



HAL
open science

Direct and indirect effects of FDI on food security: a sectoral approach

Mehdi Ben Slimane, Marilyne Huchet, Habib Zitouna

► To cite this version:

Mehdi Ben Slimane, Marilyne Huchet, Habib Zitouna. Direct and indirect effects of FDI on food security: a sectoral approach. Workshop MAD Macroeconomics of Agriculture and Development - What challenges food security?, Institut National de Recherche Agronomique (INRA). UMR Structures et Marchés Agricoles, Ressources et Territoires (1302)., Nov 2013, Rennes, France. 27 p. hal-01189920

HAL Id: hal-01189920

<https://hal.science/hal-01189920>

Submitted on 1 Sep 2015

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Direct and indirect effects of FDI on food security: a sectoral approach

Mehdi Ben Slimane¹ (IHEC Carthage-Tunisia)

Marilyne Huchet-Bourdon² (AgroCampus Ouest, Rennes, France)

Habib Zitouna³ (University of Carthage-Tunisia)

Preliminary Version

Abstract: The aim of this paper is to examine the direct and indirect effects of foreign direct investments on Food security for 63 developing countries in a panel framework over the period 1995–2009. There are various measures of food security that can be used. Our first contribution is to build a composite indicator that synthesizes the three main indicators used by the FAO to measure the individual nutritional status. Second, our empirical study is based on a model composed of a food security equation and a Cobb-Douglas agricultural production function. Our results show that sectoral FDI do not directly affect food security. Indirect positive effects are found for FDI in the agriculture and the secondary sector through the increase of agricultural production and negative effects from FDI in tertiary sector in contrast no effect by FDI in mining.

Keywords: Food security; FDI; Cobb-Douglas function; developing countries

Résumé: L'objectif de ce papier est d'examiner les effets directs et indirects des investissements directs étrangers sur la sécurité alimentaire pour un panel de 63 pays en développement sur la période 1995-2009. Il existe différentes mesures de la sécurité alimentaire. Ainsi, nous construisons un indicateur composite qui synthétise les trois indicateurs les plus utilisés par la FAO pour mesurer l'état nutritionnel d'une population. Ensuite, notre étude empirique est basée sur une équation de sécurité alimentaire et une fonction de production agricole de type Cobb-Douglas. Nos résultats montrent que les IDE sectoriels n'affectent pas directement la sécurité alimentaire. Des effets indirects sont démontrés, pour les investissements dans les secteurs agricole et industriel, via l'amélioration de la production agricole et des effets négatives par les IDE dans le secteur tertiaire par contre pas d'effet par les IDE de l'industrie extractive.

Mots clés : sécurité alimentaire; IDE; fonction Cobb-Douglas; pays en développement

1. Introduction :

Food security is a big challenge for the economic decision-makers in developing countries (DCs) and it is closely linked to social stability in these areas, where poverty can reach very high levels. According to the State of Food Insecurity in the World's report of Food

¹ E-mail: Benslimane.mehdi87@gmail.com

² E-mail: marilyne.huchet-bourdon@agrocampus-ouest.fr

³ E-mail: hzitouna@gmail.com

Agricultural Organization (FAO) in 2012, nearly 870 million people (15% of the world population) are chronically undernourished; the vast majority lives in developing countries. There is still a long way to counter the prevalence of food insecurity in these countries. Economic growth may not be sufficient to reduce hunger and malnutrition especially in a context of global changes in growth, commodity prices, climate and trade. The FAO, WFP and IFAD (2012) have mentioned that agricultural investment plays an important role in promoting agricultural growth, reduce poverty and hunger. In our paper we are interested in Foreign Direct Investment (FDI) inflows.

In recent years, FDI inflows have grown greatly in developing countries. As the figure 1 shows, there are two periods 2000-2002 and 2008-2010 where FDI inflows are decreasing. This is probably due to the Internet bubble in 2000 and the subprime crisis of 2007. We found that when FDI inflows increase, the per capita food supply variability⁴ decrease and vice versa. The same time, FDI inflows have been growing in a similar manner with the agricultural value added even with the increase and decrease of FDI in some periods (Figure 2).

According to these stylized facts, a reversed relationship between the aggregated FDI inflows and the per capita food supply is expected. In fact, the empirical literature dealing with the impact of FDI on food security dates back to the 1980s. The focus was on the distinction between the dependency and the modernization effects. Indeed, Foreign Investments could play a positive role via their effect on agricultural productivity (Hallam, 2011) but they are also a source of economic and political dependency (Jenkins and Scanlan (2001), Wimberley (1991)). While some empirical studies have shown this relationship in the context of aggregated FDI (Firebaugh (1992), Firebaugh and Beck (1994), Jenkins and Scanlan (2001), Wimberley (1991)) there is a lack in the literature about this relation when we are focusing on sectoral FDI. Do the previous observed relations apply for disaggregated FDI?

To our best knowledge, at disaggregated level, only Mihalache-O'Keef and Li (2011) analysed the direct economic relationship between sectoral FDI and food security on a large sample. Djokoto (2012) investigated the effects of FDI on food security in one particular developing

⁴ Food supply variability is estimated by the FAO Statistic Division and it corresponds to the standard deviation over 5 years of the deviation from the trend of per capita food supply observed during the period 1990 to 2010.

country, Ghana. On the other hand, a large economic literature deals with FDI spillovers. At the sectoral level, we could cite a recent work of Tondl and Fornero (2010) that examined the relationship between FDI and productivity in different economic sectors. There is no study addressing the transmission channels between FDI and food security.

This paper tries to fill in this gap. Our contribution is at least twofold. First due to different measures of food security and consequently to the possible different typology of countries associated to each measure, we propose a composite indicator of food security. Second we try to determine the channels by which FDI may affect food security focusing on the agricultural production. We try to answer the following questions: Do the sectoral FDI inflows have a positive impact on agricultural production? Does any increase in the output of the agricultural production through FDI have a positive impact on indicators of food security?

To answer these questions we rely on two equations, one for the macroeconomic determinants of food security and the other for the agricultural production determinants. These equations are linked by a simultaneous equations system and tested through 3SLS techniques for a panel of 63 developing countries during the period 1995-2009.

Our results confirm the intuition that only FDI in agriculture and in the secondary sector do have a positive effect on agricultural production. In addition, agricultural production is positively linked to our food Security indicator. Therefore, the indirect effects of FDI (in agricultural and secondary sectors) on food security are demonstrated.

In this perspective, our work is organized as follow. In the next section, a review of literature is proposed. Section 3 describes data and the methodology we adopted. Results are then discussed in section 4 and section 5 concludes.

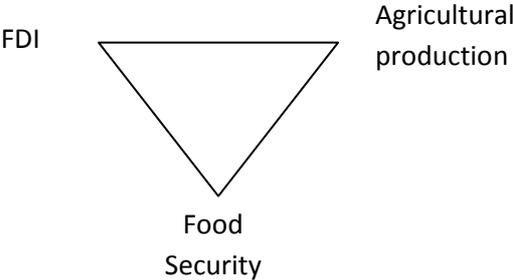
2. Review of literature:

Agriculture is pivotal crucial sector for developing countries: it represents an important weight in DC' economy. According to Timmer (2010), one of the best ways to prevent food crises in the long run is to invest in agricultural productivity. Indeed, improving agricultural productivity is an important step towards the growth of food production, the reduction in food prices on local markets and the increase in farm income which improves the poors' access to food. Productivity is sensitive to the state of health of the population. In fact,

hunger affects the health and leads to reduced productivity of people. According to FAO (2006), this problem hinders economic development and the potential of entire societies.

