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Sit down at the ball game: how trade barriers make the world less food secure

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Abstract

This paper analyses the impacts of trade policy responses to rising world food prices by carrying out a series of stylised experiments in the wheat market using a world trade model, GTAP. The sequence of events that is modelled comprises a negative wheat supply shock and subsequent implementation of an export tax by a major net exporter and a reduction in import tariffs by a small importer. The effects of trade policy responses are contrasted with those of full liberalisation of the wheat market. At the core are the (opposite) effects on producers and consumers, as well as the terms-of-trade and trade tax revenue effects. Food security is shown to depend crucially on changes in prices but also in incomes that are associated with changes in factor returns. The results reveal that major net exporters are generally better off when implementing export taxes for food security purposes. Large exporting countries export price instability causing world food prices to rise further. Net importing countries lose out and have limited leeway to reduce tariffs or subsidise imports. Liberalising wheat trade mitigates rising prices and contributes to food security, but to the detriment of production in Africa and Asia, making them more dependent on and vulnerable to changes in the world market. Concerted action at the WTO forum is required, notably clarifying and sharpening the rules regarding export measures.

Keywords: food security, world food crisis, international grain trade, trade measures, trade liberalisation, CGE modelling

1. Introduction

Sharp increases in food prices have taken place throughout history. In any market, rising prices simply serve to signal increasing scarcity, which, in an ideal world, induces producers to increase their supply (and consumers to reduce their demand) so as to restore equilibrium. The recent food price peaks of 2007-08 and 2010-11, however, are different in terms of their global reach and their degree of volatility. In contrast with the past, when low food prices were a concern to policy makers, food prices are expected to remain high in the near future (OECD-FAO, 2010). This poses a tremendous challenge to food security around the globe, especially for those living on or close to the poverty line. The FAO estimates that approximately 75 million more people became malnourished as a result of the 2007-08 price peak (OECD-FAO, 2008). According to the World Bank over 100 million people were driven into poverty, with 44 million additional people falling into poverty since June 2010 (World Bank, 2011). This, in turn, has caused a wave of civil unrest across poor countries in Africa, Asia and Latin America, and most recently in the Middle East. Given the likely further knock-on effects for the rest of the world in terms of rising oil prices and rising cost of food, it is no surprise that the issue of rising food prices is high on the international policy agenda.

The recent food price crises have prompted abundant research into the underlying causes, focusing primarily on short and long-run demand and supply side factors.[1] Only recently, emphasis has been placed on the role of trade shocks and policies (Anderson, 2009; DEFRA, 2010 Annex 3; Dollive, 2008; Heady, 2010; Karapinar and Häberli, 2010; Kim, 2010; Mitra and Josling, 2009; Valdés, 2010). During the food price crisis of 2007-08 many countries implemented trade measures to shield domestic markets from the sharp international price rises, including export taxation and/or quantitative restrictions on exports (in the extreme resulting in outright bans), and reductions in import tariffs. Of 81 developing countries covered in a recent survey, 25 were found to have implemented export restrictions or bans and 43 were found to have reduced import tariffs (Demeke et al., 2009). Justifications for such trade measures are multiple and include the generation of government revenues (in the case of export taxes), lowering intermediate input prices to the benefit of processing industries (infant industry argument), price stabilisation for farmers, improving food security for consumers, income redistribution (from producers to consumers and, in case of export taxes, to the government), retaliation to tariff escalation, improving the terms-of-trade (in the case of export taxes), the large gaps between successive crops that need to be bridged, low domestic purchasing power that prevents producers to service the domestic market and a variety of political, social and environmental reasons (Bouët and Laborde Debucquet, 2010; Defra, 2010 Annex 3; Kim, 2010; Mitra and Josling, 2009). The dominant reason for resorting to trade measures in the food price crises of 2007-08 and more recently in 2010-11 seems to have been food security. Whilst such measures prevent domestic prices from rising further and so safeguard domestic food security, they do push world food prices to even higher levels and, like a domino effect, drive more countries to follow suit thereby perpetuating high food prices, reducing the impact of each country's initial action on its domestic price, and exacerbating food insecurity around the world. In the extreme case, if

[1] See Abott et al. (2008) for an overview of the literature, and Piesse and Thirtle (2009) for a review of recent food commodity price events.

exporters and importers are determined to fully offset the impact of the original price shock on their domestic prices, the world would enter into an infinite loop (Martin and Anderson, 2010). The concern with respect to trade measures is not so much related to those taken on the import side as it is to those taken on the export side, since export taxes and/or quantitative restrictions, as opposed to reductions in import tariffs, restrict rather than promote trade and prevent international markets from carrying out their designated role of signalling changes in scarcity and market smoothing (Anderson, 2009). Importers' behaviour to offset food price rises is also constrained by the greater marginal costs imposed onto themselves, most importantly in the form of losses in import tariff revenues and potentially the requirement of introducing import subsidies, which is limited by fiscal constraints (Martin and Anderson, 2010).

Recently, some effort has been made to quantify the impact of trade policy and shocks in exacerbating the food price crisis. Specifically, Dollive (2008) presents quantitative evidence on the impact of export restrictions in the maize and wheat markets. Heady (2010) adds to this analysis by systematically tracking export volumes and prices in the world's largest grain markets. He finds that large surges in export demand precede the price surges which, together with back-of-the-envelope estimates of their price impacts, suggests that trade events played a much larger role than previously thought. We follow up on the suggestion made by Heady (2010, p.11) that "economic modellers would do well to consider endogenizing trade shocks, or at least exploring how random shocks might affect their predictions". Specifically, we simulate impacts of an adverse supply event in the world market for wheat (in Oceania) and interrelated trade policy actions around the globe that are motivated by the wish to stabilise domestic wheat prices to pre-shock levels. With respect to the latter, we firstly introduce an export tax on wheat by a major net exporter (India) and subsequently a reduction in import tariffs on wheat by a small net importer (Tanzania). We implement the shock and policy responses in the context of a worldwide Computable General Equilibrium (CGE) model.

