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Effect of Contract Farming in a Small Open Less-developed Economy: A General Equilibrium Analysis[1]

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Abstract: In this paper, we analyse the entry of a cash crop producing foreign Contract Farming (CF) subsector within the agricultural sector of a country. Entry requires a cash crop price that is substantially above the price of the food crop already being produced within the country. Entry of CF could cause 'vanishing' of the food-crop sector. We employ a variant of 3×3 mixed Specific Factor-Heckscher Ohlin general equilibrium model of production and trade where introduction of a new policy may lead to the emergence of a new cash-crop sector resulting in *finite changes* where we show the possibilities of sectoral diversification with combinations of contract farming vis-à-vis traditional agriculture under some plausible conditions. Such ramifications could (a) increase GDP; (b) give rise to adverse distributional consequences for labour, and land-owner; (c) reduce domestic production of food and increase food import and hence, (d) aggravate food insecurity. Thus, CF might imply a trade-off between food insecurity, inequality and growth. However, either zero CF and extremely high CF are suboptimal and hence, CF cannot be substitute of non-CF agricultural sector producing Food crops. In fact, fallacy of composition shows that aggregate has a price effect so that food-crop sector never disappears. Our results seem to be consistent when compared to some empirically robust conclusions found in the literature and some secondary data available in the FAO website.

Keywords: *Contract Farming, Food crops, Cash-crops, Food Insufficiency, Finite Change, General Equilibrium, Fallacy of Composition.*

JEL Classification: F11, F16, F60, J43, O13, Q17

1. Introduction:

Foreign direct investment (FDI) in agriculture has taken the form of land acquisitions and 'contract farming (CF)' in developing nations. Many researches argue that for increasing the rate of return to attract private investors for infrastructure investment and industrialization, land trust or land lease is one of the best avenues. 'Contract Farming (CF)', defined as "an agriculture production system carried out according to an agreement between a buyer and farmers, which establishes conditions for the production and marketing of a farm

[1] Caveat: Our paper is a modest attempt to provide an analytical framework for synthesis of evidences on contract farming. In our paper, we do not cover contractual arrangements and negotiations, pricing arrangement, and hence, we do not go into the current context of contract farming debate in India or the deals. This research highlights the pros and cons of contract farming as an alternative mode of production.

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product", involves vertical coordination where 'the farmer commits to providing agreed quantities of a specific agricultural product .. …and the buyer agrees to purchase the product at agreed pricing conditions and, [to] support production through the supply of farm inputs, land preparation, and the provision of technical advice' (FAO 2012). Also, CF is 'a mechanism for governing transactions in agrifood supply chains and as a tool to promote the access of small holder farmers to markets *through vertical coordination*. There is a large empirical literature on the effect of Contract Farming (CF) on the economic development of a Less Developed Economy (LDC). Transforming agriculture into an agribusiness for rejuvenating farming is an important mode where Foreign Direct Investment (FDI) occurs. FDI in agriculture has taken the form of land acquisitions and 'contract farming (CF)' in most nations.

Due to contract farming, scope of either technology dissemination and/or, factor accumulation (occurring exogenously) improving productivity within agricultural sector trigger emergence of CF sector. Modernization of agriculture for improving productivity via green revolution has been complemented by linkages with formal retail sector for servicing consumer markets via formal contractual relationships between producers and buyers (processors or exporters). Overall, we see that global agriculture has undergone restructuration through farming as well as evolution of agribusiness and agri-food system with agricultural food value-chains. The literature so far available provides evidence based information. Research needs to address that. The incidence of failure to turn resource abundance to the benefits of people and mismanagement leading to contraction of agriculture, manufacturing sectors needs further research in the context of policies, weak governance, and institutions hindering the structural diversification necessary for equitable growth and development. Our focus in this paper is to analyse the issue of food insecurity caused by introduction of Contract Farming (CF). In other words, despite the prospect of rise in GDP this might lead to a trade-off. See FAO studies (2017, 2019) and others in the context of developing economies such as India and poor nations in Africa, as well as others. Issues of land acquisition or land grabbing, corporate investment for industrialization has not been dealt here (see Dinda 2016, Holmen 2015, Sarkar 2014). However, the detrimental effects and repercussions across the economy can be traced via a general equilibrium structure. Developing a suitable analytical framework is necessary to support the claims and justify the anecdotal evidences. The general equilibrium framework (Jones 1965, 1971, 2018; Marjit and Acharyya 2003; Marjit and Jones 2009; Das 2011, etc.) is suitable to trace interplay between structural features of land-abundant economies. In order to trace such impacts, we develop basic features of a small open economy *without CF*, and then, consider the emergence of CF—thanks to external environment such as, impetus for productivity-enhancements or better business climate favouring FDI in agriculture-- and its impact on agricultural sector. Section 3 develops such 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.

2. Empirical Observations

2.1 Conflicting Observations in Micro Level Studies

Ton et al (2018) is a meta-analysis covering 166 countries. There is a vast empirical literature on CF. Wang et al (2014) reviews this literature and conclude that more than 75 percent of the studies show an increase in income from CF. This has resulted in increasing popularity of CF in many underdeveloped countries (Martin (2015)). However, a more careful look at this literature reveals that many of these empirical results suffer from inherent

weaknesses (Ton et al. (2018)). As Bellemare and Bloem (2018) point out "(A) particularly challenging limitation of these studies is selection bias, or the fact that farmers choose whether to participate in contract farming on the basis of factors that are both unobserved by researchers and highly likely to be confounders". Many authors argue that contracting farmers have special characteristics (Minot and Ronchi, 2015; Barrett et al., 2012).[2] The nature of these characteristics is reported in Michelson (2013) as availability of irrigation facilities, farm size and human capital and others.[3]

The empirical literature for CF has explored several possible sources of benefit for FDI in agriculture, both intermediate (yield, price, use of household labor etc.) and ultimate (mainly household income and food security). However, it is difficult to form any clear opinion regarding the issues mentioned above. First, the implication of the outcomes on welfare is not unidirectional: In most cases yield per hectare and household income of farmers increased along with prices of crops. Second, there is no homogeneity in the sample of crops studied or the country of occurrence. It is thus impossible to identify proper legal frameworks and nature of crops on which CF has a significantly higher probability of success. Finally since most of these contracts are private in nature with a clear objective of profit maximization there are possibilities of self-section bias in the estimates. This bias is largely recognized in the literature however, it is rarely controlled for. Looked at it in a different way, the main conclusion of all these studies is that *in the absence of spillover effects* CF appears to be conditionally beneficial to host nations. Conditional in the sense that though incomes rise for the contract workers prices of food rise. It should be noted that all the above conclusions on CF and FDI in agriculture are from micro level studies of particular crops in a few selected countries. There is, to our knowledge, no paper that looks at these issues at the macro level, to try and ascertain whether the observations made at the micro level are confirmed at the country level. Therefore the first objective of the paper is to take a casual look at the agricultural data for all countries of the world and find out any possible link between FDI in agriculture and, at least a few outcomes reported in the micro literature. As already mentioned, the main findings of the empirical literature at the micro (farm) level are: (a) Household incomes of contract farmers have increased (b) prices of crops have increased (c) the reason for the increase in prices of crops is crop export of the CF sector therefore by implication export of crops have increased and (d) yield has increased. All these data are available at the country level in the Food and Agricultural Organization (FAO) of the United Nations. Thus it is possible to form some conclusions (though casual) on the alleged link between FDI in agriculture and the outcome variables. The most obvious way to do it is to look at the time series trends of these variables to see if there was some evidence of co-movement of, say, FDI, food prices and food exports over time for all countries for which data is available.

2.2 Stylized Observations from Secondary Data

This section presents some of the main characteristics of the inward FDI data in agriculture, food security as well as some other indicators in developing countries. Our main target is to analyze developing countries. The World Bank categorizes countries into four groups based on their income: High Income, Upper Middle Income, Lower Middle

[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/**

Income and Low Income. *For this paper, all countries except the high income countries are categorized as developing countries.* Since only those countries that have data on agricultural Foreign Direct Investment (FDI) are considered here, we have a biased sample and the results reported here may not be generally true. Data used in this section are taken from the Food and Agricultural Organization (FAO of the United Nations.

Figures 1 and 2 present the general picture regarding 'Foreign Direct Investment (FDI) in agriculture' and 'agricultural exports'. Turns out that both these variables fall in the category of developmental indicators, in the sense that their values rise with the level of development of the country. While this conclusion is well known for exports, the conclusion with respect to FDI in agriculture is less documented. One major reason can be the level of institutional quality in developed countries is higher (see Sabir et al (2009)). The other important reason can be data availability. FDI data in developed countries are much more documented than in developing countries. Hence the results in the table might be biased towards developed countries. Finally many important items in the food basket of developed countries are possibly not cultivable in underdeveloped countries due to climatic reasons and soil requirements making FDI in these items infeasible in underdeveloped countries.

Figure 1: Foreign Direct Investment in Agriculture

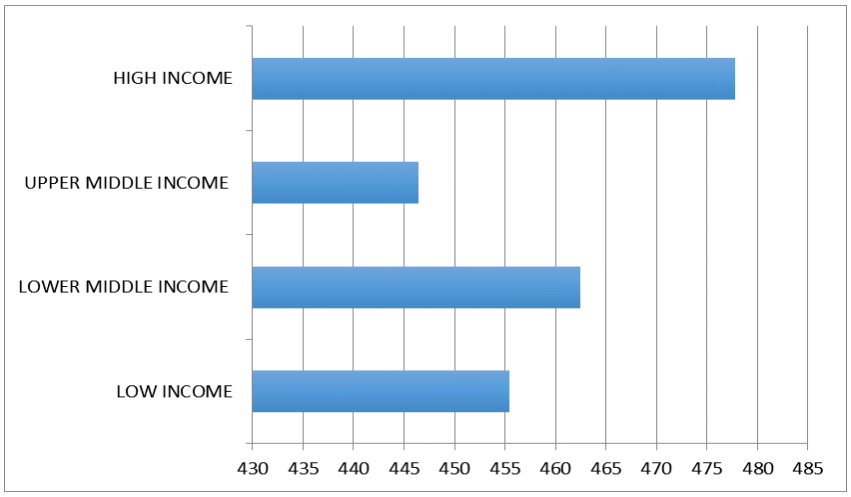
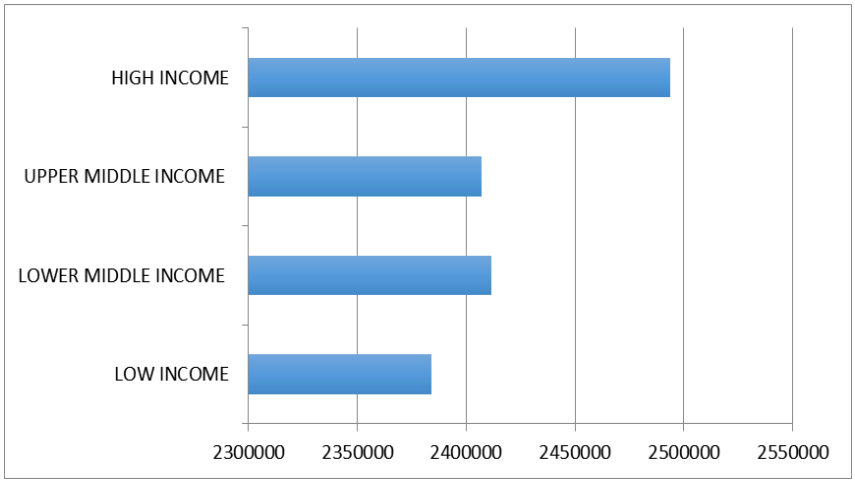


Figure 2: Export of Agricultural Commodities



This trend continues in the country wise agricultural FDI data for developing countries in table 1. FDI in the highest ranked lower middle income country (Indonesia) is more than six time that of the highest ranked low income country (Uganda). The fact about paucity of data mentioned above is clearly manifested in this table. It can be easily seen that the number of countries in the sample rapidly increases as we move towards more developed countries. *In fact, data for a large number of low and lower middle income countries reported in the FAO website were unusable for this work as they had no FDI data.* There is a wide fluctuation in the *mean value* as well as the *growth rate* among countries within an income category (table 1). The positive relationship between income levels and FDI in agriculture breaks down when we look at intra group data. When we arrange the data in terms of mean FDI, countries are more or less randomly dispersed in terms of income within every group. If we can assume that all the FDI data reported in Table 1 are for CF alone then it can be concluded from the table that CF has become popular only in a few developing countries. The number is especially small for low income and lower middle income countries. In fact, there are only 7 (seven) countries in the sample that had a foreign investment in CF beyond US $100 million. There are many countries in which total investments amounted to less than US $1million. A similar conclusion holds for the growth rates of FDI. There are only two countries with a growth rate greater than 10 per cent (Malawi and Costa Rica). In both cases the means values are fairly low so that the base effect is one of the major reasons for the high growth rates. On the other hand, there are ten countries for which growth rate is negative. In general, therefore, table 1 suggests that CF is still a small percentage of the total FDI inflows in developing countries but it is on the rise in most of these countries.

