AGRICULTURAL SUPPORT AND VULNERABILITY OF FOOD SECURITY TO TRADE IN DEVELOPING COUNTRIES

Laroche Dupraz C.[(1)]**, Huchet Bourdon M.**[(2)]

UMR SMART 1302 Agrocampus Ouest – INRA, Rennes, France

4 allée Adolphe Bobierre
CS 61103
35011 Rennes Cedex - FRANCE

[(1)] catherine.laroche@agrocampus-ouest.fr
[(2)] marilyne.huchet-bourdon@agrocampus-ouest.fr

Preliminary draft

Abstract

Our hypothesis is that the Bonilla Index (BI) can be used as a consistent indicator of food security vulnerability to trade at national level. We actually suppose that, with the aim of stabilizing national food availability and accessibility, developing countries use policy instruments (trade policies, currency value) in the sense of stabilizing their BI. This assumption is statistically tested for 39 developing countries over the period 2005-2010. Our results suggest that most developing countries have used their possibility to play with the nominal rate of assistance level to compensate the effects of the 2008 food price surge, and that exchange rate variations actually have few impact on food accessibility for consumers in a context of volatility of food prices.

Keywords: national rate of assistance, food security, exchange rate, food trade.

Acknowledgements

Financial support received by the European Union's Seventh Framework Programme FP7 2007-2011 under Grant Agreement n° 290693 FOODSECURE, is gratefully acknowledged. The views expressed in this paper are the sole responsibility of the authors and do not reflect those of the Commission, which has not reviewed or approved the content of the paper.We are grateful to Abdel Sikirou (UMR SMART-LERECO) for statistical assistance.

AGRICULTURAL SUPPORT AND VULNERABILITY OF FOOD SECURITY TO TRADE IN DEVELOPING COUNTRIES

Introduction

Food security is a major concern, especially for developing countries where a large percentage of the population lives in rural areas and the agricultural sector represents a substantial weight in the economy. The food security issue has come to the fore in recent years with the 2007-2008 food crisis and agricultural price volatility. For decades before, the focus was more on producers with lower incomes due to lower agricultural price trends. The 2007-2008 price hike turned attention to poor consumers as food riots erupted in many developing countries. Low-income countries are particularly vulnerable to agricultural price surges. That is why the World Trade Organisation (WTO) Ministerial Conference of 7 December 2013 in Bali decided to raise a negotiation on an agreement for the issue of public stockholding for food security and, in the interim, authorised, for food security reasons and under conditions, developing countries to provide support for traditional staple food crops (WTO, 2013).

First coined in the mid-1970s, food security is a multi-dimensional concept as shown by the many attempts to define it (Maxwell, 1996; Smith, 1998; Clay, 2002). Food security has been analysed at many levels (individual, household, regional, national and global) over time, but food security at one level does not guarantee food security at another level. According to the FAO, "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," (World Food Summit, 1996). This definition includes four components: physical availability, economic access, stability and adequate utilisation. Van Diij and Meijerink (2014) proposed a review of major global food security studies from 2000 to 2013. They show that most of the scenari only deal with two of the four dimensions of food security: food availability and food accessibility while food utilisation and stability are largely ignored.

Diaz-Bonilla et al. (2000) take the traditional definition of food security and propose a conceptual framework, adapted from Smith (1998), which displays the multiple links and interactions between trade and food security at each level (from individual to global level). Diaz-Bonilla and Ron (2010) demonstrate the key role played in national food availability by: i) agriculture, a major sector in most developing countries where food security is at risk; ii) domestic agricultural and food policies prompting agricultural price deviations that have opposite effects on net buyer *versus* net seller households; and iii) trade policies in developed and developing countries that affect the domestic and foreign agricultural markets, since WTO regulations have little influence on the use of trade policy tools. They also suggest considering the positive effects on employment and poverty alleviation of suitable macroeconomic policies in other areas such as agricultural, financial, human and institutional concerns.

The world agricultural price surge in 2007-2008 showed that developing countries, particularly in Africa, are constantly at risk of chronic food crisis. Food riots, rocketing prices and concerns about the future effects of climate change have led some to claim that food security is improved by agricultural trade liberalisation, because trade can offset local market shortcomings and provide consumers with commodities at low prices. Timmer (2010) suggests that the best way to prevent food crises in the long run is to invest in "agricultural productivity and policies on behalf of stable food production and prices" rather than "trying to cope afterwards with the food crisis impact on the poor."[1] To be more specific, agricultural and food imports play a key role on food security in low-income countries. Indeed, dependence on imports for food may raise some food insecurity in the case of sudden price hike putting up the national food bill. The national state of food availability in the form of food imports and domestic food production is therefore crucial information. Analysing the stability of food availability through agricultural domestic and trade policies of importing countries is the core of this paper.

Following Diaz-Bonilla et al. (2000), this contribution aims to shed light on the vulnerability of food security to trade at national level, and how some political tools may be used to reduce this vulnerability and instability of food availability. Section 1 analyses the economic links between national vulnerability of food security and different forms of policy interventions in agriculture. Those relationships are simply formalized using the Bonilla index as indicator of vulnerability of food security to trade. Second, we draw a picture on the evolution of the Bonilla Index. Section 3 tests statistically the extent to which our hypotheses and relationships are actually confirmed by the data covering the period 2005-2010, before concluding.

1 Agricultural assistance and food security

1.1. Effects of border and domestic measures on agricultural distortions

National trade policies cover border import and export taxes (tariffs) and subsidies. The effects of such trade policies on domestic supply, imports and the economic welfare of producers and consumers are well known (Krugman et al., 2012): these tools impact on the relative competitiveness of domestic production compared with the world market. A protective policy (high agricultural tariffs) has positive effects on domestic supply, but negative impacts on domestic consumers. Given that agricultural commodities are a food staple, such a policy applied to the agricultural sector is conducive to self-sufficiency, but may not promote food security where domestic supply is not sufficient or not suited to the domestic population's food needs. At the same time, applied tariffs (resp. subsidies) represent resources (resp. costs) for national budgets. This impact on government revenues may contribute to (resp. threaten) the funding of domestic policies that directly or indirectly promote an increase in household incomes and hence individual food security or that promote national investment in health and education. An open market (low or zero tariffs) is positive for urban consumers, but could discourage domestic producers from developing their production supply if they cannot compete with international competition. So an open market has a positive effect on food security in that it facilitates domestic access to international agricultural supply, but it can also have a negative impact on domestic supply and increase food dependence on imports, which becomes a serious problem in the case of high world food prices and price surges.