According to FAO (2009), the agricultural sector plays an important role in developing countries and especially poor ones. It can be a buffer to the economic and employment in periods of crisis.

Our work is at the crossroads of three fields of the literature, the relationship between FDI and Food Security, FDI and agricultural production and Food security and agricultural production as represented by the scheme below:



From these relations, we seek the direct and indirect effects of FDI on food security. The indirect effect is determined via agricultural production, the latter being important in the improvement of food security. But first we must remind the food security’s concept and measurement.

2.1. Food Security: Concept and measurements:

Food security is an old concept which was born in mid-1970s at the world food summit in 1974. In the mid-1980s, food security was defined by the World Bank (1986) *“as access by all people at all times to enough food for an active, healthy life”*. This definition has evolved over years. In 1996, the World Food Summit defined the food security in her declaration by: *“Food security exists when all people, at all times, have physical and economic access to Sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life”*.

The FAO identified four dimensions for food security. First, the food availability is *“the availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports”*. Second, the food access is *“the access by individuals to adequate*

resources (entitlements) for acquiring appropriate foods for a nutritious diet". Third, the food use is the "utilization of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met". Finally, the food stability or food secure is "a population, household or individual [who] must have access to adequate food at all times. They should not risk losing access to food as a consequence of sudden shocks (e.g. an economic or climatic crisis) or cyclical events (e.g. seasonal food insecurity)".

Food security is measured by several indicators related to nutrition and hunger as the per capita per day intake of calories, protein and fat. These indicators allow the follow-up of the food situation of a country. FAO and the World Health Organization (WHO) measure under nutrition of the individuals by energy requirements in terms of caloric intake, protein intake and fat intake.

These requirements constitute the essential nutritive elements in food. Several empirical studies have used the per capita per day calories and protein intake as an indicator of food security like Wimberley (1991), Wimberley and Bello (1992), Firebaugh and Beck (1994), Mihalache-O'Keef and Li (2011) and Djokoto (2012).

The ratio of food imports to total exports is an indicator proposed by Díaz-Bonilla et al. (2000) and it is commonly used to measure the macro-level of food security. They used it to know when a country can achieve food security by generating foreign exchange through exports allows it to finance food imports.

In their descriptive analysis, Breisinger et al. (2010) used several indicators such as the ratio of total exports over food imports⁵ to test the vulnerability of country to secure food import, food production per capita to assess the agricultural potential and hunger index to evaluate the famine.

Gentilini and Webb (2008) proposed a composite indicator labelled the poverty and hunger index. It is a multidimensional index that combines five official indicators of the Millennium Development Goals: the proportion of population living on less than US\$1/day, poverty gap ratio, share of the poorest quintile in national income or consumption, the prevalence of

⁵ Breisinger et al. (2010) use the inverse of the traditional index proposed by Bonilla et al (2002): a higher ratio means a lower vulnerability of country to secure food import.

underweight children (under five years of age) and the proportion of population undernourished.

The diversity of food security indicators justifies our first contribution which is a construction of our own composite indicator. This composite indicator, as described below, relies on three main indicators used by the FAO and is based on Principal Component Analysis Techniques.

2.2. FDI and Food security:

In the early 1980s, studies on the relationship between FDI inflows and food security have emerged. The focus was on two contradictory theories: the dependency theory and the modernization theory.

Supporters of the first theory argue that the dependency on foreign investment has negative effects on growth and income's distribution. After we referred to the literature review of Adams (2009), Bornschier and Chase-Dunn (1985) claimed that foreign investments help the dominance of monopolies which leads to the «*underutilization of productive forces*». In the same Adams' literature, Amin (1974) saw that if the economy is controlled by foreigners, it will grow in a disarticulated manner. Adams (2009) explained this by the multiplier effect which affects the demand in one sector and creates a low demand in other ones, consequently leading to stagnant growth in developing countries.

Supporters of the second theory focus on internal and external sources of economic development. Internal sources come from domestic investment, growth and education creating industrialization and cultural modernization, and finally provide social welfare (Jenkins and Scanlan 2001). External sources come from FDI which brings technology, organizational capability, managerial skills and marketing know-how. FDI inflows provide easy access to international markets and diffuse new skills and knowledge in the host economy (Kumar and Pradhan, 2002). The technology transfer and know-how lead to productivity gains and improving the efficiency of allocation of resources (Graham, 1995; Tulus, 2004).

Both theories have been adopted to explain the impact of foreign investments on welfare. Besides, several indicators of food security have been considered in the literature

(Wimberley (1991), Wimberley and Bello (1992), Firebaugh and Beck (1994), Jenkins and Scanlan (2001), Mihalache-O'Keef and Li (2011) and Djokoto (2012).

Wimberley (1991) examined the impact of transnational corporate investment (foreign investment stocks) on food consumption in 60 developing countries over the period 1967-1985. It is found that countries that have less penetration by transnational corporations have gained more calories and protein per capita per day than countries where the penetration of transnational corporations is higher. This means that the FDI has a negative impact on food security. Closely linked, Wimberley and Bello (1992) studied the relationship between FDI, export, economic growth and food consumption in a sample of 59 developing countries. They found that FDI inflows and primary export dependency harm food consumption, but economic growth improves food consumption.

Firebaugh (1992) criticized sociologists who consider that dependency on foreign capital affects negatively economic growth and welfare. He used the investment rate for a sample of 76 developing countries. He found a positive effect on economic growth. In a later work, based on 62 developing countries, Firebaugh and Beck (1994) proved that economists and sociologists are different in their vision of dependency on foreign capital in developing countries. They found contradictory results of the effect of foreign investment on caloric consumption when they compared two different models. The difference-of-logs model comes to a negative effect whereas the difference model concludes to a positive effect.

Jenkins and Scanlan (2001) found that economic growth, domestic investment and democratization improve food supply and reduce hunger while political instability, foreign capital and age dependency decline access to food.

According to Breisinger et al. (2012), economic growth can improve food security. At the macro level, they explain that growth driven by exports improves balance of payments and generates foreign exchange for food imports. At the micro level, they suggest that only inclusive growth can generate jobs and income for the poor.

Mihalache-O'Keef and Li (2011) deepened the work of Wimberley (1991), Wimberley and Bello (1992) and Firebaugh and Beck (1994) by studying the relationship between sectoral FDI and food security. Their analysis is conducted according to dependency and modernization theories. They used a sample of 56 developing countries from 1981 to 2001.