Table 2 attempts to take a casual look at the relationship between FDI in agriculture and food deficit as well as yield per hectare. Three indicators of food deficit is considered: the difference between average calories requirement per person and the actual intake (Depth of Food Deficit-DFD), the Consumer Price Index of Food and Net export of crop and livestock[4]. The first indicator appears to be sufficient to capture the extent of food deficit (see, for instance, Santangelo (2018)) in a country. However it keeps two issues open: (1) the depth of food deficit may fall in a country where food availability is generally on the rise due to unequal distribution of food and (2) if cash crops are produced and exported by contracting farms food imports can be financed through it and food deficit may fall in the face of shrinking domestic production of food and reduce food deficit in countries where food production is actually falling due to FDI in agriculture. The net export of food variable addresses this issue. To tackle the first problem, we consider a second possible indicator of food deficiency – the food CPI.

[4] There is no data on food export and import, this is the closest variable found.

Table 1: Foreign Direct Investment in Agriculture, Forestry and Fishing in Developing Countries (US $ Million)

Country	Mean	Average Annual Growth	Country	Mean	Average Annual Growth	Country	Mean	Average Annual Growth
Low Income Countries			**Lower Middle Income Countries**			**Upper Middle Income Countries**		
Uganda	68.75	0.11	Honduras	26.58	-0.09	Russia	141.79	0.27
Mozambique	39.27	-0.15	Nicaragua	12.55	3.95	Romania	102.01	-0.13
Tanzania	18.44	0.14	Laos	12.2	1.63	Mexico	67.80	0.69
Malawi	10.63	27.71	El Salvador	8.15	1.8	Cambodia	56.70	1.60
Yemen	8.86	7.23	Tunisia	5.92	0.35	Costa Rica	54.49	41.14
Afghanistan	7.98	-0.47	Bangladesh	5.37	0.95	Turkey	21.03	1.05
Madagascar	6.15	-0.86	Morocco	3.63	0.06	Belarus	20.8	-0.28
Ethiopia	2.7	0.21	Myanmar	1.46	0.72	Ecuador	18.5	3.08
Tajikistan	1.1	-0.53	Bolivia	1.39	-0.75	Peru	11.80	3.88
Lower Middle Income Countries			Philippines	0.73	3.4	Armenia	7.6	5
Indonesia	450.7	2.27	Kyrgyzstan	0.78	-1.27	Fiji	7.25	1.51
Ghana	125.32	1.34	**Upper Middle Income Countries**			Mauritius	7.06	6.07
Egypt	122.67	1.74	Argentina	571.5	0.35	Kazakhstan	6.67	2.37
Zambia	61.23	-0.18	Brazil	255.61	0.38	Paraguay	5.46	0.82
Cambodia	56.70	1.6	Malaysia	213.02	-2.31	Algeria	3.45	-0.51

Note: Growth rates are annual average growth rates (average of year on year growth rate)
***Source**:* Compiled from FDI data in Food and Agricultural Organization website (http://www.fao.org/faostat/en/#data/FDI)

Table 2: Trends in Indicators of Food Deficit and FDI in Agriculture, Forestry and Fishing in Developing Countries

Country	FDI	DFD	FCPI	CPI - FCPI	MCLS	XCLS	(X-M) CLS	GDP	AGDP/ GDP	GINI	Yield	Country	FDI	DFD	FCPI	CPI - FCPI	MCLS	XCLS	(X-M) CLS	GDP	AGDP/ GDP	GINI	Yield	Country	FDI	DFD	FCPI	CPI - FCPI	MCLS	XCLS	(X-M) CLS	GDP	AGDP/ GDP	GINI	Yield
South Korea	-/*	-/*	+/*	-/*	NA	+/*	NA	NA	NA	+/*	na	Indonesia	-/	-/*	+/*	-/*	+/*	+/*	+/*	+/*	+/*	+/*	+/*	Nicaragua	+/*	-/*	-/	-/*	+/*	+/*	+/*	+/*	+/*	+/*	+/*
Argentina	+/*	-/	+/*	NA	+/*	+/*	+/*	+/*	-/*	+/*	+/	Tunisia	+/	-/	-/	-/*	+/*	+/*	-/*	+/*	-/*	+/	+/*	Honduras	+/	-/*	+/*	+/*	+/*	+/*	+/*	+/*	-/*	+/*	+/*
Malaysia	-/*	+/	+/*	-/*	+/*	+/*	+/*	+/*	-/*	+/*	+/*	Egypt	+/*	-/*	+/*	-/*	+/*	+/*	-/*	+/*	-/*	+/*	-/*	Ghana	+/*	-/*	+/*	+/*	+/*	+/*	+/*	+/*	-/*	+/	+/*
Romania	+/*	-/	+/*	+/*	+/*	+/*	-/*	+/*	+/*	+/*	+/	Ecuador	+/*	-/*	+/	-/*	+/*	+/*	+/*	+/*	-/*	+/*	+/*	Bangladesh	+/*	-/*	+/	-/*	+/*	+/*	-/*	+/*	-/*	+/*	+/*
Turkey	+/*	-/*	+/*	-/*	+/*	+/*	+/*	+/*	-/*	NA	+/*	Fiji	+/*	-/*	-/	-/*	+/*	+/*	-/	+/*	-/*	+/	+/	Cambodia	+/*	-/*	+/*	-/*	+/*	+/*	-/*	+/*	+/*	+/*	+/*
Kazakhstan	+/	+/	+/*	-/*	+/*	+/*	-/*		+/*	+/*	+/	Armenia	+/	-/*	na	+/*	+/*	+/*	-/*	+/*	+/*	NA	+/	Zambia	-/*	+/	na	+/*	+/*	+/*	+/*	+/*	-/	+/	na
Russia	+/*	-/	+/*	-/*	+/*	+/*	-/*	+/*	+/*	+/*	+/*	Jordan	+/*	-/*	+/	-/*	+/*	+/*	-/*	+/*	-/*	+/	+/	Kyrgyzstan	-/	-/*	+/*	-/*	+/*	+/*	-/*	+/*	+/*	+/	+/
Mauritius	+/	-/*	+/*	-/*	+/*	+/*	-/*	+/*	+/	NA	+/	Jamaica	na	-/	+/*	-/*	+/*	+/*	-/*	+/*	+/*	NA	na	Tajikistan	-/*	+/*	+/	-/*	+/*	+/*	-/*	+/*	+/*	+/*	na
Bulgaria	+/	na	+/*	-/*	+/*	+/*	+/	+/*	+/*	+/*	+/*	Philippines	+/*	-/*	+/*	-/*	+/*	+/*	-/*	+/*	-/*	+/*	+/*	Tanzania	-/*	+/*	-/*	-/*	NA	+/*	NA	NA	+/*	NA	-/
Belarus	-/*	na	+/*	NA	+/*	+/*	+/	+/*	+/*	+/	na	Belize	na	-/*	+/*	NA	+/*	+/*	+/*	+/*	+/*	NA	na	Vanuatu	na	-/*	+/*	-/*	+/*	+/*	-/*	+/*	+/*	+/*	+/*
Mexico	+/*	-/*	+/*	-/*	+/*	+/*	-/*	+/*	-/*	+/*	+/*	Morocco	-/	-/*	+/	-/*	+/*	+/*	-/*	+/*	-/*	+/	+/	Yemen	-/	-/*	+/	+/	+/*	+/*	-/*	+/*	+/*	+/*	+/*
China, mainla	+/*	-/*	+/*	-/*	+/*	+/*		+/*	-/*	+/*	Na	Guatemala	na	-/	na	+/*	+/*	+/*	+/*	+/*	-/*	NA	na	Uganda	+/	-/	+/	-/*	+/*	+/*	+/	+/*	-/*	+/*	+/*
Costa Rica	+/	-/*	+/*	-/*	+/*	+/*	+/*	+/*	-/*	NA	-/	El Salvador	-/	-/*	-/	-/*	+/*	+/*	-/*	+/*	-/*	+/*	+/*	Ethiopia	+/*	-/*	+/*	-/*	+/*	+/*	+/*	+/*	+/*	+/*	+/
Brazil	+/*	+/	+/*	-/*	+/*	+/*	+/*	+/*	-/*	+/*	+/*	Bolivia	+/	-/*	na	NA	+/*	+/*	+/*	+/*	+/*	+/	na	Afghanistan	-/*	-/*	+/*	-/*	+/*	+/*	-/*	+/*	+/*	NA	+/
Algeria	-/*	-/*	+/*	-/*	+/*	+/	-/*	+/*	+/*	NA	+/*	India	na	-/*	-/	-/*	+/*	+/*	+/*	+/*	-/*	+/	na	Madagascar	+/	-/	+/*	-/*	+/*	+/*	-/*	+/*	+/*	+/*	+/*
Colombia	+/*	-/*	+/*	-/*	+/*	+/*	+/*	+/*	-/*	+/*	+/*	Vietnam	+/	-/*	-/	-/*	+/*	+/*	-/	+/*	+/*	NA	+/*	Mozambique	+/*	-/*	+/*	-/*	+/*	+/*	-/*	+/*	+/*	+/*	+/
Bosnia and H	na	na	-/	NA	+/*	+/*	-/*	+/*	+/*	NA	na	Laos	+/*	-/*	+/*	-/*	+/*	+/*	-/*	+/*	+/*	NA	Na	Malawi	+/	-/*	+/*	-/	+/*	+/*	+/*	+/*	-/*	+/	+/*
Peru	+/	-/*	+/*	-/*	+/*	+/*	+/	+/*	-/*	NA	+/*	Myanmar	-/*	-/*	+/	+/*	+/*	+/*	-/*	+/*	+/*	+/*	+/*	Cabo Verde	na	+/*	+/*	-/*	+/*	+/*	-/*	+/*	+/*	+/	NA
Paraguay	-/*	-/*	+/	-/*	+/*	+/*	+/*	+/*	-/*	NA	+/*	Pakistan	na	-/	na	+/*	+/*	+/*	-/*	+/*	-/*	+/*	na	Venezuela	+/	-/*	Na	+/*	+/*	+/*	-/*	+/*	+/*	NA	Na

Notes: '+' ('-') implies a positive (negative) value of the coefficient of the linear trend term (b) in Yt = a + bt + ε when the equation is fitted to the time series data of each country. '*' implies b is statistically significant at the 5% level. Blank after the slash (/) implies b is not significant. Yt: FDI = Foreign Direct Investment in Agriculture Forestry and Fishing. DFD = Depth of food deficit (difference between average calories required and intake). FCPI = Consumer price index of food. CPI = Aggregate Consumer Price Index. XCLS = Crop and livestock export. MCLS = Crop and livestock import. GDP = Gross Domestic Product, AGDP = GDP de to agricultre. Yield = Harvested production per hectare. X-M = Export minus import. CLS = Crop and Livestock GDPR = GDP Rank. GDPR based on: https://en.wikipedia.org/wiki/List_of_countries_by_GDP_(PPP)_per_capita#cite_note-data.worldbank.org-5.

