translates into '***Tied spillover mechanism***':

$\hat{a}_{VA} = \eta_1 \hat{a}_{VF}$ (***Land-spillover***) and $\hat{a}_{LA} = \eta_2 \hat{a}_{LF}$ (***Labor-spillover***), where $0 \le \eta_i \forall i = 1, 2$ (16a)

η_i are parameters or coefficients of tied spillover. Higher values imply pronounced effect (***Magnified spillover***); however, for values less than 'unity', it might be a '***Damped' spillover***, in which case despite production benefits being manifested in non-CF agriculture sector, 'Price effects' might not be that conducive. In other words, prices of non-CF sector might even rise, even if the extent is low. In fact, that is supported by the stylized facts in real evidence (see Section 2).

Then, we can derive conditions pertaining to λ, η_i's for tracing beneficial effects (or, otherwise) *a la* contract farming as alternative arrangements.

Proposition 1: *With spillover of technological benefits—under differential rates of land and labor productivity improvements under CF--- accruing to the traditional non-CF farms, contract farming is beneficial.*

Proof: Consider Land-spillover. Since, $\hat{X}_F - \hat{X}_A = \hat{a}_{VA} - \hat{a}_{VF} = \eta_1 \hat{a}_{VF} - \hat{a}_{VF} = \hat{a}_{VF}(\eta_1 - 1)$.

Therefore, $\hat{X}_A > \hat{X}_F$ *iff* $\hat{a}_{VF}(1-\eta_1) > 0$.

As due to technical progress parameter being factor-saving by nature, $\hat{a}_{VF} = -\beta_1, \beta_1 > 0$,

$$\hat{X}_F - \hat{X}_A = \hat{a}_{VA} - \hat{a}_{VF} = \eta_1 \hat{a}_{VF} - \hat{a}_{VF} = -\beta_1(\eta_1 - 1) \quad (17)$$

Thus, $\hat{X}_A > \hat{X}_F$ *iff* $-\beta_1(1-\eta_1) > 0, \beta_1 > 0 \Rightarrow \eta_1 > 1$ (QED)

Now, for labor-spillover, let $\hat{a}_{LF} = -\beta_2, \beta_2 > 0$ *and* $\hat{a}_{LM} = 0$.

Then, using the above arguments and assumptions, for labor-augmenting technological change,

$$\hat{a}_{LA} = \eta_2 \hat{a}_{LF} = -\beta_2 \eta_2 \quad (17a)$$

Thus, from equation (1), we can derive using envelope theorem and Jones (1965, 1971) that:

$$\left.\begin{aligned} &\hat{a}_{LF} + \hat{X}_F + \hat{a}_{LA} + \hat{X}_A = 0 \ (as\ \hat{a}_{LM} = 0) \\ &\Rightarrow -\beta_2(1+\eta_2) + \hat{X}_F + \hat{X}_A = 0 \\ &\Rightarrow \hat{X}_F + \hat{X}_A = \beta_2(1+\eta_2) > 0 \end{aligned}\right\} \quad (18)$$

Thus, ***joint augmentation*** of both sectors are positive under tied spillover effects via labor productivity. However, it remains to be seen under what conditions the effects are pronounced and whether non-CF sector derives the transmitted benefits more as observed in the case of land productivity improvements. This can only happen when both the spillover parameters are greater than unity so that conjointly labor and land-productivity improvements under CF are transferred to non-CF.

Lemma 2: $\hat{X}_A > \hat{X}_F$ *iff* $\eta_2 > \eta_1 > 1$, *or, conjointly,* $\eta_1 + \eta_2 > 1$

Proof: From (17), $\hat{X}_A - \hat{X}_F = \beta_1(\eta_1 - 1)$ and from (17), $\hat{X}_A + \hat{X}_F = \beta_2(1+\eta_2)$. Adding these, we get on simplification that:

$$2\hat{X}_A = \beta_2(1+\eta_2) + \beta_1(\eta_1 - 1)$$
$$2\hat{X}_F = \beta_2(1+\eta_2) - \beta_1(\eta_1 - 1)$$

From (26a), we can infer that $\hat{X}_A > 0$ iff $\beta_2 + \beta_2\eta_2 + \beta_1\eta_1 - \beta_1 > 0$. As the joint impact additive terms are always positive, this relation can hold *iff* $\beta_2 > \beta_1$. Similarly, from (26b) we can infer, $\hat{X}_F > 0$ iff $\beta_2 + \beta_2\eta_2 - \beta_1\eta_1 + \beta_1 > 0$.

