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Are FDI inflows and energy price affect the food import dependency in developing countries? Evidence from panel VAR Model

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Abstract: After the global food crisis of 2007-2008, the dependency of developing countries on food imports has been revived in the economic debates. The ability of a country to import food depends on several factors. Considering food security as a priority issue, we focus in this paper on the FDI inflows and the energy price as a determinant of food import dependency. Indeed, on the one hand FDI as a substitute/complement to trade flows could impact the depending nation. On the other hand energy prices affect production and transport costs, thereby impacting international trade in food productions. To investigate this relationship, we follow the methodology of Love and Zicchino (2006) by estimating a panel vector autoregressive (PVAR) of 40 developing countries for the period between 1990 and 2012. The results show that FDI inflows leads to food import dependency in upper middle income countries and energy price leads to dependency in upper-middle income countries.

Keywords: FDI inflows, energy price, food imports dependency, impulse response function

JEL code: F14 ; F6 ; Q1 ; O1

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1. Introduction

International trade plays an important role in economic growth and development. However, it can become problematic if it leads to dependency on imports (Rakotoarisoa et al., 2011) and more problematic if this dependency affects food security. A growth driven by exports improves balance of payments and generates foreign exchange for food imports (Breisinger et al., 2012). Indeed, after the international food crisis of 2007-2008 caused by higher agricultural and food prices, the vulnerability's issue of developing countries (DCs) to the volatility of international markets has risen to the surface of the economic debates. In fact, it appeared that this increase has affected the ability of countries to import, which makes several questions about the factors that may boost or reduce dependency on food imports.

Improving food availability through imports can be a solution to the decline in local food production (Diaz Bonilla et al., 2000), but developing countries do not have the same import's capabilities and preferences on imported products. So the degree of dependency is different between countries, for example, many Middle East countries spend a large part of their foreign exchange earnings on importing food (Hoering, 2013).

DCs need resort to imports because it appears the only solution at short-run to recover the food gap between local demand and local production and at the end to improve food availability. The recourse to the international market is relatively expensive for those countries because they pay their imports in foreign currency. However, it is necessary to differentiate between national food security and food security for the poorest population because enough food availability doesn't mean that the poorest have access to food. So when we speak about food import dependency, we are interested with the national food insecurity. In fact, upset food insecurity for the poorer population requires several factors such as better distribution of national wealth, which improves the infrastructure, income, and subsequently facilitates food's distribution and finally access to food (Hoering, 2013).

Nowadays, the economic environment is characterized by a growth in foreign direct investment (FDI) inflows and outflows to/from DCs and volatility in prices of agricultural, food and energy products in international markets. So, our first line of researches has examined the relationship between FDI and food import dependency. Indeed, the major interest of DCs to improve their ability to import food in case of higher food prices is the increase of local food demand. In brief, attracting FDI would enhance food and this seems to be an important policy to increase the stock of foreign currency. The theoretical literature on the relationship between FDI and international trade is extremely abundant. This relationship arises from substitution and complementary effects between these two factors. The empirical literature is divided between studies that analyze the relationship between trade and FDI outflows, which is usually treated in the case of developed countries, and between trade and FDI inflows in the cases of DCs.

According to the empirical literature, we can distinguish the works, which use time series (Liu et al., 2002; Pacheco-López, 2005; Wang and Wan, 2008) and those using panel data (Liu et al., 2001; Tekin, 2012). From a methodological point of view, all these works use the same econometric techniques such as cointegration and Granger causality.

However, technological development has made the world more dependent on energy use and thus more sensitive to higher energy prices via the high demand. Also, high-yield varieties of food require more energy use and intensive fertilizer irrigation and in the final this rises production's cost and prices (Steinfeld et al., 2006; Kamara et al., 2009). Thus, our second line of researches examines the relationship between energy price and food import dependency. The liter-

ature is increasingly suggesting that energy prices affect the trade flows inter-country, more specifically between importer and exporter energy countries. Another transmission channel can be mentioned here, the growth of the biofuel industry, which affects the availability of cereals in the international market and thus may lead to higher food import prices.

The third line of research is the relationship between FDI and energy price. In previous works, it appears that FDI don't affect the energy demand in DCs (Sadorsky, 2010). In another work, Mielnik and Goldemberg (2002) noticed that more FDI inflow increase, the energy intensity decreases. This is a good thing for energy net importer countries that FDI contributes to weakening the local energy demand. But other works have demonstrated the opposite. For example, according to Tang (2009), Malaysia is an energy dependent country where FDI inflows are positively related to electricity consumption and this made the energy importer countries more vulnerable to energy price volatility.

However, our research focuses on the first relationship mentioned above, because our objective is to investigate from the existing economic literature the transmission channels by which the food import dependency is affected and to answer empirically the following questions: How FDI influences the dependency on food imports in DCs? What role can be played by the energy price in this relationship?

In fact, we are aware of the existence of other channels that may affect the food import dependency. But, according to data availability in our hand, we focus on the major factors which have nowadays influenced the international trade and more specifically the food import dependency.