Using the stylised experiments, we not only aim to quantify the contributions of trade policies in exacerbating food price rises, but also their consequences for producers, owners of factors of production, households and governments around the world. The incremental fashion in which we implement the scenarios allows for an assessment of the relative contributions of each policy action. Moreover, the decomposition of welfare impacts over the various actors in the economy and countries and/or regions in the world makes visible the trade-offs inherent to the measures taken, notably between producers and consumers and between net wheat exporters and importers, who have an interest in, respectively, higher and lower wheat prices. The analysis is also able to elucidate the mechanisms that determine overall food security, notably price effects and income effects that are related to changes in underlying factor returns. Our analysis forms a substantial improvement over more aggregative econometric analyses, such as that by Mitra and Josling (2009), that is unable provide this level of detail.

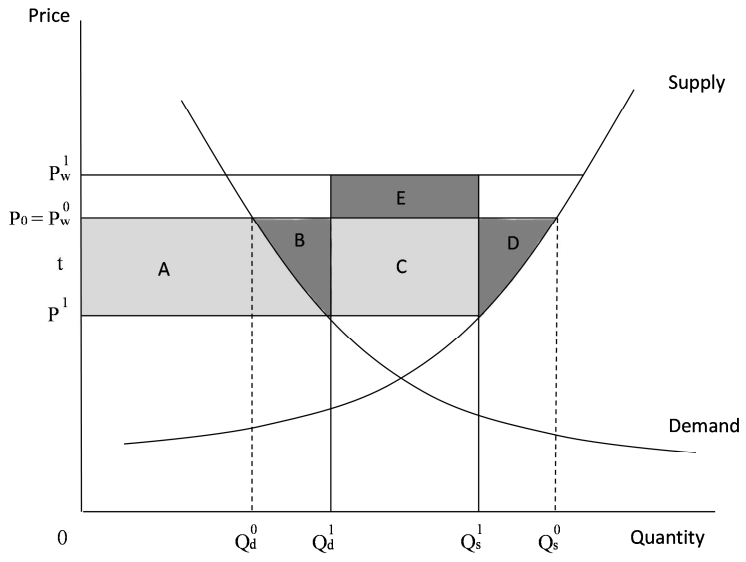
A second objective of this paper is to inform the debate on whether or not liberalising agricultural trade will mitigate or worsen food price volatility and food security.[2] We do this by contrasting aforementioned scenarios with a scenario in which worldwide trade in wheat is liberalised. Our analysis adds to the paper by Bouët and Laborde Debucquet (2010) which incorporates similar shock and trade policy response scenarios in a global CGE setting but does not present a full liberalisation scenario and does not offer the same amount of detail. The resulting shifts in global production and consumption of wheat bear important consequences for the objectives of food security, food sovereignty and the aim of some countries to be self-sufficient in wheat.

This paper is organised as follows. The next section presents the theoretical underpinnings of the economic impacts of export taxes and reductions in import tariffs using a partial equilibrium graphical analysis. The Global Trade Analysis Project (GTAP) model, data and scenario setup used in the applied general equilibrium analysis is described in section 3. Section 4 presents the results of the scenarios. The final two sections discuss the main findings and present conclusions and policy implications.

2. The economic impacts of trade measures: a graphical exposition

In this section we examine the economic impacts of export taxes and (reductions in) import tariffs in a low-dimension partial equilibrium analysis. The basic partial equilibrium analysis of trade policy is formulated in terms of one good being traded between one country and the rest of the world, and can be illustrated graphically (Södersten and Reed, 2010 Chapter 10). It enables the understanding of the basic impacts of the trade measures and guides the interpretation of the outcomes of the more complex applied general equilibrium analysis.

Fig. 1. The economic impacts of export taxes in a small and a large exporting country



[2] Other quantitative studies in this area include, for example, the study by Hertel et al. (2001) which finds that world-wide trade liberalisation leads to the lowest levels of grain price volatility, with little impact on poverty. Single country studies include Pyakuryal et al. (2010), which finds that trade liberalisation has improved overall food security in Nepal, but with unequal impacts across regions, and Tanaka and Hosoe (2011), which finds little evidence to support the contention that trade liberalisation threatens Japan's national food security.

Figure 1 shows what happens when either a small exporter that is a price taker or a large exporter that can influence world prices impose an *ad valorem* export tax.[3] In the case of a small country, the initial domestic price is p^0, which in an open economy is equal to the world price. At this price domestic demand equals Q_d^0, domestic supply equals Q_s^0 and the difference (Q_s^0- Q_d^0) is exported. When exports are taxed by t, the domestic price falls to p^1, with the world price remaining at p^0. At p^1, domestic supply falls to Q_s^1, while domestic demand increases to Q_d^1. As a consequence, less is exported from the small country (Q_s^1- Q_d^1). Domestic consumers benefit from the export tax because they consume more (Q_d^1- Q_d^0) at a lower price (p^1). This benefit, the change in the consumer surplus, amounts to the light grey shaded area under A. Conversely, domestic producers are at a disadvantage as they produce less (Q_s^0- Q_s^1) at a lower price (p^1). This loss, the change in the producer surplus, amounts to the total shaded area (A + B + C + D). The export tax that is levied by the government increases public revenues by t times the level of exports (Q_s^1- Q_d^1), which amounts to the light grey shaded are under C. Summing the benefits (for consumers and the government) and losses (for producers) results in a net welfare loss, the dead-weight loss, that can be represented by the dark grey shaded areas under B and D.[4] For a large country, similar effects occur with one major difference, which is that, as a result of the export tax imposed by the government, world supply falls substantially, which pushes the world price upwards from P_w^0 to P_w^1. The benefits for domestic consumers and the loss to domestic producers remain the same. However, tax revenues are increased by the dark grey shaded area under E because the world price rises to p_w^1, which represents an improvement in the country's terms-of-trade. Consequently, whereas a small exporting country is always worse off in total when it implements an export tax, a large exporting country may be better off if the terms-of-trade gain exceeds the dead-weight loss (i.e. the area E exceeds that of B + D).[5]