They found that the impact of primary FDI is negative on food security. These effects are explained by the increase in unemployment, changes in the use of agricultural land, and negative environment and demographic externalities. However, FDI in the secondary sector improves food security by raising employment and wages, technology and knowledge spillovers. Finally, tertiary FDI have an ambiguous impact partitioned between unskilled and skilled labor. According to Todaro (1969), Evans and Timberlake (1980) and Mihalache-O'Keef and Li (2011), the unskilled labor is affected by tertiary FDI when this latter spurs rural labors to migrate to urban slums for jobs with high incomes, thus subsistence agriculture decline, and therefore migrants pay higher prices on urban markets which reduce their access to food. However, the skilled labor is affected by tertiary FDI flows when this latter improve the individual income, which is favorable to the satisfaction of basic nutritional needs.

For Ghana, Djokoto (2012) used the ARDL method for testing the relationship between food security and agricultural FDI. He measured the hunger by daily energy consumption and the nutrition by daily protein consumption. He found a negative short run and long run relationship between food security indicator and agricultural FDI inflow.

On the environmental side, FDI could damage the environment, especially those in the mining industry. For instance, according to Akabzaa and Darimani (2001), the mining industry has weakened and polluted the water table in the Tarkwa mining region in Ghana and this pollution has affected the health of households.

2.3. FDI and agricultural production:

The literature review suggests that the impact of FDI in the agricultural sector can be positive or negative. For example, according to Dries and Swinnen (2004), there are positive spillovers effects resulted by the vertical and horizontal FDI inflows in the dairy sector of Poland. The improvement of agriculture and the status of farmers are linked to the transfer of technology and know-how that are a result of FDI inflows (Djokoto, 2012).

According to Gerlach and Liu (2010), some case studies have shown that FDI contributes positively to the increase in the agricultural production in developing countries. In Ghana, investment by one transnational company contributed to an increase in total production of palm oil. In Uganda, companies such as Tilda(U) Ltd contributed to the growth of rice

production, which has almost doubled in the last decade after the introduction of a new variety of rice called NERICA.

Hallam (2011) explained how FDI can have a positive impact on agriculture in host countries. The agriculture could benefit from technology transfers, which lead to greater domestic productivity, increase in production and employment in addition to reduction in domestic prices. On the environmental side, he noted that FDI can have positive or negative effect. In this context, Gerlach and Liu (2010) quote the Uganda's government which adopts friendly production methods to the environment .i.e. investment in floriculture. The pollution haven argument can be put forward to explain the potential negative effect of FDI on the environment.

The effect of sectoral FDI on productivity across economic sectors is tested by Tondl and Fornero (2010) for the Latin America. By considering the productivity in agriculture and fishery sectors as a dependent variable, they found a positive effect from agricultural FDI and positive spillovers from manufacturing and services FDI. The spillover effect of manufacturing FDI may be explained by the presence of foreign capital in agri-food industries which requires more efficiency in agricultural production. Regarding the spillover effect from FDI in services, the agricultural sector can be beneficial by enhanced productivity in transport sector.

By using time series methodology, Djokoto (2011) examines the relationship between agricultural growth and FDI in agricultural sector in Ghana between 1966 and 2008. He doesn't find any causality. In the case of Nigeria, Akende and Biam (2013) find a positive short run causal influence from FDI in agriculture to agricultural production and they don't find any long-run effect over the period 1960-2008.

Further, the Cobb-Douglas agricultural production function is used in several studies e.g. to test for the effects of transportation infrastructure and electricity on the agricultural production (Felloni et al., 2001) or to examine the governance indicators' effect (Lio and Liu, 2008). To our best knowledge, there is no study that analyses the link between sectoral FDI and the agricultural production function.

To conclude the literature review, the theory is in favor of a relationship between foreign direct investment and food security, but according to empirical analyzes, there is a lack of evidence on the way FDI may impact food security.

3. Data and Methodology:

3.1. Data:

This work is based on annual date for an unbalanced panel of 63 developing countries over the period 1995-2009 (Appendix 1). Most of the data were extracted from the World Development Indicators database of the World Bank. Other data are collected from UNCTAD, FAOSTAT and Polity IV. Table 1 summarizes the variables and their sources.

Table 1: Variables definition:

Variable	Definition	Source
Fat	Per capita per days fat supply	FAOSTAT
Calorie	Per capita per days caloric supply	
Protein	Per capita per days protein supply	
fsi	The composite indicator of food security	
fdi_agri	Agriculture, hunting, forestry and fishing FDI inflows as share of GDP (%)	CNUCED
Fdi_mining	Mining, quarrying, oil and gas FDI inflows as share of GDP (%)	
fdi_secondary	Secondary FDI inflows as share of GDP (%)	
fdi_tertiary	Tertiary FDI inflows as share of GDP (%)	
gdp/pop	GDP per capita million at constant 2000 prices	WDI
gdp_growth	Economic growth rate (%)	WDI
agr_export/gdp	Agricultural exportation as share of GDP (%)	FAOSTAT and CNUCED
age_dependency	Age dependency ratio in %	WDI
polity2	Political regime	Polity IV
Ln_prod_agr	The logarithm of agricultural production, measured by the value of agricultural production in millions of dollars at constant 2005 prices	FAOSTAT
Ln_K	The logarithm of capital stock in agriculture millions at constant 2005 price	FAOSTAT
Ln_L	The logarithm of labor force in agriculture in thousand people	CNUCED
Ln_land	The Logarithm of arable land in hectares	WDI

First of all, a correlation analysis is performed between variables (Appendix 2). We observe that the correlation is low between variables but it is high between the values of agricultural production, capital stock and labor force in agriculture and the arable land. This high

correlation reflects the combination between these variables to achieve the production process. Table 2 provides summary statistics on the variables.

Table2: Summary statistics:

Variables	Observation	Mean	Std. Dev.	Min	Max
Fat	630	73.69683	25.91938	16.3	153.4
Calorie	630	2724.694	404.8827	1664	3688
Protein	630	73.91968	16.5989	35.4	126.1
FSI	630	7.290782	1.434895	4.086503	10.74659
FDI_agri	492	.1196823	.3424275	-.646552	2.846407
FDI_mining	492	.5567992	1.33214	-1.55195	15.9483
FDI_secondary	630	.8737378	.8837433	-1.784948	4.566771
FDI_tertiary	629	2.123746	2.753946	-2.125577	32.1708
GDP/pop	622	2734.741	2339.843	116.946	18416.9
GDP_growth	621	4.665567	4.395053	-17.95499	34.5
agr_export/GDP	598	15.40823	13.62984	.0624451	85.59
age_dependency	630	60.27952	14.32562	37.96358	96.64707
polity2	619	5.042003	5.464938	-10	10
Ln_prod_agr	630	15.35651	1.685181	10.31576	20.07799
Ln_K	536	9.531439	1.682501	4.414978	13.23481
Ln_L	630	7.274861	2.051235	0	13.13469
Ln_land	630	14.9291	1.833434	8.006368	18.88984

Different measures of food security were proposed by FAO like the per capita per day supply of calories and the per capita per day supply of protein. These two indicators are used in some empirical works to measure the nutritional status of individuals and their access to food. But the calories and proteins are not the only nutrients in food. The FAO also provided data on per capita per day fat supply so we constructed a composite indicator based on three indicators mentioned above.

