Volume: 3 Issues: 12 [June, 2018] pp. 34 - 48]
International Journal of Accounting, Finance and Business
eISSN: 0128-1844
Journal website: www.ijafb.com

RELATIONSHIP BETWEEN DISTORTIONARY AGRICULTURAL TRADE POLICIES AND FOOD SECURITY IN DEVELOPING COUNTRIES: A CAUSAL ANALYSIS

Shaheera Mohammed and Haniza Khalid [1]

[1]International Islamic University Malaysia. **Email:** hanizamv@iium.edu.my

Accepted date: 30 May 2018 **Published date**: 24 June 2018

To cite this document: Mohammed, S., & Khalid, H. (2018). Relationship Between Distortionary Agricultural Trade Policies and Food Security in Developing Countries: A Causal Analysis. *International Journal of Accounting, Finance and Business (IJAFB)*, 3(12), 34 - 48.

Abstract: *In an increasingly globalised world, agricultural trade and food security inevitably goes hand in hand. On paper, the idea of free agricultural trade continues to be a contentious one as opinions remain divided whether it can lead to greater access and variability of food to a larger number of people or whether it ends up exacerbating hunger and environmental degradation in the developing world by reinforcing pre-existing inequities in the global trading system. In practice, countries tend to intervene in food trade to protect domestic producers from volatilities in international markets, as most obviously seen in 2007-2008. Empirical evidence is mixed regarding the impact distortionary agricultural trade policies have on food security, particularly for developing countries. This study examines the issue using long panel data from 24 developing countries from 1990-2010. The Generalised Propensity Score (GPS) method, a non-parametric matching technique with continuous treatment, is used to assess the effect of Nominal Rates of Assistance (NRA) on the four dimensions of food security; food access, food availability, food utilization and food stability. While it is found that the relationships can be statistically proven, the numbers point to a positive link between distortionary trade policies and food security levels for the majority of these countries. Nonetheless, prolonged and widespread price insulations will ultimately push up global prices, offsetting their domestic food security benefits and distract or slow down the much-needed structural improvements in the country's agricultural sector.*

Keywords: *Food security, International trade, Generalised propensity score (GPS), Distortionary trade policies*

Introduction

The agricultural sector makes up only six percent of world trade and is highly distorted. Trade reform in the sector is expected to bring out up to 70 percent of total potential real income gains from WTO negotiations (Laborde and Martin, 2012). However, critics argue that neoliberal economic reforms recommended to developing countries through the IMF, the World Bank, and the WTO eventually leads to worsening hunger and environmental degradation by relegating many developing countries to the export of primary agricultural commodities as a means of generating the revenue with which to purchase imported food and manufactured goods. For instance, in the African region where value of agricultural import is 1.7 times that of exports, price instability and food insecurity is exacerbated by tax and trade fragmentation and red tape imposed on traders (NEPAD, 2014). The traditionally biodiverse agro-ecosystems is replaced with a monoculture agro-system which is associated with intensive pesticides and fertilizers use. The shift towards export commodities erodes food security by firstly depressing domestic food production incentives and secondly by exposing the country to vulnerabilities of global commodity markets as well as declining terms of trade for agricultural products.

As a reaction to domestic circumstances, many countries turn to restrictive trade terms stabilise domestic food supply and prices (FAO, 2008). Exporting countries use export restrictions to lower domestic prices relative to world prices, while importing countries can opt to raise tariff or consumption taxes on imported food. Many countries resorted to stock-piling and hoarding, while increased government intervention led producers in the exporting countries to under-invest (Anderson, 2011). These domestic price insulation tendencies led to the worsening of global food price and contributed to significant negative income effects in developing and developed countries alike, particularly in the 2007-2008 crisis. Since then, international prices has spiked three times between 2008 and 2012, during mid-2008, early 2011 and mid-2012. While food price trends have moderated in recent years, there is no telling when and how countries will react in the next food crisis with respect to trade practices. It is imperative that for the future, particularly with increasing climate and geo-political risks that the workings and effects distortionary agricultural trade restrictions are fully appreciated by those in the academic and policy-making realms. This study adds to the literature on relationship between distortionary agricultural trade policies and food security in developing countries. The approach adopted by this paper follows Magrini, Montalbano, Nenci and Salvatici (2014) in using a non-parametric matching technique known as the generalised propensity score (GPS) to detect causality structures between trade restrictions and food security indicators. The technique controls the likely presence of self-selection bias, allowing us to set specific controls on the various proxies for distortionary agricultural trade policies and dimensions of food security. This paper will comprise of five sections. Section 2 provides important observations of food insecurity risks in developing countries and the effects of distortionary agricultural trade policies. The GPS methodology and data definitions are given in Section 3. Results are discussed in Section 4 while Section 5 concludes.

Linking Food Security and Trade

Food security is defined under the Food and Agriculture Organization of the United Nations (FAO) as a condition in which “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.” Singer (1997) and Ecker and Breisinger (2012) conceptualise food security both micro and macro constructs. The micro aspect relates to the way food is distributed within and between households, whereas the macro aspect relates to economic factors and shocks may generate poverty and hence, food insecurity. OXFAM (Young, 2001) defined food security as the ability of everyone, especially the most vulnerable individuals, to attain dignified and unthreatening access to the quantity and quality of culturally appropriate food that will fully support their physical, mental, emotional and spiritual health.