Agricultural domestic support measures are also taxes (if negative) or subsidies (if positive) applied to outputs or inputs. Like border measures, positive domestic support coupled to production, like price support or production payments, introduces a gap between a higher domestic price and a lower world price. This is not the case with decoupled domestic support, which is not expected to have such a distortive effect on agricultural prices. As a result, positive domestic support, if coupled, has similar effects to border tariff protection, i.e. a positive impact on domestic supply and a negative effect on domestic demand. However, the

[1] A third view defended by the food sovereignty movement is that long-term food security cannot depend on food imports, but must be built on the development of domestic production with enough barrier protection to shelter it from world price fluctuations and unfair trading (Laroche Dupraz and Postolle, 2013).

impact on government revenue is not the same: price support is directly financed by domestic consumers, while subsidies are charged to the national budget.

Positive domestic support and tariff protection to encourage domestic supply may both have a negative distortive impact on the world price. This is why the use of border measures and domestic support measures has been regulated by the WTO in the agricultural sector since the Uruguay Round Agricultural Agreement (1994) in order to limit the negative impact of agricultural support on world agricultural prices. However, although WTO rules are binding on major developed countries, which have had to reform their agricultural policies to comply, most developing countries are not similarly bound for two reasons. First, most developing countries have known very low agricultural support levels (often even negative in the 1970s or 1980s). Second, WTO reduction commitments for developing countries are much lower than for the developed countries, and the recent WTO Ministerial Decision confirms this differential treatment at middle term for food security purposes (WTO, 2013). Note that WTO regulations are only designed to counter negative agricultural world price distortions. There are no rules to restrict support measures that have positive effects on world prices, such as export restraints or import subsidies.

1.2. Measuring global agricultural support indicators

Agricultural support points to the impact of general government measures to support agricultural producers' earnings by raising domestic prices vis-à-vis world market prices (in the form of domestic price support and import tariffs) and by granting direct and indirect subsidies to the agricultural sector. There are a number of national agricultural support indicators. The OECD calculates annual Producer Support Estimates (PSEs) for OECD members. The PSEs measure the value of annual transfers to agricultural producers across all support policy measures.[2] PSEs have been assessed with great accuracy and are updated annually for the OECD countries and more recently for the emerging economies. Yet PSEs are calculated on the basis of agricultural policy only.

The World Bank has also estimated agricultural incentive distortions more broadly by assessing the rate of assistance for a large panel of countries. This calculation is fairly similar to the PSE in its consideration of agricultural policy, but it is also designed to take into account the indirect effects of other sectoral policies (e.g. industrial tariffs) and macroeconomic policies (e.g. exchange rate distortion) on the agricultural sector. Krueger et al. (1988) hence estimate the impact on agriculture of general and agricultural policies put in place by 18 developing countries in different geographic areas over the 1975-1984 period. The direct effect is measured by the difference between the producer price and the border price adjusted for transport, storage, distribution and other marketing costs. The indirect effect includes the impact of fiscal policies, industrial protection policies and the overvaluation of the exchange rate, which distort agricultural product prices compared with other product prices. The authors find that, in almost all cases, the combined direct effects are equivalent to a tax on exportable products (approximately 11% on average) and a subsidy for imports (approximately 20% on average). The indirect effects also tax agriculture (approximately 27%) and dominate the direct effects, even when these direct effects are directed towards helping the domestic agricultural sector. Anderson (2009, 2010) coordinated a huge survey for the World Bank to evaluate the nominal rate of assistance (NRA) trend in 75 developing

[2] The Aggregate Measurement of Support (AMS), on which WTO members' domestic support reduction commitments are based in agricultural negotiations (amber box), is inspired by the same logic as the PSE, but excludes from its calculation decoupled support and the minimum authorised support "*de minimis*" i.e. 5% of agricultural production for developed countries and 10% for developing countries. AMS is a political indicator decided by WTO member states. To have an idea of the differences between Producer Support Estimates and Aggregate Measurement of Support to assess agricultural support using the examples of United States, China and Brazil, see Tokgoz et al. (2014).

and developed countries for a number of periods ranging from 1955 to 2006-2007. He notices that from 1975-1979 to 2000-2004, much progress was made by reducing the anti-agricultural and anti-trade biases of policy especially in Africa: substantial reforms reduced the burden of taxation on export cash crops in particular (cocoa, coffee and cotton), groundnuts, beef, rice and sugar. The last updated NRA data (Anderson and Nelgen, 2012) add six developed countries and three additional years (2008-2010), including the 2008 price surge year. In this updated database, the only exchange rate-induced indirect effect covered is the case where a government imposes a different exchange rate for imports and exports that actually has an especially distortive effect on the agricultural sector. The “straightforward” overvaluation is disregarded, unlike in previous calculations, because the authors consider that such an overvaluation has a similar effect on imports and exports of all products and that the particular impact on agriculture is negligible.

However, the links between domestic policy and national food security indicators need to be analysed in order to understand how the determinants of food security interact, in particular by differentiating market context (falling *versus* rising, low *versus* high agricultural prices) and national agricultural trade position (net food importer/exporter).

1.3. The Bonilla index and its determinants

Diaz-Bonilla et al. (2000) put forward that the ratio of national food import expenditure to the value of total exports is a useful indicator of national access to the world food supply (hereafter the Bonilla Index, BI).

$$BI = \frac{m^{value}}{X^{value}} = \frac{m \cdot p_m}{X \cdot p_X} \tag{1}$$

with m^{value} : value of food imports in local currency;

X^{value}: value of total exports in local currency;

m: quantity of food imports;

X: quantity of total exports;

p_m, p_X : domestic aggregated price in local currency for food imports and for total exports.