Despite dependency is an old concept, existing work has not exceeded the descriptive analyzes. Our first contribution is to address the weakness of the existing literature about food import dependency by identifying some important factors, which can influence it. Here, we provide evidence on the existence of links between FDI inflows, energy price and international trade and consequently affecting food security. Our second contribution is the use of panel vector autoregressive (VAR) methodology. This choice is justified by some criteria of this model and is coherent with the aims of our work. i) The panel VAR methodology is useful in the specification of a model with a limited theoretical background; ii) it has the capacity to address the endogeneity problem between variables; iii) it takes into account the country fixed effects and it allows to register the dynamic effects between variables and present the reaction of one variable to a shock of another variable (Grossmann et al., 2014). Finally, this paper distinguishes data by countries' groups (e.g. based on income level). Ours results can provide recommendations on trade and economic policy to be followed by DCs to resist to the food insecurity problem.

The remainder of the paper is organized as follows. In the next section, we propose a review of the literature on the international trade and the major determinants of food import dependency. Section 3 gives theoretical and empirical evidences of the links between food import dependency and its determinants. Section 4 discusses the data used in the paper. Section 5 describes the methodology and section 6 presents the main results of the dynamic relationship between variables and the impulsion response function. In the last section, we conclude.

2. Food import dependency: definition and determinants

There are at least two ways to present the concept of food security. Indeed, this concept of food security is treated from two sides. Diaz-bonilla et al. (2000) have used this concept to ana-

lyze the dependency from an international trade point of view. Their objective was the measurement of the ability of countries to finance their food imports out of total export incomes. Many years before, Siamwalla and Valdés (1980) used the same concept. They used the average of food imports to total export incomes for the period 1965-1977 in DCs. They found only four countries such as Bangladesh, India, Sri Lanka and Egypt with a ratio more than 15%. Their results confirmed that Asian countries are more dependent than the other regions. By contrast, Farzin (1988) analyzed the food supply situation of some DCs by using a different measurement because his question was how food imports are dependent on local food consumption. Farzin (1988) followed just a descriptive analysis and found that the food aid was a source of dependence in Somalia's economy: about 51.7% of food imports for the period between 1980 and 1984.

A new descriptive data analysis is here proposed and based on 40 developing countries divided in two groups: 23 low and lower middle-income countries and 17 upper middle-income countries (see figure 1). For the period 1990 to 2012, the share of food imports over total merchandise exports displays a dependency ratio not lower than 19% and 11% for low and lower middle-income countries and upper middle-income countries, respectively. For the same period, we can see that the low and lower-middle income countries are more dependent on import food than the upper middle-income countries.

Figure 1: The average of food import dependency in 40 developing countries:

Source: Authors' calculations based on world development indicators (WDI) database

Table 1 presents the average of food import dependency based on World Bank's income classification and we can see that countries with low income are the most dependent and upper income countries are the lowest dependent¹. However, a larger share of imports deals with manufactured and energy products and these imports are also necessary for economic development of these countries. These imports stifle the ability of these countries to import food. So increasing their exports and shrinking imports can be adopted as trade policy. For example, before her accession to the World Trade Organization (WTO) in 2001, China has set a trade policy aimed to give the import authorization to a limited number of firms. Nowadays, China has the largest foreign-exchange reserves in the world. Likewise, the United Republic of Tanzania imposes export bans on key food items (Liu et al., 2012).

Table 1: The average of food import dependency for the period 1990-2012 (by country)²

Low-income	Lower middle	Upper middle income
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1 For more information about the trend of food import dependency by country, see the appendix C.

2 The sample has been chosen according to the World Bank's classification of countries by income. However, the data of FDI inflows, energy price and food import dependency are not available for all developing countries so the sample may be adapted.

income					
Country	Dependency ratio (%)	Country	Dependency ratio (%)	Country	Dependency ratio (%)
Bangladesh	27.49	Bolivia	12.08	Albania	81.03
Burkina Faso	44.35	Egypt	64.84	Brazil	6.57
Kenya	21.76	El Salvador	28.81	Bulgaria	9.08
Madagascar	23.64	Ghana	21.89	China	4.13
Malawi	23.49	Guatemala	21.93	Colombia	10.91
Mali	24.11	Honduras	19.44	Costa Rica	11.11
Mozambique	39.09	India	5.93	Dominican R.	27.61
Tanzania	26.92	Morocco	22.40	Fiji	34.58
		Nicaragua	46.62	Hungary	5.116
		Nigeria	9.84	Malaysia	5.43
		Pakistan	19.25	Mauritius	25.65
		Paraguay	25.77	Mexico	7.89
		Philippines	11.06	Peru	14.48
		Senegal	50.84	Romania	11.47
		Zambia	8.49	Thailand	5.08
				Tunisia	13.16
				Turkey	7.713

Source: Author's calculations based on world development indicators (WDI) database

In a report on the search of an alternative to food import dependency for Global Policy Forum, Hoering (2013) considered the dependency as a harmful for DCs. The author justified that by the experience of India and South Africa with the United States, where the last refused in 1960 to send food to India under the program PL480 because of some political reasons and in 2002, it insisted to send Genetically modified maize (GM-maize) as food aid to South Africa. In fact, many factors can affect the vulnerability of the country beyond people and government like market forces on the loose of sovereignty (Hoering, 2013). There is a natural factor like adverse weather conditions, which affect the agricultural crops. Some monetary and financial factors also exist like dollar's depreciation, financial crisis, and a higher speculative demand on food commodity futures markets provoked by the low of international stock level. In addition, the energy plays an important role in this issue when the high fuel prices increase transportation cost and food production cost, especially for energy importing countries. Finally, a trade policy as an export bans and price controls on cereals may push producers to reduce their supply to the world market and this increases the international prices (Kamara et al., 2009). All these factors are the main determinants of food price rises in international markets and affect the vulnerability of DCs.