Our analysis will also shed light on the importance of sectoral FDI inflows presented by (i) FDI in agriculture, hunting, forestry and fishing (ii) FDI in mining, quarrying and oil and gas extraction⁶, (iii) FDI in secondary sector and (iv) FDI in tertiary sector in addition to other

⁶ In this paper, we regressed the agricultural production value (not the value added of primary sector). For a more accurate result, we use the agricultural FDI and mining FDI separately.

factors such as economic development, economic growth, agricultural production, export dependency, age dependency and political regime.

The economic development and economic growth are measured respectively by GDP per capita and the economic growth rate.

To test for the impact of the export dependency, we use the agricultural exports as share of total merchandise export. According to dependency theory, exports have harmful effects on food security. The agricultural exports limit the effective demand for food and then it contributes to undernourishment (Wimberley and Bello, 1992).

The age dependency ratio is used to test if the structure of the population affects food security. According to Jenkins and Scanlan (2001), increased reliance on older people is not good for rural areas. In fact, the age dependency intensifies the use of land, which degrades the soil and causes the reduction of agricultural production, thus threatening food security. This ratio is defined as the ratio of inactive persons under 15 and over 64 years compared to the working age population (those aged from 15 to 64).

The political regime is measured by POLITY2 indicator. In fact, democratic governments are more likely to provide nutrition to their people than the less democratic or autocratic countries (Mihalache-O'Keef and Li, 2011). This indicator is a modified version of POLITY which varies between 10 (highly democratic and -10 (very autocratic)⁷.

We finally consider the value of agricultural production with a Cobb Douglas function. The main inputs are capital, labor and land. They are measured respectively by the stock of capital in agriculture, the labor force in agriculture and the area of arable land.

3.2. Methodology:

First we build a composite indicator for food security. Then we specify the equation of macroeconomic determinant of food security and the equation of agricultural production in the Cobb-Douglas form.

3.2.1. Construction of a composite index for food security:

⁷ See « Polity IV Users' Manual » viewed at : <http://www.systemicpeace.org/inscr/p4manualv2012.pdf>

In this paper, three indicators of food security, i.e. per capita per day caloric supply, per capita per day protein supply and per capita per day fat supply, are used to build a composite indicator using the principal component analyse (PCA).

Table 3: Correlation test between the food security indicators

	fat	calorie	protein
fat	1		
calorie	0.7843	1	
protein	0.7156	0.9141	1

Source: authors’ calculations

We followed the methodology of Verardi (2009). The method is to make a robust analysis of the principal component. The number of principal components is chosen based on two criteria. It is chosen according to (1) the cumulative variance of which at least 60 to 70% of the total information is explained and (2) the Kaiser criterion which is used to keep the principal components that have an eigenvalue more than 1. The following table shows the eigenvalues of the analysis of robust principal components.

Table 4: Total variance of Principal components

Component	Eigenvalue	Proportion of information	Cumulative of information
Comp1	2,81182	93,73 %	93,73 %
Comp2	0,157906	5,26 %	98,99 %
Comp3	0,0302788	1,01 %	100 %

Source: authors’ calculations

The result shows that the choice of a single composite indicator is most appropriate because it is represented by 93% of the total information and its own value is greater than 1. Appendix 1 gives this computed composite indicator for each country of our sample.

3.2.2. Estimated model:

Taken separately, the three indicators mentioned in table 3 provide a fragmented and sometimes contradictory picture: they tell little about net progress towards reaching the overall goal. A composite index can assemble the information provided by individual measures.

As an initial step, we test for the direct relationship between sectoral FDI and food security. We estimate with ordinary least square method (OLS) a fixed effect model with robust standard errors, wherein the explanatory variables are lagged one period⁸. The explanatory variables are the sectoral FDI, the value of agricultural production, GDP per capita, the economic growth rate, the agricultural export, the age dependency ratio and the political regime.

$$\begin{aligned}
 FSI_{it} = & \alpha_0 + \alpha_1 FDI_agri_{it-1} + \alpha_2 FDI_minig_{it-1} + \alpha_3 FDI_secondary_{it-1} + \\
 & \alpha_4 FDI_tertiary_{it-1} + \alpha_6 \ln_prod_agr_{it-1} + \alpha_6 (GDP/pop)_{it-1} + \alpha_7 GDP_growth_{it-1} + \\
 & \alpha_8 (Agr_export/GDP)_{it-1} + \alpha_9 age_dependency_{it-1} + \alpha_{10} Polity2_{it-1} + \\
 & \sum_{t=1996}^{2009} \gamma_t T_t + \sum_{i=2}^{63} \varphi_i C_i + \varepsilon_{it} \quad (1)
 \end{aligned}$$

Where *i* and *t* refer to countries and years, respectively. α_k is the estimated coefficients, *FSI* is the food security composite indicator which is the dependent variable. *FDI_agri*, *FDI_mining*, *FDI_secondary*, *FDI_tertiary* represent agricultural, mining, secondary and tertiary foreign direct investment respectively, *ln_prod_agr* is the logarithm of agricultural production value, (GDP/pop) is the per capita GDP, *GDP_growth* is the GDP growth rate, (Agr_export/GDP) is the agriculture export in percent of GDP, *age_dependency* is the age dependency ratio and *Polity2* is the political regime. T_t is the years binary variable, γ_t is the coefficient of the years binary variables. C_i represents the binary variable by country, φ_i is the coefficient of binary variables and ε_{it} is the error term.

In a second step, we estimate with OLS the agricultural production function as the fixed effect model with robust standard errors. The Cobb-Douglas production function model is specified as follows:

$$\begin{aligned}
 \ln_prod_agr_{it} = & \beta_0 + \beta_1 \ln_K_{it} + \beta_2 \ln_L_{it} + \beta_3 \ln_land_{it} + \beta_4 FDI_agri_{it} \\
 & + \beta_4 FDI_mining_{it} + \beta_6 FDI_secondary_{it} + \beta_7 FDI_tertiary_{it} + \\
 & \beta_8 FSI_{it} + \beta_9 age_dependency_{it} + \sum_{t=1996}^{2009} \gamma_t T_t + \sum_{t=2}^{63} \varphi_t C_t + \theta_{it} \quad (2)
 \end{aligned}$$

⁸ We lag the explanatory variables like in the work of Mihalache-O'Keef and Li (2011) who said that the current period of caloric and protein intakes are a function of past stimuli.

Where β_i is the estimated coefficient and θ_{it} is the error term. \ln_K , \ln_L and \ln_land are the main inputs of the agricultural production function and they represent the capital stock and labor force in agriculture and arable land respectively. As shown in the equation, we test for the impact of the sectoral FDI in the agricultural production. We integrate the composite indicator as a measure of individual nutrition because the lack of a person's nutrition reduces its ability to produce which means more workers are malnourished; less labor productivity is provided for agricultural production⁹. We added the ratio of age dependency because it is related to the intensive use of agricultural land which has an effect on agricultural production.

In a third step, we determine whether there is a relationship among variables between equations (1) and (2). So, we tested for the endogeneity between food security composite indicator and agricultural production with the Durbin-Wu-Hausman test¹⁰. The results suggest that endogeneity is significant. Thus, we estimated a simultaneous equations model with fixed effects (by year and by country) by using the three-least square (3SLS) method.