This Bonilla Index (BI) is a consistent indicator of the national capacity to finance food imports from exports. In this regard, it is an interesting indicator of the vulnerability of food security to trade in developing countries, especially for net food importing countries. This index is sensitive to variations in:

- The volumes of food imports and total exports, because food imports point to national food needs not covered by domestic production and total exports are indicative of the country’s trade performance and competitiveness;
- The value of food imports and total exports; these values depend on world price trends and their effects on the local currency *via* the exchange rate.

The Bonilla Index assessment finds that food security is less vulnerable to trade when the BI decreases and more vulnerable when the BI increases. Contrary to the food trade position (food net importer/exporter), the BI considers the relative food import bill to total export earnings, hence pointing up the role of international trade and its effects on national food security.

In the following analysis, we focus on the agricultural food sector, assuming the relative stability, *ceteris paribus*, of the total export sector, at least in the short term.

In order to highlight world food prices in the equation, we introduce the exchange rate in equation (2). With the BI formula written this way, we can analyse the effects of food prices and exchange rate deviations on BI:

$$BI = \frac{m \cdot P_m \cdot E}{X \cdot P_X .E} \tag{2}$$

with m: quantity of food imports

X: quantity of total exports;

P_m: world price for food imports in foreign currency;

P_X : domestic aggregated price in foreign currency for total exports.

E: nominal exchange rate, i.e. the number of national currency units against one unit of foreign currency: 1 foreign currency unit = E domestic currency units.

Border measures (export and import taxes and subsidies) and domestic support have direct impacts on the BI because they introduce the gap between world and domestic food prices. The Nominal Rate of Assistance (NRA) index on importable food products, as calculated by the World Bank (Anderson, 2009; Anderson and Nelger, 2012), provides information on the effects of agricultural policy domestic support and border measures. Thus taking into account these measures, equation (2) may be written:

$$BI = \frac{m \cdot P_m \cdot (1 + NRA^m) \cdot E}{X \cdot P_X .E} \tag{3}$$

with NRA^m: Nominal rate of assistance assessed for importable food products (in %).

This equation highlights the role of the several determinants of the vulnerability of food security to trade identified in previous sections: world price P_m (and its potential volatility), the level of national or trade policies applied to the food imports sector (NRA^m), and the exchange rate policy with the nominal exchange rate E may modify the numerator of BI, i.e the food import bill expressed in local currency after custom clearing.

1.4. Impact of NRA^m and E deviations on BI.

In the very short term, in an environment of relative agricultural price stability, we observe that:

- In the event of the depreciation (resp. appreciation) of the local currency to the foreign currency, E rises (resp. falls). The BI numerator then automatically rises due to the increase (resp. decrease) in the cost of food imports expressed in the local currency. But the BI may not move because, expressed in local currency, the denominator increases in the same proportion as the numerator if X remains at the same level.

- If NRA^m increases (resp. decreases), for example due to higher (resp. lower) food import tariffs or domestic food production subsidies, the BI automatically increases (resp. decreases) due to the price rise for imported food, increasing (resp. decreasing) the vulnerability of food security to trade.

In the longer term, the estimated effects of E and NRA^m on food security vulnerability to trade are not so clear because a local currency depreciation (resp. appreciation) or an increase (resp. decrease) in agricultural support may improve (resp. undermine) domestic agricultural competitiveness and stimulate (resp. cut back) domestic food production and total exports. This may have a negative (resp. positive) impact on food import demand m, positive impact on exports X and may drive down (resp. drive up) the BI by reducing (resp. increasing) food dependence on imports.

1.5. Impact of price volatility on food security

In 2000, the downward trend in world agricultural prices started to shift. Global demand rose more sharply than supply, slowing the downward trend in agricultural prices from 2000 to 2007. Suddenly, agricultural prices spiralled in 2007-2008, triggering hunger riots in a number of developing countries in 2008.

The price volatility debate was reopened following the 2007-2008 price surge as farmers' earnings and consumer purchasing power suddenly looked uncertain, putting food security at risk. Recent years have seen two peaks in world prices for cereals and other major food commodities: once in 2007-2008 and a second time in 2010-2011. And prices have generally remained at a higher level than during the period from the 1980s to the early 2000s. There may be a number of reasons for this trend such as a growing imbalance between food demand and supply, the rise in oil prices, exchange rate movements and trade restrictions.

Price hikes can have mixed effects in terms of food security. High food prices could be viewed as an opportunity for producers. They could drive an increase in food production, improving the physical availability and access to food and raising producers' incomes. Yet at the same time, the cost of consumption goes up such that, under the hypothesis of stable food aid, economic access to food is reduced (Diaz-Bonilla and Ron, 2010). This phenomenon is more of a concern in developing countries where a large proportion of household income goes on food. Households in these countries therefore face a drop in real income and greater uncertainty should shoot up agricultural prices suddenly. Moreover, many producers are net food buyers (being mostly small farmers, livestock producers and artisanal fishers in the developing countries). The main impacts of price volatility on producers and consumers are in the uncertainty surrounding income, investment decisions and access to food. Price transmission from international prices to domestic prices can be limited for a number of reasons including previously analysed policies such as trade, exchange rate policy and other domestic policies, as well as other factors like infrastructure and transportation costs (Baffes and Gardner, 2003; Meyer and von Cramon-Taubadel, 2004; Greb et al., 2012).

So rising prices may benefit producers by raising their profits, but it may be to the detriment of consumers by cutting their purchasing power. Besides, even in the case of producers, the opportunity depends on the producers' ability to really produce more. Developing countries suffer from a lack of agricultural productivity and weak infrastructures. They may face obstacles such as poor access to credit.

The developing countries responded in different ways to the 2007-2008 price surge. Yet many chose, at least as a short-term emergency measure in response to rocketing domestic food prices and to the threat to their cities' food supply, to raise imports by lifting tariffs (and even subsiding imports) and to restrict their exports with export taxes and bans (FAO, 2009). Although 2008 clearly showed that export taxes generally make food crises worse, which is why they are widely criticised by both developed and developing countries along with many international agencies (Lui and Bilal, 2009), it certainly strengthened the conviction of countries using such export taxes that it is in their best interests to retain the right to use them, in particular when the commodity is agricultural and when food security is at stake (Bouet and Laborde-Debucquet, 2010). Looking into WTO members' responses to structural food crises, Crump (2010) concludes that export restrictions would most certainly be used on a massive scale in response to cases such as climate change.