That means, given $\beta_2 > 0, \beta_1 > 0$, $\beta_2\eta_2 > \beta_1\eta_1 \Rightarrow \beta_2 / \beta_1 > \eta_1 / \eta_2$. As from above, $\hat{X}_A > 0$ when $\beta_2 > \beta_1$,we can easily infer that $\beta_2 / \beta_1 > 1 > \eta_1 / \eta_2 \Rightarrow \eta_2 > \eta_1$. Conjointly, using both conditions we can write that SOE effects are dominant (magnified) when $\eta_2 > \eta_1 > 1 \Rightarrow (\eta_1 + \eta_2) > 1$.Not only that, this confirms that only if $\eta_2 > \eta_1 > 1 \Rightarrow (\eta_1 + \eta_2) > 1$

holds, then $\hat{X}_A > \hat{X}_F$, implying that spillover effects will *outshadow* the self-selection bias. But to trace the price effects is essential for consideration of implications from welfare point of view.

Proposition 2: *Under differential rates of land and labor productivity improvements under CF---with spillover of technological benefits tied to the traditional non-CF farms-- contract farming is '**relatively more**' beneficial depending on the values of $\eta_1 > 0, \eta_2 > 0$. In other words, exceeding the values of Unity will cause P_A to fall or, even if rises, to a smaller extent while $X_A>0$. However, with damped effect (values less than unity), P_A will rise definitely, despite $X_A>0$.*

Proof: Here we postulate $\widehat{P}_A = T.\widehat{P}_F, T > 0$ and $T \geq, =,$ or, ≤ 1 as the case may be. Consider, as before, the tied spillover relationships, (25a) and (25b), viz., $\hat{a}_{VA} = \eta_1 \hat{a}_{VF}$ and $\hat{a}_{LA} = \eta_2 \hat{a}_{LF}$, where $0 \leq \eta_i \forall i = 1,2$ and $\hat{a}_{VF} = -\beta_1, \beta_1 > 0$, $\hat{a}_{LF} = -\beta_2, \beta_2 > 0$. Also, consider

$$\theta_{LF} w + \theta_{VF}(r_p + R_A) = P_F$$

$$\theta_{LA} w + \theta_{VA} R_A = P_A$$

Applying Cramer's rule we obtain:

$$\begin{pmatrix} \theta_{LF} & \theta_{VF} \\ \theta_{LA} & \theta_{VA} \end{pmatrix} \begin{pmatrix} w \\ R_A \end{pmatrix} = \begin{pmatrix} P_F - \theta_{VF} r_p \\ \widehat{P}_A \end{pmatrix}$$

Under CF (assumption), $\theta_{LF} < \theta_{LA}, \theta_{VF} > \theta_{VA}$ and $|\theta| = \theta_{LF}\theta_{VA} - \theta_{LA}\theta_{VF} = \theta_{VA} - \theta_{VF} = \theta_{LF} - \theta_{LA} < 0$

Solving for w and R_A, we find:

$$w = \frac{(P_F - \theta_{VF} r_p)\theta_{VA} - P_A \theta_{VF}}{|\theta|}$$

And $$R_A = \frac{P_A \theta_{LF} - (P_F - \theta_{VF} r_p)\theta_{LA}}{|\theta|} > 0$$

With $\widehat{r}_p \geq 0$, $\widehat{w} > 0$ *iff* $\widehat{P}_F \theta_{VA} < \widehat{P}_A \theta_{VF} \Rightarrow \dfrac{\widehat{P}_A}{\widehat{P}_F} > \dfrac{\theta_{VA}}{\theta_{VF}} \Rightarrow \dfrac{\widehat{P}_A}{\widehat{P}_F} > 1 \Rightarrow \widehat{P}_A > \widehat{P}_F$. In this case, T>1.

Same is the case with $\widehat{R}_A$. Also, at the same time following Proposition 2, $\widehat{X}_A > 0, \widehat{X}_F > 0$. This is corroborated by the evidences.

Proposition 3: With ***differential technical progress*** across sectors, price effects on non-CF sector could be different—falls or rise--as per the restrictions on the coefficients of '***tied spillover***' channel. In both scenarios, prices might rise or fall in both the CF and non-CF sectors.

Proof: Using above spillover mechanism, and applying envelope conditions we can write:

Case 1: *Land-spillover context:*

For non-CF sector, $-\beta_1\eta_1 = \frac{\hat{P}_A}{\theta_{VA}} \Rightarrow \hat{P}_A < 0$, $\hat{X}_A = -\hat{a}_{VA} = \beta_1\eta_1 > 0$

For CF-sector, $-\beta_1 = \frac{\hat{P}_F}{\theta_{VF}} \Rightarrow \hat{P}_F < 0, \hat{X}_F > 0$.