Trade distortion with respect to food entails any change in the prices of domestic products away from the international price, leading to levels inconsistent with a competitive global market. Agricultural commodity markets are characteristically thin markets, implying relatively small shares of internationally traded production. Although, wheat, maize and rice are the main crops traded in cereals, only 20 percent of globally produced wheat was traded in the past decade, with rice trade accounting to only 6 percent of global rice production (Kshirsagar and Baffes, 2011). This naturally leads to highly volatile prices, which are often worsened by trade distorting policies imposed on national borders (Liapis, 2012; Alavi and Htenas, 2015). Predictably, in an already volatile market environment, protective trade measures can quickly become ubiquitous (Jones and Kwiecinski, 2010). An FAO survey found that between 2007 to 2011, 33 countries impose export restrictions on at least one agricultural product (Sharma, 2011). In fact, according to Gillson and Busch (2014), based on surveys by the International Trade Centre, generally the number of nontariff measures (NTM) imposed on agricultural products is much greater than on manufactured products.

Essentially, food security is a state that exists only when all the four dimensions of food security: availability, accessibility, stability and utilization are realized. The manner how distortionary trade affects each dimension is described below:

Availability

Availability means sufficient quantities of food of appropriate quality, supplied through domestic production and/or imports; including food aid (Tweeten, 1999; Rose, 2016). The commonly offered justfication for restricted trade is to protect farmers, producers and consumers from the full effect of international price volatility, at least in the short run (Keats, Wiggins, Compton and Vigneri., 2010; Timmer, 2010). However, the measure will only transfer the risks to another country, and that if many countries apply the same measure at the same time, it will be ultimately counter-productive (Martin and Anderson, 2012; Lembergman, Rossi and Stucci., 2015). This is especially true if they affect farmers' motivation to increase productivity.

Access

Access focuses primarily on the economic (through earnings and transfers) and physical access to food by an individual or household. Open trade promotes food accessibility through comparative advantage, by allowing for production to happen at its lowest cost location, thus lowering its prices and making them more affordable for poorer households. Trade restrictions that led to higher food prices inflict uneven burdens within the society of both importing and exporting countries. High prices enhance food producers' access to food but severely limits consumers' access to food (Diaz-Bonilla and Ron, 2010; Brooks and Matthews, 2015). The welfare-reduction effect here can mitigate only if there is greater derived demand for labour from higher food production, and this shift in demand leads to a sufficient raise in wages (Azzoni, Brooks, Guilhoto and McDonald, 2007).

Stability

Stability refers to the household's ability to secure access to food even in event of severe economic shocks. In theory, open trade protects national food markets against domestic supply shocks by easing the way for food imports during times of shortage and allowing for exports when there is an excess (Gillson et al, 2014). With unpredictable climate change, it is likely that trade will continue to play a large role in ensuring food stability.

Utilization

Food utilization concerns food care, preparation and feeding practices, diversity in the diet and intra-household distribution of food as well as the nutritional effects of food consumed. Gross, Schoeneberger, Pfeifer and Preuss (2000) claimed that nutrition security is more important than food security, and measures Food and Nutrition Security (FNS) through four dimensions: (i) categorical; (ii) socio-organisational; (iii) managerial; and (iv) situation-related. Increase in trade openness has been found to be associated with lower infant mortality rates and higher life expectancy (Owen and Wu, 2007).

Despite the compelling arguments against distortionary trade above, many governments continue to intervene in the food market, regardless of the collective effect this has on world food prices and the economic stabilization strategies that were implemented (Anderson and Nelgen, 2012). Empirical support for liberalization of food trade is scarce. For instance, Rodrik (2001) discovered that countries will generally reduce trade barriers as they get richer, implying that it was trade protection which generated the initial economic growth. Trade liberalisation has also resulted in imports growth exceeding export growth and is associated with a reduction in domestic production capacity and the purchasing power of consumers (SAPRIN, 2001). Brooks and Matthews (2015) argued that that greater trade openness brings more risks of supply shocks.

Methodology

The bulk of empirical research in assessing the relationship between food security and agricultural trade lie in the assessment of the gains from trade including in its restricted form. Ex post studies on food security relies on existing data and focuses on the statistical relationsip of specific intermediary mechanism, such as the nature of price adjustment or price transmission following a policy reform (McCorriston, Hemming, Lamontagne-Godwin, Parr, Osborn and Roberts, 2013). Preferred economic models include the partial equilibrium and the computable general equilibrium model (see for example Abdullateef and Ijaiya, 2010; Panda and Ganesh-Kumar, 2009; Das and Rout, 2014). Others such as Bezuneh and Yiheyis (2009) used panel data analysis to examine trade liberalisation’s short run effect on the food availability of sample countries; Olper, Curzi, Bedin and Swinnen (2014) employed the Synthetic Control Method to examine causal inference between food security, health and trade liberalisation variables; Abler and Fleming (2013) used a switching regression model; Huchet and Laroche (2014) employed the Bonilla index, an indicator of national access to world food supply, to analyse the impact that domestic support and border measures have on developing countries’ food security.