3. FDI, energy price and trade: Theoretical and empirical evidences

From a theoretical viewpoint, FDI and trade have a substitution and complementary relationships. The Heckscher-Ohlin view is that international trade and capital flows are substitutes

because of differences in factor endowments. Indeed, a country well-endowed with capital and less labor has an interest to trade with other countries with less capital and well-endowed with labor. This explanation was given by Mundell (1957) in a model with two countries, two goods and two factors of production. Fontagné (1999) explained this relation by the replacement of imports by local production, leading to a lower deterioration of the trade balance. About the complementary relationship, Markusen (1983) demonstrated by the use of five theoretical models, but under some flexible assumptions, such as the identical technology, the identical homothetic demand, perfect competition, constant returns to scale and the no domestic distortions in the two countries that the substitution relationship can be a complementary relationship when it is based on factor endowments. When an increase in FDI inflows is followed by a decrease in exports, this means that the relationship is substitutive. But in the case when FDI inflows and exports progress in the same direction, this means a complementary relationship (Marchant et al., 2002).

For Multinational corporations (MNCs), trade is easier and less risky than locate in a foreign country. So, before moving to the new markets, MNCs trade and thus gain experience and acquire knowledge of the host country's economic situation (Liu et al., 2001). In addition, the MNCs have interest to locate in the importing countries to produce and deliver goods locally. The localization will boost the imports of inputs for production. These results have been proven by Pacheco-López (2005) in the case of Mexico during the period between 1970 and 2000, when the author has found a bidirectional causality between FDI and exports and between FDI and imports.

Based on the existing empirical studies, the relation between FDI and trade is always controversial. Liu et al. (2002) have argued that FDI and export have a bidirectional causality in China by the use of quarterly data from 1981 to 1997. However, they found an unidirectional causality from FDI to imports. In other words, FDI inflows are determinant on the import growth, while imports are not a FDI attractiveness factor. Chinese trade policy encourages the export more than the imports by adopting an import policy depending on planning import and tariff and non-tariff barriers. But it should be noted that this policy is before the accession of China to the WTO.

We provide two recent empirical works on the causality between FDI and trade by author, sample, causal relationship, and countries results in Table 2.

Table 2: Summary of recent empirical studies on the FDI-Trade nexus

Author	Sample	Causal relationship	Countries
Ahmed et al., (2011)	five countries from Sub-Saharan	Bidirectional causality	Ghana, Kenya and Nigeria
		Unidirectional causality from FDI to Exports	South Africa
		Unidirectional causality from exports to FDI	Zambia
Tekin (2012)	18 African developing countries 1970 and 2009	Bidirectional causality	--
		Unidirectional causality from FDI to Exports	Benin, Chad, Haiti, Mauritania, Niger, Togo and Yemen
		Unidirectional causality from exports to FDI	Haiti, Madagascar, Mauritania, Malawi, Rwanda, Senegal and Zambia

While most empirical studies consider the trade taking the export and import separately, Wang and Wan (2008) used the ratio of trade balance expressed by the ratio of imports to exports in value. They examine whether FDI inflows and outflows, real exchange rates, Chinese income and the income of the world are determinants for the trade balance of China over the period 1979 to 2007. Their results showed that FDI outflows have no effect on the trade balance. However, FDI inflows contributes to enhance the exports and thus to improve the trade balance.

Now, let us examine the role of the energy market. In the context of food security, the energy plays an important role in the supply and demand of food. Several studies have shown that instability in the international energy market affects international trade.

Firstly, the rising price of energy increases the cost of production of goods and services (Turhan et al., 2013), and consequently, leads the increase in the prices of tradable commodities. At the same time, the price of energy affects the cost of transport, which promotes trade of cheaper products. In this context, it will be more profitable for an importing country to divert its trade flows to nearest countries and, in this case, gains are benefited by this country because of the minimization of the cost of transport, but a loss of well-being will be supported by it (Bridgman, 2008; Kousnetzoff et al., 2008; Mirza and Zitouna, 2009). However, an increase in energy price can take two forms. An increase caused by an energy supply shock, leading to a decline in international trade flows, and an energy demand shock gives rise to an increase in the international trade flows (Chen and Hsu, 2012). Theoretically, the beneficiary from these two shocks are the energy-exporters countries and the losers are the energy-importers countries.

The literature distinguished a trade and a financial channels transmission by which a rise in energy price affects the current account (Le and Chang, 2013). By focusing on the trade channel, we illustrate the transmission channel by which an increase in oil price affects the international trade (see Figure 2 and Figure 3).