We start the analysis from the importer's perspective by first discussing the impacts of introducing an import tariff and subsequently the impacts of a reduction in the import tariff. Figure 2 shows what happens when either a small importer that is a price taker or a large importer that can influence world prices impose an *ad valorem* import tariff.[6] In the case of a small country, the initial domestic price is p^0, which in an open economy is equal to the world price. At this price domestic demand equals Q_d^0, domestic supply equals Q_s^0 and the difference (Q_d^0- Q_s^0) is imported. When a tariff t is levied on imports, the domestic price rises to p^1, with the world price remaining at p^0. At p^1, domestic supply increases to Q_s^1, while

[3] The treatment of export taxes closely follows that of Bouët and Laborde Debucquet (2010).

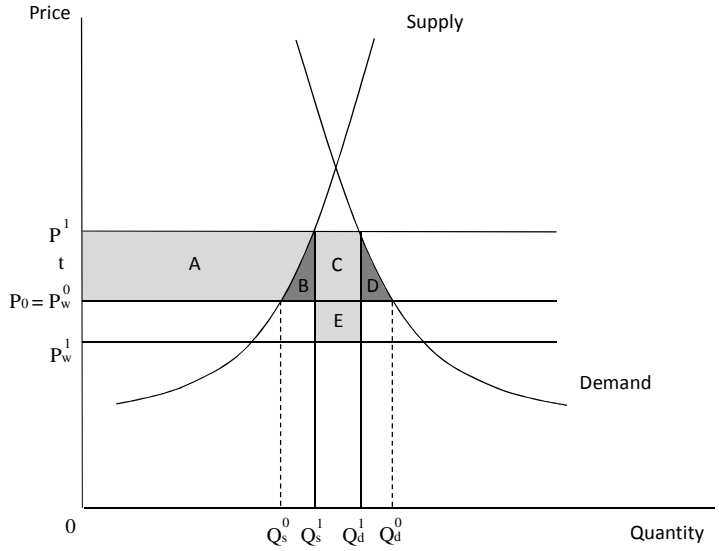
[4] Note that the size of the welfare loss depends on the slope of the demand and supply curves, the latter depicted to be elastic in that producers are assumed to respond to changes in prices. In reality, given the time it takes before a new crop is ready to be harvested, this may take some time, resulting in an inelastic (vertical) supply curve in the short-run which reduces the welfare loss to the dark grey shaded area under B. The situation depicted in Figure 1 is thus representative of the long-term.

[5] Our analysis makes the usual *ceteris paribus* assumption, i.e. that all else remains the same. As Bouët and Laborde Debucquet (2010) note it could well be that the rise in the world price could lead other countries to produce and export more so that world prices fall, partly offsetting the effect of the large country export tax. However, as noticed before, other countries that are concerned about food security could also be induced to impose an export tax thus further pushing up world prices.

[6] The treatment of import tariffs follows that of Krugman and Obstfeld (1994, Chapter 9). As before we assume that the situations described are representative of the long term and we assume the *ceteris paribus* condition in that all else remains the same.

domestic demand falls to Q_d^1. As a consequence, less is imported from the small country (Q_d^1- Q_s^1). Domestic consumers lose out from the import tariff because they consume less (Q_d^0- Q_d^1) at a higher price (p^1). This loss is captured by the change in the consumer surplus represented by the total shaded area (A + B + C + D). Conversely, domestic producers benefit as they produce more (Q_s^1- Q_s^0) at a higher price (p^1). This benefit is captured by the change in the producer surplus, as indicated by the light grey shaded area under A. The import tariff that is levied by the government increases public revenues by t times the level of imports (Q_d^1- Q_s^1), which amounts to the light grey shaded are under C. Summing the benefits (for producers and the government) and losses (for consumers) results in a net welfare loss, the dead-weight loss, that can be represented by the dark grey shaded areas under B and D. For a large country, similar effects occur with one major difference, which is that, as a result of the import tariff imposed by the government, world demand falls substantially, which lowers the world price from P_w^0 to P_w^1. The benefits for domestic consumers and the loss to domestic producers remain the same. However, tax revenues are increased by the dark grey shaded area under E because the world price falls to p_w^1, which represents an improvement in the country's terms-of-trade. Consequently, whereas a small importing country is always worse off in total when it implements an import tariff, a large importing country may be better off if the terms-of -trade gain exceeds the dead-weight loss (i.e. the area E exceeds that of B + D).

Fig. 2. The economic impacts of import tariffs in a small and a large importing country



We now continue our analysis starting from the situation in which a distorting import tariff is in place, as depicted in Figure 2, and derive the changes caused by reducing the import tariff. If a small country in this second-best situation were to reduce the import tariff it imposed on the good in question, the losses to consumers (area A + B + C + D) would fall, whereas the gains to producers (area A) and the government (area C) would fall too. In total, the welfare distortion created by the import tariff (area B + D) is reduced. For the large country, in addition to aforementioned effects, the terms-of-trade now deteriorates (the world price rises) as a result of which the additional tax revenues (area E) fall. In total, this country could now be worse off depending on the magnitude of the terms-of-trade loss viz-a-viz the dead-weight gain effects. The benefits for both the small and the large country will be converted into sure

losses if the import tariff is reduced by so much that it becomes a subsidy. Whereas consumers would benefit and producers would lose out from the fall in the domestic price caused by a subsidy, the government in addition has to pay for the import subsidy. In the case of a large country, the cost of the subsidy is higher due to the deterioration in the terms-of-trade as world price rises. As a result, both the small and large country will be worse off.