Our study is closest to Magrini et. al (2014) in that it employs a non-parametric matching technique with continuous treatment, namely the generalised propensity score (GPS) which is an extension of the Propensity Score Matching (PSM) technique. It is based on the process of causal inference, whereby a causal connection is drawn based on the conditions of an occurrence of an effect (Pearl, 2009). The technique is suitable in non-experimental settings or in determining causal inference and has long been utilized by the medical community in particular, to observe the effects of medical treatment programs on patients (see for example

Huang, Lou and Teitel, 2013; D'Agostino, 2007; Zheng, Zou, Xiu, Da and Li et. al, 2012; Feng, Zhou, Zou, Fan and Li, 2012). In economics, its use has gained traction in the assessment of treatment effect in a program or policy's implementation (Imai and Van Dyk, 2004; Essama-Nssah, 2006; Bia and Mattei, 2012; Michalek, Ciaian and Kancs, 2014; Flores, Flores-Lagunes, Gonzalez, and Neumann; 2012; Liu and Florax, 2014; Serrano and Requena-Silvente, 2011). The GPS technique is essentially an extension of the more well-known Propensity Score Matching (PSM) technique. The latter is a statistical matching procedure often used to estimate the effect of an intervention (e.g. policy, medication program) by accounting for the control variables that could predict the intervention (Austin, 2011). PSM uses predicted probability of group membership, i.e. Treatment versus Control groups, based on observed predictors obtained from a logistic regression. This matching technique then imitates randomization through the creation of a sample of units that had undergone the intervention to be comparad to a sample of units that did not undergo any intervention.

The propensity score itself is the probability of treatment assignment, conditional on observed baseline covariates (Pearl, 2009). The propensity score can be expressed as $e(x) = \Pr(Z = 1|X)$, where *e(x)* is the propensity score; *Z* is the Treatment Outcome; and *X* is the set of covariates. It is the function of observed covariates X, such that the conditional distribution of X given *e(x),* is the same for the treated *(Z=1)* and control *(Z=0)* units. The model proposed by Hirano and Imbens (2004) is as follows:

$$r(t,x) = f(T|X(t|x) \qquad [1]$$

and the GPS is *R=r (T,X),* where *R* is the propensity score under the assumption of the existence of a random sample of units *i= 1,…, N; T* represents the Treatment, with a continuous interval of *[t_0,t_1],* and *X* is the vector of covariates. For each unit of *i,* a set of potential outcomes $Y_i(t)$, for a particular level of potential treatment, $t \in T$ is postulated and is referred to as the unit-level dose-response function (DRF). The GPS estimator is interested in finding the mean DRF, expressed as:

$$\mu(t) = E[Yi(t)]$$

The DRF reflects the expected value of the outcome variable, conditional on continuous treatments, given the co-variates. The generalised propensity score (GPS), R, is estimated via the following standard model:

$$R_i = \frac{1}{\sqrt{2\pi\sigma^2}} exp\left[-\frac{1}{2\sigma^2}(t_i - \beta_0 - X\beta_1)^2\right] \qquad [2]$$

where β_0 and β_1 are the parameters to be estimated. The validity of *R* as a measure of similarity or dissimilarity across observations depends on the the following assumptions. First, treatment is applied randomly to prevent the likelihood of selection bias between food security and trade policy distortions. Thus, the GPS has the following property:

$$X \perp I\{T=t\}|r(t,X)$$

where *I(.)* is the indicator function. From here, the GPS can then be used to estimate the average dose-response function (DRF). As mentioned before, the average DRF is a function that relates the treatment level to the associated outcome level and is the function that will be used to analyse the relationship between distortionary trade policies and the dimensions of food security.

In order to eliminate selection bias, the implementation of the GPS model comes in three steps (Hirano and Imbens, 2004). The first is to estimate the GPS itself, and to check for its balancing property. They proposed a flexible parametric specification and used a normal distribution of the treatment given the covariates (Bia and Mattei, 2012).

$$T_i|X_i \sim N(\beta_0 + \beta_1' X_i, \sigma)^2 \quad [3]$$
$$g(T_i)\ |X_i \sim N\ \{h(\gamma, X_i), \sigma^2\ \} \quad [4]$$

where $g(T_i)$ is a suitable transformation of the treatment variable, and $h(\gamma, X_i)$ is a function of covariates with linear and higher order terms, depending on a vector of parameters, γ. The first step is to estimate the parameters of the conditional distribution of treatment given the covariates. If the assumption of normality holds, the GPS is then estimated as in [2]. The second step of the estimation would be to estimate the conditional expectation of the outcome Y, as a function of two scalar, which are the level of treatment, T and the GPS, R with the following estimation model:

$$\beta(t, r) = E[Y|T = t, R = r] = \psi[t, r; \alpha] \quad [5]$$

whereby α are the parameters to be estimated and $\psi(.)$ is a link function that relates the predictor to the conditional expectation, E. These parameters will be estimated by using ordinary least squares (OLS) method, using the estimated GPS, R.