The theoretical framework presented in this section points clearly to the potential impact when a national government implements corrective policies. Changing the local currency value and/or the level of domestic support theoretically offsets the effects of an agricultural price deviation. Equation (3) actually shows that by rising (resp. reducing) E and/or NRA^m, it is theoretically possible to offset a fall (resp. rise) in P_m and keep BI stable. The abovementioned policies adopted by importing countries in 2008 can be understood in this way: lifting import tariffs and reducing NRA^m may offset the food price surge and limit the BI deviation so as not to damage food security vulnerability to trade.

2 Evolution of the food security vulnerability to trade of developing countries from 2005 to 2010

2.1. Available Data

BI is computed from the BACI database using equation (1).

The annual food import value (numerator) and total export value (denominator) are used to calculate the BI for each country. The BACI-92 database provides consistent trade data in US dollars (import and export values) at HS2, HS4 and HS6. The HS4 level is used to differentiate food commodities from other products so that we can calculate food import values[3]. In order to be consistent with statistical regressions of section 3, highly transformed products are excluded because NRA^m data are only given for agricultural products. We consider chapters 1 to 12 of the HS4 classification (excluding chapters 5 and 6 and Code 1209[4]) as agricultural food commodities: we name "food imports" the agricultural food imports.

Our sample is composed of 39 developing countries over the period 2005-2010. Characteristics of those countries are presented in Appendix, table A1.

2.2. BI evolution paths of developing countries from 2005 to 2010

Figure 1 presents 2005-2010 average BI of the sample's countries. Each country is represented by a point placed on a plan by including the value of food imports on the x-axis and the value of total exports on the y-axis. Axis values are plotted using a decimal logarithmic scale to allow the representation of the vast differences in national situations in our sample. The value of BI is growing when moving from the Northwest to the South East of the graph. In order to see more clearly the countries according to the value of their BI, 3 lines iso-BI are shown which respectively take the BI values of 1% (green line), 10% (yellow line) and 100% (Red line).

This graph enables to distinguish:

- The countries at low or moderate BI (1 - 10%) between the green and yellow lines, and the countries with a high BI (10 - 100%) between yellow and red lines, or greater than 100% (case of Benin). Remind that BI higher than 100% means that total exports value is insufficient to finance food imports;

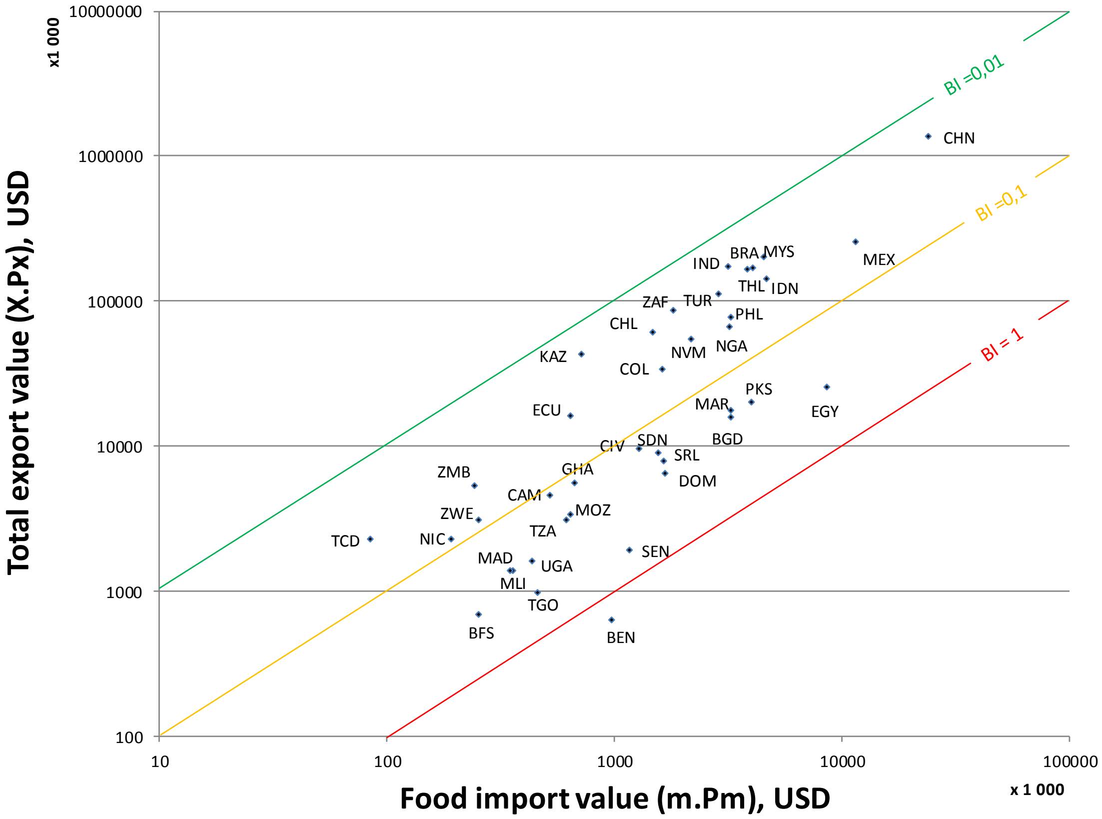
- The big countries (China, Mexico, Asian countries, Egypt), which are located to the Northeast of the graph, and the small countries (Chad, Burkina Faso, Nicaragua, Benin, Mali,

[3] The World Bank NRA database also computes the nominal exchange rate needed to convert USD trade data into local currency units, when necessary.

[4] Chapter 5 covers feathers and other animal products for non-food use, Chapter 6 covers ornamental plants and Code 1209 corresponds to seed for sowing.

Togo, Madagascar), located in quarter Southwest. Indeed the value of total exports on the one hand and food imports on the other hand are correlated respectively to the economic size and the number of inhabitants of the country.