Thus, $\hat{P}_A - \hat{P}_F = -\beta_1[\eta_1\theta_{VA} - \theta_{VF}] > 0, \Rightarrow \theta_{VF} > \eta_1\theta_{VA} \Rightarrow \theta_{VF}/\theta_{VA}\,(>1) > \eta_1$ (QED)

Case 2: *Labor-spillover context:*

For non-CF sector, $-\beta_2\eta_2 = \frac{\hat{P}_A}{\theta_{LA}} \Rightarrow \hat{P}_A < 0$, $\hat{X}_A = -\hat{a}_{VA} = \beta_1\eta_1 > 0$

For CF-sector, $-\beta_2 = \frac{\hat{P}_F}{\theta_{LF}} \Rightarrow \hat{P}_F < 0, \hat{X}_F > 0$.

Thus, $\hat{P}_A - \hat{P}_F = -\beta_2[\eta_2\theta_{LA} - \theta_{LF}] > 0, \Rightarrow \theta_{LF} > \eta_2\theta_{LA} \Rightarrow \theta_{LF}/\theta_{LA}\,(=<1) > \eta_2$ (QED)

In both cases, $\hat{P}_A - \hat{P}_F$>0, or $\hat{P}_A > \hat{P}_F$ when $0 < \eta_1 < 1, 0 < \eta_2 < 1$ (damped tying effect). In this case, extent of rise in P_A >0 is much less.

Otherwise, $\hat{P}_A < 0$, when $\eta_i > 1 \forall i = 1,2$ (magnified tying impact).

Proposition 4: Consider the case of ***uniform Technical progress*** where $\hat{a}_{LF} = -\beta_2 = \hat{a}_{VF} = -\beta_1 = -\beta(say), \beta > 0$. Under this scenario, returns to labor and owner of non-CF lands benefit as returns inflate.

Proof: Using above relationships, we can deduce that:

$$\hat{a}_{LA} = -\beta\eta_2, \hat{a}_{VA} = -\beta\eta_1 \Rightarrow \hat{a}_{LA} + \hat{a}_{VA} = -\beta(\eta_1 + \eta_2) < 0$$

This confirms positive transmission of benefits via tied diffusion. Not only that, (27) indicates that when technical progress happens under CF-arrangements augmenting both land and labor productivity via Farm acquisition, SOE is the only way that can deliver potential benefits via tied-spillovers to non-CF. Without these spilling over of productivity benefits, CF is not conducive and fails to counter the in-built self-selection bias.[9]

Using the above specifications and equations of change, we can write:--

$$\theta_{LF}\hat{w} + \theta_{VF}\hat{R}_F = \beta > 0$$
$$\theta_{LA}\hat{w} + \theta_{VA}\hat{R}_A = \beta(\eta_1 + \eta_2)$$

---

[9] This is important for considering differential rates of technical progress in land and labor, as well as for different skill categories in heterogeneous labor types. In that case, the skilled labor can facilitate more spillovers via symmetric information sharing or contribution to productivity. This is beyond the scope of the current paper. Further work is in research agenda where more sectors with decomposition of labor types are considered.

$$\theta_{LM}\hat{w}+\theta_{KF}\hat{r}=0$$

Using Cramer's rule, we get from the matrix:

$$\begin{pmatrix}\theta_{LF} & \theta_{VF}\\ \theta_{LA} & \theta_{VA}\end{pmatrix}\begin{pmatrix}\hat{w}\\ \hat{R}_A\end{pmatrix}=\begin{pmatrix}\beta\\ \beta(\eta_1+\eta_2)\end{pmatrix}$$

$$\hat{w}=\frac{\beta\theta_{VA}-\beta(\eta_1+\eta_2)\theta_{VF}}{|\theta|}$$

And $\hat{R}_A=\dfrac{\beta(\eta_1+\eta_2)\theta_{LF}-\beta\theta_{LA}}{|\theta|}$

Here, under certain factor-intensity assumption, $|\theta|=\theta_{LF}\theta_{VA}-\theta_{LA}\theta_{VF}=\theta_{VA}-\theta_{VF}=\theta_{LF}-\theta_{LA}<0$.

Thus, when lands are more into CF-arrangements, $\theta_{VF}>\theta_{VA}\Rightarrow\theta_{LA}>\theta_{LF}$, from (29) we can say

$$\hat{w}>0\ \ iff\ \ \beta\theta_{VA}-\beta(\eta_1+\eta_2)\theta_{VF}<0\Rightarrow(\theta_{VA}/\theta_{VF})<\eta_1\Rightarrow\ iff\ (\eta_1+\eta_2)>1.$$

Similarly, from (30), $\hat{R}_A>0\ iff\ \ \beta(\eta_1+\eta_2)\theta_{LF}-\beta\theta_{LA}<0\Rightarrow$

$(\eta_1+\eta_2)>(\theta_{LA}/\theta_{LF})>\Rightarrow\ iff\ (\eta_1+\eta_2)>1$.