Sample period varies across countries. All time periods are between 1991 and 2017. Source: Authors' calculations from FAO data. Data Source: FAO: Food deficiency → https://ourworldindata.org/hunger-and-undernourishment, CPI → http://www.fao.org/faostat/en/#data/CP
Export – Import → http://www.fao.org/faostat/en/#data/TP, Yield → http://www.fao.org/faostat/en/#data/QC, FDI (agri, forestry, fishing)→ http://www.fao.org/faostat/en/#data/FDI,

A look at table 2 immediately points out to a complete contradiction between these indicators of food security. While DFD is falling in almost all countries, this has happened at a time when almost all these countries have experienced a rising prices of food. Further, both export and import of crops and livestock[5] has risen in all countries, however net export of corps and livestock have fallen in a majority (26 out of 48) countries considered here. Clearly therefore depth of food deficit has fallen in the face of rising food prices and food imports and cash crop export. This of course may be possible under many circumstances the most important of which is rising real income of the food deficient people. It may also be caused by government policies (like subsidized food price for the poor). Other conclusions can also be made from the table: GDP and crop yield per hectare has increased significantly in all countries in the sample. Interestingly, the proportion of agriculture in aggregate GDP has also increased in a majority of the countries, most of them being low income countries. Summarizing the observations we can say that a simple yearly trend analysis of developing countries for whom data on FDI in agriculture is available reveals that these countries have experienced rising aggregate income, food prices, per hectare yield and inequality at a time when FDI in agriculture was on the rise.

Quoting Deininger (2011): "Currently none of the African countries of interest to investors achieves even a quarter of its potential productivity. Rather than just focus only on an expansion of uncultivated land, it is important that investors and governments support improvements in technology, infrastructure, and institutions that can improve productivity on existing farmland.*"* As reviewed by Otsuka, Nakano, and Takahashi (2015) for the empirical evidences of CF in both developed and developing countries with divergences in effects, the perceived benefits under CF is emphasized for exports of high-value crops, new crops with new agricultural technologies, and presumably better marketing management. Different types of contracts—production and/or, marketing—and its merits and demerits have been discussed in the context of large and small holders (Feder 1985, Hayami and Otsuka 1993, Key 2005, Byerlee 2014, etc.). One of the strong arguments in favour of CF is the perceived benefits of better inputs provision, productivity-benefits via new technology, management, modernization of agriculture for esp. smallholders, and marketing without asymmetric information regarding quantity and quality, etc. Benefits from CF via exports of high value crops has been documented by Casaburi, Kremer, and Mullainathan 2016 in the context of Kenya; Minten, Randrianarison, and Swinnen 2007 for Madagascar, Barrett et al. (2012) for Ghana, India, Madagascar, Mozambique, and Nicaragua. On the other hand, Ragasa, Lambrecht and Kufoalor (2018) has mentioned about the limitations of CF as a 'pro-poor strategy' in the context of Ghana where high input, capital and credit costs counter the benefits of increases in yields. Thus, there are lack of consensus on 'welfare and benefits' under CF (Bellemare and Bloem 2018 World Development).

Recent uproar in India about CF has resurfaced the debate in the efficacy of CF for marketing and selling crops, servicing markets, investing in storage and distribution, scrapping of subsidies, etc. without proper debate or discussion on long overdue agricultural reform for increasing productivity, infrastructure, overcoming deficiencies in agriculture for spillover benefits, grass-root level development, and the potential detrimental effects, etc. so that the proposed reforms are sensibly done without sacrificing yields or harvests, inclusiveness of small and marginal farmers, livelihoods, nutritional security (Gulati, Kapur, and Boulton 2020, Nanda 2021 . This might cause food security problem (Sarkar 2012; Rulli

[5] Note the crops and livestock trade data includes cash crops.

and D'Odoric 2014). However, without considering in details about country-specific factors, in this paper we analyse the possible adverse implications of CF in terms of food security. As Bellemare and Bloem (2018) mentioned that it is necessary to go beyond RCT, micro-level survey, or difference-in-difference estimates to 'incorporate insights from other areas of investigation' such as, 'trade or growth', we provide a framework. Although Chaudhuri and Yabuuchi (2010) and Chaudhuri and Banerjee (2010) has discussed the role of FDI in land and its positive impact on employment via improving land-efficiency and agricultural productivity, and Das (2013 and 2018) has considered the case of land-grabbing and its adverse impacts, they have not considered the case of CF and its repercussions.

Brief review above confirms the necessity of in-depth works on mode of organizing large-scale commercialization of agriculture in LDCs. As the small farmers in LDCs suffer from lack of technology, financial reserves, imperfect information about markets, uncertainty and risk of production, these affect their productivity. It needs to be seen whether and under which alternative scenarios/conditions these modes of contract farming could solve the problems faced by small farmers in commercial production or, it aggravates the deficiencies. The entire picture is murky and academic literature is incapacious. To motivate this issue of land scarcity for domestic food consumption we need to compare it with a *simplest benchmark situation with respect to which such scarcity is likely to arise*. In what follows, we start with a specification that defines the *business as usual* scenario for the economy. The primary requirement is the use of land as a factor of production in the agricultural sector producing food. Since use of land in agricultural versus non-agricultural activities is a separate debate that does not concern us here, we set aside all such channels arising out of the 'allocation' of land across agricultural and non-agricultural activities. Here, we make land specific to agriculture.

3. The Benchmark Model

Based on Jones (1965, 1971), a model is developed to closely resemble the phenomenon. Whole structure is based on a mixture of Heckscher-Ohlin and Specific variety models (see Jones 2014 and 2018). Literatures have been inundated with models based on Heckscher-Ohlin and its derivatives to explore the trade and wage inequality debate (see for example, Jones, 2000; Marjit and Acharyya, 2003; Anwar (2009), Beladi et al. (2006) Feenstra and Hanson, 2003; Kar and Marjit 2005, Das, Marjit and Kar 2020, Das 2013&2018, Sanyal and Jones 1982, Marjit and Kar 2013). We consider a small open economy and its 'structural change' in terms of evolution or disappearance of a sector in response to external stimuli causing changes in which commodities will be ultimately produced[6]. Host countries are land-abundant and scarce in investors, social capital, human capital, skills, and governance. This represents primarily an underdeveloped agricultural economy.

To facilitate the understanding of the evolution of CF, and the possible contraction (and collapse) of the traditional land-intensive agriculture sector (X_A), to start with, we consider 2 sectors, viz., Agriculture and Manufacturing (*composite non-agricultural*). However, the former sector is of our immediate interest due to potential transformation *a la* foreign investment enhancing competition in agricultural sector itself for production reallocation. The CF sector requires land to set up their activity. *Assume,* for the moment, that all the existing lands are fully employed in the Agricultural (food producing) sector.

[6] 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.

However, as the CF sector is purported to produce non-Food Cash crops that it exports entirely, there will be a land-competition effects within the 'broad' agricultural sector. In this context, typically contract farming--*induced via either technological benefits or factor accumulation (more productive capital improving marginal productivity of land or the farmer*), or rise in world market price could cause *'structural transformation'—viz., a 'finite change'*—so that the returns or rewards to concerned factor change (Jones 1971, Jones and Marjit 2009, Marjit, Kar and Beladi 2013).[7]

In fact, as CF changes the economic environment esp. pertaining to the agricultural sector this might lead to contraction (if not ceasing to exist) of the agricultural sector (the competing sector for land endowment). In this paper, we argue that either a government policy to allow FDI in agriculture or, an exogenous price increase make such investments possible at the home country. As envisaged, this brings in a *discrete change in the output baskets* as a new separate sector splits out of the land-competing agricultural sector and hence there is scope for one sector to engage in a more competitive one at the expense of the existing one. *Therefore, the essence of food insecurity boils down to the scarcity of land for the traditional agricultural sector that produces food and solely caters to the needs for food of the domestic residents.* This, in turn, leads to an <u>*ambiguous outcome of CF*</u> that could have adverse or beneficial impacts to the country in many other respects.

In other words, external factors and competition may shut down Agricultural (food-producing) sector, as return to occupations specific to the CF sector—*unrewarded beforehand*—is raised ex post.[8] Food-insecurity impact and ensuing policy changes for welfare are important. Theoretically, the situation is similar to situations analysed 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) where 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 change *a new equilibrium emerges* that 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 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)

[7] 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 (1974) and its extensions.
[8] Although beyond the purview of this paper, the 'survival' of the contracting sector from being vanished or re-emergence depends on specific conditions as well as positive external spillover via CF-induced changes.

a_{ij} = i[th] input required to produce 1 unit of j[th] final good, i =K, L, V;

$\frac{da_{ij}}{a_{ij}} = -t(t > 0)$ is the uniform rate of technical progress where negative sign indicates that unit factor requirement shrinks thanks to boons of technical progress.

$\theta_{ij} = wa_{lj} / P_j$ is the distributive share of l^{th} labor-types in j∈{ X_M, X_A, X_C }, ∀l;

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

$\theta_{vj} = R_j a_{vj} / P_j$ is the distributive share of owner of V[th] specific land for j∈{A,F},∀v∈{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 $\hat{x} = \frac{dx}{x}$

However, the basic structure could be extended or modified as necessary, and accordingly notations above will be altered. We assume perfect competition in product and factor markets. Mobility of labor ensures a uniform low-wage (w) across Manufacturing (M) and Agriculture (A). On the contrary, immobility of *specific land and capital* types causes returns to vary across 'A' and 'M'. Production functions represented above are assumed to exhibit linear homogeneity and diminishing returns to respective inputs.

3.1 Base-case Structure of a Small Open Economy

We assume a small open economy with two sectors, to start with: (i) the agricultural sector (A), producing a homogeneous agricultural commodity like food (X_A) and (ii) another sector that produces a composite non-agricultural (manufacturing, M) product, X_M. As explained before, agriculture uses land (V, specific to X_A). Let labour (L) be the other factor used by both the sectors. The composite manufacturing sector (M) uses labour and capital (K, specific to X_M). Under the assumption of competitive markets with full-employment of resources, this gives rise to a simple 2-sectors× 3-factors Specific-factor framework with capital specific to manufacturing sector (M) and homogenous labour--the common mobile factor-- across 2 sectors. Here, we *do not* explicitly introduce agriculture subject to contract farming. Thus,

$$X_M = X_M(L,K); X_A = X_A(L,V).$$

The General equilibrium structure is captured in the following equations:

$$a_{VA}X_A = \bar{V} \quad (1)$$

$$a_{KM}X_M = \bar{K} \quad (2)$$

$$a_{LA}X_A + a_{LM}X_M = \bar{L} \quad (3)$$

$$a_{VA}R + a_{LA}w = \bar{P}_A \quad (4)$$

$$a_{KM}r + a_{LM}w = \bar{P}_M \quad (5)$$

$$a_{ij} = a_{ij}(R,r,w) \quad (6)$$

where the returns to land, capital, and labor are R, r and w respectively and a_{ij}'s are the unit factor requirements. (1) to (5) are five independent equations in five variables, the three factor returns and the two outputs and therefore can be solved. Via (1) – (5), note that these equilibrium factor returns are functions of the exogenous commodity prices as well as exogenous factor endowments. Being mobile labour endowment is allocated by the equality of the value of marginal products of labour in the two sectors. Endowment differences will cause specialization in different sets of goods, and factor prices will diverge ex post.

An *exogenous price rise* in 'A' sector increases wage and more labour is allocated to the sector. However, as is well known via standard '*magnification effect*', real wage in terms of the good whose price has increased declines as the greater part of the benefits of the price rise goes to the specific factor (V) in this sector. On the other hand, real wage in terms of the other good rises as there has been no increase in the price of this good and absolute wage has increased. Welfare of the workers (in terms of real wage) depends on consumption shares of the goods in demand function a la Engel law in consumption. This 'sandwiched effect' is typically summarised as: $\hat{R} > \widehat{P_A} > \hat{w} > \widehat{P_M} \geq 0 > \hat{r}$. This is the magnification effect (Jones 1971). Land-owners' (*R)* gains in terms of both sectors. Being specific in nature land and capital have no scope for reallocation and real returns increase in terms of both goods.

Here, comparative statics exercises show that with rise in prices of agricultural products in the world market, the Value marginal product (VMP) curve of land will shift. In the following section, we explore the situation in the land market in the wake of the CF sector and the possibility of shift of land to the CF-sector with rise in 'returns' to land.