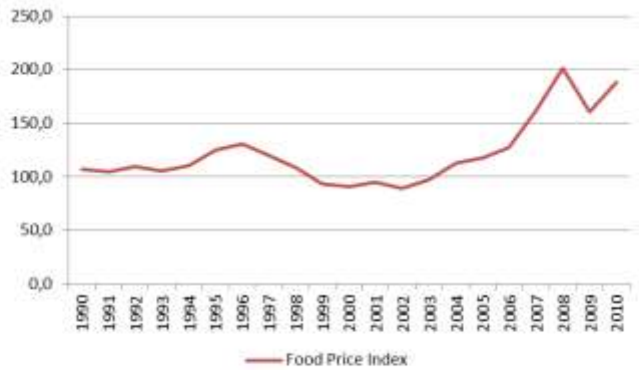
Fig 1: 2005-2010 average BI of our panel of 39 developing countries



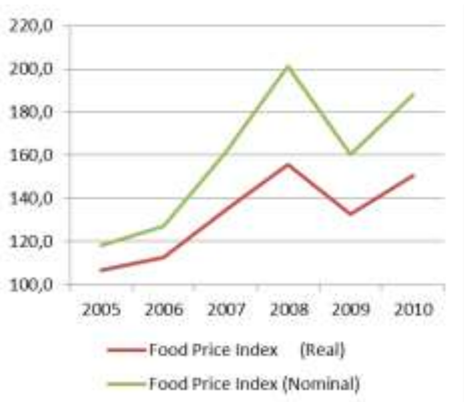
We can check on this graph that countries which present very close BI averages are however not in the same situation. For example Egypt, with BI at level 34%, is a large country whose exports are important resources, while Burkina Faso, with BI at level 37%, is a much smaller country whose both food imports needs and export resources are lower than Egypt's ones.

Fig 2 : FAO Food Price Index from 1990 to 2010 ; 2002-2004 = 100.

(2a) Nominal Food Price Index evolution from 1990 to 2010



(2b) Nominal and Real Food Price Index



Source: authors from FAO data, website http://www.fao.org/worldfoodsituation/foodpricesindex/en/

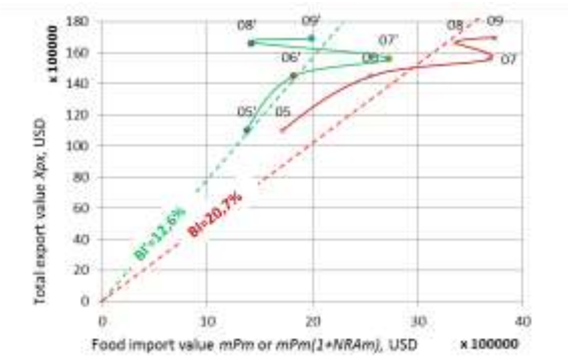
"Food Price Index consists of the average of 5 commodity group prices indices [meat, Dairy, Cereals, Vegetable Oils, Sugar, ndrl]) weighted by the average export shares of each of the group for the base period 2002-2004: in total 73 price quotations considered by FAO commodity specialists as representing the international prices of the food commodities are included in the overall index".

During the period 2005-2010, food prices are characterized by an upward trend with a high level of variability, even in real terms (fig 2b), compared to the previous decade (fig 2a). Without corrective adjustments, one can expect that observed variations of food prices lead to similar fluctuations of food import value that would have an impact on their BI in particular for countries which are net food importing countries with limited export resources.

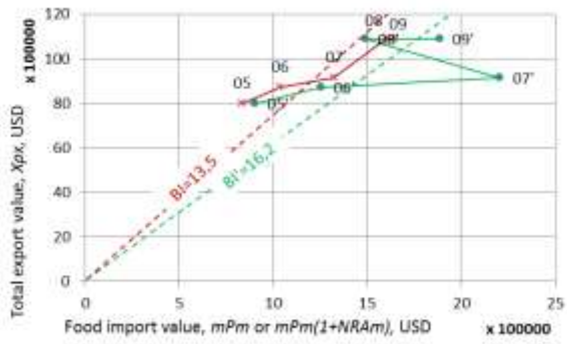
Following figures show the temporal BI path from 2005 to 2010 of some countries which are from different geographic areas. Red lines correspond to BI calculated with food import value before import border measures while green lines (named BI') refer to BI calculated including NRA^m ie., after import border.

Fig 3: BI paths from 2005 to 2010

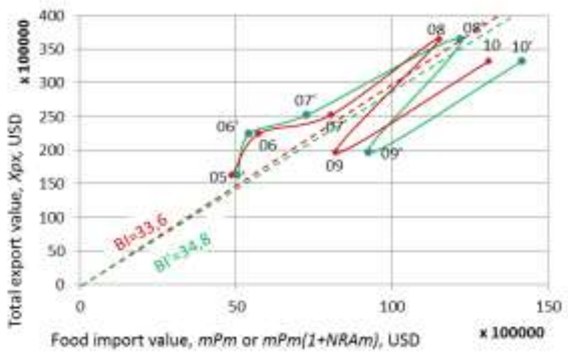
(3a) Bangladesh (Asia)



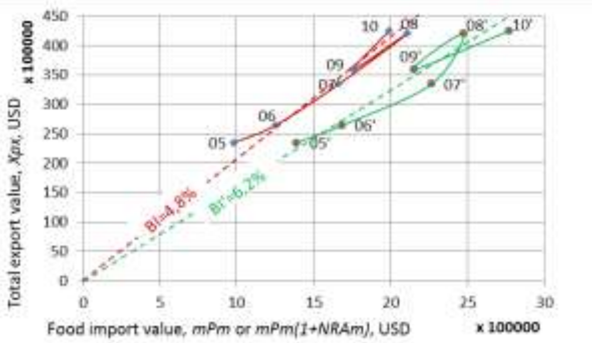
(3b) Côte d'Ivoire (West Africa)



(3c) Egypt (Northern Africa)



(3d) Colombia (America)



Over the whole period 2005-2010, the average BI calculated before application of trade measures at the import border (without NRA^m) may be higher (as in Bangladesh), lower (case of Côte d'Ivoire or Colombia) or very similar (as in Egypt) to the average BI calculated after applying NRA^m. This corresponds to the fact that during this period, agricultural products are subject to a greater or lower import protection by country: negative in Bangladesh, absent or low in Egypt but generally positive in Colombia or in Côte d'Ivoire.