In all these above cases, welfare improves as both sector expands, real wage increases.

This reinforces <u>*Proposition 2 and Lemma 1*</u> that with magnified spillover effects, wage increases, so does the return to the owners of agricultural land-holders *even without* being directly under the privilege of CF.

Proposition 5: With ***uniform technical*** progress, we can show the **'Price effects'** of such technical progress are similar in nature, such that: $\hat{P}_A<0\ and\ \hat{P}_F<0$. However, under certain conditions, P_A >0 might occur. Also, magnified spillover causes returns to labor to rise more than that of land.

Proof: Here, $\hat{a}_{LF}=-\beta_2=\hat{a}_{VF}=-\beta_1=-\beta(say),\beta>0$ and hence, given $\beta_i>0,\eta_i>0$

$$\hat{a}_{LA}\hat{w}+\hat{a}_{VA}\hat{R}_A=\hat{P}_A=\ -\beta(\eta_2\hat{w}+\eta_1\hat{R}_A)=\hat{P}_A<0\ and\ \beta(\hat{w}+\hat{R}_F)=\hat{P}_F<0\ \text{(QED)}.$$

With price fall, welfare improves as given budget share of consumption items in the basket, real income improves causing decline in relative poverty.

Now, in ***Proposition 5 (both cases),*** we have proved that $\widehat{P}_A < 0,$ when $\eta_i > 1 \forall i = 1,2$ (magnified tying impact). Also, in both cases, $\widehat{P}_A - \widehat{P}_F$ >0, or $\widehat{P}_A > \widehat{P}_F$ when $0 < \eta_1 < 1, 0 < \eta_2 < 1$ (damped tying effect) with extent of rise in P_A >0 being much less.

From (29), we can infer that:

$$\widehat{w} > 0 \text{ iff } \beta\theta_{VA} < \beta(\eta_1 + \eta_2)\theta_{VF}$$
$$\Rightarrow (\eta_1 + \eta_2) > \frac{\theta_{VA}}{\theta_{VF}}, \text{ where } \frac{\theta_{VA}}{\theta_{VF}} < 1$$

Also,

$$\widehat{R}_A > 0 \text{ iff } \beta(\eta_1 + \eta_2)\theta_{LF} < \beta\theta_{LA}$$
$$\Rightarrow (\eta_1 + \eta_2) < \frac{\theta_{LA}}{\theta_{LF}}, \text{ where } \frac{\theta_{LA}}{\theta_{LF}} > 1$$

Conjointly, therefore, $\widehat{w} > 0, \widehat{R}_A > 0$ when $\widehat{P}_A > 0$ *iff* $\frac{\theta_{VA}}{\theta_{VF}} < (\eta_1 + \eta_2) < \frac{\theta_{LA}}{\theta_{LF}}$, which means the values of the 'tying parameters' should lie between the ratios of cost-shares of labor and land. It's a weighted average of the shares of the factors.

(QED)

We also show that:

$$\widehat{w} - \widehat{R}_A = \frac{\beta\theta_{VA} - \beta(\eta_1 + \eta_2)\theta_{VF} - \beta(\eta_1 + \eta_2)\theta_{LF} + \beta\theta_{LA}}{|\theta|}$$
$$= \frac{\beta(\theta_{VA} + \theta_{LA}) - \beta(\eta_1 + \eta_2)(\theta_{VF} + \theta_{LF})}{|\theta|} = \frac{\beta - \beta(\eta_1 + \eta_2)}{\|\theta\|}$$

Thus, given $|\theta| < 0$, $\widehat{w} - \widehat{R}_A$>0 *iff,* $\beta - \beta(\eta_1 + \eta_2)$<0 $\Rightarrow (\eta_1 + \eta_2) > 1$

Analogously, we can prove that the same condition holds for the case of $\widehat{w} - \widehat{R}_F$ >0. Importantly, this is valid for $\widehat{r}_p \geq 0$ where $\widehat{R}_F = \widehat{R}_A + \widehat{r}_p$.

Corollary 1: With more CF, when $\eta_1 > 1$ (magnified spillover) as share of land going to CF increases () $\lambda > 0, \hat{r}_p > 0$ (incentivising more CF via premium), the SOE effect will outweigh the negative SSB per se, iff λ in such a way that $\beta > \eta > 1 > \lambda > 0$. It follows directly from other results and Rybczynski effect (1952) via Jones (1965).