The third, and final step is to compute the average dose-response function (DRF) of the outcome, by estimating the average potential outcome, over the GPS at any different level of treatment:

$$D(t) = E[(\beta)t, r(t, X))] \quad [6]$$

The average dose-response function (DRF) illustrates the causal link between the changes in treatment, given the estimated GPS, and the treatment outcomes.

Data for the study is from a selection of 24 developing countries from the Asian, African and Latin American regions, for a period beginning 1990-2010. treatment variable, Ti represents distortionary agricultural trade policies proxied by Nominal Rate of Assistance (NRA) received by domestic producers in a country (Anderson and Nelgen, 2012). The NRA can be defined as the percentage by which government policies directly raise or lower the gross return to producers of a product above the world price, computed as

$$NRA = \frac{[\mathrm{E.P}\ (1 + \mathrm{d}) - \ \mathrm{E.P}]}{\mathrm{E.P}}$$

where E is the exchange rate, d is distortion due to government action, and P is the international price of a product (Anderson, 2006). A positive NRA implies a rise in gross return for domestic producers, indicating the presence of either an output subsidy or a consumption tax. A negative NRA denotes a lower gross return for domestic producers relative to international price, indicating an export tax or consumer subsidy. In the estimation, the NRA will be converted into the nominal assistance coefficient (NAC) where $NAC = 1 + NRA$. Therefore an $NAC=1$ is the threshold between a positive and negative NRA. Table 1 summarizes average frequency of NAC by all the sample countries for the entire period between the years of 1990 to 2010.

Table 1: NAC frequencies by countries, percentage (1990-2010)

Country	NAC below 1	NAC above 1
Brazil	29	71
Bangladesh	63	37
China	29	71
Colombia	9	91
Cote d'Ivoire	100	0
Dominican republic	29	71
Ecuador	71	29
Ghana	76	24
India	24	76
Indonesia	48	52
Madagascar	57	43
Malaysia	24	76
Mexico	14	86
Nicaragua	95	5
Nigeria	52	48
Pakistan	76	24
Philippines	9	91
Senegal	52	48
Sri Lanka	43	57
Tanzania	86	14
Thailand	67	33
Uganda	57	43
Vietnam	43	57
Zambia	93	7

Source: Author's calculations.

Out of 24 sample countries, 11 countries show a higher frequency of NAC above 1. Out of these, the majority of them are Asian countries. On the other hand, from the 13 countries that have a frequency of NAC less than 1, seven of them belong to the African continent. It can be concluded that in general, there seems to be a balanced implementation of both positive and negative nominal rates of assistance (NRA) in developing Latin American countries. Developing countries in the African region tend to implement distortionary trade policies that are catered to consumers rather than producers. This is expected given the region's problems in combating poverty. On the other hand, Asian countries tend to implement distortionary trade policies that are beneficial to producers, implying a stronger bias towards trade competition amongst countries in the region.

The outcome variable, $Y(t)$, is the dependent variable in the model, embodying the separate impact of distortionary agricultural trade policies on the four dimensions of food security. Food availability and accessibility are proxied by per capita food supply (kcal/person/day) and per capita depth of food deficit (kcal/person/day) respectively. Infant mortality rate is the proxy for nourishment and therefore can reflect food utilization effectiveness. Finally, per capita food supply variability is used to measure food stability.

The covariates, X_i or the pre-treatment variables are to assist in the attainment of more precise estimates by controlling for some of the variation in the outcome. The first of the six control variables is real GDP per capita, along with its squared and cubic power used to ensure the GPS's balancing property, as suggested by Dehejia and Wahba (1999). Total population is used to control for country size while size of arable land is to control for relative agricultural comparative advantage. The country's food production index is a control for its agricultural sector's actual productivity. All continuous variables were transformed into logs. Two sets of dummy variables are added. One to indicate a country's net exporter status and another the 2007-2008 food crisis. Table 2 shows a summary of the variables.

Table 2. List of variables

Variable	Proxy	Source
Treatment Variable	Aggregate Nominal Rates of Assistance (NRAag)	World Bank Dataset
Food security dimensions (Y(t))		
a) Availability	Log of food supply (kcal/capita/day)	FAOSTAT
b) Access	Log of depth of food deficit	World Bank indicators
c) Utilization	Log of infant mortality rate	World Bank Indicators
d) Stability	Log of per capita food supply variability	FAOSTAT
Covariates	Log of GDP per capita	World Bank indicators
	Log of population (million)	World Bank indicators
	Log of per capita arable land	World Bank indicators
	Food production index	FAOSTAT
	Dummy for net exporter (=1 if yes)	
	Dummy for food crisis (=1 if 2007/2008	