We've assumed throughout the analysis that a dollar's worth of the gains and losses that accrue to different actors are worth the same and so that we could simply add them up to get the total net gain (loss) for the country implementing the trade measure. Since concerns for food security currently dominate the policy agenda of countries around the world this is unlikely to be the case for agri-food markets; countries may thus be observed behaving 'irrationally' by implementing trade measures that result in overall welfare losses to the benefit of local consumers who profit from higher levels of consumption at lower prices. The stylised experiments carried out in section 4 shed further light on whether this may have been the case or not. We also relax the *ceteris paribus* assumption implicit in the partial equilibrium analysis that all else remains the same by allowing for responses by other actors in a full-fledged model of the world economy.

3. Empirical model

For the empirical analyses in this paper we employ the comparative static multi-regional general equilibrium Global Trade Analysis Project (GTAP) model. The GTAP model accounts for the behaviour of households, firms and governments in the global economy and how they interact in markets. The model has been widely used as a tool for global trade analysis. In line with other Computable General Equilibrium (CGE) models, the GTAP model incorporates profit and utility maximisation behaviour of producers and consumers, perfectly competitive markets which clear via price adjustments, constant returns to scale in production, and the Armington assumption in trade which differentiates domestic and imported goods by origin. In contrast with other models, the GTAP model has been constructed around a 'representative regional household', which collects all income that is generated in the economy (both from the employment of endowments as well as from various (net) taxes) and allocates it over private household and government expenditures on commodities and savings for investment goods. Savings and investments are linked via a global banking sector. Private household consumption behaviour is modelled via a non-homothetic constant difference of elasticity (CDE) function, which allows for non-constant marginal budget shares and is calibrated using data on price and income elasticities. Finally, all policy interventions, including those pertaining to trade, are incorporated via price wedges. The standard GTAP model has been documented in Hertel (1997) and is available from the GTAP Center (www.gtap.agecon.purdue.edu). In agriculture, we extend the standard GTAP model by adding a more elaborate two-level nested constant elasticity of substitution (CES) production structure, which allows for (imperfect) substitution between and within value added and intermediate inputs, drawn from GTAP-AGR (Keeney and Hertel, 2005).

Table 1 List of regions, sectors and factors of production in the model

Country/Region		Net trading position[a]		
		Rice	Wheat	Other grains
NLD	The Netherlands	M	M	M
EU26	EU, excluding the Netherlands	M	E	M
USC	United States and Canada	E	E	E
ARG	Argentina	E	E	E
LACR	Rest of South and Central America, and Caribbean	M	M	M
ME	Middle East: Iran, Turkey, Egypt, Arabian Peninsula and Fertile Crescent, excluding Cyprus	M	M	M
FSU	Post-Soviet states, excluding Baltic states	M	E	E
CHN	China	E	M	E
IND	India	E	E	E
ARP	Other major Asian rice producers and exporters: Thailand, Vietnam, Pakistan	E	M	E
SEAR	Rest of South and East Asia	M	M	M
OCE	Oceania: New Zealand, Australia and Pacific Islands	E	E	E
TZA	Tanzania	M	M	E
ROA	Rest of Africa	M	M	M
ROW	Rest of the World (rest of North America and Europe)	M	M	E

Sectors		Factors of production
Pdr	Paddy rice	Unskilled labour
Wht	Wheat	Skilled labour
Gro	Other grains (including maize)	Capital
FoodPrim	Other primary food categories	Land
FoodProc	Processed food categories	Natural Resources
Mnfcs	Manufacturing industry	
Serv	Services	

[a] Using GTAP V7 data from 2004; M = Net importer; E = Net exporter

3.1 Model data and aggregations

The model is calibrated to 2004 data, using version 7 of the GTAP database (www.gtap.agecon.purdue.edu/databases/default.asp). The GTAP commodities are aggregated into seven categories (Table 1), distinguishing the most important types of grain, i.e. rice, wheat, and other grains (including maize), alongside other primary and processed

food, manufacturing and services sectors. The GTAP regions are aggregated into fifteen countries and/or regions (Table 1), distinguishing the most important net exporters and importers on the world markets for grains, many of which acted in view of the price hikes of 2007-08. The Netherlands is identified separately as this study was originally carried out for the Dutch Ministry of Agriculture and Innovation. Tanzania is also separated from the rest of Africa to analyse the impacts of high grain prices and policy responses for a 'typical' African country that is both highly dependent on grain imports (especially wheat), but also a small producer of grains (notably other grains).Whilst the focus of this study is to analyse shocks and policy responses in the market for wheat, the model is suitable for further analyses of shocks and policy interventions in other grain markets. The model retains the standard GTAP specification of five factors of production (Table 1), including fully mobile skilled and unskilled labour and capital, and land and natural resources that sluggishly adjust to changes in factor returns.

3.2 Simulation scenarios

The model has been updated to 2010 using USDA's ERS data on annual GDP and population growth (www.ers.usda.gov/data/macroeconomics). Specifically, we assume that skilled and unskilled labour endowments grow in line with population and that capital grows in line with GDP. All other endowments are assumed to remain unchanged. We subsequently carry out four stylised 'what if' scenarios to examine the impact of rising wheat prices under protectionist and free-trade policy responses.

Scenario 1 represents a situation in which a negative supply shock occurs in a major wheat producing country that reduces productivity of land in that country's wheat sector by 25%. We assume that the supply shock occurs in Oceania (mainly Australia), a large exporting region that has been grappling with drought and floods in the recent past.