4. Main results:

4.1. Food security equation:

The main results of equation (1) are provided in table 6. We integrated our variables in four steps. First, only FDI variables are regressed and the results are shown in regressions (1) and (2). Second, we dropped the sectoral FDI variables and we included the agricultural production, per capita GDP, GDP growth, agricultural exportation, age dependency and political regime and the results are shown in regressions (3) and (4). Third, we used all variables in regressions (7) and (8). In each step, we include country and/or time fixed effects. The difference within each pair of regressions comes from the introduction of year fixed effects or not.

Globally, regressions with years and countries fixed effects gave good results. The coefficient of determination R^2 is good in most equations. In regression (2), the direct effects of

⁹ The effect of nutrition on farm productivity was tested by Strauss (1986). He used a household-level data from Sierra Leone and an agricultural production function. He found that nutrient intake has increased the productivity of agricultural labor in rural Sierra Leone. In the same context, Deolalikar (1988) used a sample from the rural south of India and a Cobb-Douglas agricultural production function. He found that average daily calorie intake and weight-for-height are important in the agricultural production's growth.

¹⁰ The test is explained by LI and LIU (2004) who test the endogeneity between FDI and economic growth.

sectorial FDI on Food security is not significant. Results show that there is a negative relationship between primary FDI (corresponding either to the agricultural or the mining sector and food security indicator. Only the secondary and tertiary FDI's coefficients are positive.

According to regression (4), the agricultural production is a good determinant of food security: its effect is positive and significant at the level of 1%. All other variables are significant and have the expected signs. In regressions (6), agricultural, mining secondary and tertiary FDI coefficients remain no significant. The agricultural production's coefficient has increased compared to the regression (4) and it is significant at 1% level but the growth rate's coefficient and age dependency's coefficient became not significant.

Table 7 displays the agricultural production equation's estimation results with fixed effects model. We follow the same method: the production function is estimated with/without sectoral FDI. The time and countries fixed effects are included in the same manner as in Table 6.

All the explanatory variables are statistically significant in equation (2). The same is observed in equation (1) except for labor. After the inclusion of sectoral FDI variables in regression (4), only mining FDI is not significant, all the rest of variables are statistically significant. Agricultural FDI, secondary FDI, food security indicator, capital stock, labor force and arable land have a positive impact on agricultural production while the tertiary FDI and the age dependency have a negative impact on agricultural production. These results are coherent with theory.

4.2. Estimation results' of the Simultaneous equations models:

In Table 8, we report the estimation results of simultaneous equations using 3SLS. First, we estimate the system when the sectoral FDI variables are dropped from the food security's equation and are included only in the production equation. Two specifications are tested for, with only country fixed effects in column (1) and with time and country fixed effects in column (2).

Taking into account years and countries fixed effects give a better result in our estimation. Most of the coefficients still have expected signs. In column (2), the main inputs of agricultural production function have a positive sign and are statistically significant.

Agricultural and secondary FDI have a positive and significant effect at 5% level but tertiary FDI have a negative and significant effect at 1% level. The food security and the age dependency have, respectively, a positive and negative impact on agricultural production. In the food security equation, the agricultural production's coefficient has a positive sign and is significant at 1% level. Our results suggest that agricultural exportations are harmful for food security: the coefficient is negative and significant at 5% level. In terms of growth, a 1% increase in agricultural and secondary FDI inflows leads to 4,3% and 1,1% increase in agricultural production, while 10% growth in tertiary FDI inflows decline the agricultural production about 6,3%. A unit increase in food security indicator associated with an average of 11% in agricultural production. At the same time, a 1% increase of growth in agricultural production is associated with an average of 0,0124 unit increase in the food security's composite indicator.

After including the FDI variables in food security equation, column (4) confirm that sectoral FDI don't affect directly food security but indirectly via agricultural production. We notice that the effect of agricultural production grew compared to column (2).

5. Conclusion:

This paper relies on a panel data of 63 developing countries for the period 1995-2009. The review of literature shows that the relation between FDI and food security is discussed as direct relationship. Our work propose an extension: take into account the indirect effect through the agricultural production.

The direct relationship between food security and sectoral FDI shows no significant effect from sectoral FDI on food security even though a negative coefficient for primary FDI (shared between agricultural FDI and mining FDI) and positive coefficients for secondary and tertiary FDI. The direct relationship between agricultural production and sectoral FDI shows that agricultural FDI contributes significantly to improving the production but it is not the case for mining FDI. Whereas, some positive spillovers effects are found from secondary FDI some negative spillovers effects exist for the tertiary FDI.

The endogenous test confirms the endogeneity between food security and agricultural production in the presence of sectoral FDI. This allows performing a simultaneous estimation.

According to our simultaneous equations estimations, we don't find any significant direct relation between sectoral FDI and food security. But, FDI have indirect effects on food security. Agricultural FDI contributes to the improvement of food security thanks to the increase in agricultural production which is the main source of food. The benefits for agriculture due to agricultural FDI are in terms of know-how, R&D and technology transfer. The secondary FDI creates employment and increases the individual's income and therefore improves access to food security. In contrast, negative spillovers by tertiary FDI on agricultural production could be explained by the argument that FDI create jobs in urban areas with higher wages which encourages workers in rural areas to migrate. However, the increase in demand in urban areas will increase the price paid by migrants and therefore reduces their access to food (Todaro (1969); Evans and Timberlake (1980); Mihalache-O'Keef and Li (2011)).

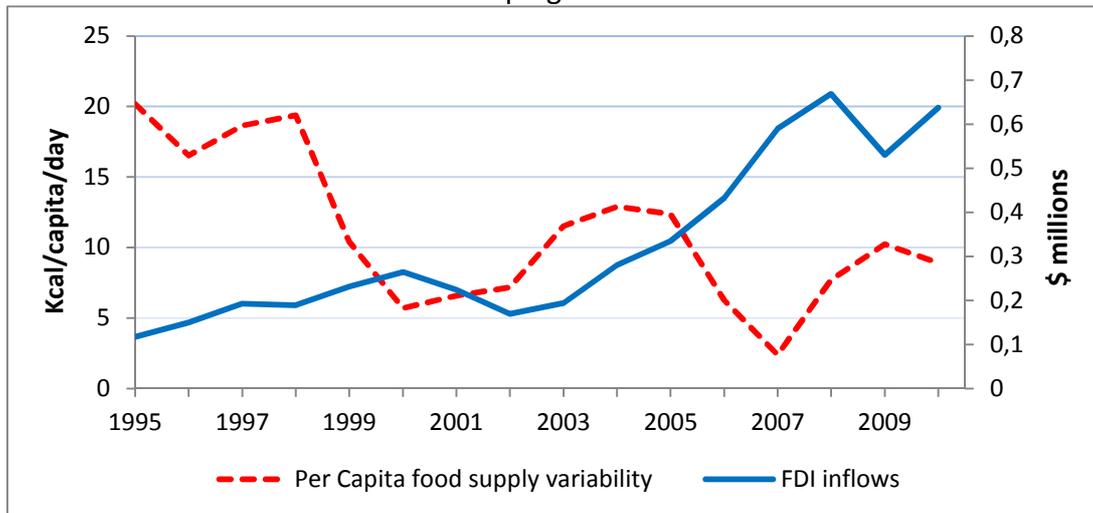
References:

- Adams, S. (2009). Foreign Direct investment, domestic investment, and economic growth in Sub-Saharan Africa . *Journal of Policy Modeling* 31, 939–949.
- Akabzaa, T., & Darimani, A. (2001). *Impact of mining sector investment in Ghana: A study of the Tarkwa mining region*. Third World Network.
- Akande, O., & Biam, C. (2013). Causal relations between foreign direct investment in agriculture and agricultural output in Nigeria. *African Journal of Agricultural Vol. 8(17)*, 1693-1699, May.
- Amin, S. (1974). Accumulation on a world scale: A critique of the theory of underdevelopment. *New York: Monthly Review Press*.
- Bank, W. (1986). *Poverty and Hunger: Issues and Options for Food Security in Developing Countries*. Washington D.C: World Bank.
- Bornschier, V., & Chase-Dunn, C. (1985). Transnational corporations and underdevelopment. *New York: Praeger*.
- Breisinger, C., Ecker, O., Al-Riffai, P., & Yu, B. (2012). Beyond the Arab Awakening: Policies and Investments for Poverty Reduction and Food Security. *Food policy report (IFPRI)* , February.
- Breisinger, C., Rheenen, T. v., Ringler, C., Pratt, A. N., Minot, N., Aragon, C., et al. (2010). Food Security and Economic Development in the Middle East and North Africa. *IFPRI Discussion Paper 00985*, May.
- Deolalikar, A. B. (1988). Nutrition and Labor Productivity in Agriculture: Estimates for Rural South India. *The Review of Economics and Statistics* 70 (3), 406-413.
- Diaz-Bonilla, E., Thomas, M., Robinson, S., & Cattaneo, A. (2000). Food security and trade negotiations in the world trade organization: a cluster analysis of country groups. *International Food Policy Research Institute TMD DISCUSSION PAPER NO. 59*, December.
- Djokoto , J. (2012). Effects of Foreign Direct Investment Inflows into Agriculture on Food Security in Ghana. *Journal of Economics and Sustainable Development* 3 No.2.
- Djokoto, J. G. (2011). Inward Foreign Direct Investment flows, growth, and agriculture in Ghana: a granger causal analysis. *International Journal of Economics and Finance Vol. 3, No. 6*, November.

- Dries, L., & Swinnen, J. F. (2004). Foreign direct investment, vertical integration, and local suppliers: evidence from the polish dairy sector. *World Development* 32(9), 1525-1544.
- Evans, P. B., & Timberlake, M. (1980). Dependence, Inequality, and the Growth of the Tertiary: A Comparative Analysis of Less Developed Countries. *American Sociological Review*, 45(4), 531-552.
- FAO. (2006, june). Food security. *Policy Brief*.
- FAO. (2006). *The State of Food Insecurity in the World: Eradicating world hunger – taking stock ten years after the World Food Summit*.
- FAO. (2009). *Declaration of the World Summit on Food Security*. Rome.
- FAO, WFP, & IFAD. (2012). *The state of food insecurity in the world*. Rome: FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS.
- FAO, WHO, & UNU. (2001). Human energy requirements. *Food and nutrition technical report series*.
- Felloni, F., Wahl, T., Wandschneider, P., & Gilbert, J. (2001). Infrastructure and agricultural production: across-country evidence and implications for China. *TW-2001-103. Pullman: Washington State University*.
- Firebaugh, G. (1992). Growth Effects of Foreign and Domestic Investment. *American Journal of Sociology*, Vol. 98, No. 1, 105-130.
- Firebaugh, G., & Beck, F. D. (1994). Does Economic Growth Benefit the Masses? Growth, Dependence, and Welfare in the Third World. *American Sociological Review*, Vol. 59, No. 5, 631-653.
- Gentilini, U., & Webb, P. (2008). How are we doing on poverty and hunger reduction? A new measure of country performance. *Food policy* 33, 521-532.
- Gerlach, A., & Liu, P. (2010). Resource-seeking foreign direct investments in Africa: A review of country case studies. (FAO, Éd.) *Trade policy research working paper*.
- Graham, E. H. (1995). Foreign Direct Investment in the World Economy. *IMF Working Paper WP/95/*.
- Hallam, D. (2011). International investment in developing country agriculture—issues and challenges. *Food Security* 3, 91-98.
- IFPRI. (2010,). Agriculture, Nutrition, Health: Exploiting the links. New Delhi: Brochure produced for the 2020 conference, "Leveraging Agriculture for Improving Nutrition and Health ", February 10-12.
- INSCR. (2012). *Polity IV Users' Manual*. Consulté le Aout 10, 2013, sur www.systemicpeace.org/inscr/inscr.htm
- Jenkins, J. C., & Scanlan, S. (2001). Food Security in Less Developed Countries, 1970-1990. *American Sociological Review* 66 (5), 718-44.

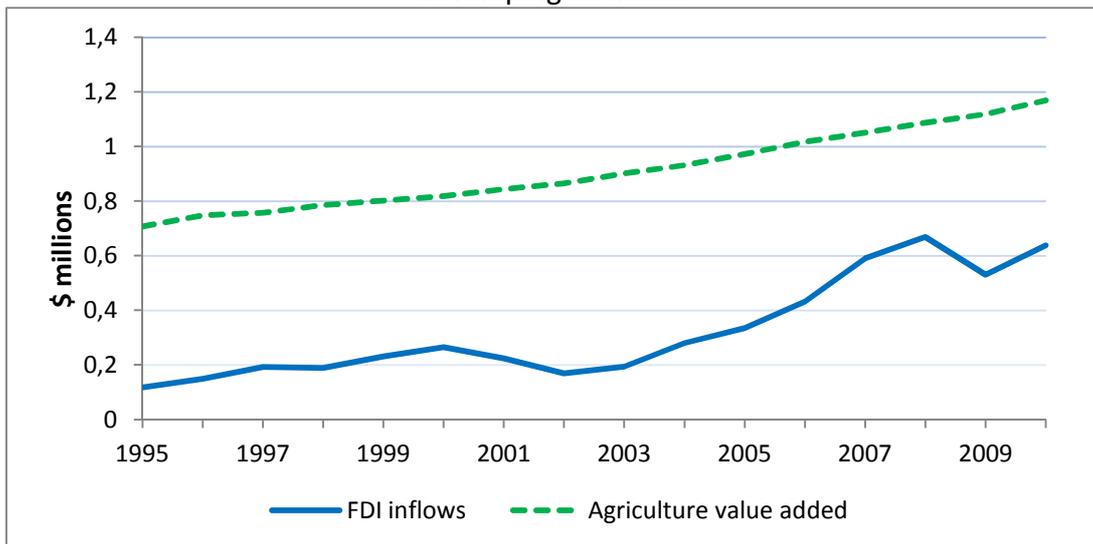
- Kumar, N., & Pradhan, J. P. (2002). FDI, externalities, and economic growth in developing countries: Some empirical explorations and implications for WTO negotiations on investment. *RIS Discussion Paper No. 27/2002*.
- LI, X., & LIU, X. (2005). Foreign Direct Investment and Economic Growth: An Increasingly Endogenous Relationship. *World Development Vol. 33, No. 3*, 393-407.
- Lio, M., & Liu, M.-C. (2008). Governance and agricultural productivity: A cross-national analysis. *Food Policy* 33, 504–512.
- Mihalache-O'Keef, A., & Li, Q. (2011). Modernization vs. Dependency Revisited: Effects of Foreign Direct Investment on Food Security in Less Developed Countries. *International Studies Quarterly* 55, 71–93.
- Strauss, J. (1986). Does Better Nutrition Raise Farm Productivity. *Journal of Political Economy* 94, issue 2, 297-320, April.
- Timmer, C. P. (2010). Reflections on food crises past. *Food Policy, Elsevier, vol. 35(1)*, 1-11, February.
- Todaro, M. P. (1969). A Model of Labor Migration and Urban Unemployment in Less Developed Countries. *The American Economic Review, Vol. 59, No. 1*, 138-148.
- Tondl, G., & Fornero, J. (2010). Sectoral productivity and spillover effects of FDI in Latin America. *FIW Working Paper series 053*, August.
- Tulus, T. (2004). The impact of foreign direct investment on poverty reduction: a survey of literature and a temporary finding from Indonesia. *Faculty of Economics, University of Trisakti*.
- Verardi, V. (2009). Robust principal component analysis in Stata. *United Kingdom Stata Users' Group Meetings 2009 02, Stata Users Group*.
- Wimberley, D. (1991). Transnational Corporate Investment and Food Consumption in the Third World: A Cross-National Analysis. *Rural Sociology* 56, 406–431.
- Wimberley, D., & Bello, R. (1992). Effects of Foreign Investment, Exports, and Economic Growth on Third World Food Consumption. *Social Forces* 70, 895–921.