Examination of the red curves shows that for the four countries there is a jump in the value of food imports between 2005-2006 and 2007-2008, that results in a strong Eastward shift of the BI points of the graph. We also observe a concomitant increase in the value of total exports. Graphically, BI points were located in 2005 and 2006 in the Northwest of the average BI line and move to the South East of this line in 2007, 2008 and 2009, except for Egypt.

The examination of the green curves (BI') shows that the evolution of the BI taking the NRA^m into account not substantially follows the same trend as the red curve. A correction appears between 2007 and 2008: BI points return Northwest of the average BI. This suggests that countries seek to adjust their level of NRA^m to stabilize the BI after crossing the border, at least when the variations in the value of food imports are not offset by the change in the value of total exports.

Indeed, as mentioned in section 1, many authors have shown that during the food price peak of 2008, lots of countries had reduced their food exports and reduced their protection against imported food. Was 2008 an isolated year or that it fits in a BI stabilization strategy in the longer term, global food prices varying upward or downward? Does the exchange rate play a role in stabilizing food availability at national level?

3 Domestic support level as an adjustment variable for the short-run stability of food security?

Based on the equation (3), this section assesses to what extent variations of NRA^m and E are adjusted to external variations of food import prices or exports prices on the recent period 2005-2010, for our sample of 39 developing countries. Our assumption is that countries which have to bear an external shock on food market price P_m, or on export price P_X, give the priority to stabilize their own perception of vulnerability of food security to trade, i.e. by stabilizing BI through NRA^m or E adjustments.

3.1 Data and method

The World Bank's latest updated NRA data (Anderson and Nelgen, 2012) present the nominal rate of assistance (NRA) for 81 countries (including 42 developing countries[5]) worldwide from 1955 to 2009 or 2010. The data do not cover the entire period for all developing countries, but the years 2005 to 2009 (or 2010) are well covered. A number of NRA aggregates are calculated (as weighted averages) such as NRA applied to tradable products, importable and exportable products, total NRA and its components: NRA due to domestic measures *vs.* NRA due to border measures. Dealing especially with the food import bill in this section, this study focuses especially on total NRA applied to importable agricultural commodities (NRA^m).

Trade data used are those presented in section 2.1. We use nominal exchange rate collected from the World Bank[6] (Anderson and Nelgen, 2012): it is expressed as the number of local currency against one US dollar.

We estimate the following two equations by using random effects:

$$d\ln(1+NRA^m)_{i,t} = \alpha + \beta_1 d\ln(m.P_m)_{i,t} + \beta_2 d\ln(X.P_X)_{i,t} + \beta_3\ dum_{i,t} + \beta_4 dum_{i,t} * d\ln(mP_m) + u_i + w_{i,t} \quad (5)$$

$$d\ln E_{i,t} = \alpha' + \beta_1' d\ln(m.P_m)_{i,t} + \beta_2' d\ln(X.P_X)_{i,t} + \beta_3'\ dum_{i,t} + \beta_4' dum_{i,t} * d\ln(mP_m) + u_i + w_{i,t} \quad (5')$$

Where i is the number of observations over time; t denotes the time, $\alpha\ (\alpha')$ is the average NRA (exchange rate) according to the equation, u_i is the individual-specific random effect and $w_{i,t}$ the error term.

[5] Kenya, Ethiopia and Argentina are dropped due to the lack of availability of data.

[6] We use the exchange rate as defined by Anderson and Nelgen (2012): estimated equilibrium economy-wide accounting for distortions in currency markets (in local currency per dollar). We have compared this exchange rate with the nominal bilateral exchange rate provided by the IMF (in local currency per USD) and both data exhibit closely the same patterns.

$m.P_m$ and $X.P_X$ are expressed in USD; they are respectively the numerator and denominator of the BI. ($1+NRA^m$) is computed with NRA^m in percent, this term is always positive. E is the exchange rate in local currency per USD. The variables are introduced in growth rates.

Dum is a dummy variable equal to 1 for the year 2008.

As we are interested in the role of the value of food imports regarding the impact of the price shock of 2008, we add an interaction term $dum_{i,t} * d\ln(mP_m)$ as to test for a non linear effect of the value of food imports due to the price shock.

3.2 Results

We estimate two panel data models which provide information on two dimensions, over individuals (countries) and over time (years). Among the various types of panel data models, fixed and random effects models are those which are the most commonly analyzed. It then remains the question of which model to choose. Several arguments are found in the literature to justify the use of each of these models but they are often contradictory or inclusive (Clark and Linzer, 2015).

The fixed effects model is also known as the within estimator. Its main assumption is that the error term is correlated with the individual specific term because the model can exclude time-invariant variables. In the random effects model, the specific term is assumed to be independent of the errors and also mutually independent (Greene, 2005). It is generally considered that random effects models are more appropriate when the observations constitute a sub-sample of the whole population (Nerlove, 2003).

Finally, the Hausman test (Hausman, 1978) is frequently used to check the validity of the random effects assumptions, namely the conditional independence between group-specific intercepts and covariates. If the associated probability of the test (p-value) is over 0.05 (at 5% significance level) then we can conclude that the random effects model is most likely appropriated.

To better identify the role of custom union or monetary union, we split the sample in two sub-samples according to the membership to a custom union (we add a dummy variable *cu* is equal to1 in equation (5)) or to a monetary union (we add a dummy variable *mu* equal to 1 in equation (5')).

In our sample of 39 countries, 8 countries belong to a monetary union and 19 countries belong to a custom union.

Table 2: Results of estimated random models, period 2005-2010

	NRA^m Equation (5)			Exchange Rate Equation (5')		
	All countries	Countries belonging to a Custom Union	Countries not in a custom union	All countries	Countries belonging to a monetary union	Countries not in a monetary union
intercept	0.06	0.54	0.08***	-0.01	0.01	0.02
	(0.04)	(0.05)	(0.03)	(0.16)	(0.01)	(0.20)
dlnmpm	-0.35*	-0.45	-0.24*	0.36	-0.13**	1.24
	(0.18)	(0.37)	(0.14)	(0.76)	(0.06)	(0.98)
dlnxpx	0.03	0.04	-0.01	-0.54	0.01	-.2.20**
	(0.09)	(0.12)	(0.13)	(0.40)	(0.02)	(0.87)
dum	-0.29**	-0.24	-0.34***	0.54	-0.07**	0.93
	(0.12)	(0.19)	(0.11)	(0.51)	(0.04)	(0.63)
dlnmpm*dum	0.70*	0.86	0.53	-2.10	0.13	-3.51*
	(0.39)	(0.65)	(0.37)	(1.69)	(0.11)	(2.15)
Observations	174	91	83	181	35	146
Hausman test	Random effects	Random effects	Random effects	Random effects	Random effects	Random effects

Note: standard errors in brackets
***, **, *: statistically significant at 1%, 5% or 10% level.