3.2. Emergence of Contract Farming in an 'Otherwise Mixed' Production Structure

To begin with, either low international price of cash crops producible in this country *without CF,* or, given prices, the backdated technology, or, even ban on foreign direct investment in agriculture could make such investments unprofitable and hence, impossible. There are ample evidences that this situation could reverse if one or all of these factors change for inducement.

Once we allow such investments, the new CF sector competes for land with the traditional agricultural sector and for labour with both the traditional agricultural and the manufacturing sector. Three cases are clearly possible:

(1) the CF sector completely overwhelms the traditional agricultural sector so that there is *complete specialization of CF* in the agricultural sub-sector;

(2) the CF sector co-exists with traditional agriculture leading to an *incomplete specialization* in the agricultural sub-sector;

(3) the CF sector fails to compete with the traditional agricultural sector and exits after entry and the equilibrium relapses into the model in the previous subsection (*complete specialization in 'A' sector*)[9]. There has been no empirical evidence of the first situation anywhere in the world. The incumbent country's government will obviously never allow this to happen.

[9] These cases of complete and incomplete specialization can be explained in terms of the cone of diversification (see Caves and Jones (1977)). Briefly, due to changes in the world price of the agricultural sub-system of contract farming and/or the marginal productivity in that sector, the country's endowment point moves from complete specialization in traditional agriculture to incomplete specialization involving both, and could further lead to complete specialization in CF. On which, more to follow.

These three cases could be conceptualised via considering the Value Marginal Product of Land (VMPV) in CF and Agriculture sectors under different scenarios. Without CF, the value of marginal productivity of land ($VMPV^A$) curve for A is the only curve in the land market. If full employment of land is assumed, then R^0 is determined at the point where the land market is cleared. Suppose for some reason (due to higher cost or bad technology and/or, lower price) rent (value marginal productivity of land ($VMPV^{CF}$) in CF is even lower than that in Agriculture ($VMPV^A$), then it must imply that *with zero land* in CF (i.e., without CF) it would be much lower than that in agriculture sub-sector. *Then, all land is allotted to 'A' sector (i.e., case of complete specialization). See figure 1, where $VMPV^{CF}$ is much below $VMPV^A$.*

Whether CF can enter the agricultural sector or not depends on the position of the CF sector's VMP_V ($VMPV_{CF}$): it can enter only if it can pay at least R^0. If $VMPV^{CF}$ shifts left up to intersect $VMPV^A$ at higher equilibrium at I_1, we can see that land allocation does not start until the 'gap' between these two VMPV curves shrink. In case of I_1, the land going to CF sector is much less (V_0V_{CF}) with the scope of productivity benefits being less. *However, if $VMPV^{CF}$ shifts a 'big way' upwards (thanks to much higher world price or, superior technological progress with prospects of cost-reduction) so that the new point of intersection is at new equilibrium C, then it will be lucrative to switch land from "A-sector" to CF.* Thus, any VMP_V curve uniformly below R^0 (say, at $VMPV_{CF0}$) implies that entry is not possible. In other words, the position of $VMPV^{CF}$ depends on *two scenarios*: ***given prices****,* an entrant must have a sufficiently good technology (MP_V) for land usage to be able to penetrate the country's market. *Secondly*, on the other hand, ***given technology***, international prices decide entry. As any of these scenarios happens, it increases the probability of entry as the VMP_V curve for CF shift to the right ($VMPVCF^2$). This makes agricultural products- alike cash crops- better candidates for CF at least for some landowners. *Once CF enters, allocation of land depends on the relative position of the VMP_V curves (see Figure 1):*

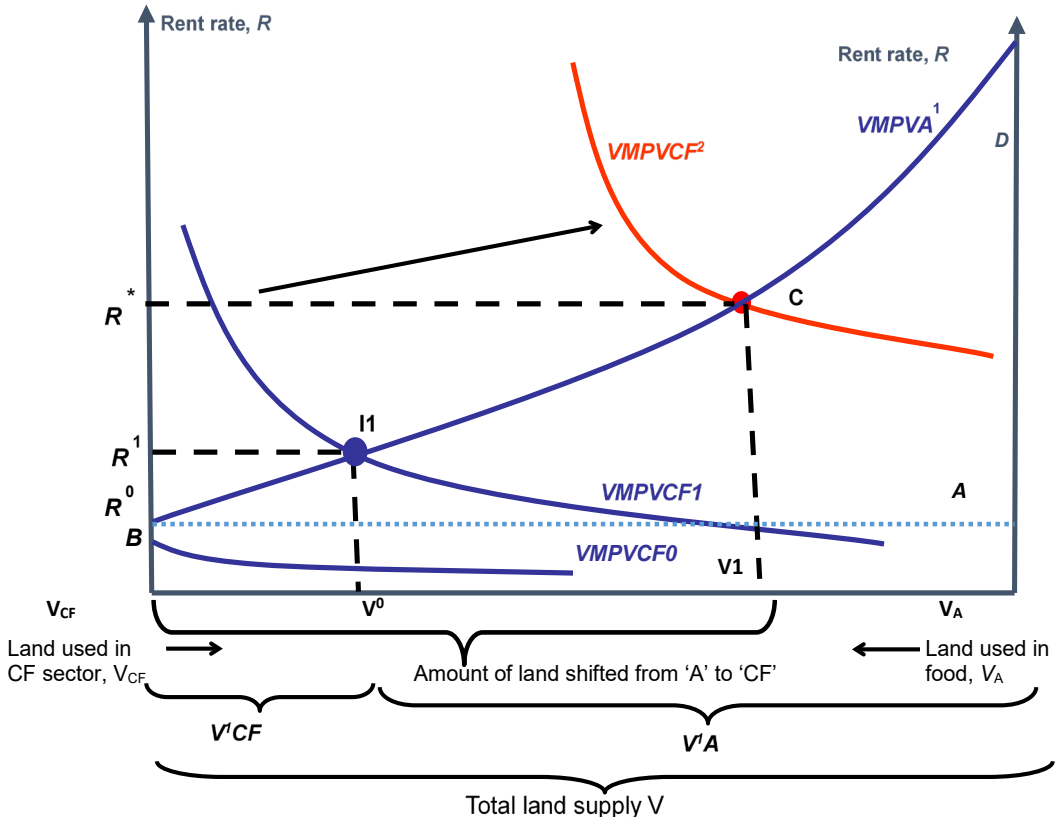


Figure 1: Allocation of Land and entry of CF in the Agricultural Sector

In particular, from figure 1 we observe-

(1) New $R = R^*$ is higher than the pre CF returns to land (say, R^0)

(2) 'V_1V_{CF}' amount of land moves from the traditional agricultural sector to the CF sector with much higher $VMPV_{CF}$.

(3) value of output in the traditional agricultural sector changes from $DVV_{CF}A$ to DVV_1C and

(4) total value of agricultural products increase from $DVV_{CF}A$ to $DVV_1C + CV_1V_{CF}B$ out of which the latter part is exported.

In order to consider the three possibilities, we consider the cases where ranges of specialization corresponding to *endowment and allocation* determine the scope of diversification. Choice of production technique in keeping with endowment ratio will determine the full-employment production bundles.[10] *A finite change in structure depends on these triads.*

Let $\frac{L}{V} = l, \frac{V}{L} = v = \frac{1}{l}$ be the factor-endowment ratio.

For any given R/W, aggregate relative demand is weighted average of sectoral factor-intensities (*l or v*):-

[10] See Caves, Frankel and Jones (2010). Also, Sen (1968), Choice of Techniques. Chapter VI on International Trade.

$$l_d = \frac{L_{CF} + L_A}{V_{CF} + V_A} = \frac{V_{CF}}{V} l_{CF} + \frac{V_A}{V} l_A = \lambda_{VCF} l_{CF} + \lambda_{VA} l_A, \lambda_{VCF} + \lambda_{VA} = 1$$

Where $\lambda_{ij} =$ proportion of factor 'i' employed in sector 'j'. For complete specialization in 'A' or 'CF', we will have $\lambda_{VCF} = 0, \lambda_{VA} = 1$ or, $\lambda_{VA} = 0, \lambda_{VCF} = 1$. By property of weighted average, we can write: $l_A > l_d > l_{CF}$. *Now producers will choose a production technique that exactly matches with the endowment ratio.*[11] With this condition and given R/W and $\frac{L}{V} = l$ both goods are produced (incomplete specialization) as the overall endowment ratio lies between the labor- intensities l_A and l_{CF} in two sectors, and that matches with the aggregate relative demand. *In between these ranges, as relative price of CF compared to price of 'food' rises, R/W rises as well, and change in composition of production bundle (at full employment) occurs with rise in relative supply of CF-output.*

With the production structure (See Section 2.2 and 2.3), a la Jones (1965):

$$\begin{pmatrix} a_{LA} & a_{LC} \\ a_{VA} & a_{VC} \end{pmatrix} \begin{pmatrix} X_A \\ X_C \end{pmatrix} = \begin{pmatrix} L \\ V \end{pmatrix} \qquad (7a)$$

Where Technology matrix $|T| = a_{LA} a_{VC} - a_{VA} a_{LC}$

$$X_A = \frac{a_{VC} L - a_{LC} V}{a_{LA} a_{VC} - a_{VA} a_{LC}}$$
$$X_C = \frac{a_{LA} V - a_{VA} L}{a_{LA} a_{VC} - a_{VA} a_{LC}} \qquad (7b)$$

Simplifying above,

$$X_A = \frac{a_{LC} L(\frac{a_{VC}}{a_{LC}} - \frac{V}{L})}{a_{LA} a_{LC}(\frac{a_{VC}}{a_{LC}} - \frac{a_{VA}}{a_{LA}})} = \frac{L(v_C - v)}{a_{LA}(v_C - v_A)} \qquad (7c)$$
$$X_C = \frac{L(v - v_A)}{a_{LC}(v_C - v_A)}$$

Using (7b) and (7c), we offer three plausible specialization scenarios as:

(i) Complete specialization in 'A': $X_C = 0$ if $v_A = v$ (or, equivalently, $l_A = l$)

(ii) Complete specialization in 'CF': $X_A = 0$ if $v_C = v$ (or, equivalently, $l_C = l$)

(iii)*Incomplete specialization*: $X_A > 0, X_C > 0$ if $v_C > v > v_A$ (or, equivalently, $l_A > l > l_C$)

For this, we make the following pertinent **assumption**: CF is land-intensive relative to A and incomplete specialization prevails in the agricultural sub-system sector. ***Assumption***

[11] Of course, here we assume that relative land-to-labor supply has a maximum (sufficiently high) and vice versa to rule out the possibility that in countries where abundance of fallow, unused land to labor exists, such situation does not overwhelm traditional agricultural sector so that the later ceases to exist.

that 'A' is labor-intensive (relatively) boils down to: $|T| = a_{LA}a_{VC} - a_{VA}a_{LC} > 0$ and *guarantees the possibility where pairs of both goods are produced in the zone where the above condition (iii) is satisfied,* namely in the cone of diversification. This is presented below in Figure 2.[12]

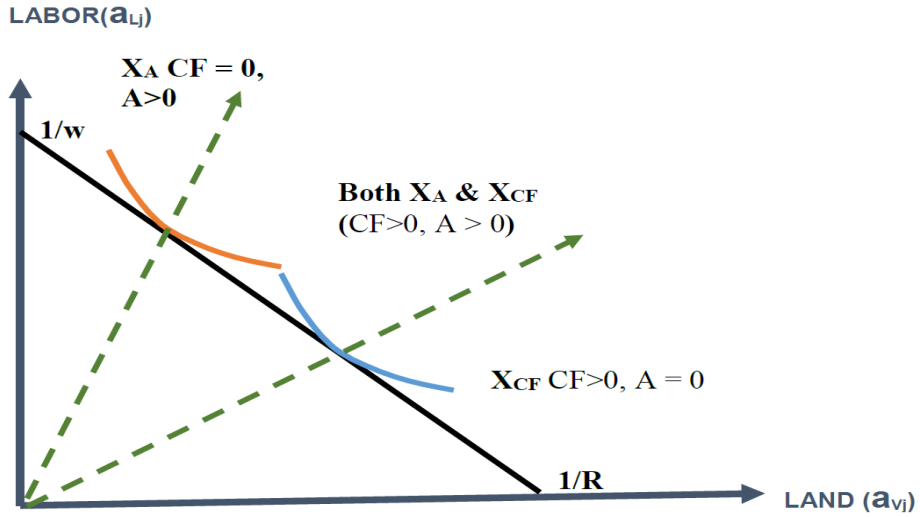


Figure 2: Food-sector and Contract Farming Outputs under different specialization patterns.