In scenario 2, a large exporting country that is concerned with domestic food security reacts to the higher world price for wheat by placing a tax on wheat exports. The export tax is (endogenously) set at a level which maintains the domestic supply price at the baseline level, i.e. before the wheat price rose from the negative supply shock. We assume that the export tax response is carried out by India, a large wheat exporter that in reality has suspended wheat exports since 2007.

Scenario 3 simulates the response of an African wheat importing country that is concerned with domestic food security and so lowers its tariffs on wheat imports. Import tariffs are (endogenously) reduced so as to maintain the domestic supply price at the baseline level, i.e. before the wheat price rose from the negative supply shock. We assume that the import tariff response is taken up by Tanzania, a typical African country that is highly dependent on imports of wheat but is also a small producer of wheat. Tanzania reduced import tariffs on cereals to "ease food shortages, with the objective of easing food prices" (Tanzania Ministry of Finance and Economic Affairs, 2008 p.1). Many African countries typically have to balance the interests of grain producers and consumers. In this scenario the latter are assumed to dominate.

Scenario 4 provides a contrasting picture in which all regions in the world, instead of taking protectionist measures, liberalise (i.e. reduce to zero) both export taxes and import tariffs for wheat in the face of higher prices. This scenario offers a way to evaluate whether a concerted trade liberalisation response improves food security through lower prices and increases welfare compared to the reactionary responses by large exporting countries as observed during the 2007-08 food price crisis. As this scenario involves reducing import tariffs on wheat across the globe, it roughly speaking extends scenario 3, in which only one importing country (Tanzania) was assumed to reduce its import tariffs on wheat.[7]

Scenarios 1-3 are introduced incrementally, so as to allow the contribution of each trade policy response to the various effects to be identified. Scenario 4 includes the supply shock and full trade liberalisation of the wheat market and acts as a comparator to the results of the other scenarios. In each case, the wheat shock and trade policy responses are introduced in 2010. Due to the comparative static nature of the model, the results of the experiments are indicative of what may happen in the long-term.[8]

4. Simulation results

For each of the supply shock and policy response scenarios we first consider effects on the domestic economy of the country where the shock or response occurs. Following Bouët and Laborde Debucquet (2010), we focus on the four most important effects of trade measures as identified in the partial equilibrium analysis of the previous section, namely the effect on wheat consumers, i.e. private households (the 'food security effect'), the effect on wheat farmers (the 'anti-farmer effect'), the effect on the overall terms-of-trade and the effect on overall trade tax revenues. We place these effects in the context of changes in the wider economy so as to also capture changes in overall food security (i.e. impacts on the entire food bundle, not that of wheat alone). We then discuss the impacts on the other countries and/or regions in the world, also by means of the four mechanisms. In order to evaluate how the underlying mechanisms play out at the country level, we present welfare impacts across the globe. The trade policy scenarios are contrasted with the scenario of full liberalisation of the wheat market in terms of the four effects and overall welfare impacts.

[7] As will become evident, this is not entirely correct as the unitary action by Tanzania that is required to stabilise domestic wheat prices to pre-shock levels actually implies subsidising wheat imports from certain source regions. Moreover, Tanzania responds in reaction to the adverse supply shock in Oceania and India's subsequent action to tax its wheat exports. In the wheat trade liberalisation scenario, neither wheat export taxes/import tariffs nor wheat import tariff to subsidy swaps arise as all trade policy instruments for wheat are assumed to fall to zero.

[8] In line with, for example, Heady (2010), one may argue that such a comparative-static simulation model is only suitable to assess economic behaviour under 'normal conditions' (i.e. in the absence of large and unexpected shocks an policy responses as those that occurred during the food price crises). Not only do demand and supply elasticities that underpin the model reflect such normal conditions, one may also question the implicit assumptions of market equilibrium and rational economic behaviour. In the absence of good, i.e. agreed-upon and tested, alternatives it seems inappropriate to resort to different assumptions. Moreover, the purpose of our simulations is to trace the contributions of trade policy measures to rising world food prices, which can be interpreted as changes in the behaviour of governments around the world. We do not attempt to analyse how economic behaviour of other actors might change over the course of the cycle.

Table 2 Impacts of a negative supply shock on the wheat market in Oceania[a,b]

Country/ Region	Food security effect (wheat)		Anti-farmer effect (wheat)		Overall t.o.t. effect (%)	T revenue effect (%)	Welfare impacts (EV)	
	P_C (%)	C (%)	P_Q (%)	Q (%)			In absolute changes (million US$)	Relative to GDP in 2010 (%)
OCE	4.437	-0.146	4.508	-23.32	0.009	-0.122	-117.62	-0.01438
NLD	0.073	-0.001	0.038	0.377	–	-0.061	-1.15	-0.00019
EU26	0.113	-0.004	0.072	0.429	–	-0.091	-22.82	-0.00018
USC	0.428	-0.004	0.434	1.883	0.006	-0.113	86.58	0.00065
ARG	0.266	-0.029	0.266	0.969	0.023	-0.104	9.44	0.00493
LACR	0.261	-0.028	0.157	0.668	-0.002	-0.114	-15.99	-0.00070
ME	0.253	-0.028	0.113	0.701	-0.003	-0.132	-17.9	-0.00126
FSU	0.145	-0.019	0.146	0.443	0.001	-0.125	-0.61	-0.00007
CHN	0.137	-0.02	0.133	0.561	-0.002	-0.204	-12.28	-0.00047
IND	0.092	-0.008	0.092	0.201	0.007	-0.216	4.99	0.00055
ARP	1.736	-0.179	0.474	1.376	-0.004	-0.167	-12.55	-0.00353
SEAR	0.988	-0.043	0.624	2.625	-0.004	-0.104	-68.31	-0.00100
TZA	0.461	-0.041	0.259	1.064	-0.016	-0.199	-0.94	-0.00629
ROA	0.202	-0.025	0.084	0.637	-0.004	-0.14	-14.56	-0.00175
ROW	0.139	-0.007	0.125	0.275	–	-0.044	-1.39	-0.00018
World							-185.11	-0.00042

Source: Own calculations.