The Hausman test suggests that random effects model fits better our data for all cases.[7] Random-effects models are estimated by using the Generalized Least Square (GLS) estimator.

The key coefficient of interest is that one associated to the value of importable food products whatever the estimated equation. With regard to the evolution of prices over the period, we interpret the changes in the value of imports as those from the food prices. We thus suppose that the volume remains broadly stable.

Our results suggest that NRA^m adjusts well to variations in food prices P_m to reduce the food import bill when we consider either the whole sample or the sub-sample of countries not belonging to a custom union: the estimated direct impact is respectively -0.35 and -0.24. It may suggest that the countries aim at stabilizing the Bonilla Index from one year to the other by using their agricultural and trade policies to compensate the effects of the changes in the prices of imported food products. On the contrary NRA^m doesn't adjust to variations in export prices P_X.

The year dummy variable set on 2008 emerges significantly. It therefore appears clear that the downward adjustment of NRA^m is particularly marked in 2008, year of global spike in food prices. To control for this price shock of the year 2008, we added an interaction term with mP_m deviation which appears to be significant when considering the whole sample[8]. The estimated impact of the food import bill once controlling for this shock price is -0.21. This confirms that countries have actually adjusted their NRA^m downward to compensate for the rising cost of food bills related to the 2008 peak prices but this adjustment seems to be lower. The NRA^m adjustment for the change in the BI (compared to the previous year and compared to the average for the period) was also tested but never emerged significantly. It seems to exclude a strategy of countries to use border instruments as a stabilization tool of their BI over the long term.

[7] Besides, when comparing both estimates of the models, we notice that there is no significant difference between fixed effects models and random effects models. Fixed effects models are available upon request.

[8] We also tested an interaction term with XP_X deviation but it remains not significant whatever the cases.

Those results are however not found for countries which are belonging to a custom union. This may be explained by the fact that most of these countries are not flexible enough to use any trade policies (by cutting tariffs for instance) at the national level without a broader agreement at the custom union level. They depend on the trade policy of the area to which they belong.

According to the results of the exchange rate estimated equation, it appears that the exchange rate adjusts downward (appreciation of the local currency) in the event of rising food prices in countries belonging to a monetary union. Most of these concerned countries use Franc CFA as currency which is anchored to the Euro. Besides, the studied period is characterized, beyond the upward trend of agricultural and crude oil prices, by an appreciation of the Euro, and consequently the Franc CFA, relative to the Dollar. These countries probably have benefited from such an appreciation of the local currency that actually reduces the food bill expressed in local currency since prices of imported food products are expressed in foreign currency. It thus contributes to improve the purchasing power of domestic households of food importing country.

However this argument deserves to be deepened because the appreciation of the local currency presents the risk of reducing the competitiveness of exported products over the long-term. The capacity to finance food imports by exports revenue could then be prejudicially affected.

Note that the exchange rate growth adjusts to the variation of total exports value only when countries are not membership of a monetary union. In this case the estimated impact is negative meaning that the exchange rate decreases (appreciation of the local currency) when the value of total exports is increasing. This is consistent with the international macroeconomics expectations.

Conclusion

The main contribution of this paper is to shed light on the theoretical and empirical economic links between agricultural assistance, measured using the Nominal Rate of Assistance (NRA) and the vulnerability of food security to trade at national level, measured by using the Bonilla Index (BI) and the food import bill (mP_m). The novelty of this paper is to use NRA to assess the impact of domestic support on food security vulnerability to trade. We first draw an overall picture of the evolution of the BI over the period 2005-2010 for 39 developing countries.

BI calculated taking into account NRA^m seems not to follow the same pattern than BI calculated before custom clearing, as if the effects of changes in food prices were offset by direct intervention of States seeking to stabilize their ability to source food products on the world market, especially in case of food price surge observed in 2008.The assumption that, in a context of high volatility of food prices, developing countries aim to stabilize their vulnerability to trade by compensating food price deviations using trade policy is then partially checked over the period 2005-2010. Few conclusions emerge. First, its adjustment is mainly observed through NRA^m channel. Second, NRA^m adjustment seems to be correlated to food import value deviations for most countries but not to total export value deviations. This suggests that countries are more sensitive to the numerator of the BI, i.e. the food import bill, than to the global BI. Finally, the estimated adjustment appears to be more pronounced in case of a food price surge like that experimented in 2008 than out of this context.

Our analysis only considers the support applied to importable agricultural products (NRA^m). But agricultural products account for a large proportion of total exports for most developing countries. Hence positive or negative assistance for exportable agricultural commodities (NRA^x) can have an effect on total export value if this share is significant. For example, during the 2008 food crisis, a number of countries introduced export bans or taxes on food commodities. These decisions will normally result in negative NRA^x being applied to exported agricultural products with a positive effect on BI (and hence a negative effect on food security). Available World Bank (NRA) and BACI (trade) data could be used to complete this study by extending it to the BI denominator. Such a global analysis of the combined effects of NRA^m and NRA^x on BI could turn up clearer explanations of paradoxical situations (such as in Egypt) observed at this stage.

Moreover, this study focuses on the more recent period 2005-2010 characterized by a great instability and volatility of food prices, and an upward trend. It would be interesting to complete the analysis regarding developing countries behaviour in a different context, when world food prices were falling down during the nineties'. How did developing countries use their food import protection level when food prices were decreasing? Did their behaviour have positive effect on national food security in the long term? Those questions call for further research.

References

Anderson, K. (2009). Distorsions to agricultural incentives, A global perspective 1955-2007. *The World Bank*. Palgrave Macmillan, 644p.