The isoquants for each sectors are the Unit-value isoquants and the isocost line is drawn accordingly. For any given R/W ratio, CF-production has higher land-labor ratio than A-sector and vice versa. Here if the economy incompletely specializes in both A & CF sectors, then it must be the situation that costs of producing one-dollar worth of both of them must be the same. This is possible if the minimum cost of production for A and CF both lie on the same isocost line whose slope is –R/W. Two rays from the origin form the 'cone of diversification'. Thus, the condition that both 'food' crops and contract farming outputs are produced at full employment is that the relative endowment of labor vis-à-vis land must not exceed (or, falls short of) the land-labor (or labor-land) intensity of both 'A' and 'CF', i.e.,

$$\frac{\bar{L}}{\bar{V}} \gtrless \frac{L_A}{V_A} > \frac{L_C}{V_C} \gtrless \frac{\bar{L}}{\bar{V}} \Leftrightarrow \frac{a_{VC}}{a_{LC}} > \frac{\bar{V}}{\bar{L}} > \frac{a_{VA}}{a_{LA}}$$

Given that CF is a term that is reserved for foreign investment in the agricultural sector, CF can be considered as an influx of capital in the 'broad' agricultural sector, inducing 'finite 'effect of a prospective exogenous rise in the price in the exportable cash-crops that attracts foreign investment (capital). The first case requires capital (either as foreign or composite capital) to be an additional factor of production in the exportable crop sector, opening an additional channel of inter-sectoral adjustment process. In both these cases, CF needs to be exogenously built into the above model as an independent sector.

Here, the possible 'rise in price' in the world market due to scope of international trade provides the 'positive' shocks or incentives for shifting land from food sector to an activity that could boost productivity (via access to better agricultural input bundles). This

[12] Case such as CF becomes labor-intensive (i.e., factor intensity reversal) will alter the consequences although similar logic prevails. We rule out that case because the basic premise is that CF ushers in better technology or benefits in the agricultural sector.

causes potentials for endogenous collapse of the traditional food sector ('finite change'), and emergence of a CF-sector with output X_C. 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* one producing say, food (as before) and the other say, cash crops. In this model, foreign investment in the agricultural sector introduces a new technology for producing agricultural goods in selected tracks of land (in terms of separate 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*: $\mu_C = (1-\rho)P_C$ where $\rho < 1$ is the proportion of unit prices accruing to the domestic economy and (1-ρ) is the proportion of unit prices that is repatriated. We can then immediately write:

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

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 rather than in 'A' sector. Therefore, there will be incentive for landowners to reallocate land towards CF. This give rise to endogenous production structure thanks to mobility of land as will be modelled below (Jones 2014).

Necessity: 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 that: $\Omega^0 < \Omega^*$, which implies that the *non-CF equilibrium* becomes suboptimal as soon as the option of CF opens up.

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

$$a_{VA}X_A + a_{VC}X_C = \bar{V} \quad (1')$$

$$a_{KM}X_M = \bar{K} \quad (2')$$

$$a_{LA}X_A + a_{LM}X_M + a_{LC}X_C = \bar{L} \quad (3')$$

$$a_{VA}R + a_{LA}w = \bar{P}_A \quad (4')$$

$$a_{KM}r + a_{LM}w = \bar{P}_B \quad (5')$$

$$a_{VC}R + a_{LC}w = \rho\bar{P}_C \quad (6')$$

$$a_{ij} = a_{ij}(R, r, w) \quad (6'')$$

These are *six independent equations in six variables*: the three factor prices and the three outputs of the three sectors. Thus, once again the system is solvable. Note that the system is now decomposable into (1') to (3') and (4') to (6') where the three latter equations determine the factor prices. Unlike the previous model, there are two mobile factors: labour and land. Land has restricted mobility only between the two subsectors within the agricultural sector.

Note that entry of CF leads to emergence of an *'endogenous production structure' due to exogenous shift in technology and/or, change in price causing the allocation of available*

land endowment. Rise in "R" is 'endogenous'--a consequence of this land-switching thanks to scope of major technological shifts or cost adjustments causing structural change in the overall economy. As "R" rises endogenously, thanks to rise in demand for land with fixed land supply, there might be contraction of output in the food sector (A). "V" is a binding constraint here and it could have distributional implications, as well as commensurate food insecurity issues.

3.3 Equations of Change:

Here we consider two types of exogenous 'shocks': (i) changes in world prices of tradeable sectors; (ii) technical progress causing changes in total factor productivity or factor-augmenting changes.

3.3.1) Exogenous Price Change/s:

Consider the following comparative statics parametric changes to focus on ensuing exogenous changes, such as, world price rise. For enumerating proportional changes for the equation system (1') to (6'), employing envelope theorem (Jones 1965), we derive the cost-shares—θ_{ij} --to obtain 'Equations of Change':

$$\theta_{LA}\hat{w} + \theta_{VA}\hat{R} = \hat{P}_A \qquad (8)$$
$$\theta_{LC}\hat{w} + \theta_{VC}\hat{R} = \hat{P}_C \qquad (9)$$
$$\theta_{LM}\hat{w} + \theta_{KM}\hat{r} = \hat{P}_M \qquad (10)$$

With no price changes for sectors A and M and following our conjectures on exogenous price increase in the exportable cash-crop sector (X_C), we obtain:

$$\theta_{LA}\hat{w} + \theta_{VA}\hat{R} = 0 \qquad (8')$$
$$\theta_{LC}\hat{w} + \theta_{VC}\hat{R} = \hat{P}_C = \lambda\hat{P}_A \geq 0 \qquad (9')$$
$$\theta_{LM}\hat{w} + \theta_{KM}\hat{r} = 0 \qquad (10')$$

Proposition 1: *Ceteris paribus, with* $\hat{P}_C > 0$, $\hat{X}_A < 0, \hat{X}_C > 0$ *causing loss in real wage.*[13]

Proof: there will be intersectoral migration of labor from shrinking traditional agriculture sector to contract farming. Thus, $\hat{X}_A < 0, \hat{X}_C > 0,$ and $\hat{X}_M > 0$ while $\hat{P}_C = \lambda\hat{P}_A \geq 0.$
Now, using equation system (8')---(10'), we can write:

$$\hat{R} = -\frac{\theta_{LA}}{\theta_{VA}}\hat{w} = -\frac{\theta_{LC}}{\theta_{VC}}\hat{w} \Rightarrow \hat{R} > 0, \text{as } \hat{w} < 0. \text{ Similarly, } \hat{r} = -\frac{\theta_{LM}}{\theta_{KM}}\hat{w} \Rightarrow \hat{r} > 0 \text{ as } \hat{w} < 0.$$

3.3.2) Exogenous Technical Progress-led Changes:

Depending on the nature of technology thanks to CF, given full employment, the new sets of factor returns will depend on whether this new technology is more labour-saving or land-

[13] Of course, relative budget shares of these outputs will determine the extent of net welfare impacts. In this case, household income and wealth effects and Engel aggregation conditions need to be satisfied. This is beyond the scope of the current emphasis of the paper; but surely, the fall in real income is critical to note.

saving. From Section 2, $\frac{da_{ij}}{a_{ij}} = -t(t > 0)$ is the rate of technical progress. Assuming differential rates of Hicks-Neutral technical progress across sectors, viz., α, β, and γ (where t ∈ {α, β,γ}) for traditional agriculture, contract farming, and manufacturing sectors respectively, from (8)—(10):

$$\theta_{LA}\hat{w} + \theta_{VA}\hat{R} = \alpha \qquad (11)$$

$$\theta_{LC}\hat{w} + \theta_{VC}\hat{R} = \beta \qquad (12)$$

$$\theta_{LM}\hat{w} + \theta_{KM}\hat{r} = \gamma \qquad (13)$$

Proposition 2: $\hat{R} > 0$ iff $\alpha\theta_{LC} < \beta\theta_{LA}$, and $\hat{w} < 0$ iff $\beta\theta_{VA} > \alpha\theta_{VC}$, $\hat{r} > \hat{w}$ iff $\gamma > \hat{w}$ (as $\theta_{KM} > 0$) and $\hat{R} - \hat{w} = \frac{\alpha - \beta}{|\theta|} > 0$ iff $\alpha < \beta$.

Proof: *For detailed derivation see Appendix.*

Ex post with CF, as land moves from X_A, CF (X_C) will have higher cost-shares of land implying $|\theta| = \theta_{VA} - \theta_{VC} = \theta_{LC} - \theta_{LA} < 0$. Also,

$\hat{R} = \frac{\alpha\theta_{LC} - \beta\theta_{LA}}{\theta_{VA}\theta_{LC} - \theta_{VC}\theta_{LA}} > 0$ iff $\alpha\theta_{LC} < \beta\theta_{LA} (given |\theta| < 0)$. This implies also $\frac{\alpha}{\beta} < 1$ as $\theta_{LA} > \theta_{LC}$.

Similarly, for $\hat{w} < 0$ iff $\beta\theta_{VA} - \alpha\theta_{VC} > 0 \Rightarrow \beta\theta_{VA} > \alpha\theta_{VC}$ $(given |\theta| < 0)$.

As above, we can prove that it holds when $\frac{\alpha}{\beta} < 1$ as $\beta\theta_{VA} > \alpha\theta_{VC}$, expost $\theta_{VC} > \theta_{VA}$

Hence, we can infer that: $\hat{R} - \hat{w} = \frac{\alpha - \beta}{|\theta|} > 0$ iff $\alpha < \beta$.

From (13), $\hat{r} = \frac{\gamma - \theta_{LM}\hat{w}}{\theta_{KM}} \Rightarrow \hat{r} - \hat{w} = \frac{\gamma - \hat{w}}{\theta_{KM}}$ (as $\theta_{LM} + \theta_{KM} = 1$)

As $\hat{w} < 0$, and $\gamma > 0 \Rightarrow (\gamma - \hat{w}) > 0$. Also, with technical progress in the manufacturing sector, the fall in wage rate must be superseded by the rate of increase in marginal productivity of capital. This is quite intuitive that contingent on higher rate of technical progress and accrual of its spillover benefits in the CF sector, there is maximum return to the factor used in CF-sector which survives as the allocation of land enables more earning to land-owners undertaking CF-mode. Return to the perfectly mobile labour (used in all three sectors) is determined via standard HOS mechanism, and it unambiguously suffers.

Proposition 3: *If CF introduces labor-augmenting technical change then capitalists and landowners gain at the cost of labourers. The labor-augmenting technical progress boosts the manufacturing sector while traditional agricultural sector shrinks.*

Proof: As the new technology introduced by CF is more labour-saving (or, synonymously labor-augmenting) than the traditional agricultural sector in which the land was previously

employed, then CF reduces the demand for labour in the agricultural sector and w^* is less than w^0. As wages fall, the cost of production in the manufacturing sector falls and, given price, there is entry of labor in the manufacturing sector, *increasing 'r'* as demand for capital that is specific to the manufacturing sector rises. Since we have shown that R increases due to the introduction of CF, clearly introduction of CF implies that capitalists and landowners gain at the cost of labourers.

It is easy to check that X_M increase. The reason for this is clear from equation (2'). As wage falls the manufacturing sector becomes more labour intensive and a_{KM} falls. On the other hand, X_A falls. This is obvious from comparing equations (3) and (3'). In (3') $a_{LM}X_M$ rise as both a_{LM} and X_M separately rise. Thus, given L, $a_{LA}X_A + a_{LC}X_C$ falls. However both of these unit labour requirements rise due to fall in wages and X_C appears as an additional entry compared to (3), making it necessary for X_A to fall. In fact, if the CF and the traditional agricultural sector have same productivity of land, it can be checked from (1') that the fall in X_A is proportional to the rise in X_C.