Results

The first step in our empirical strategy is to estimate the conditional distribution of the treatment given the covariates following [4] using a panel regression method. This step is necessary to validate the assumption that the treatment has a normal distribution conditional on the covariates. Table 3 presents the outcome for the first-stage equation using Generalised Least Squares with random effects. Even though the estimated values have no substantive meaning, there is plenty to be learned from the signs and significance of the coefficients, being indicative of the historical relationships between the variables. For instance, the positive relationship between NAC and *lngdp* might imply that a higher per capita income is associated with higher levels of agricultural trade distortionary policies. This is consistent with the theory that higher income countries tend to implement more distortionary trade conditions. The NAC is also directly related to *lnarb* (percentage of arable land) and *lpopn* (percentage of population size), meaning that developing countries with a higher comparative advantage in agriculture tend to impose relatively more distortionary agricultural trade conditions compared to others. Interestingly, NAC moves against *fpi* (food production index), implying that a more productive agricultral sector is associated with lower levels of trade intervention. If the country is a net exporter, it may be imposing higher import subsidies or export taxes. During the 2007/2008 crisis, on average and ceteris paribus, there were less agricultural trade distortionary policies implemented by developing countries, a result that is consistent with Magrini et al (2014).

Table 3: Coefficient estimates

	NAC	
Covariates	Coeffecient	S.E.
Lngdp	1.178303	0.8112854
lngdp2	-0.1469832	0.1162034
lngdp3	0.0064278*	0.0054816
lnarb	0.0267911*	0.031875
lpopn	0.0114692*	0.0193936
Fpi	-0.000578*	0.0005551
Dfc	-0.1470061*	0.0236031
Dnx	-0.0267275*	0.0672843
Constant	-2.291847	1.862088
No. Of observations	488	
R-squared	0.2370	

Source: Author's calculations. Standard Error at 5% statistical significance.

The balancing property of the GPS is tested using a standard two-sided t-test. The test is basically to compare the covariates across groups, with and without adjustment for the estimated GPS. The covariates are stratified into five groups according to the treatment interval, NAC, and tested for equality of their means. In general, we find the balancing property was satisfied at a level lower than 0.01. The second step would be to estimate the conditional expectation of the outcome Y, as a function of two scalar, which are the level of treatment, T and the GPS, *R* with the following estimation model based on Equation [5]

$$Y = T + T^2 + R + R^2 + T.R$$

The third and final step in the procedure is to estimate the average dose-response function (Figures 1 through to 4). Essentially, the DRF shows the relationship between distortionary trade policies (treatment) and the dimensions of food security (the outcome).