Anderson, K. (2010). Krueger/Schiff/Valdes revisited: agricultural price and trade policy reform in developing countries since 1960. *Policy Research Working Paper Series* 5165. The World Bank.

Anderson, K. and Nelgen, S. (2012). Updated National and Global Estimates of Distortions to Agricultural incentives, 1955 to 2010, spreadsheet at www.worldbank.org/agdistorsions, World Bank, Washington DC, March.

Baffes, J. and Gardner, B. (2003). The Transmission of World Commodity Prices to Domestic Markets under Policy Reforms in Developing Countries. *Journal of Policy Reform*. 6 (3): 159-180.

Bouet, A. and Laborde Debucquet, D. (2010). The economics of export taxation in a context of food crisis – a theoretical and CGE approach contribution. *IFRI working paper*.

Clark T.S. and Linzer D.A. (2015), Should I use fixe or random effects?, *Political Science Research and Methods*, 3 (2), 399-408.

Clay, E. **(**2002). *Food Security: Concepts and Measurement*, Paper for FAO Expert Consultation on Trade and Food Security: Conceptualising the Linkages Rome, 11-12 July 2002. Published as Chapter 2 of Trade Reforms and Food Security: conceptualising the linkages. Rome: FAO, 2003.

Crump, L. (2010). Climate Change, Multilateral Trade and National Food Security: Adam Smith in a Warmer World. Communication to117th EAAE Seminar. Hohenheim 25-27 November 2010.

Diaz- Bonilla, E., Thomas, M., Robinson, S. and Cattaneo, A. (2000). Food security and trade negociations in the world trade organization: a cluster analysis of country groupe, *International Food Policy Research Institute*, Division Paper n° 59.

Diaz-Bonilla, E. and Ron, J.-F. (2010). Food security, price volatility and trade: Some reflections for developing countries. *ICTSD Programme on Agricultural Trade and sustainable Development*, Issue Paper n°28.

FAO. (2009). Policy Responses to Higher Food Prices. Committee on Commodity Problems. CCP 09/8. Rome.

Greb, F., Jamora, N., Mengel, C., von Cramon-Taubadel, S. and Würriehausen, N. (2012). Price transmission from international to domestic markets, Georg-August-Universität Göttingen, *Discussion paper N° 125,*September.

Krueger, A.O., Schiff, M. and Valde,s A. (1988). Agricultural Incentives in developing countries: Measuring the effect of sectoral and economy wide policies. *The World Bank Economic Review* 2 (3): 255-271.

Krugman, P. R., Obstfeld, M. and Mélitz, M. (2012).International economics: theory and policy. Pearson Education, 9th edition, 736 pages.

Laroche Dupraz, C. and Postolle, A. (2013). Food sovereignty and agricultural trade policy commitments: How much leeway do West African nations have? *Food Policy* 38: 115-125.

Lui, D. and Bilal, S. (2009). Contentious issues in the interim EPAS: Potential flexibility in the negotiations. European Centre for Development Policy Management. *Discussion Paper* No.89. www.ecdpm.ord/dp89. Accessed 15 January 2010.

Maxwell, S. (1996). Food security: a post-modern perspective. *Food Policy* 21 (2): 155-170.

Meyer, J., and von Cramon-Taubadel, S. (2004). Asymmetric Price Transmission: A Survey. *Journal of Agricultural Economics* 55 (3): 581-611.

Smith, L.C. (1998). Can FAO's measure of chronic undernourishment be strengthened? *Food Policy* 23 (5): 425-445.

Timmer, C.P. (2010). Reflections on food crises past. *Food Policy* 35: 1-11.

Tokgoz S., Alencar Parente Torres D., Laborde D., Huand J. (2014). The role of US, China, Brazil's agriculture and trade policies on global food supply and demand. *FoodSecure Working Paper n°19*.

Van Dijk M., Meijerink G. (2014). A review of global food security scenario and assessment studies: results, gaps and research priorities. *FoodSecure Working Paper n°20*.

WTO (2013). Public stockholding for food security purposes, Ministerial Decision of 7 December 2013, Ministerial Conference Bali, 3-6 Dec 2013. WT/MIN(13)/38 WT/L/913.

Appendix:

Tab A1: Some characteristics of the 39 developing countries of our sample

Continent	Country	CODE	Average BI	Monetary Union	Custom Union
Africa	Benin	BEN	153,83%	1	1
	Burkina Faso	BFS	36,82%	1	1
	Cameroon	CAM	11,17%	1	1
	Chad	TCD	3,66%	1	1
	Cote d'ivoire	CIV	13,52%	1	1
	Egypt	EGY	33,58%	0	0
	Ghana	GHA	11,98%	0	1
	Madagascar	MAD	24,85%	0	0
	Mali	MLI	25,46%	1	1
	Morocco	MAR	18,46%	0	0
	Mozambique	MOZ	18,73%	0	0
	Nigeria	NGA	4,78%	0	1
	Senegal	SEN	60,15%	1	1
	South African Republic	ZAF	2,10%	0	1
	Sudan	SDN	17,47%	0	1
	Tanzania	TZA	19,80%	0	1
	Togo	TGO	46,48%	1	1
	Uganda	UGA	26,98%	0	1
	Zambia	ZMB	4,52%	0	1
	Zimbabwe	ZWE	8,03%	0	1
America	Brazil	BRA	2,40%	0	1
	Chile	CHL	2,41%	0	0
	Colombia	COL	4,78%	0	1
	Dominican Republic	DOM	25,80%	0	0
	Ecuador	ECU	3,93%	0	1
	Mexico	MEX	4,46%	0	0
	Nicaragua	NIC	8,40%	0	1
Asia	Bangladesh	BGD	20,66%	0	1
	China	CHN	1,76%	0	0
	India	IND	1,79%	0	0
	Indonesia	IDN	3,28%	0	0
	Kazakhstan	KAZ	1,66%	0	1
	Malaysia	MYS	2,27%	0	0
	Pakistan	PKS	20,05%	0	0
	Philippines	PHL	4,21%	0	0
	Srilanka	SRL	20,70%	0	0
	Thailand	THL	2,30%	0	0
	Turkey	TUR	2,58%	0	0
	Vietnam	NVM	3,99%	0	0