Clearly therefore the introduction of CF increases the demand for land bidding up its price. As land prices rise traditional agriculture becomes more labour intensive and shrinks in size. The traditional manufacturing sector gain in the bargain if the CF sector is labour-saving than the traditional agricultural sector as the shift of land from traditional agriculture to CF releases labour reducing its wage, reducing cost of production in that sector and triggering entry of new firms. (QED).

However, if CF is land-saving in nature, there will be changes in the above result as discussed in the following corollary.

Corollary 1: Introduction of land-augmenting technical progress via CF boosts the CF sector, while manufacturing sector shrinks (even could vanish). Depending on the scope of spillover externality, food-crop sector might expand. However, the traditional agricultural sector shrinks as Prices of cash-crop rises with migration of labourers to the CF sector. In these cases, labourers and landowners gain at the cost of capital-owners. A scenario could emerge where capital flows into CF (as manufacturing is on the verge of collapse) to change the factor-intensity of CF-farm via making it capital-intensive. *Here,* $\widehat{X_A} < 0, \widehat{X_C} > 0$, $\widehat{X_M} < 0$ *and* $\hat{R} > 0$, $\hat{w} > 0$, $\hat{r} < 0$. In this counter-intuitive case, the effect is not all gloomy for the workers. Definitely, there is scope of silver lining in CF.

Note that since X_A falls, if the entire amount of X_C is exported, then domestic food availability falls unambiguously. However, such decline in domestic food availability can be met by food imports. Since output of the CF sector is exported, such imports become feasible to the country as well. All this brings us to the question of the balance of trade, on which more to follow in the next subsection.

However, the shrinkage of agriculture food crop sector opens up the consideration for a more general case where such exogenous positive shocks provide incentives for factor flowing explicitly into the targeted sector. It is akin to exporting capital (and labor) to the land (or, labor) abundant country. Consider a situation where land is immobile, land-intensive goods can then be produced by exporting capital or labor (or both) to land-abundant country (like India or China), which can then be imported. For example, developed countries like EU

or USA might export "K" to use 'Land' in Africa, India, or China. China exports both labor and capital to Africa, though. The question that arises is the distribution of gains from such trade between countries and among people within these host nations.[14]

The above analysis shows that: without capital flow embodying technological boons, and capital explicitly entering into the contract farming sector, prospect of reaping the benefits in some emerging and developed nations could provide the incentive for conversion to CF into the less-developed host; factor-augmenting (labor or land-saving) technological progress originating abroad raises "effective" labor and land in the destination.

4. A Generalized Model of Emergence of Contract Farming: Finite Change

Following from the above motivation*, we rewrite the above model with CF as an additional sector*. In this case, the sector with prospects of highest return to the specific factor land (most productive sector) will survive. *Ex post* impact is conditional on the surviving sector experiencing such external perturbations and this could ensue *'finite changes'* in the structure of the economy (see Mandal and Marjit 2014; Dutta, Kar, and Marjit 2013; Beladi, Kar and Marjit 2012; Marjit and Kar 2013 & 2019).

This model offers an important insight that in the presence of another agricultural sector experiencing favourable business climate facilitating exportability and prospects of superior inputs bearing fruits of technological progress. The adversely affected sector ceases to exist with perverse distributional consequences. It makes room for the case that CF could evolve via FDI such that the backward sector faces the threat of extinction despite providing food crops. Relatively 'promising' targeted crop sector receiving 'endowment' via better quality 'capital' augments land-productivity as superior technology improves marginal productivity of land as well as labor moving to that sector. Ensuing changes in the wake of contract farming via flow of 'capital types' (machinery, irrigation, biotechnology-induced seed variety, and fertilizer) causes structural shifts to more capital-intensive farming.

Consider 3 sectors (as before), *but we introduce capital in X_C*. Thus, we have 3 factors and the altered structure becomes[15]:

$$CF: X_C = X_C(V_C, K, L)$$
$$Non-CF: X_A = X_A(V_A, L)$$
$$MFG: X_M = X_M(K, L)$$

Competitive equilibrium and P = AC means:

$$a_{VC}.R + a_{KC}.r + a_{LC}.w = P_C \quad (14)$$

$$a_{VA}.R + a_{LA}.w = P_A \quad (15)$$

$$a_{KM}.r + a_{LM}.w = P_M \quad (16)$$

Full-employment conditions are:

$$a_{VC}X_C + a_{VA}X_A = \overline{V} \quad (17)$$

[14] Export of 'K' and 'L' to land-abundant country (Newly emerging countries or Southern Engines of Growth)

[15] We, unlike benchmark model, include K_C in CF sector as that does impart additional intuitions. We do not model contract negotiation here. Dealing with establishing, designing, and implementing contract is beyond the scope of this paper.

$$a_{KC}X_C + a_{KM}X_M = \overline{K} \qquad (18)$$

$$a_{LC}X_C + a_{LM}X_M + a_{LA}X_A = \overline{L} \qquad (19)$$

We can solve for 6 variables, viz., X_M, X_A, X_C and w, r, and R, from 6 equations.

4.1 Comparative statics:

As in the previous section, with P_A=0, $P_M = 0$ *and for cash-crop sector (*P_C *>0)*, we rewrite:

$$\theta_{VA}R + \theta_{LA}w = 0 \qquad (20)$$

$$\theta_{KC}\hat{r} + \theta_{VC}R + \theta_{LC}w = P_C = \lambda P_A \geq 0 \qquad (21)$$

$$\theta_{KM}\hat{r} + \theta_{LM}w = 0 \qquad (22)$$

Note here $\theta_{KC} + \theta_{VC} + \theta_{LC}$=1

Following section 2 and 3, similar kinds of consideration for uniform factor-neutral technological change, $\frac{da_{ij}}{a_{ij}} = -t(t > 0)$, leads us to rewrite above as:

$$\theta_{VA}R + \theta_{LA}w = \alpha \qquad (23)$$

$$\theta_{KC}\hat{r} + \theta_{VC}R + \theta_{LC}w = \beta \qquad (24)$$

$$\theta_{KM}\hat{r} + \theta_{LM}w = \gamma \qquad (25)$$

Proposition 4: $R > \hat{r}$ iff $\theta_{VA} < \theta_{KM} \Rightarrow \theta_{LM} < \theta_{KM}$ and $\hat{r} > w$, as $w < 0$, $\theta_{KM} > 0$, also $R > \hat{r} > w$.

Proof: Using (20) — (22), we can write: $R = -\frac{\theta_{LA}}{\theta_{VA}}w \Rightarrow R > 0, \text{as } w < 0.$

Also: $w = -\frac{\theta_{VA}}{\theta_{LA}}R = -\frac{\theta_{KM}}{\theta_{LM}}\hat{r} \Rightarrow w < 0$ as $R > 0$ and $\hat{r} > 0$.

$\hat{r} = -\frac{\theta_{LM}}{\theta_{KM}}w \Rightarrow \hat{r} > 0$ as $w < 0$.

Thus, $R - \hat{r} = (\frac{\theta_{LM}}{\theta_{KM}} - \frac{\theta_{LA}}{\theta_{VA}})w \Rightarrow$

$R > \hat{r}$ iff $\frac{\theta_{LM}}{\theta_{KM}} < \frac{\theta_{LA}}{\theta_{VA}} \Rightarrow \theta_{LM}\theta_{VA} < \theta_{KM}\theta_{LA} \Rightarrow \theta_{VA} < \theta_{KM} \Rightarrow \theta_{LM} < \theta_{KM}$

As manufacturing sector is relatively capital-intensive with capital being specific there, the above result is intuitively clear. Analogously,

$$\hat{r} - w = -\frac{\theta_{LM}}{\theta_{KM}}w - w = -\frac{1}{\theta_{KM}}w \Rightarrow \hat{r} - w > 0 \text{ as } w < 0,\ \theta_{KM} > 0.$$

Thus, we can invoke: $R > \hat{r} > w$. Also, use equations (23) — (25) to derive:

$$R = \frac{\alpha - w\theta_{LA}}{\theta_{VA}} \text{ and } \hat{r} = \frac{\alpha - w\theta_{LM}}{\theta_{KM}} \qquad (26)$$

Therefore, $w.\theta_{LC} + \frac{\theta_{KC}}{\theta_{KM}}(\alpha - w\theta_{LM}) + \frac{\theta_{VC}}{\theta_{VA}}(\alpha - w\theta_{LA}) = \beta \qquad (27)$

and $\hat{w}.[\theta_{LC} - \frac{\theta_{KC}}{\theta_{KM}}\theta_{LM} - \frac{\theta_{VC}}{\theta_{VA}}\theta_{LA}] = \beta - \alpha[\frac{\theta_{KC}}{\theta_{KM}} + \frac{\theta_{VC}}{\theta_{VA}}]$ (28)

By algebraic manipulation, we can ensure: $\theta_{LC} < (\frac{\theta_{LM}}{\theta_{KM}}\theta_{KC} + \frac{\theta_{LA}}{\theta_{VA}}\theta_{VC})$

And also,

$$(1-\Delta)\hat{w} = \beta - \alpha\Delta \Rightarrow \hat{w} = \frac{\beta - \alpha\Delta}{(1-\Delta)} \quad (29)$$

Again, $(1-\Delta) < 0 \Rightarrow \hat{w} < 0$. See appendix (QED).

Proposition 5: *Land-augmenting and/or, labor-augmenting technical change via contract farming-induced effects causes structural changes such as, emergence of a 'new' sector and leading to vanishing of a sector unexposed to such benefit. The existing traditional agricultural sector undergoes radical transformation with diversified production structure.*

Now, using (21), plugging in $\hat{R}$ and $\hat{w}$ obtained above, we get:

$$\hat{w}(\theta_{LC} - \frac{\theta_{LM}}{\theta_{KM}}\theta_{KC} - \frac{\theta_{LA}}{\theta_{VA}}\theta_{VC}) = \hat{P}_C \quad (30)$$

But, $\theta_{LC} - \frac{\theta_{LM}}{\theta_{KM}}\theta_{KC} - \frac{\theta_{LA}}{\theta_{VA}}\theta_{VC} = 1 - \left(\frac{\theta_{VC}}{\theta_{VA}} + \frac{\theta_{KC}}{\theta_{KM}}\right) = 1 - \Delta$ (31)

Therefore, $(1-\Delta).\hat{w} = \hat{P}_C$ (32)

This also implies that: $\hat{w} = \frac{\hat{P}_C}{(1-\Delta)} < 0$

Hence, we can say that: when $\hat{w} < 0$, $\hat{P}_C \geq 0$, then $(1-\Delta) < 0$ so that in both cases, $\Delta > 1$

Summing up all the above relationship, we now invoke:

$$\theta_{LC} < (\frac{\theta_{LM}}{\theta_{KM}}\theta_{KC} + \frac{\theta_{LA}}{\theta_{VA}}\theta_{VC}) \quad (33)$$

The intuitive explanation of (33) is that the share of labor in the contract farming sector (θ_{LC}) undergoing structural changes via capital-intensive technology augmenting productivity of land is less than the weighted average of shares of land and capital in CF.

Proposition 5: *Ceteris paribus, with* $\hat{P}_C > 0$, $\hat{X}_A < 0, \hat{X}_C > 0$.[16]

As the CF sector is using all inputs—alike a HOS sector---this could emerge as a mixed sector. As it is strongly land and capital intensive, with more productive employment of capital embodying the boons of technological progress the asymmetric productivity gap between the source and the host will cause such movement causing $\hat{X}_A < 0, \hat{X}_C > 0$ and $\hat{X}_M > 0$ while $\hat{P}_C > 0$. In the manufacturing sector, with no change in the world price ($\hat{P}_M = 0$), more capital is flowing in that sector and as $\hat{w} < 0$, $P_M \geq AC_M$ (average cost). In the CF sector, land and capital-biased technical change causes marginal productivity of land to

[16] Of course, relative budget shares of these outputs will determine the extent of net welfare impacts. In this case, household income and wealth effects and Engel aggregation conditions need to be satisfied. This is beyond the scope of the current emphasis of the paper; but surely, the fall in real income is critical to note.

rise with better combination of inputs, so that both factors benefits ensuring $\hat{R} > \hat{r} > \hat{w}$ and $\hat{X}_C > \hat{X}_M \geq 0 > \hat{X}_A = 0.$

Thus, $\hat{X}_A < 0, \hat{X}_C > 0,$ and $\hat{X}_M > 0$ while $\hat{P}_C = \lambda \hat{P}_A \geq 0.$

Import-competing manufacturing sector expands as there will be intersectoral migration of labor from shrinking traditional agriculture sector to contract farming as well as manufacturing experiencing boons of technical progress induced productivity benefits improving marginal productivity of land and capital.