Figure 1: The evolution of per capita food supply variability and aggregate FDI inflows in developing countries



Source: FAO and CNUCED

Figure 2: The evolution of aggregate FDI inflows and the added value of agriculture in developing countries



Source: FAO and CNUCED

Appendix 1: Summarize of Food security composite indicator by country

code	countries	min	max	mean	code	countries	min	max	mean
1	Albania	7.022007	7.703688	7.458272	33	Latvia	6.853511	7.993998	7.513516
2	Argentina	7.606214	8.744338	8.156861	34	Lithuania	6.902125	9.464344	8.338088
3	Armenia	5.068578	7.339084	5.876904	35	Macedonia, FYR	5.908352	7.797749	6.866074
4	Azerbaijan	4.711016	6.992615	5.84929	36	Madagascar	3.996135	4.301113	4.177002
5	Bangladesh	3.931081	4.870162	4.47265	37	Malawi	4.207649	5.02761	4.596118
6	Bolivia	4.478662	4.972958	4.765695	38	Malaysia	6.686452	6.970775	6.835762
7	Bosnia and Herzek	6.12289	7.293777	6.818787	39	Mauritius	6.523647	7.217235	6.90149
8	Brazil	6.640952	7.978578	7.347383	40	Mexico	7.203889	7.833865	7.602326
9	Brunei Darussalam	7.015649	7.635359	7.361439	41	Moldova	5.559683	6.524198	5.994833
10	Bulgaria	6.846957	7.401106	7.094598	42	Morocco	6.519606	7.378405	7.010986
11	Cambodia	3.681313	5.073855	4.435503	43	Mozambique	3.795851	4.079739	3.942114
12	Chile	6.605453	7.470803	6.997031	44	Nicaragua	4.172953	5.723663	4.986548
13	China	6.52566	7.737702	7.105263	45	Pakistan	5.408259	5.761608	5.516958
14	Colombia	5.848842	6.242394	5.992891	46	Panama	5.401446	6.296352	5.778123
15	Costa Rica	6.322046	6.898668	6.590677	47	Paraguay	6.15511	6.976003	6.550374
16	Croatia	5.688545	8.020804	6.804565	48	Peru	5.004882	5.634796	5.242046
17	Dominican Republic	5.044981	5.787492	5.365052	49	Philippines	4.82513	5.512324	5.114891
18	Ecuador	5.219131	5.714301	5.456486	50	Poland	8.368464	8.693128	8.567976
19	Egypt, ArabRep.	7.132867	7.644707	7.337324	51	Romania	7.659077	9.107277	8.35054
20	El Salvador	5.245314	6.063406	5.717247	52	Russian Federation	6.958347	8.281444	7.473404
21	Ethiopia	3.334905	4.506712	3.925659	53	Saudi Arabia	6.737316	7.457716	7.203627
22	Fiji	6.664966	7.403749	7.055131	54	Syrian Arab Rep.	7.073363	7.98704	7.522376
23	Guatemala	4.657405	5.268351	4.979227	55	Thailand	4.939244	5.98347	5.57719
24	Guyana	5.704884	6.542611	6.231066	56	Trinidad and Tobago	5.696889	6.289049	6.039796
25	Honduras	5.39291	6.221	5.770752	57	Tunisia	7.382404	8.200411	7.812841
26	Hungary	8.284169	9.061291	8.783651	58	Turkey	8.566677	9.025593	8.758472
27	India	4.762569	5.084925	4.90344	59	Ukraine	6.597327	7.988569	7.211362
28	Indonesia	4.806069	5.540612	5.087485	60	United Republic	4.199201	4.779653	4.493479
29	Jamaica	6.258638	6.946623	6.62197	61	Uruguay	6.627782	7.521173	7.025229
30	Kazakhstan	5.656543	8.441846	7.380308	62	Vanuatu	6.182489	6.816995	6.483878
31	Kyrgyz Republic	5.784095	6.731337	6.274917	63	Zambia	3.828631	4.256211	4.039128
32	Lao PDR	4.08187	5.167784	4.578948		Total	3.334905	9.464344	6.319413

Table 6: fixed effect model for food security equation:

Dependent variable	Food Security composite indicator					
	(1)	(2)	(3)	(4)	(5)	(6)
FDI_primary :						
l.FDI_agri	.0442 (.757)	-.0194 (-.418)			-.0934* (-1.93)	-.0599 (-1.16)
l.FDI_mining	-.00145 (-.0688)	-.0147 (-.883)			-.0143 (-.935)	-.00772 (-.501)
l.FDI_secondary	.0521** (2.13)	.0234 (1.25)			.0238 (1.46)	.0255 (1.52)
l.FDI_tertiary	.0216** (2.14)	.00184 (.217)			-.00106 (-.174)	.00219 (.296)
l.Ln_prod_agr			.572*** (4.89)	.409*** (2.84)	.725*** (4)	.692*** (3.15)
l.GDP_per_capita			.000218*** (5.86)	.000176*** (4.33)	.000368*** (7.92)	.000327*** (5.95)
l.GDP_growth			.0113*** (3.66)	.0109*** (3.48)	.00393 (.691)	.00112 (.2)
l.Export_agr			-.0068*** (-3.5)	-.00667*** (-3.19)	-.0132*** (-6.01)	-.0114*** (-4.67)
l.Age_dependency			-.0164*** (-5.06)	-.0105*** (-2.63)	-.00744 (-1.4)	.00243 (.345)
l.polity2			.0218*** (3.31)	.0193*** (3.12)	.0239** (2.08)	.0198* (1.86)
_cons	6.5*** (199)	6.2*** (93.7)	-1.96 (-1.01)	.268 (.118)	-5.15* (-1.67)	-5.17 (-1.45)
R-squared	0.953	0.973	0.966	0.967	0.977	0.978
Observation	457	457	780	780	433	433
Years fixed effects	no	yes	no	yes	no	yes
country fixed effects	yes	yes	yes	yes	yes	yes

T-statistics in parentheses. ***, **, * Significant at the 1%, 5 % and 10 % respectively.