Figure 2: The effects of oil price on international trade before the intervention of the monetary authority in trading-partner countries

We present in Figure 2 a host economy, which trades with several other countries named here trading partner countries. An increase in oil price potentially causes inflationary pressure in several countries, leading to rise the import prices in host economy. As a result, the monetary authorities in trading partner countries interfere to curb inflation by increasing the interest rate (see Figure 3). This monetary policy leads to reduce the inflation, to decline the investment and consumption, and thus to decrease imports from the host economy (Korhonen and Ledyeva, 2010; Le and Chang, 2013).

Figure 3: The effects of oil price on international trade after the intervention of the monetary authority in trading-partner countries.

Secondly, the energy price may play a role due to the fact that food has a competitor which affects its supply. The extraction of biofuel from agricultural products has led to a greater demand for agricultural products for non-food purposes and therefore it contributes to increase their price (FAO, 2008). Biofuel is extracted from cereals and presents around 5% of the world cereal production (UN, 2009; Elbehri et al., 2013). The rise of biofuel production has increased the transmission of energy price volatility into agricultural commodity price variation (Hertel and Beckman, 2011). Starting from the idea that high energy price affects the trade flows between countries, we examine if the vulnerability of DCs to import food can be affected.

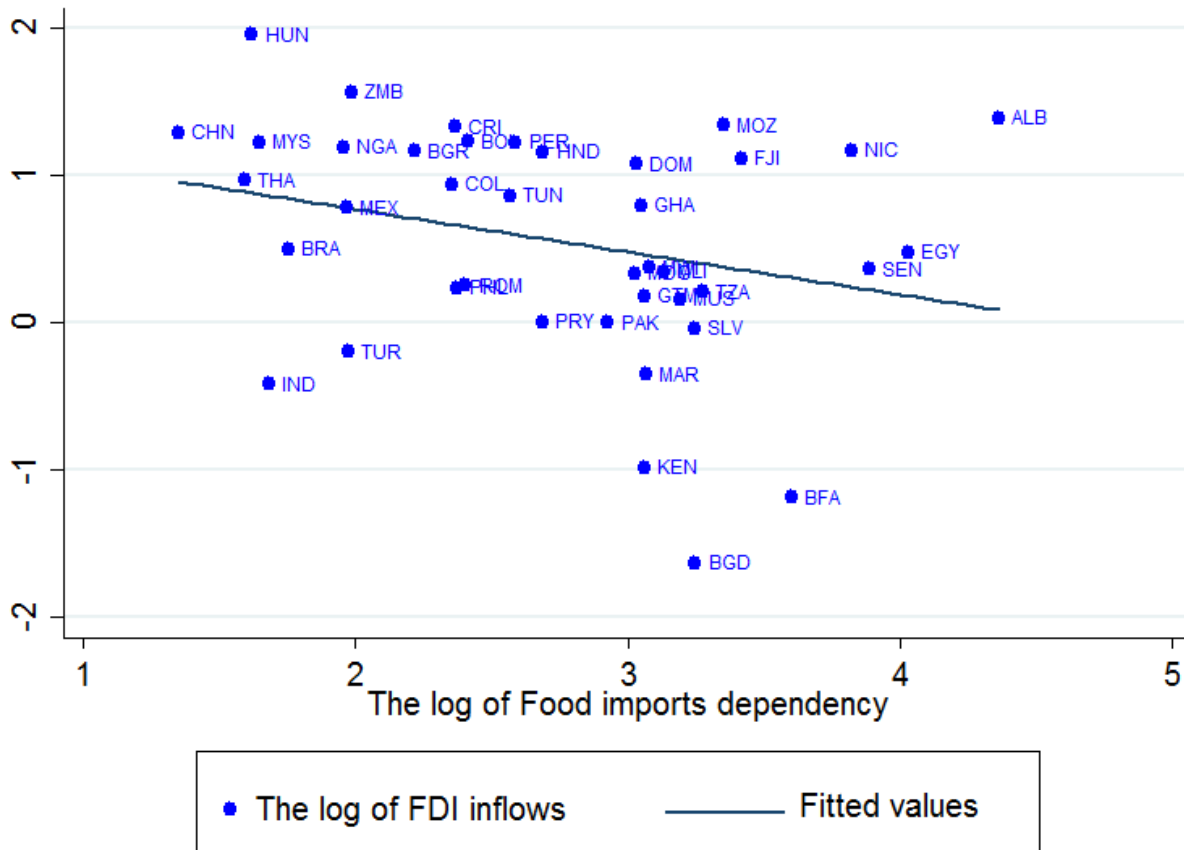
To resume, the impact of FDI inflows on the food import dependency is related to the nature of the relation between FDI and trade, and the increase in energy price is a brake to international trade, so we expect to find at minimum a response of food import dependency to a shocks on FDI inflows and energy price.