5. Food Security and Contract Farming

5.1 Balance of Trade and Food Imports

To guarantee food imports, we assume that the traditional agricultural sector is the import sector and, in order to sustain the pre-CF equilibrium, the manufacturing sector is the export sector. For further simplicity, let us assume that the entire manufacturing output is exported. Consider two scenarios as below:-

***(i) Without CF*,**

Export earning is $P_M X_M$ and Import is: $P_A D_A - P_A X_A = P_A (D_A - X_A)$ where D_A is the domestic demand for food.

Let T be the balance of trade deficit then, $T = P_M X_M - P_A (D_A - X_A)$ (34)

If we further assume homothetic preferences and *a constant proportion μ of income goes to domestic demand for food then*,

$D_A = \mu (w^* L + r^* K + R^* V) = \mu Y$ (*where Y is GDP*). (35)

Since *we assume* that the entire amount of manufacturing output to be exported, people only consume food and μ is 1. Representing pre-CF situation by a '0' and post-CF situation by a '*', trade surplus (pre-CF) is:

$$T^0 = P_M X_M - P_A (D_A - X_A). \quad (36)$$

***(ii) With CF*,**

Export (earnings) changes to: $(1 - \rho) P_C X_C + P_M X_M$ and Import (earnings) remains $P_A D_A - P_A X_A$. Balanced trade (using (35)) then implies:

$$T^* = [(1 - \rho) P_C X_C + P_M X_M] - [P_A \mu Y - P_A X_A] \quad (37)$$

Proposition 6: *Introduction of CF increases food import.*

Proof: Given exogenous price of food, food import will increase if

$(D^0_A - X^0_A) < (D^*_A - X^*_A)$

Note that we have already shown that GDP increases (before). This will increase D_A. By proposition 1, X_A falls. Thus, the above inequality is always true.

Proposition 7: *CF creates a trade surplus.*

Proof: Let us think of the *change in* Pc (1- ρ) = Pc* (the price the local producers receive) and GDP (Y) is evaluated at Pc*. By the envelope theorem dY/dPc* = Xc. Also note μY is spent on Agriculture. Therefore, μ Y = $P_A D_A$ (the demand for A). Let us choose M as the numeraire good so that GDP is in the units of M and P_ADA is in the units of M. Now,

μ dY/dPc* = d($P_A D_A$)/dP_C*. Thus trade Surplus goes up by X_C (1- μ) (note that the change in X_A has been accounted for by the envelope condition). Thus, we must have a trade surplus. Since exports will always pay for our imports, we have an increase in food import and a trade surplus. Therefore, *technically* countries can import food for mitigating demand. In fact, there is nothing in the model to show that food production goes to zero (see the discussion on Cone of Diversification in Section 2). Next section describes such impossibility.

5.2. Fallacy of Composition and the Possibility of Vanishing Agriculture.

There cannot be a fallacy of composition under perfect competition with perfect information. If the fallacy exists, it is short-term in nature. Aggregate affect is internalized by the individuals in the long run. Thus, the fallacy of composition is resolved in the long run.

In the model above, *we focus on a single country (small open economy).* Suppose there are 'n' such countries which are exactly similar (homogeneous), and symmetric. Each one engages in CF so that land devoted to Food is slashed because of CF. Taken together, they represent a considerably large chunk of the world food market and no one can refrain from engaging in CF. Thus, in **'symmetric equilibrium'**, there will be an adverse supply shock –causing left upward shift of the World Food Supply. For LDCs, more of the rising income (relaxing the initial budget constraint) is spent on Food (without Engel's law setting in).[17] Thus, overall, it has a price effect via escalating demand (causing the demand curve for Food to shift rightward). In any event, the adverse supply triggers food inflation as food prices rise. This is the '*high price externality*' due to excessive CF—unlike heterogeneous country size where CF could be stopped for some—making cooperation on regulating CF, and internalizing it impossible. Thus, import prices of food might increase if many such small countries pursue CF (i.e., the aggregate has a price effect).

This is illustrated graphically and algebraically (Symmetric case for i= 1, 2, 3, …., n countries) as below:

World Demand = $D_W^A = \sum_{i=1}^{n} D_i^A$ and World Supply = $S_W^A = \sum_{i=1}^{n} S_i^A$

Such countries are heterogeneous in terms of their size where $D_i^A = \mu_i^A Y_i, S_i^A = P_i^A X_i^A$

World equilibrium for Food sector (X_A) is given by:

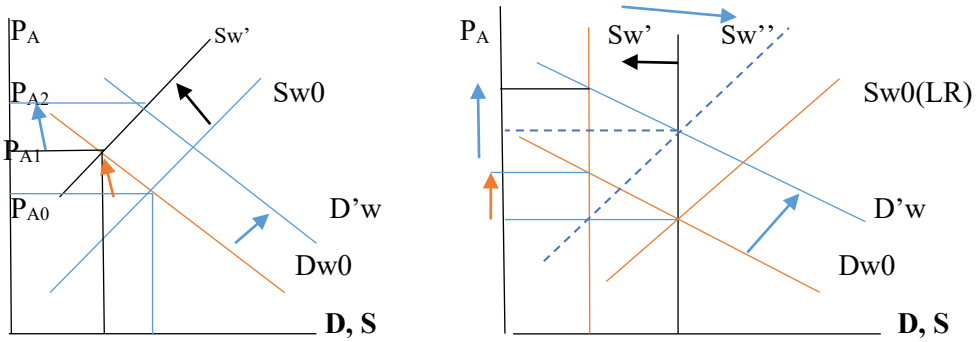
$$D_W^A = \sum_{i=1}^{n} D_i^A = S_W^A = \sum_{i=1}^{n} S_i^A \Rightarrow \sum_i \mu_i^A Y_i = \sum_i P_i^A X_i^A \qquad (38)$$

In case of non-symmetric, $D_i^A = \mu_i^A(Y_i).Y_i$. Now in post-CF case, we know form the propositions that for each small economy GDP (Y_i) rises, and X_A shrinks.

[17] Engel's law is that proportion of income spent on food consumption falls although absolute expenditure on food rises with income. Income elasticity of demand for food is positive and less than unity.

Thus, $\sum_i \mu_i^A Y_i > \sum_i P_i^A X_i^A$ causing P_A to rise in general and for each 'i = 1,2, … , n. As they are heterogeneous in terms of their sizes (GDP), they *cannot* cooperate and decide on prohibition or regulation of land-conversion to CF, and abide by an implicit cooperative solution.

With same sizes, this might not occur. As world prices of food shift up and demand remains the same (or, even rises), some economies quit CF and supply responds until price comes back to the previous level. On top is Engel's law, causing food prices to inflate more and that creates a self-correcting mechanism such that CF gets less and less land, causing limited amount of land being transferred from Agriculture (Food-crop) sector.[18] Thus, with symmetric n-country price-taking model due to fallacy of composition, the aggregate price effect is not internalized by each country, and there is excessive CF in each small country. Internalization of the international price rise occurs in our model via movement of firms from CF to food sector triggered by price hike thanks to combined effect of adverse supply and favourable demand impact (see Figure 3a). Here as land moves to CF, world supply of food (***Sw***) shifts left up thanks to slash of land in traditional agricultural sector for food. Food prices inflate due to leftward supply shift with the same or more demand causing two rounds of price increases. As real wage falls (in terms of food prices -W/P_F), workers lose unambiguously resulting in insecurity (relative poverty increases with rise in inequality as real returns to workers fall). This causes loss of welfare initially without internalizing the externality due to high price.



Figs: 3a & 3b: Long run and Short-run adjustments with adverse Supply shock in food and favourable demand effects.

With vertical supply curve (inelastic) in Fig 3(b), this price rise is a binding constraint. In this case, we think of a global social planner who will allocate a smaller proportion of land to CF in countries with higher GDP (Y), and less to CF if world demand curve is highly inelastic.

Suppose $\sum_i \mu_i^A Y_i = \sum_i P_i^A X_i^A$ and P_A being fixed. As X_A falls but $\mu_i^A Y_i$ rises, P_A has to rise. Post-CF Supply (vertical) shifts further left, and with the same or more demand, P_A rises. If this is 'internalized', then in the long-run ***"Sw"*** shifts right and with rising marginal cost, the ***Sw*** curve becomes more elastic, but does not go back to the 'old' level. X_A rises and P_A falls

[18] Given fixed amount of non-renewable scarce land to be 'divided' between CF and non-CF sector, Land-conversion rate between two competing uses are important as physical shares of land used in CF vis-à-vis Food sector must satisfy land-resource constraint without expansion of land via deforestation, or, fallow land being 'recycled' into use. Elasticity of land conversion (switching) could be important factor for extent of CF vis-à-vis non-CF as that depends on relative returns in those activities.

but not fully. The main question is the long run adjustment may take a very long time depending on: nature of contracts and regulations, management, and laws pertaining to CF etc. Thus, it is possible that the vertical supply curve may keep on shifting left and not shift back due to the long run process.

Proposition 8: A ceteris paribus increase in the price of food sector (agriculture, X_A), due to the symmetric cases with shift in world food supply and demand (*as described above*) leads to contraction of the CF sector, and it is profitable to produce more X_A as expected profit and return to land rises. Thus, land returns to food sector from CF and limits to CF are attained.

Proof: follow the hat algebra of the previous section/s to obtain:-

$If\ \hat{P}_A > 0, \hat{w} > \hat{P}_A > \hat{R}_A > \hat{P}_{CF} = \hat{P}_M = 0 > \hat{r}$. Further, $\hat{X}_A > 0, \hat{X}_{CF} < 0, \hat{X}_M < 0$.

$If\ \hat{P}_A > \hat{P}_M > 0, \hat{P}_{CF} = 0, \hat{R}_A > \hat{P}_A > \hat{w} > \hat{P}_M > \hat{r} > \hat{P}_{CF} = 0$. Further, $\hat{X}_A > 0, \hat{X}_{CF} < 0, \hat{X}_M > 0$

As labour relocates to X_A from other two sectors, and X_A uses more labor relative to CF and X_M sectors, 'r' falls as X_M uses only capital (specific) when prices of manufacturing does not change at all. In case of our generalized model, via equations (24) and (26), even if capital is used in the CF-sector, as P_{CF} does not change, 'r' falls further. With $\hat{R}_A > 0, \hat{w} > 0\ \hat{P}_{CF} = 0$, X_{CF} must contract. This provides the rationale for *Endogenous Limits to CF,* where land-switching away from CF to non-CF food-sector takes place so as to "internalize" the "externality induced by high price"—caused by food insufficiency or removal of farm subsidy or food-biofuel-cash crop competition-- facing the world food market.

Following Jones (1965, 1971), we can write that:

$$\hat{X}_A = \theta_{LA}\sigma_A(\hat{w} - \hat{R}) \text{ and } \hat{X}_C = \theta_{LC}\sigma_C(\hat{w} - \hat{R}) \qquad (39)$$

$$\Rightarrow \hat{X}_A > \hat{X}_C \text{ iff } \theta_{LA}\sigma_A > \theta_{LC}\sigma_C$$

$$\Rightarrow \theta_{LA}/\theta_{LC} > \sigma_C/\sigma_A.$$

However, as X_A is relatively more labour-intensive than X_{CF} (see sections 3, 4 above), $\theta_{LA} > \theta_{LC} \Rightarrow \theta_{LA}/\theta_{LC} > 1 \Rightarrow \sigma_A > \sigma_C$. where σ_A, σ_C are elasticity of substitution between labor and land in the respective sectors. Using endowment shares, we have derived (see appendix) that:

$$\widehat{X_C} = -\left(\lambda_{VA}/\lambda_{VC}\right)\widehat{X_A} \qquad (40)$$

Also, using envelope condition, $\hat{V} = \lambda_{VA}\widehat{X_A} + \lambda_{VC}\widehat{X_C}$ (41)

Further combining these, we can show that $\hat{X}_A > 0$ iff $\lambda_{LA}\lambda_{VC} > \lambda_{LC}\lambda_{VA} \Rightarrow \lambda_{LA} > \lambda_{VA}$.