Corollary 2: With Uniform technical progress, *tied spillover* but without incentive or premium $\widehat{w} > \widehat{R}_A = \widehat{R}_F$ and $\widehat{P}_A < 0$ and $\widehat{w} > \widehat{R}_A$ when $\eta_1 > 1, \eta_2 > 1, (\eta_1 + \eta_2) > 1$. This happens due to tied spillover of technical progress improving homogenous labor's productivity. But as no incentive or premium is paid, engaging in CF is not so lucrative. The contractual arrangement might peter out as contract farming is no longer offering higher returns. This might cause gaps in wage and returns to land to improve, so that inequality improves.

But $\widehat{P}_A > 0$ and $\widehat{w} > \widehat{R}_A$ when $\eta_1 < 1, \eta_2 < 1, (\eta_1 + \eta_2) < 1$ and $\frac{\theta_{VA}}{\theta_{VF}} < (\eta_1 + \eta_2) < \frac{\theta_{LA}}{\theta_{LF}}$

With $\widehat{r}_p > 0$ where $\widehat{R}_F = \widehat{R}_A + \widehat{r}_p$, $\widehat{w} > \widehat{R}_F > \widehat{R}_A > \widehat{P}_A < 0,$ when $(\eta_1 + \eta_2) > 1$ and $\widehat{w} > \widehat{R}_F > \widehat{R}_A > \widehat{P}_A > 0,$ when $(\eta_1 + \eta_2) < 1$

5. Estimating the Spillover Effects of FDI on Agricultural Production

The above theory has evaluated two aspects of FDI in agriculture: effect on returns to factors of production and effect on agricultural output. In this section we take a look at the available evidence regarding the second issue. In what follows we first define spillovers into a simple production function framework and then report the results of estimating such a spillover augmented production function.

5.1 Methodology

We assume a simple Cobb-Douglas production function of the following form:

$$Y = AL^{\beta_1} K_d^{\beta_2} K_f^{\beta_3} T^{\beta_4} (Pe)^{\beta_5} (Fe)^{\beta_6}$$

Where L = Labour, K_d = Domestic Capital, K_f = FDI, T = Land, Pe = Pesticide usage and Fe = Fertilizer usage.

Following Javorcik (2004) spillover effects of K_f are estimated by including the following variable in addition to K_f in the production fumction:

$$SpillY_{it} = \frac{Y_{it}}{\sum_{i=1}^{n} Y_{it}} K_f$$

The variable puts higher weightage to FDI higher the country's agricultural output. We can think about different weight structures for the FDI variable. For instance the weights can be redefined in terms of one of the factors of production and interpret the coefficient of the variable as the effect of FDI flowing through the channel of the relative factor intensity/employment of the country compared to other countries in the sample. Thus, for example, if the labour weighted FDI is statistically significant but the capital weighted FDI is not then we can predict that FDI works better if agriculture in the country is more labour intensive but does not work if the country is relatively more capital intensive compared to the sample countries. Keeping this in view we report intensities to capital, labour and land. We therefore define the following three additional spillover mechanisms:

$$SpillL_{it} = \frac{L_{it}}{\sum_{i=1}^{n} L_{it}} K_f$$

$$SpillK_{it} = \frac{K_{dit}}{\sum_{i=1}^{n} K_d} K_f$$

$$SpillT_{it} = \frac{T}{\sum_{i=1}^{n} T_{it}} K_f$$

We draw two separate subsamples by dividing countries by their income classes. World Bank classifies countries into Low, Lower-Middle, Upper-Middle and High Income countries. We assume income dummies and use them to divide Low Income (consisting of Low and Lower Middle Income) and High Income (comprised of Upper Middle and High Income) groups. The regressions are re-run with both the sub-samples (see Table 3 and Table 4). Given the above set of equations the estimated equations with spillover effects is[10]:

$$\log(Y)_{it} = \alpha + \beta_1 \log(Kd_{it}) + \beta_2 \log(Kf_{it}) + \beta_3 \log(T_{it}) + \beta_4 \log(L_{it}) + \gamma_Y Spill\_Y_{it} + \varepsilon_{it} \ldots\ldots \text{(a)}$$

$$\log(Y)_{it} = \alpha + \beta_1 \log(Kd_{it}) + \beta_2 \log(Kf_{it}) + \beta_3 \log(T_{it}) + \beta_4 \log(L_{it}) + \gamma_{Kd} Spill\_Kd_{it} + \varepsilon_{it} \ldots\ldots \text{(b)}$$

$$\log(Y)_{it} = \alpha + \beta_1 \log(Kd_{it}) + \beta_2 \log(Kf_{it}) + \beta_3 \log(T_{it}) + \beta_4 \log(L_{it}) + \gamma_L Spill\_L_{it} + \varepsilon_{it} \ldots\ldots \text{(c)}$$

$$\log(Y)_{it} = \alpha + \beta_1 \log(Kd_{it}) + \beta_2 \log(Kf_{it}) + \beta_3 \log(T_{it}) + \beta_4 \log(L_{it}) + \gamma_T Spill\_T_{it} + \varepsilon_{it} \ldots\ldots \text{(d)}$$