4. Data and unit root test

This paper focuses on the study of 46 DCs for the period between 1990 and 2012. The data of FDI inflows as a share of GDP is taken from the world development indicator (WDI) database of the World Bank. Dependency on food imports is here measured by the ratio of food imports over total merchandise exports (see the formula 1). The data is taken from the WDI and we named it FMX:

The energy price is proxied here by the consumer price index (CPI). Data comes from WDI database. Our choice is justified, first, by the lack of energy prices data for a panel of 46 countries. The second argument is that residents and industries in many countries don't pay the same price of energy because it is subsidized by government. For instance, Mahadevan and Asafu-Adjaye (2007)³ presented these arguments to justify the use of the consumer price index (CPI) as a proxy of energy prices to examine the relationship between energy consumption, energy price and economic growth in developed and developing countries. In addition, the correlation test shows that there is a high correlation of 0.81 between the oil price index in international market and the CPI in our sample, and as illustrated in the previous section, the oil price influences the inflation, so we expect that the CPI reflects the variation in energy prices. All variables are used in the natural logarithm form. A correlation analysis is performed between all variables in question (Table A2 in the Appendix A). We found a low correlation between variables.

Figure 4: Linear correlation between FDI inflows and food imports dependency ratio (FMX)



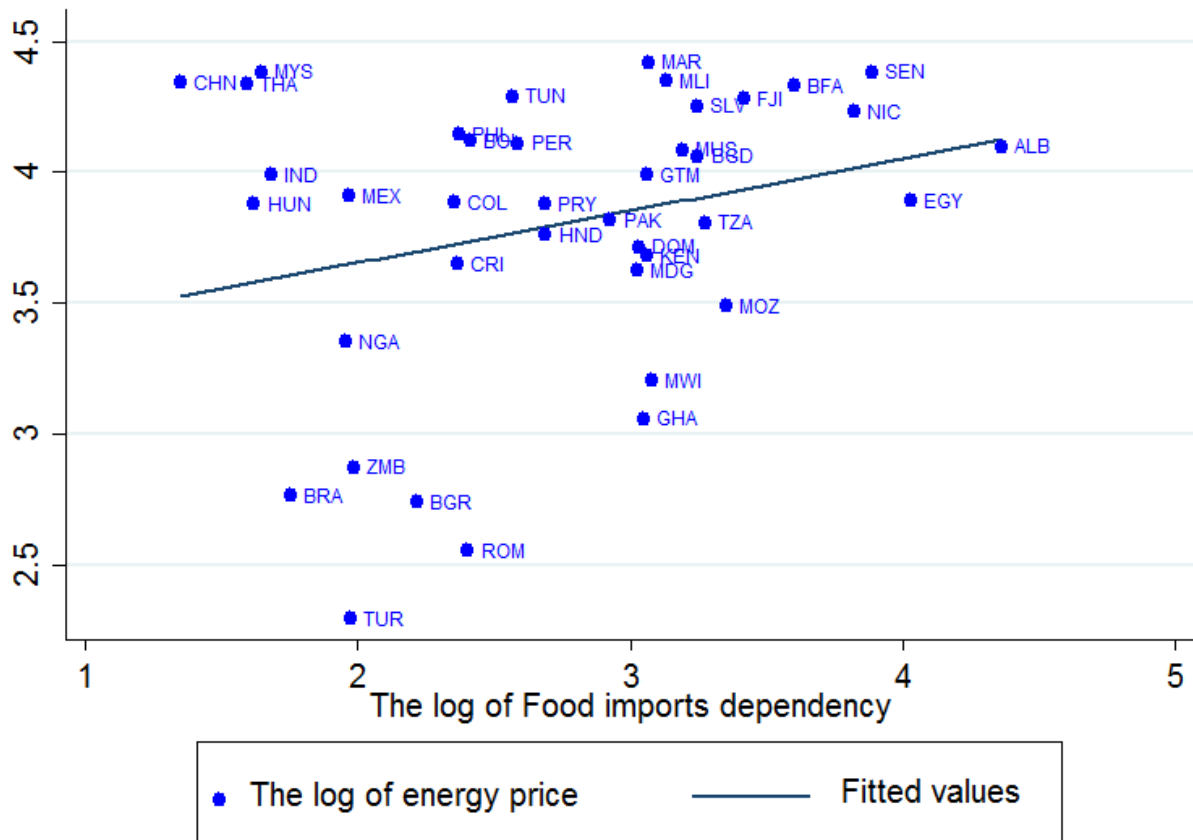
Source: Authors' calculations

The relationship between the natural logarithm of FDI inflows and energy price with food import dependency (FMX) can be observed from Figure 4 and Figure 5 which represent the aver-

³ Asafu-Adjaye (2000) and Odhiambo (2010) used also the same proxy CPI to energy prices.

aged variables from 1990 to 2012 (See Table A1 in the appendix A for the list of countries). FDI seem to be negatively associated with FMX, but this is not the case for energy price where the correlation seems to be positive. The linear correlation suggests that FDI can be a reducer for the food import dependency, but the energy price can be an amplifier.

Figure 5: Linear correlation between energy price and food import dependency ratio (FMX)



Source: Authors' calculations

In fact, it's not possible to confirm this intuition with just a linear correlation test between variables. But the limit here is that the dynamic relationship between the variables is not taken into account and therefore these relations are currently lacking additional information. So in the next section we deepen the analysis of such relationships. In a first step, we apply a panel unit root test to our variables. We use the Cross-sectionally Augmented Dickey-Fuller (CADF)⁴ test of Pesaran (2007) to take into account the correlation across sections in one serie. The optimal lag length is selected by Schwarz's criteria. Null hypothesis assumes that all series are non-stationary. The results of Pesaran's CADF unit root test are reported in Table 3. We proceed by testing the unit root at level with constant and next with constant and trend. The non stationarity of the variables in levels leads to transform them into first difference.