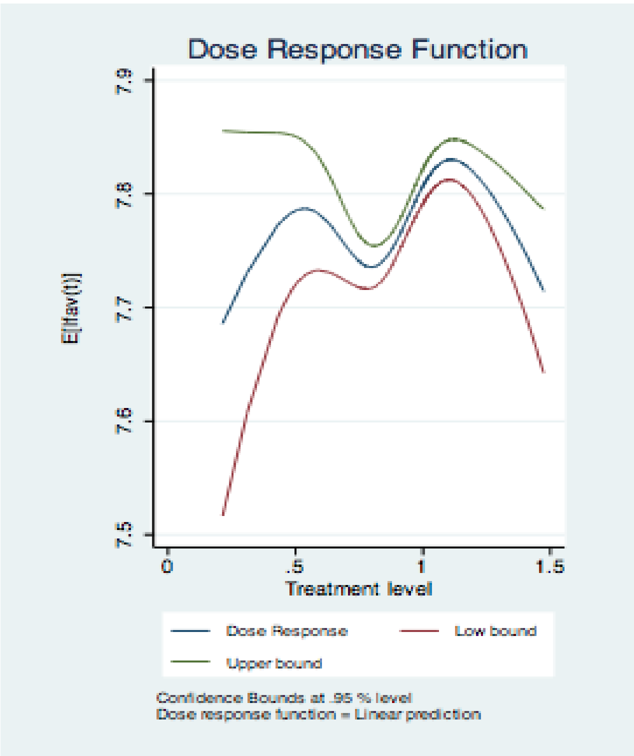

Figure 1. Average DRF of NAC and Food availability

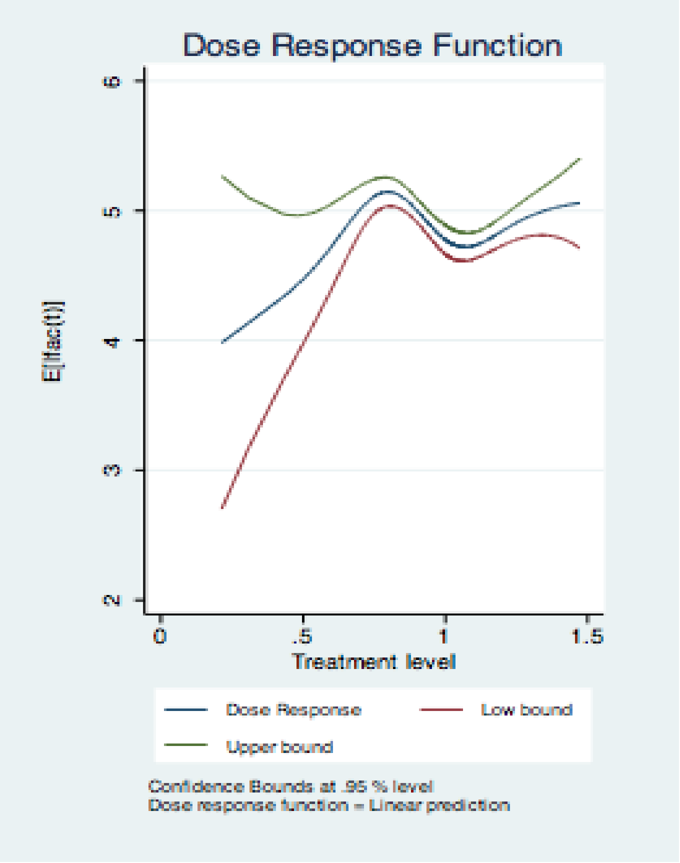

Figure 2. Average DRF of NAC and Food Access

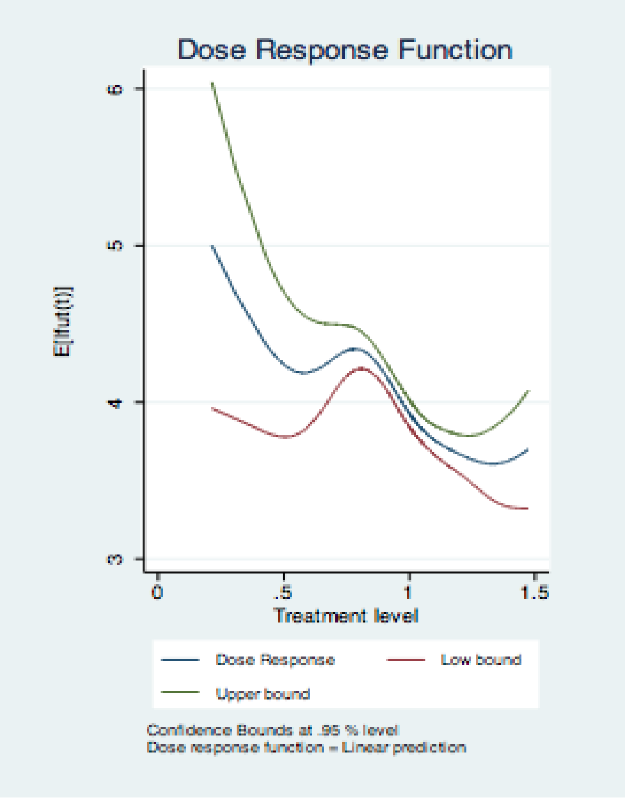

Figure 3. Average DRF of NAC and Food Utilization

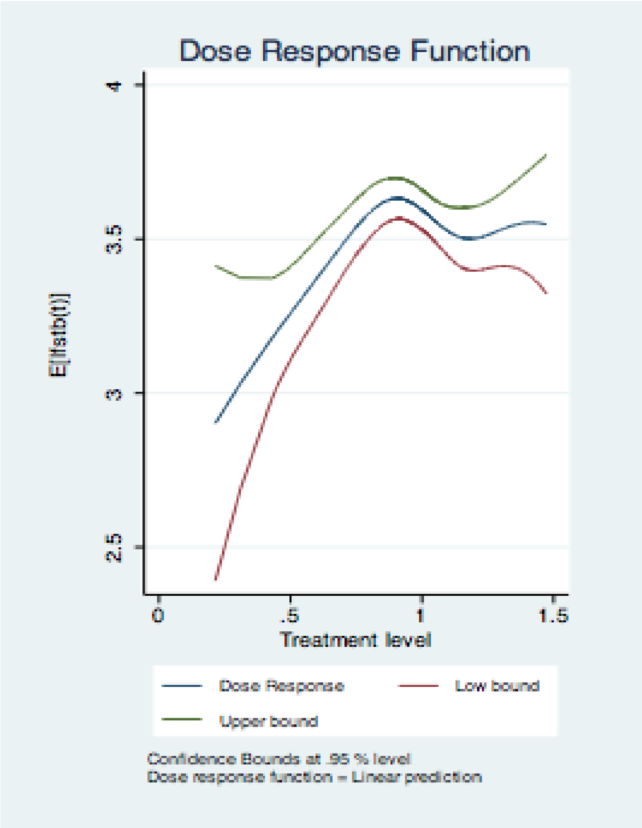

Figure 4. Average DRF of NAC and Food Stability

Availability

Figure 4.1 shows two maximum points of food availability, which are when the NAC is 0.5 and 1.2. It can then be concluded that both export (consumption) tax and subsidy had a positive impact on food availability, but only to a certain extent. NAC levels below 0.5 and above 1.2 indicated risks to food availability. In other words, excessive government protection has a negative impact on overall food availability.

Access

In Figure 4.2 the lowest point of depth of food deficit occurs at the treatment level 1.2, indicating that government protective policies tend to lead to better food access for the population. However, too much government support appears to bring the opposite effect and contributed to higher levels of food deficit as shown in the rising portion of the DRF beyond 1.2.

Utilization

In Figure 4.3, the lowest levels of infant mortality is recorded at 1.4 of the NAC. The positive value essentially implies that differences in gross return for domestic producers through distortionary trade policies tend to bring down rates of infant mortality. Again, excessive policy intervention is capable of reversing gains from protective trade policies, as seen when NAC rose beyond 1.4 bringing infant mortality rates up along with it.