[a] – : impact < 0.001 in absolute value.

[b] P_C = consumer price; C = consumption; P_Q = producer price; Q = output; t.o.t. = terms-of-trade; T = trade tax; EV = Equivalent Variation.

4.1 Scenario 1: a negative supply shock in Oceania

As expected, the reduction of land productivity in the wheat sector in Oceania (OCE) has a big impact on supply and reduces output by 23% (Table 2, first row). As a result wheat producer and consumer prices rise by approximately 4.5%. As most wheat is normally exported, wheat consumption in Oceania, albeit lower, is barely affected (-0.15%). The negative wheat production shock in Oceania, however, has consequences for the rest of its economy, bringing about a slightly smaller economy with structural change away from wheat production and towards other goods, and lower welfare (falls by 117 million US$). Household consumption of all food products in Oceania falls, i.e. food security in Oceania deteriorates. The high wheat price drives most of the reduction in household wheat consumption in Oceania. For other food products, lower prices boost consumption but this is more than offset by reductions in consumption driven by lower household incomes (not shown).

Changes within one region impact other regions through changes in trade patterns and world prices (Table 2, second row and further). The reduction in wheat production and exports in Oceania pushes up the world price for wheat by 0.25%. This leads to higher consumer and producer prices in all regions, although the price increase differs per region. The higher prices induce farmers in other regions to increase production of wheat. The increase in production is greatest in the region with the highest price increase (Rest of South East Asia, SEAR) and lowest in India (IND). The production increases outside Oceania cannot prevent consumer price increases, which lead to lower levels of wheat consumption in all countries. The Netherlands (NLD) experiences only very little impact on wheat consumption, whilst wheat consumption among the Asian Rice Producers (ARP), where demand for wheat is relatively more responsive to a change in its price, is 0.18% lower. In summary, the negative wheat supply shock in Oceania, whilst boosting wheat production elsewhere, has a negative effect on food security in wheat across the globe.

Most regions experience welfare losses from the higher wheat prices, apart from the major net exporters of wheat, US and Canada (USC), Argentina (ARG) and India (Table 2, final two columns). The US and Canada, important wheat producers and exporters, experience the largest welfare gain in absolute terms (87 million US$), whereas Oceania, struck by a harvest loss, experiences the biggest welfare loss (118 million US$). The second and third biggest losers are Rest of South East Asia and the EU, big consumers of wheat, with losses of 68 million US$ and 24 million US$ (EU including Netherlands) respectively. Welfare changes relative to GDP in the baseline are small (<0.1% in absolute value), but show that relative welfare gains (losses) are highest for Argentina (Oceania). In summary, a harvest loss in Oceania, whilst benefiting a few high income and emerging wheat exporting economies, has detrimental effects for the rest of the world, including poor countries.

4.2 Scenario 2: introducing an export tax on wheat by India

The higher world price for wheat increases the domestic price for the Indian consumer by 0.092% and reduces wheat consumption by 0.008% (Table 2).[9] India's status as a large exporting country affords it the opportunity to introduce an export tax to protect domestic prices in the face of rising world prices. In the export tax simulation, a destination-generic export tax of 1.15% on wheat by India ensures that the domestic supply price for wheat is maintained at the same level as before the negative supply shock in Oceania. The incremental impact of the introduction of the export tax for India and the other regions is presented in Table 3.

The Indian export tax on wheat offsets the increase in the consumer price brought about by the supply shock to wheat in Oceania, such that wheat consumption returns to its pre-shock level (Table 3, first row). However, producer prices fall by approximately the same amount as consumer prices which leads to an 'anti-farmer' effect of reducing wheat production. The terms-of-trade effect and trade tax revenue effect for India are negligible due to the small size

[9] Whilst these changes are reported for the average consumer, the effect of the price change depends on the income of the household and associated consumption behaviour. Households with low incomes spend a larger portion of their income on food and particularly on grains. Changes in the prices of food can therefore have significant consequences for those living on or near the poverty line.

of the export tax imposed on wheat. The introduction of the export tax on wheat brings about a small amount of structural change in India, with contracting wheat and manufacturing sectors and expansions in other sectors, resulting in a slightly bigger economy and higher overall welfare (rises by 6 million US$). On balance, factor returns increase, causing household incomes to rise by more than the rise in the consumer price level (not shown), as a result of which household consumption of all food items is slightly higher than before. As the export tax on wheat enhances overall food security (in wheat and in other food items) and enhances overall welfare, it is clear why India or for that matter any other large grain exporter, would introduce an export tax to insulate its economy from rising world prices.

Table 3 Incremental impacts of an export tax on wheat by India[a,b,c,d]

Country/ Region	Food security effect (wheat)		Anti-farmer effect (wheat)		Overall t.o.t. effect (pp)	T revenue effect (pp)	Welfare impacts (EV)	
	P_C (pp)	C (pp)	P_Q (pp)	Q (pp)			In absolute changes (million US$)	Relative to GDP in 2010 (%)
IND	-0.091	0.009	-0.092	-0.205	–	–	6.44	0.00071
NLD	0.005	–	0.003	0.027	–	–	-0.03	--
EU26	0.007	–	0.005	0.027	–	–	-1.04	-0.00001
USC	0.028	–	0.027	0.116	–	–	5.63	0.00004
ARG	0.026	-0.003	0.026	0.093	0.002	–	0.88	0.00046
LACR	0.018	-0.002	0.011	0.046	–	–	-1.14	-0.00005
ME	0.025	-0.003	0.011	0.068	–	–	-1.01	-0.00007
FSU	0.011	-0.001	0.011	0.034	–	–	0.01	--
CHN	0.005	-0.001	0.005	0.023	–	–	-0.41	-0.00002
ARP	0.061	-0.006	0.017	0.048	–	–	-0.14	-0.00004
SEAR	0.066	-0.003	0.042	0.175	–	–	-0.98	-0.00001
OCE	0.055	-0.002	0.055	0.097	0.001	–	1.99	0.00024
TZA	0.415	-0.038	0.224	0.835	-0.017	–	-0.94	-0.00629
ROA	0.013	-0.002	0.005	0.040	–	–	-0.79	-0.00010
ROW	0.010	–	0.010	0.021	–	–	-0.08	-0.00001

Source: Own calculations.