Furthermore, to model spillover of FDI to unit factor requirements we simply rewrite the independent variable in terms of average productivities and render the following regression equations.

$$\log(Y/L)_{it} = \alpha + \beta_1 \log(Kd/L_{it}) + \beta_2 \log(Kf/L_{it}) + \beta_3 \log(T/L_{it}) + \gamma_Y Spill\_Y_{it} + \theta_{it} \ldots\ldots \text{(e)}$$

$$\log(Y/L)_{it} = \alpha + \beta_1 \log(Kd/L_{it}) + \beta_2 \log(Kf/L_{it}) + \beta_3 \log(T/L_{it}) + \gamma_Y Spill\_Kd_{it} + \theta_{it} \ldots\ldots \text{(f)}$$

$$\log(Y/L)_{it} = \alpha + \beta_1 \log(Kd/L_{it}) + \beta_2 \log(Kf/L_{it}) + \beta_3 \log(T/L_{it}) + \gamma_Y Spill\_L_{it} + \theta_{it} \ldots\ldots \text{(g)}$$

$$\log(Y/L)_{it} = \alpha + \beta_1 \log(Kd/L_{it}) + \beta_2 \log(Kf/L_{it}) + \beta_3 \log(T/L_{it}) + \gamma_Y Spill\_T_{it} + \theta_{it} \ldots\ldots \text{(h)}$$

5.2 Variables and Data

All of the data was acquired from FAOSTAT. The data on FDI Inflows to Agriculture, Forestry and Fishing was found to contain a lot of negative values. This is because FAO presents this data on a net basis

[10] With country fixed effects and robust standard errors.

(capital transactions' credits less debits between direct investors and their foreign affiliates). Net decreases in assets or net increases in liabilities are recorded as credits, while net increases in assets or net decreases in liabilities are recorded as debits. (see report). Hence all observations having negative values for FDI Inflows were dropped as well. The resultant dataset was a unbalanced panel[11] with data on 85 countries and 4254 observations. As per results of BP Test, the dataset suffers from heteroskedasticity and so robust standard errors clustered across countries were used.

5.3 Results

Table 1 introduces the variables. Table 2, Table 3 and Table 4 reports the results for equations (a) to (d). When we take the entire sample consisting of low, lower-middle, upper-middle and high income countries, Spill_Y and Spill_T turn out to be statistically significant. Thus we see that the significance of FDI increases with the agricultural output of the country. And that FDI performs better if agriculture of the country is land intensive. But it does not work if agriculture in the country is either labour or capital intensive. This is a clear indication that Contract Farming is more useful for firms that are large in size. Together with the significance of Spill_Y, the results indicate that large land intensive firms producing a lot of output are ideal for FDI in agriculture to be effective. This result is strengthened by Table 3 and Table 4. While the result in Table 3 is a replica of result in Table 2 in the sense that the same variables are significant, Table 4 strengthens the above conclusion. Effectiveness of FDI is high for all kinds of Spillover Effects either through labour, domestic capital, land or output, for high income countries that is typically characterized by a larger size of land holdings than under-developed countries.

5.4 Linking the Theoretical and the Empirical Observations

The main theoretical observation on spillover noted in this paper is that spillovers from foreign direct investment can significantly reduce any negative influences of these FDI flows. The literature has given particular attention on the FDI flowing into the contract farming sector. Since outputs produced by contract farms are exported, this leads to the possibility of food scarcity in the countries where such farming occurs. The manifestation of this food scarcity in the model is through the rise of prices of agricultural goods in these countries. Indeed we find clear evidence of such price rise in developing countries. The theoretical model predicts that such price rise can be mitigated through spillover effects of FDI but the spillovers need to be 'magnified' in the sense that average productivities of the non-FDI agricultural sector need to increase at a faster rate than the FDI sectors. The empirical part indeed finds strong evidence of spillovers of FDI on agricultural output but the magnitudes are nowhere near the magnitudes need to reverse price increase. Thus bringing theory and evidence to gather we can say that the spillovers are not strong and hence agricultural prices have continued to increase in these countries, leading to a decline in welfare for the country through this route.

[11] Minimum 3 years up to a maximum of 64 years.