Stability

Figure 4.4 shows that the highest point of food variability is at 0.825, indicating that a negative NRA, i.e. tax on the domestic producers tends to lead to better food stability.

Conclusion

The paper examines the causal relationship relationship between distortionary agricultural trade policies and food security in developing countries. The results confirm that while there is a degree of causal relationship between distortionary agricultural trade policies and all the four dimensions of food security, they do not necessarily threaten food security levels of the country. From the average dose-response functions (DRF) obtained, both negative and positive NRAs, i.e. both export (consumption) subsidy and tax have a positive impact on each dimension of food security, at least up to a certain extent. However, what is the degree of trade distortion necessary in order for these countries to protect their borders and ensure domestic food security? The study shows that there seems to be certain optimal ranges of the NRAs that can positively affect food security. Too little or too much will lead to a detrimental effect on the chosen dimensions of food security. Excessive government intervention can lead to not only volatile international prices but could also provide a superficial level of comfort to a country's population.

Hence, we argue that despite the positive effects of distortionary agricultural trade policies on food security levels in developing countries, the shift towards freer trade should remain an important component of a country's trade strategy; particularly as the threat of climate change looms upon us and domestic shocks become more unpredictable. In addition, the developing countries must not be distracted from embarking on structural changes that can contribute to greater and more efficient food production and utilization. Policymakers should also consider running more direct domestic measures such as conditional cash transfers targeted to the most vulnerable households, or other forms social protection policies.

The study suffers from two common form of limitations: selection of countries and length of the data. The unbalanced panel of 24 countries were formed after careful selection of the countries available and consistent data. Restricting the countries according to main cereal type or continent were not possible given the nature of available data. The estimation range for the data is relatively short, covering a period of only twenty years from 1990 to 2010. Although the GPS method could work just as well with smaller samples as it does with larger samples, we assumed that a larger set of data will lead to a much more comprehensive result. The FAO aggregate price index and the issue of domestic price transmission process are among the issues that are not addressed in the study. It however, helps to shed light on how agricultural trade distortion impacts specific food security metrics in a general sense.

References

Abdullateef, U., Ijaiya, A., 2010. Agricultural trade liberalization and food security in Nigeria. J. Econ. Int. Finance, 2, 299-307.

Alavi, H. R., Htenas, A. 2014. Using Trade to Enhance Food Security in Southeast Asia. Trade Policy and Food Security: Improving Access to Food in Developing Countries in the Wake of High World Prices, 273-298.

Austin, P., 2011. An Introduction to Propensity Score Methods for Reducing the Effects of Confounding in Observational Studies. Multivariate Behavioral Research, 46(3), 399-424.

Azzoni, C., Brooks, J., Guilhoto, J., McDonald, S., 2007, Who in Brazil Will Gain from Global Trade Reforms? World Economy, 30, 1568–1593.

Bezuneh, M., Zelealem, Y., 2009. Has Trade Liberalization Improved Food Availability in Developing Countries? An Empirical Analysis, 2009 Conference, August 16-22, 2009, Beijing, China 51136, International Association of Agricultural Economists.

Bia, M., Mattei, A., 2012. Assessing the effect of the amount of financial aids to Piedmont firms using the generalized propensity score. Statistical Methods & Application, 1-32.

Brooks, J., Matthews A., 2015. Trade Dimensions of Food Security. OECD Food, Agriculture and Fisheries Papers.

D'Agostino, R., 2007. Propensity Scores in Cardiovascular Research. Circulation, 115(17), 2340-2343.

Das, K., & Rout, H., 2014. Applied General Equilibrium Analysis of Food Security in India: A CGE Modelling Approach. MANTHAN, 1(2).

Diaz-Bonilla, E., Ron, J., 2010. Food security, price volatility and trade: Some reflection for developing countries, ICTSD Programme on Agricultural Trade and Sustainable Development.

Ecker, O., Breisinger, C., 2012. The food security system: A new conceptual framework. IFPRI discussion papers 1166, International Food Policy Research Institute (IFPRI).

Essama-Nssah, B., 2006. Propensity score matching and policy impact analysis - a demonstration in EViews, Policy Research Working Paper Series 3877, The World Bank.

FAO. (2008). An introduction to the basic concepts of food security. Food Security Information for Action. EC-FAO Food Security Programme.

Feng, P., Zhou, X., Zou, Q., Fan, M., Li, X., 2011. Generalized propensity score for estimating the average treatment effect of multiple treatments. Statist. Med., 31(7), 681-697.

Fleming, D., & Abler, D., 2013. Does agricultural trade affect productivity? Evidence from Chilean farms. Food Policy, 41, 11-17.

Flores, C., Flores-Lagunes, A., Gonzalez, A., Neumann, T., 2012. Estimating the Effects of Length of Exposure to Instruction in a Training Program: The Case of Job Corps. Review Of Economics And Statistics, 94(1), 153-171.

Gillson, I., Busch, C., 2014. Trade Policy Responses to High and Volatile Food Prices. Trade Policy and Food Security: Improving Access to Food in Developing Countries in the Wake of High World Prices, 87-117.