Table 3: Results of CADF Unit root test

4 Our test of unit root is implemented in Stata 13 using the procedure described by Lewandowski (2006)

variables	At level		At first difference			
	lags	with constant	lags	with constant		
		Standardized Z[t-bar] statistics		with constant and trend	Standardized Z[t-bar] statistics	lags
All sample						
FMX	1	-0.562	1	0.936	1	-8.193***
FDI	1	-4.325***	1	-1.534*	1	-10.786***
CPI	1	-4.194***	2	-4.077***	1	-8.831***
Group A						
FMX	1	-0.757	1	1.425	1	-5.206***
FDI	1	-2.645***	1	-0.467	1	-8.255***
CPI	1	-2.624***	1	1.265	2	-3.537***
Group B						
FMX	1	-1.211	1	-0.151	1	-5.663***
FDI	1	-3.216***	1	-1.584*	1	-7.177***
CPI	1	-1.467*	1	-2.203**	1	-3.921***

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

We have divided our sample into two groups A and B, the group A includes low and lower middle-income countries and the second concerns upper middle and high-income countries. We adopted this partition because the number of low and high incomes countries is smaller than lower and upper middle-income countries, so we added the low-income countries to lower middle incomes countries and high-income countries to upper income countries.

The results show that in most specifications, FMX, FDI and CPI are stationary at level. In the low and lower middle-income countries, only FMX seems to be stationary at first difference. In high and upper income countries, only the FDI variable is stationary at first difference. The variables are integrated at a level of zero, which means they do not share a common trend, so they are not cointegrated. This allows us to estimate a VAR model in panel framework.

5. Methodology

In the literature, as we have already mentioned above, many econometric studies have used the VAR (Vector Autoregressive), the VEC (Vector Error Correction) and Autoregressive Distributed Lag models. Some models are used in time series framework while others are used in panel framework. According to the literature and to our CADF test used in the previous section, the appropriate technic is a panel vector auto regression (PVAR)⁵ model proposed by Love and Ziccino (2006). The specificity of this model is that it allows for individual heterogeneity in the levels of the variables by introducing fixed effects. The estimation of PVAR is based on the generalized method of moments (GMM). Love and Ziccino (2006) have used lagged regressors as instruments and have estimated the coefficients by system GMM. This is justified by the presence of

5 A Stata program built by Love and Ziccino (2006) is used to estimate VAR model in panel framework. This program allows to analyze the impulse-response functions.

correlation between fixed effects and regressors. Therefore, they applied the forward mean-differencing procedure to remove the mean of all the future observations available for each firm-year. This transformation preserves the orthogonality between transformed variables and lagged regressors.

Our model is specified as follow:

is a vector of three macroeconomic variables : FDI, energy price, and food import dependency, all variables between transformed in logarithmic form. is a vector containing the constant terms, is the matrix of coefficients for lag k. is the term of error.

The specification (2) is a system of three equation estimated by the GMM method. However, we are interested only to one equation where the food import dependency ratio is the dependent variable. Thus, our estimated equation assumes the following specification:

Where α is the constant. , and are the coefficients of lagged variables. The estimation's results are presented in the next section.

6. Empirical results

6.1. Panel VAR and Granger causality test

Following the methodology of Love and Ziccino (2006), the results are presented in Tables 4, 5 and 6 for bivariate and trivariate panel VAR model. The choice of the best lag length is important in any VAR model. The check of lag order avoids us the loss of degrees of freedom and over-parameterization. We have used the Schwartz information criteria (SIC) to check the appropriate lag length. The appropriate lag here is one period.

Table 4: Panel VAR's results for 40 developing countries

Independent variables	Dependent variables		
	(1)	(2)	(3)
	ΔFMX	ΔFMX	ΔFMX
ΔFMX_{t-1}	-0.154*** (-3.27)	-0.161 (-3.36)	-0.162*** (-3.38)
FDI_{t-1}	0.19 (1.05)	--	0.017 (1.23)
CPI_{t-1}	--	0.029 (1.12)	0.012 (0.4)

Heteroskedasticity adjusted t-statistics are in parentheses

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

In Table 4, we have estimated first the panel of 40 countries in a bivariate and trivariate panel VAR model. For all three models, we have not found any significant effect from FDI and CPI to FMX.

Table 5: Panel VAR's results for Group A (low and lower middle income countries)

Independent variables	Dependent variables		
	(1)	(2)	(3)
	ΔFMX	ΔFMX	ΔFMX
ΔFMX_{t-1}	-0.180*** (-3.05)	-0.188 (-3.18)	-0.194*** (-3.26)
FDI_{t-1}	0.0470** (2.31)	--	0.011** (2.22)
ΔCPI_{t-1}	--	-0.011 (-0.37)	-0.049 (-1.37)

Heteroskedasticity adjusted t-statistics are in parentheses

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

Second, we estimated the panel VAR model for only low and lower middle-income countries (See Table 5). In model (1), the result show that the FDI inflows has a positive and significant effect at level of 5%. In model (2), CPI has a negative sign but not significant. Model (3) show the same results in the previous models, where FDI has a positive and significant effect and CPI kept the negative and no significant coefficient. These results show that FDI increases the dependency of low and lower income countries to import food and the energy price don't has any effect.