[a] – : impact < 0.001 in absolute value. -- : impact < 0.00001 in absolute value.

[b] P_C = consumer price; C = consumption; P_Q = producer price; Q = output; t.o.t. = terms-of-trade; T = trade tax; EV = Equivalent Variation.

[c] pp = percentage points (difference between two percentages).

[d] Results are presented in differences from the supply shock results (scenario 1, Table 2).

India's action however negatively affects food security in wheat and positively affects wheat production in other regions in the world (Table 3, second row and further). These changes are brought about by a rise in the price of wheat exports from India (by 1.07 percentage points, pp), yielding an increase in the world price for wheat of 0.25pp relative to the supply shock (scenario 1). India's reaction can be seen as 'exporting price instability' by taking protectionist measures. This can have disastrous consequences for importing countries that are highly dependent on food imports. Consider for example Tanzania (TZA): whilst farmers in Tanzania increase wheat output by 0.84pp, wheat consumption falls by 0.04pp due to a relatively large rise in the consumer price for wheat (rises by 0.42pp).

The general pattern of welfare changes (Table 3, final two columns) is one of gains for the major net exporters of wheat and losses for net importers. Specifically, India, which imposes the export tax, the US and Canada and Oceania, big wheat producers and exporters, experience the greatest welfare gains, whereas Rest of Latin America and Caribbean (LACR), EU26 and the Middle East (ME) experience the greatest losses in absolute terms. Welfare changes relative to GDP in the baseline are small (<0.007% in absolute value), but show that relative gains (losses) are highest for Argentina (Tanzania). These results imply that the negative food security (and terms-of-trade) effects outweigh the positive farmer effect in Tanzania. It shows that high food prices combined with trade measures can have a detrimental impact on poor countries.[10]

4.3 Scenario 3: introducing a reduction in import tariffs on wheat by Tanzania

In the import tariff simulation, a 1.18% source-generic reduction in import tariffs on wheat by Tanzania ensures that the domestic supply price for wheat is maintained at the pre-shock level.[11] Tanzania has no significant influence on the world price of wheat, because it is a 'small country' with its wheat imports representing only 0.5% of global wheat imports. The world price of wheat rises by only 0.004pp relative to the export tax scenario (scenario 2) and so the impacts on other countries are negligible. We thus suffice with a discussion of the domestic impacts in Tanzania following a reduction in import tariffs by Tanzania. We report the results in differences from the export tax scenario (including the supply shock), i.e. scenario 2.

The results show that the reduction in import tariffs (and in some cases subsidisation of imports) is effective in almost returning wheat consumption to pre-shock levels. The domestic consumer price falls by 0.887pp which boosts consumption of wheat by 0.069pp. However in the face of falling producer prices (by 0.483pp), Tanzanian farmers now lower production (by 1.734pp). In addition to this negative effect on output, Tanzania's terms-of-trade and its trade tax revenues slightly worsen (fall by 0.009pp and 0.004pp respectively). The economy of Tanzania is shown to contract slightly, with lower household and government expenditures and investments. Exports and wheat imports are higher, and all other imports are lower. The reduction in household income results in a deterioration in consumption of other food items. Food security in Tanzania only slightly improves following the reduction in import tariffs on wheat; households are almost as food insecure as after India's response to the negative supply shock in the wheat sector in Oceania (scenario 2). Overall, Tanzania experiences a welfare loss of 0.32 million US$, a relatively big loss compared to the other regions in our model. Most of the loss can be traced back to a terms-of-