Gross, R., Schoeneberger, H., Pfeifer, H., Preuss, H., 2000. The four dimensions of food and nutrition security: definitions and concepts. Food and Agriculture Organization of the United Nations.

Hirano K., Imbens, G.W., 2004. The Propensity Score with Continuous Treatments, in: Applied Bayesian Modeling and Causal Inference from Incomplete-Data Perspectives: An Essential Journey with Donald Rubin's Statistical Family, Wiley Series in Probability and Statistics, 73–84.

Huang, Z., Lou, Y., Taitel, M., 2013. A Case Application of Propensity Score Matching in the Outcomes Evaluation of Medication Therapy Management at Retail Pharmacy. In SAS Global Forum 2013. San Francisco.

Imai, K., van Dyk, D., 2004. Causal Inference With General Treatment Regimes. Journal Of The American Statistical Association, 99(467), 854-866.

Jones, D., Kwiecinski, A., 2010. Policy responses in emerging economies to international agricultural commodity price surges. OECD Food, Agriculture and Fisheries Working Papers No. 34, OECD Publishing, Paris.
Keats, S., Wiggins, S., Compton, J., Vigneri, M., (2010). Food price transmission: Rising international cereals prices and domestic markets. Project Briefing 48. Overseas Development Institute. London.
Kshirsagar, V., Baffes, J., 2011. The Nature and Structure of Global Food Markets. World Bank, Washington, DC.
Laborde, D., Martin, W., 2012. Agricultural Trade: What Matters in the Doha Round?. Policy Research Working Paper 6261, World Bank, Washington, DC.
Lembergman, E.G., Rossi, M., Stucchi, R., 2015. The impact of restrictions to exports on production: A synthetic controls approach. Universidad de San Andres, Departamento de Economia Working Papers. Buenos Aires.
Liapis, P., 2013. How Export Restrictive Measures Affect Trade of Agricultural Commodities. OECD Food, Agriculture and Fisheries Papers.
Liu, J., Florax, R., 2014. The Effectiveness of International Aid: A Generalized Propensity Score Analysis. 2014 Annual Meeting, July 27-29, 2014, Minneapolis, Minnesota 169804, Agricultural and Applied Economics Association.
Magrini, E., Montalbano, P., Nenci, S., Salvatici, L., 2014. Agricultural Trade Policies and Food Security: Is There a Causal Relationship?. Working Paper 9/14. Sapienza University of Rome.
Martin, W., Anderson, K., 2012. Export restrictions and price insulation during commodity price booms. Am. J. of Agri. Ec.. 94 (2), 422–427.
McCorriston S, Hemming D.J., Lamontagne-Godwin, J.D., Parr, M.J., Osborn, J., Roberts, P.D., 2013. What is the evidence of the impact of agricultural trade liberalisation on food security in developing countries? A systematic review. London: EPPICentre, Social Science Research Unit, Institute of Education, University of London.
Michalek, J., Ciaian, P., Kancs, D., 2014. Capitalization of the Single Payment Scheme into Land Value: Generalized Propensity Score Evidence from the European Union. Land Economics, 90(2), 260-289.
Olper, A., Curzi, D., Bedin, E., Swinnen, J., 2014. Food security, health and trade liberalization: A quasi-experimental approach. Europa.
Owen, A.L., Wu, S., 2007, Is Trade Good for Your Health?, Rev.of Int. Ec., 15, 660–682.
Pearl, J., 2009. Causal inference in statistics: An overview. Statistics Surveys, 3(0), 96-146.
Rodrik, D., 2001. The global governance of trade: as if development really mattered . New York: UNDP.
Rose, Donald. 2016. Access to Healthy Food: A Key Focus for Research on Domestic Food Insecurity. The Journal of Nutrition. 140, 1167-1169.
SAPRIN. 2001. The policy roots of economic crisis and poverty: a multicountry
participatory assessment of structural adjustment - Executive Summary. Washington DC: Structural Adjustment Participatory Review International Network.
Serrano-Domingo, G., & Requena-Silvente, F., 2013. Re-examining the migration–trade link using province data: An application of the generalized propensity score. Economic Modelling, 32, 247-261.
Sharma, R., 2011. Food export restrictions review of the 2007-2010 experience and considerations for disciplining restrictive measures. Rome: FAO.
Singer, H. W., 1997. A global view of food security. Agriculture and rural development. In Food security and innovations: successes and lessons learned: international symposium 1996. Frankfurt am Main; New York: P. Lang.

Timmer, P., 2010. Management of rice reserve stocks in Asia: Analytical issues and country experience, in Commodity Market Review 87–120, FAO, Rome.
Tweeten, L., 1999. The Economics of Global Food Security. Applied Ec. Pers. and Policy 21.2, 473-488.
Young, H., & Overseas Development Institute. Humanitarian Practice Network. (2001). Food-security assessments in emergencies: A livelihoods approach. London: HPN, ODI.
Zheng, L., Zou, L., Xiu, J., Da, W., & Li, J., 2012. Can we consider plasma alkyresorcinols as a potential biomarker of whole-grain food?. Am. J. Of Clinical Nutrition, 96(5).