Third, we use only the upper middle-income countries in the estimation. The results are different from the previous estimation where we have not found a significant effect of FDI. Only CPI affects positively FMX (see Table 6). This result confirms our intuition that energy price has an adverse effects on international trade and specifically food import dependency.

Table 6: Panel VAR's results for Group B (upper middle income countries)

Independent variables	Dependent variables		
	(1)	(2)	(3)
	ΔFMX	ΔFMX	ΔFMX
ΔFMX_{t-1}	-0.063 (-0.99)	-0.117 (-1.22)	-0.125 (-1.15)
FDI_{t-1}	0.057 (-1.17)	--	-0.021 (-0.61)
CPI_{t-1}	--	0.0862** (2.06)	0.107* (1.81)

Heteroskedasticity adjusted t-statistics are in parentheses

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

Then, to test the causality between variables, we have applied a bivariate and trivariate Granger causality test and results are reported in Table 7. The unidirectional causality is found running from FDI to FMX only on group A and from CPI to FMX only on group B. The last line in Table 7 provides the causality test of all variables jointly.

Table 7: Bivariate and trivariate Granger causality test for FDI, CPI and FMX:

	All sample			Group A			Group B		
	Δ FMX			Δ FMX			Δ FMX		
FDI	1.095	--	1.501	5.042**	--	4.667**	1.360	--	0.371
CPI	--	1.254	0.161	--	0.029	1.402	--	4.249**	3.291*

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

6.2. Impulsion functions results:

Figures in appendix B present the impulse-response functions with a standard error of 95% confidence; errors are 5% on each side generated by Monte-Carlo with 1000 replications. Figure B1 reports the impulse-responses for group A, while Figure B2 reports the impulse-responses for Group B. The objective here is to check the expected reaction in the future of the capacity of importing food to shocks.

In Group A, we found that, FMX responds positively to the FDI inflows increase with the response peaking in the first year then the respond begins to decrease. After six years, the response becomes quite weak, close to zero all the time (see Figure B1). In contrast, the respond of FMX to the energy price impulse is completely the reverse for the same period. The influence magnitude of one standard deviation from CPI on FMX first decreases. Low and lower middle-income countries have a positive food import dependency's response to FDI inflows, as the FDI inflows are not able to boost exports.

Passing to the analysis of group B (Figure B3), we observed that FMX has a negative and short-term response to a shock in FDI, and a positive short-term response to a shock in CPI. It seems that upper middle-income countries are more vulnerable to shocks in energy price than FDI inflows. Moreover, the response is the reverse to the response in Group A. This means, therefore, that the low and lower middle-income are more sensitive to shock in FDI inflows.

7. Discussion and Conclusion

In this paper, the causal relationship between FDI inflows, energy price and food import dependency is examined for 40 countries using a panel VAR model. We split the sample on two groups, the first is the DCs with low income and lower middle income and the second is the DCs with upper middle income, over the period 1990-2012.

Our paper reveals some interesting findings regarding the food stability in developing countries. We provide empirical evidence of the causal links from FDI inflows and energy price to food import dependency. However, it seems that FDI inflows leads to dependency in low and lower middle-income countries. Otherwise, FDI inflows are unable to improve the capacity of

these countries to import food. This result seems to be logical because these countries haven't the ability to absorb the all benefits of FDI and they are more vulnerable to access to the international foods' markets. On the other hand, the energy price rising increases food import dependency in upper middle-income countries and therefore their ability to import food deteriorates.

Our paper has highlighted the transmission mechanism by which the vulnerability of DCs to import food responds to a FDI or energy price shock. We found theoretical evidence for the existence of indirect links about the direction of the response of food import dependency. In addition, our research reveals that food import dependency response depends on the income level of the country. This result is proved in the estimation of panel VAR model and is found in the impulse response function results, where the responsiveness of the food import dependency is positive in low and lower-middle income countries to FDI inflows and positive in upper middle income countries to energy price shock.

This research has some emerging policy implications. It is strategically important for low and lower income countries to change their trade policy, specifically in the food sector. Firstly, these countries must seek to attract export oriented FDI and it is recommended to minimize their export of local produced food in such a way that it did not face to import food. Thirdly, these countries must invest on their ability in absorbing the FDI's spillovers because it can be a way to acquiring skills and technology, to innovate new marketing strategies and managerial practices, to find new methods and channels of distribution and thus access to international markets. For upper middle-income countries, we recommend the use of renewable energy to reduce their access to international energy market.