As we know, $V_A + V_C = \overline{V}$ and we write,

$a_{VA}X_A = V_A$ and $a_{VC}X_C = V_C$ or, $V_C = (1-\omega)V, 0 < \omega < 1.$ (42)

Let $R_A \neq R_{CF}$. Then ω determines the extent of land switching *ex post* the rise in world food prices (as explained before). However, such switching or conversion will depend on

elasticity of substitution between X_A and X_F on the supply side, and hence on relative factor price changes (see Jones 1965). This extent of land-switching or conversion is important for endogenous limit on CF and it is sensitive to relative returns on CF vis-à-vis non-CF agriculture $\hat{R}_A - \hat{R}_{CF}$ where $R_{CF} = R_A \pm Rp$. Marjit and Kar (2019) discuss such possibility in a different context. In the current context, shifting land to X_A from X_{CF} will raise net demand for labour as the former is relatively labor-intensive ($\theta_{LA} > \theta_{LC}$ and $\lambda_{VC} > \lambda_{LC}, \lambda_{LA} > \lambda_{VA}$; in fact, in LDCs agriculture is relatively labor-intensive).

Following Jones (1965, 1971), we can further derive and write (more in the Appendix later):

$$\hat{X}_A - \hat{X}_C = \frac{1}{|\lambda|}(\hat{L} - \hat{V}) + \sigma_S[\hat{P}_A - \hat{P}_{CF}] = \frac{1}{|\lambda|}\frac{\sigma_D}{\sigma_S + \sigma_D}(\hat{L} - \hat{V}) \tag{43}$$

Where σ_S is elasticity of substitution (supply side) between food crops and CF output and σ_D is the elasticity on the demand side triggered by $\hat{P}_A / \hat{P}_{CF}$. Thus, land-switching and compositional changes in product-mix of X_A and X_{CF} is contingent on interplay of demand and supply captured by σ_S and σ_D.

Also, we can derive:

$$\begin{aligned}
\hat{w} - \hat{r} &= \frac{1}{\theta_{LM}}(\hat{P}_M - \hat{r}) \\
\hat{w} - \hat{R} &= \frac{1}{\theta_{LA}}(\hat{P}_A - \hat{R}) \\
\hat{w} - \hat{R} &= \frac{1}{\theta_{LC}}(\hat{P}_{CF} - \hat{R})
\end{aligned} \tag{44}$$

$$\begin{aligned}
\sigma_A &= \frac{\hat{a}_{LA} - \hat{a}_{VA}}{\hat{w} - \hat{R}} \\
\sigma_C &= \frac{\hat{a}_{LC} - \hat{a}_{VC}}{\hat{w} - \hat{R}}
\end{aligned} \tag{45}$$

Using (44) block of equations, we can infer that: $\frac{1}{\theta_{LA}}(\hat{P}_A - \hat{R}) = \frac{1}{\theta_{LC}}(\hat{P}_{CF} - \hat{R})$ and hence, $\hat{P}_A > \hat{P}_C \Leftrightarrow \theta_{LA} > \theta_{LC}$. As long as labor-demand increases with land shifting from CF to food-sector, Dw shifts right ($\hat{w} > 0$). Using (49) block, we infer that:

$\sigma_A > \sigma_C \Leftrightarrow \hat{a}_{LA} - \hat{a}_{VA} > \hat{a}_{LC} - \hat{a}_{VC} \Leftrightarrow \left(\frac{a_{LA}}{a_{VA}}\right) > \left(\frac{a_{LC}}{a_{VC}}\right)$ and, as before, $\sigma_A > \sigma_C \Leftrightarrow \lambda_{LA} > \lambda_{VA}$.

Combining all these conditions, we can argue: (i) given endowment shares such that $\lambda_{LA} > \lambda_{VA}$ and (ii) cost-shares such that $\theta_{LA} > \theta_{LC}$, $\hat{P}_A > \hat{P}_C$ ---triggered by excessive CF shifting Sw leftward and Dw remaining the same or, shifting right (due to increase in GNP thanks to CF and associated effects) as depicted in Figs 3(a) and (b)—will induce endogenous

limit on CF via elasticity of substitution in production (between L and V) on the transformation schedule of the economy, ensuring $\hat{X}_A > \hat{X}_C$.

6. Concluding Remarks and Policy Insights:

CF is a contentious issue and has been extensively covered in the literature on FDI in agriculture and its potential impacts on smallholder agriculture. In the developing countries, it raises lots of concern and debates. In the current paper, without going into details of contractual arrangement, designing and bargaining for price negotiations, we model the feasibility of contract farming as a viable solution for food insufficiency issue as we see the evidences that CF is rising in LDCs except in few cases. We show that CF cannot replace non-CF unequivocally. In the above model, we have shown that there is food import due to excessive CF. Note world food price increase hurts the LDCs adversely as they become more and more food importers. If that happens (i.e., all land is dedicated to CF), then as a theoretical possibility the country can survive by financing food import via export surplus by export revenue coming from CF. In fact, there is nothing in the model to show that food production goes to zero (see the discussion in Section 2 above). However, we show that this will never happen in the long run and a condition for an interior solution is determined. As all such small open economies start importing food, there is a rise in world food demand, and world food price increases (aggregate has a price effect). This price rise (that is exogenous to a small open economy) will trigger firms to exit the CF and re-enter food sector.

The amount of land allocated to CF determines the extent of food insecurity and hence, inequality. In fact, zero CF and extremely high CF—both extreme cases—are suboptimal, and unregulated/uncontrolled CF is problematic if it is not properly managed via policies to design 'positive spillover effects'(de Janvry and Sadoulet 2019). There are mixed evidences. For example, Lay, Nolte and Sipangule (2020) has shown in the context of Zambia (in particular Africa) that potential spillovers from large-scale farms to 'smallholders' with good infrastructure, market access, access to technology bundles (fertilizer, seeds, irrigation, etc.), agricultural extension policies, and establishment of land tenure rights as complements to reinforce potential positive externalities. In the context of Madagascar, Minten et al. (2007) has shown the importance off "high-value agriculture for exports" for yield and productivity increase (*labor-saving type*) in rice due to post-CF application of fertilizer for soil fertility (*i.e., land-augmenting tech change discussed earlier*). Thus, proper management with well-defined 'terms of contract' (such as, price-guarantee reducing uncertainty, inputs, extension training, etc.) can ameliorate the constraints on such 'coordination' arrangements, and internalizing such inequality (insecurity) and higher income via a social welfare function is important. Such land switching to agriculture (food sector) will reduce the extent of CF and increase food production to ameliorate the food insufficiency problem. Also, in the context of developing economy like Philippines, Adamopoulos and Restuccia (2020) has found that given the choice of options for small-scale "cash-crop" and large-scale "food-crop" technologies, exogenous policy variation could have adverse impacts and the land reform program designed appropriately could have beneficial productivity effects via controlling the negative impact of misallocation of resources (i.e., land due to government mandate).

The main question is the long run adjustment may take a very long time due to (i) nature of contracts, and (ii) reform of laws pertaining to CF for switching to cash-crops, etc.

Therefore, what may happen is that the vertical supply curve may keep on shifting left and not shift back due to the long run process. All these happen while we have excessive CF and excessive inequality. Thus, CF has the potential of hurting a less developed country considerably if they are not properly regulated by the government. Governments need to understand the fallacy of composition and internalize it from the beginning. This is the policy implication of the paper. Assessing different impacts and weighing their net effects are crucial for policymakers.

Appendix

Note that change in labour demand within the agricultural sector due to the introduction of CF is:

$$\widehat{L_d} = \lambda_{LA}\widehat{a_{LA}} + \lambda_{LA}\widehat{X_A} + \lambda_{LC}\widehat{a_{LC}} + \lambda_{LC}\widehat{X_C} \qquad \text{(A1)}$$

Where $\lambda_{Li} = {}^{a_{Li}X_i}/_{\bar{L}}$ and a '^' over a variable implies relative change due to the entry of CF.

Given factor prices w and R, $\widehat{a_{LA}} = 0$. Our assumption regarding labour saving technology in CF implies that $\widehat{a_{LC}} < 0$. On the other hand, with R fixed land allocation between agriculture and CF sectors are fixed and so are unit land requirements, hence land allocation between the CF and traditional agricultural sector is given by:

$$\hat{V} = 0 = \lambda_{VA}\widehat{a_{VA}} + \lambda_{VA}\widehat{X_A} + \lambda_{VC}\widehat{a_{VC}} + \lambda_{VC}\widehat{X_C}$$

With $\widehat{a_{VA}}, \widehat{a_{Vc}} = 0$ (as w and R is fixed), thus:

$$\widehat{X_C} = -\left({}^{\lambda_{VA}}/_{\lambda_{VC}}\right)\widehat{X_A} \qquad \text{(A2)}$$

Putting (A2) in (A1), $\left(\frac{\lambda_{LA}\lambda_{VC} - \lambda_{LC}\lambda_{VA}}{\lambda_{VC}}\right)\widehat{X_A} + \lambda_{LC}\widehat{a_{LC}} = \widehat{L_d}$

Since $\widehat{a_{LC}} < 0$ so that $\lambda_{LC} < 0$, a sufficient condition for $\widehat{L_d} < 0$ is the term in the first bracket in the above equation is less than zero.

Proof of Proposition 2:

Using (11) and (12), and applying Cramer's Rule:

$$\begin{pmatrix} \theta_{VA} & \theta_{LA} \\ \theta_{VC} & \theta_{LC} \end{pmatrix}\begin{pmatrix} \hat{R} \\ \hat{w} \end{pmatrix} = \begin{pmatrix} \alpha \\ \beta \end{pmatrix} \Rightarrow$$

$$\hat{R} = \frac{\alpha\theta_{LC} - \beta\theta_{LA}}{\theta_{VA}\theta_{LC} - \theta_{VC}\theta_{LA}}$$

$$\hat{w} = \frac{\beta\theta_{VA} - \alpha\theta_{VC}}{\theta_{VA}\theta_{LC} - \theta_{VC}\theta_{LA}}$$

where $|\theta| = \theta_{VA} - \theta_{VC} = \theta_{LC} - \theta_{LA}$

Thus, $\hat{R} - \hat{w} = \frac{\alpha\theta_{LC} - \beta\theta_{LA} - \beta\theta_{VA} + \alpha\theta_{VC}}{|\theta|} = \frac{\alpha - \beta}{|\theta|}$

Using (23)—(25) above, assuming $\gamma = 0$, applying Cramer's rule we can write:

$$\begin{pmatrix} \theta_{VA} & \theta_{LA} \\ \theta_{VC} & \theta_{LC} \end{pmatrix} \begin{pmatrix} \hat{R} \\ \hat{w} \end{pmatrix} = \begin{pmatrix} \alpha \\ \beta - \theta_{KC}\hat{r} \end{pmatrix}$$

Therefore, $\hat{R} - \hat{w} = \dfrac{\alpha\theta_{LC} - \theta_{LA}(\beta - \theta_{KC}\hat{r}) - \theta_{VA}(\beta - \theta_{KC}\hat{r}) + \alpha\theta_{VC}}{|\theta|}$ where $|\theta| < 0, \theta_{VC} > \theta_{VA}$

It simplifies to: $\hat{R} - \hat{w} = \dfrac{\alpha - (\beta - \theta_{KC}\hat{r})}{|\theta|}$ where $\theta_{VC} + \theta_{LC} = 1 = \theta_{VA} + \theta_{LA}$

Hence, $\hat{R} - \hat{w} > 0$ iff $\alpha - \beta + \theta_{KC}\hat{r} < 0$ where $|\theta| < 0 \Rightarrow \beta - \alpha > \theta_{KC}\hat{r}$

As $\theta_{KC}\hat{r} > 0 \Rightarrow \beta - \alpha > 0 \Rightarrow \beta > \alpha$ (QED).[19]

[19] In this case, equivalently, the condition boils down to: if $\hat{P}_C > \hat{P}_A = 0$.

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