Table 7: Fixed effect model for agricultural production function:

dependent variable	Agricultural production value			
	(1)	(2)	(3)	(4)
FDI_primary :				
FDI_agri			.0342 (1.24)	.0455** (2.26)
FDI_mining			.00551 (1.04)	.00327 (.616)
FDI_secondary			.0119 (1.54)	.015** (2.48)
FDI_tertiary			-.00501** (-2.01)	-.00651** (-2.36)
FSI	.0935*** (6.13)	.0667*** (4.21)	.107*** (4.85)	.0754*** (3.73)
Ln_capitalstock ^a	.793*** (10.7)	.668*** (7.26)	.296** (2.42)	.176* (1.69)
Ln_laboragri ^a	.0771 (1.39)	.157** (2.37)	.332*** (3.14)	.516*** (5.3)
Ln_arabland ^a	.0995** (2.18)	.116*** (2.69)	.0637 (1.18)	.123** (2.32)
Age_dependency	-.0138*** (-12.9)	-.00653*** (-5.15)	-.0174*** (-9.02)	-.00393 (-1.52)
_cons	5.92*** (7.94)	5.89*** (8.78)	9.53*** (9.45)	7.67*** (6.98)
R-squared	0.998	0.998	0.998	0.999
Observation	819	819	413	413
Years fixed effects	no	yes	no	yes
country fixed effects	yes	yes	yes	yes

T-statistics in parentheses.

***, **, * Significant at the 1%, 5 % and 10 % respectively.

^a No transformation in logarithm for these variables.

Table 8: estimation's results of simultaneous equations:

Dependent variable	(1)		(2)		(3)		(4)	
	Invalprodagr	fsi	Invalprodagr	fsi	Invalprodagr	fsi	Invalprodagr	fsi
FDI_agri	.0234 (1.26)		.0433** (2.38)		.0357* (1.74)	-.0961 (-1.44)	.0447** (2.41)	-.0417 (-.664)
FDI_mining	.00348 (.687)		.00228 (.453)		.00689 (1.23)	-.024 (-1.33)	.00335 (.652)	-.0117 (-.685)
FDI_secondary	.00767 (1.44)		.0114** (2.19)		.00406 (.688)	.0202 (1.08)	.00913* (1.72)	.0237 (1.37)
FDI_tertiary	-.00536*** (-2.87)		-.00636*** (-3.25)		-.00691*** (-3.39)	.012* (1.68)	-.00697*** (-3.49)	.00975 (1.36)
Ln_prod_agr		1.75*** (6.44)		1.24*** (5.05)		2.12*** (6.32)		1.55*** (4.9)
GDP_per_capita		.000382*** (11.3)		.000394*** (8.42)		.00035*** (9.96)		.000386*** (8.05)
GDP_growth		.00495 (1.03)		.00157 (.317)		.00434 (.858)		.000955 (.181)
Export_agr		-.0118*** (-4.29)		-.0102*** (-3.45)		-.0112*** (-4.04)		-.00966*** (-3.23)
Age_dependency	-.0154*** (-11.7)	.0179** (2.52)	-.00418** (-2.13)	.0113* (1.81)	-.0156*** (-11.7)	.026*** (3.04)	-.00467** (-2.38)	.0155** (2.31)
polity2		.0218*** (3.51)		.0193*** (3.03)		.0224*** (3.56)		.0191*** (2.96)
fsi	.165*** (9.59)		.111*** (6.79)		.167*** (9.74)		.12*** (7.36)	
Ln_capitalstock	.218*** (2.65)		.16** (1.97)		.199** (2.49)		.155* (1.94)	
Ln_labor_agri	.284*** (4.39)		.493*** (7.61)		.25*** (3.89)		.469*** (7.29)	
Ln_arable_land	.0324 (.72)		.104** (2.36)		.0246 (.565)		.0958** (2.21)	
_cons	9.3*** (11.9)	-18.3*** (-4.46)	7.09*** (8.97)	-10.9*** (-3.09)	9.78*** (12.3)	-23.8*** (-4.7)	7.37*** (9.29)	-15.4*** (-3.39)
R-squared	0.998	0.974	0.998	0.978	0.998	0.971	0.998	0.977
Years fixed effects	no	no	yes	yes	no	no	yes	yes
country fixed effects	yes	yes	yes	yes	yes	yes	yes	yes
Observation	392		392		392		392	

T-statistics in parentheses. ***, **, * Significant at the 1%, 5 % and 10 % respectively.

All variables are lagged one period only in the equation of food security.

Appendix 2: Correlation test

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) fsi	1.0000												
(2) fdi_agri	-0.1340	1.0000											
(3) fdi_mining	-0.1961	-0.0595	1.0000										
(4) fdi_secondary	0.0969	0.1360	-0.1353	1.0000									
(5) fdi_tertiary	0.1341	0.0110	0.0511	0.3093	1.0000								
(6) gdp_per_capita	0.6389	0.0557	-0.1246	0.0874	0.1248	1.0000							
(7) gdp_growth	0.0066	0.0532	0.0385	0.1615	0.0791	-0.0813	1.0000						
(8) expot_gdp	-0.1976	0.1743	0.0894	-0.0613	0.0270	0.0001	-0.1386	1.0000					
(9) age_dependency	-0.7184	0.1871	0.1795	-0.1295	-0.1736	-0.4866	-0.0841	0.2682	1.0000				
(10) polity2	0.0929	0.0628	-0.0840	0.0058	0.1504	0.3394	-0.1852	0.2528	-0.1560	1.0000			
(11) ln_prod_agr	0.1822	-0.1549	-0.0449	0.0404	-0.2305	0.0563	0.1054	-0.1702	-0.2659	-0.2097	1.0000		
(12) ln_capital_stock_agr	0.1522	-0.1335	0.0410	-0.0771	-0.2226	0.0311	0.0728	-0.1162	-0.1673	-0.2336	0.9349	1.0000	
(13) ln_labor_agri	-0.1920	-0.0898	0.0297	-0.0222	-0.2757	-0.3432	0.1455	-0.1780	0.1774	-0.3676	0.6428	0.6429	1.0000
(14) ln_arable_land	0.1165	-0.1478	0.0079	0.0023	-0.1678	-0.1072	0.1505	-0.2031	-0.1279	-0.3101	0.8623	0.8748	0.6142