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Appendix A

Table A1: Countries list:

low-income economies GNI per capita less than \$1,045	Code	Lower middle in- come economies GNI per capita of more than \$1,045 but less than \$4,125	Code	Upper middle income eco- nomies GNI per capita of more than \$4,125 but less than \$12,746	Code
Bangladesh	BGD	Bolivia	BOL	Albania	ALB
Burkina Faso	BFA	Egypt	EGY	Brazil	BRA
Kenya	KEN	El Salvador	SLV	Bulgaria	BGR
Madagascar	MDG	Ghana	GHA	China	CHN
Malawi	MWI	Guatemala	GTM	Colombia	COL
Mali	MLI	Honduras	HND	Costa Rica	CRI
Mozambique	MOZ	India	IND	Dominican Republic	DOM
Tanzania	TZA	Morocco	MAR	Fiji	FJI
		Nicaragua	NIC	Hungary	HUN
		Nigeria	NGA	Malaysia	MYS
		Pakistan	PAK	Mauritius	MUS
		Paraguay	PRY	Mexico	MEX
		Philippines	PHL	Peru	PER
		Senegal	SEN	Romania	ROM
		Zambia	ZMB	Thailand	THA
				Tunisia	TUN
				Turkey	TUR

Table A2: Correlation test between all variables

	FMX	FDI	CPI
FMX	1		
FDI	-0.1395	1	
CPI	0.0507	0.3606	1

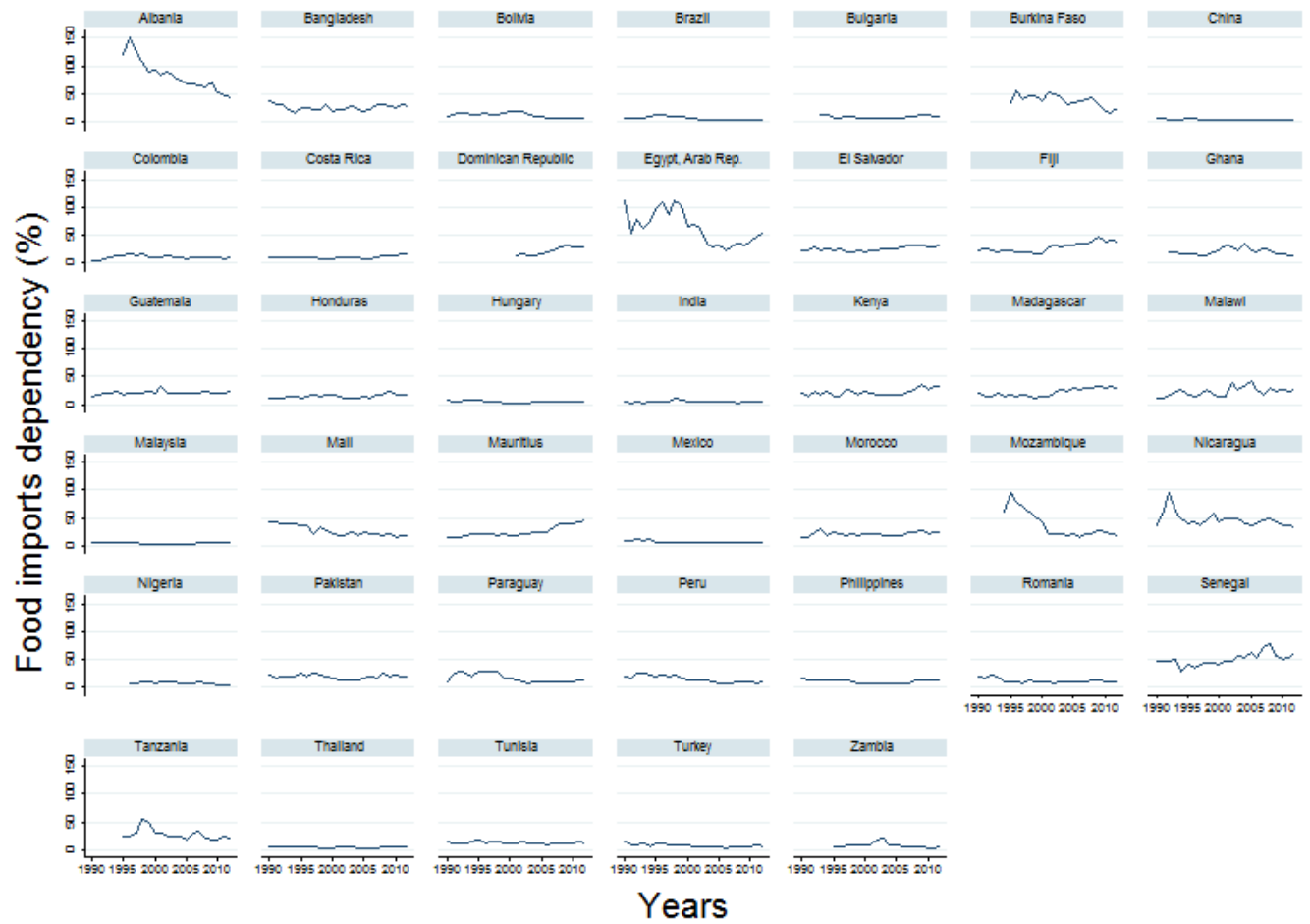
Appendix B: Impulse response functions

Figure B1: *Impulse response of FMX to shocks in FDI and CPI for low and lower middle income countries (Group A)*

Note: The errors are 5% on each side generated by Monte-Carlo simulation with 1000 reps.

Figure B2: *Impulse response of FMX to shocks in FDI and CPI for high and upper income countries (Group B)*

Note: The errors are 5% on each side generated by Monte-Carlo simulation with 1000 reps.



Appendix C: The trend of food import dependency by country for the period 1990-2012.