6. Concluding Comments

The main focus of this paper was to investigate the effect of FDI in agriculture on the host country. Casual observations at the country level and literature review for the farm level indicated that the perceived effects of FDI in agriculture is mixed. As noted by many farm level studies, country level analysis revealed that the source of a major problem with FDI was the rise in food grain price in countries along with a rise in food exports. The positive effect of FDI was that household income and yield increased. In order to explain such observations and to think of possible solutions a simple general equilibrium model under perfect competition is proposed. The model can replicate most of the empirical observations noted at the country level and reported by earlier literature. The solution that was proposed was the possibility of spillover effects of such FDI. The extent of spillover in FDI was then estimated by estimating a cross country production function with spillovers. The estimated spillovers was then compared to the magnitudes of the spillovers required by the theoretical model. Though the nature of the spillovers estimated was different from the spillovers that could be accommodated in the model, the magnitude of spillover was clearly far below the amounts required to reverse price rises.

There is a lot of scope for future work in this area. The main question is, now that we have seen that spillovers do occur but they are minimal and far short of ensuring welfare increase through FDI in agriculture, what is the next step for the government? Since the theoretical model talks about CF to non-CF spillovers and the empirical exercise talks about FDI spillovers on output can the model be extended to include exactly the same type of spillover as we observe empirically (working the other way is not possible as CF vs non-CF data is not available at the secondary level)? These questions will be answered by future research.

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TABLES

Table 1 List of Variables

Name	Description
Y	Gross Production Value (constant 2014-2016 thousand US$)
Kd	Gross Fixed Capital Formation (Agriculture, Forestry and Fishing), million US$, 2015 prices
Kf	FDI inflows to Agriculture, Forestry and Fishing (million US$, 2015 prices)
L	Total Employment in agriculture - ILO modelled estimates (thousands)
T	Agriculture Land Area (1000 Ha)

Table 2 Estimating the Production Function of Agricultural Products with Spillover Effects (All Countries)

	Equation a	Equation b	Equation c	Equation d
Variable	**Eqa**	**Eqb**	**Eqc**	**Eqd**
log_L_b	0.401*** (19.374)	0.399*** (19.24)	0.399*** (19.232)	0.402*** (19.362)
log_T	0.899*** (22.467)	0.909*** (22.707)	0.909*** (22.686)	0.899*** (22.354)
log_K_d	0.511*** (46.782)	0.509*** (46.564)	0.51*** (46.611)	0.511*** (46.714)
log_K_f	0.016*** (3.754)	0.021*** (4.89)	0.02*** (4.562)	0.016*** (3.656)
Spill_Y	0.002*** (4.278)			

Spill_K_d		-0.001 (-1.832)		
Spill_L_b			0 (0.389)	
Spill_T				0.003** (2.78)
R^2 (Within)	0.512	0.511	0.51	0.511
R^2 (Between)	0.502	0.5	0.5	0.501
R^2 (Overall)	0.965	0.965	0.965	0.965
Hausman Test	691.09	703.43	801.10	637.92
BP Test	121.75	151.48	140.19	120.16

Note: Under Country Fixed Effect and heteroskedasticity-consistent (HC) Standard Error

Table 3 Estimating the Production Function of Agricultural Products with Spillover Effects (Low and Lower-Middle Income Countries)

Variable	**Equation a**	**Equation b**	**Equation c**	**Equation d**
	Eqa	**Eqb**	**Eqc**	**Eqd**
log_Lb	0.521*** (15.497)	0.514*** (15.238)	0.515*** (15.267)	0.522*** (15.52)
log_T	-0.06 (-1.685)	-0.054 (-1.508)	-0.054 (-1.525)	-0.06 (-1.686)
log_K_d	0.45*** (17.731)	0.453*** (17.781)	0.453*** (17.751)	0.449*** (17.669)
log_K_f	0.08*** (8.352)	0.084*** (8.754)	0.083*** (8.628)	0.08*** (8.317)

Spill_Y	0.003*** (3.355)			
Spill_K_d		-0.001 (-0.726)		
Spill_L_b			0 (0.365)	
Spill_T				0.008*** (3.338)
R^2 (Within)	0.797	0.796	0.795	0.797
R^2 (Between)	0.792	0.791	0.791	0.792
R^2 (Overall)	0.955	0.955	0.955	0.955
Hausman Test	14.38	9.34	10.80	13.15
BP Test	78.53	64.66	74.27	81.71

Note: Under Country Fixed Effect and heteroskedasticity-consistent (HC) Standard Error

Table 4 Estimating the Production Function of Agricultural Products with Spillover Effects (High and Upper-Middle Income Countries)

	Equation a	**Equation b**	**Equation c**	**Equation d**
Variable	**Eqa**	**Eqb**	**Eqc**	**Eqd**
log_L_b	0.563*** (22.848)	0.562*** (22.315)	0.557*** (22.151)	0.564*** (22.546)
log_T	0.053* (2.113)	0.071** (2.788)	0.063* (2.489)	0.064* (2.544)
log_K_d	0.503*** (29.909)	0.496*** (28.617)	0.503*** (29.36)	0.497*** (29.008)
log_K_f	-0.007 (-0.686)	0 (0.026)	-0.002 (-0.232)	-0.001 (-0.141)
Spill_Y	0.029*** (6.587)			

Spill_K_d		0.014** (2.621)		
Spill_L_b			0.119*** (3.53)	
Spill_T				0.013*** (4.305)
R^2 (Within)	0.859	0.854	0.855	0.856
R^2 (Between)	0.856	0.85	0.851	0.852
R^2 (Overall)	0.967	0.966	0.966	0.966
Hausman Test	12.82	8.23	10.19	8.71
BP Test	129.79	119.92	122.44	122.16

Note: Under Country Fixed Effect and heteroskedasticity-consistent (HC) Standard Error

Table 5 Spillover Effects of Foreign Direct Investment on Average Productivity of Labour (All Countries)

	Equation e	**Equation f**	**Equation g**	**Equation h**
Variable	**Eqe**	**Eqf**	**Eqg**	**Eqh**
log_T_L_b	0.166*** (6.449)	0.166*** (6.435)	0.167*** (6.473)	0.164*** (6.384)
log_K_d_L_b	0.467*** (40.909)	0.465*** (40.569)	0.465*** (40.625)	0.468*** (40.915)
log_K_f_L_b	0.013** (2.863)	0.019*** (4.116)	0.017*** (3.809)	0.011* (2.424)
Spill_Y	0.003*** (5.472)			
Spill_K_d		0 (-1.365)		
Spill_L_b			0.001 (1.039)	

Spill_T				0.005*** (4.879)
R^2 (Within)	0.427	0.423	0.423	0.426
R^2 (Between)	0.415	0.411	0.411	0.414
R^2 (Overall)	0.948	0.948	0.948	0.948
Hausman Test	27.98	119.70	41.01	39.10
BP Test	178.07	261.89	213.03	173.79

Note: Under Country Fixed Effect and heteroskedasticity-consistent (HC) Standard Error

Table 6 Spillover Effects of Foreign Direct Investment on Average Productivity of Labour (Low and Lower-Middle Income Countries)

	Equation e	**Equation f**	**Equation g**	**Equation h**
Variable	**Eqe**	**Eqf**	**Eqg**	**Eqh**
$log\_T\_L_b$	-0.137* (-2.36)	-0.123* (-2.126)	-0.124* (-2.145)	-0.137* (-2.362)
$log\_Kd\_L_b$	0.578*** (23.862)	0.58*** (23.921)	0.58*** (23.894)	0.577*** (23.8)
$log\_Kf\_L_b$	0.042*** (4.125)	0.048*** (4.698)	0.046*** (4.503)	0.042*** (4.134)
Spill_Y	0.002** (2.809)			
$Spill\_K_d$		-0.001 (-1.335)		
$Spill\_L_b$			0 (-0.16)	
Spill_T				0.006** (2.667)
R^2 (Within)	0.363	0.36	0.359	0.363

R^2 (Between)	0.351	0.348	0.347	0.351
R^2 (Overall)	0.704	0.702	0.702	0.704
Hausman Test	27.95	21.16	22.88	27.81
BP Test	19.16	32.25	39.86	20.16

Note: Under Country Fixed Effect and heteroskedasticity-consistent (HC) Standard Error

Table 7 Spillover Effects of Foreign Direct Investment on Average Productivity of Labour (Upper-Middle and High Income Countries)

	Equation e	**Equation f**	**Equation g**	**Equation h**
Variable	**Eqe**	**Eqf**	**Eqg**	**Eqh**
log_T_Lb	0.395*** (7.427)	0.371*** (6.885)	0.368*** (6.871)	0.38*** (7.088)
log_Kd_Lb	0.369*** (16.157)	0.368*** (15.875)	0.368*** (15.969)	0.366*** (15.873)
log_Kf_Lb	-0.029* (-2.387)	-0.015 (-1.191)	-0.012 (-0.978)	-0.019 (-1.539)
Spill_Y	0.017*** (3.531)			
Spill_Kd		0 (-0.024)		
Spill_Lb			-0.018 (-0.467)	
Spill_T				0.003 (1.105)
R2 (Within)	0.68	0.675	0.675	0.676
R2 (Between)	0.672	0.667	0.667	0.668
R2 (Overall)	0.851	0.849	0.849	0.849
Hausman Test	11.30	8.63	5.91	9.19
BP Test	121.83	113.68	118.67	115.16

Note: Under Country Fixed Effect and heteroskedasticity-consistent (HC) Standard Error

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