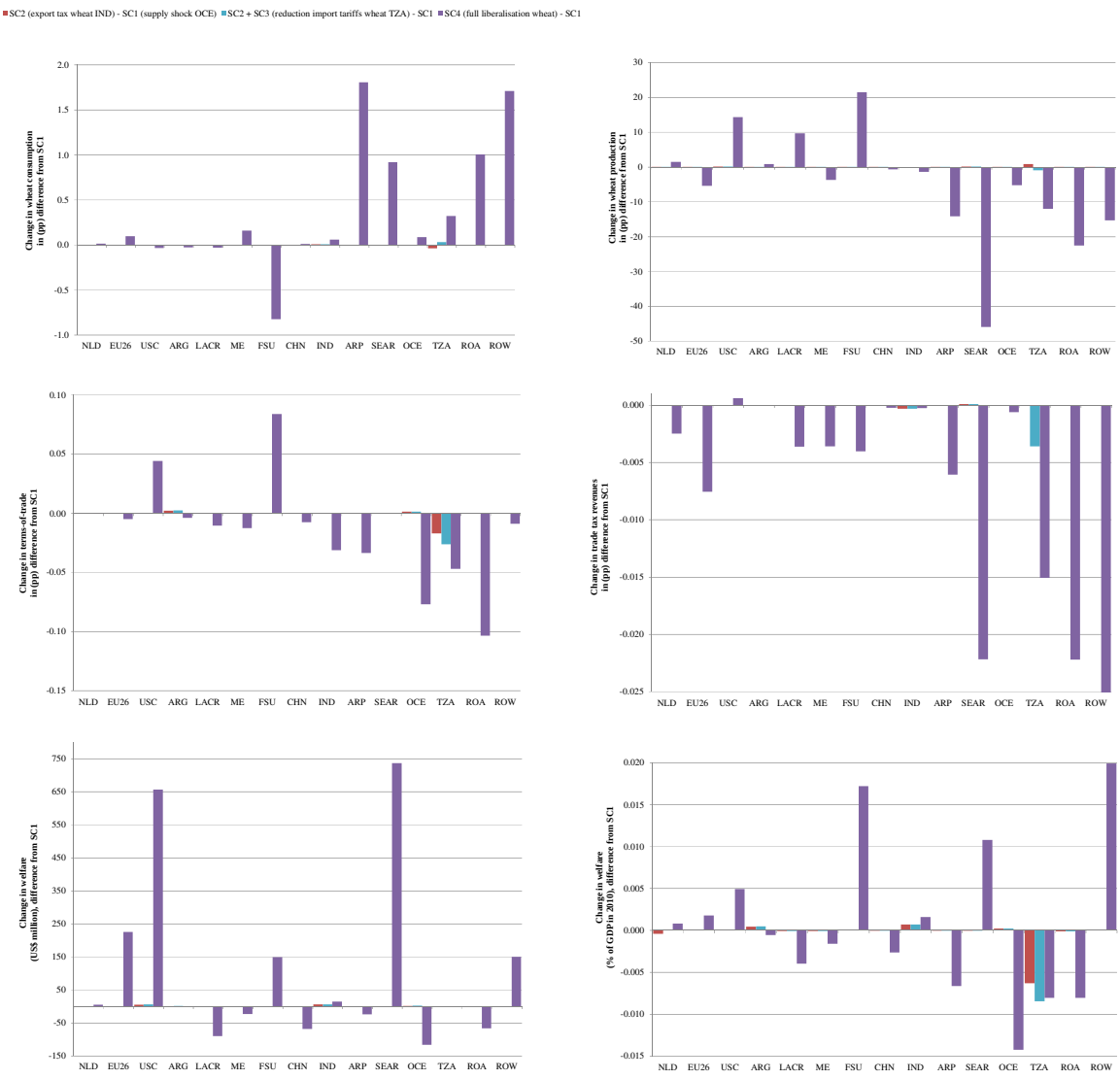
[10] The results seem to suggest that overall, the world is slightly better off if India imposes an export tax on wheat when worldwide wheat prices are rising due to a negative event (i.e. a negative supply shock). It remains to be seen if this conclusion, representative of a second-best world with protected wheat markets, holds compared to the first-best solution of fully liberalised trade in wheat.

[11] As Tanzania's import tariffs on wheat from certain source regions were already zero, imports from these regions (NLD, LACR, FSU, CHN, ARP, SEAR) will be subsidised in this scenario. It is also important to note that, since Tanzania's lowering of import tariffs on wheat slightly increases the demand for wheat on the world market, India has to increase its export tax on wheat by slightly more (0.018pp) so as to counterbalance the steeper rise in the world price of wheat. Due to the incremental setup of the scenario design this effect is included and (marginally) influences the results.

trade loss on food processing, a sector which uses wheat intensively as an intermediate input. Lower input costs for wheat allow this sector to produce and export more, at lower prices. However, the lower input costs arise from a reduction in import tariffs on wheat by Tanzania, not from a reduction in real costs as measured by the world price. Whilst food processing in Tanzania benefits, the country as a whole is worse off.

The welfare loss for Tanzania suggests that it is relatively costly for a small country such as Tanzania to unilaterally use trade policy (i.e. reducing import tariffs, and in some cases subsidising imports) so as to insulate its domestic market from rising world prices. The asymmetry with India, which has the means to do so by implementing an export tax, is clear. Moreover, if trade tax revenues were to fall more considerably than is the case for Tanzania, the poorest wheat importing countries may need support to find alternative sources of government revenues to finance much needed basic expenditures.

Panel 1 Effects of a rising wheat price in a (non)-liberalised wheat market



Source: Own calculations.

4.4 Scenario 4: full liberalisation of the wheat market

A comparison of the impacts of the alternative trade policies of scenarios 2 and 3 with a full liberalisation policy of trade in wheat by all regions in the world (scenario 4) in response to a rising world price for wheat is presented in Panel 1. Results are presented in differences from the supply shock (scenario 1).

The results clearly show that full liberalisation has large effects on wheat consumption, production, terms-of-trade, trade tax revenues and welfare across the globe compared to what countries can achieve with isolated actions so as to soften domestic impacts of a rising world price for wheat. More wheat is produced at a lower cost (in line with comparative advantages), as a result of which the world price for wheat rises by less (half as much relative to scenario 2 and 3) and world food security in wheat and overall welfare improves. Oceania, Africa and all of Asia benefit from much higher consumption of wheat.[12] In India and Tanzania wheat consumption is also higher, suggesting that price increases in a fully liberalised wheat market are less harmful in terms of food security, under the conditions that all countries participate. Whilst wheat consumption in Africa and Asia is higher in a fully liberalised wheat market, wheat production in these regions falls to the benefit of US and Canada, Rest of Latin America and Caribbean and FSU, so that they become more dependent on wheat imports. Thus whilst food security in wheat is strengthened in the liberalisation scenario, food sovereignty in wheat and the aim of some countries to be self-sufficient in wheat is weakened, making countries more vulnerable to changes in the world market. Terms-of-trade effects are small, but typically follows the pattern of changes in wheat production. Unsurprisingly, trade tax revenues go down drastically if trade in wheat is liberalised, most notable in Africa, Asia (excl. India and China), the EU and the Rest of the World (including rest of North America and Europe) where tax revenues from traded wheat are relatively important. This is another reason why fully liberalising wheat markets may be politically difficult. However, welfare gains (and losses) of full liberalisation of wheat trade exceed that of the unilateral responses to the wheat supply shock many times. Rest of South East Asia, US and Canada, EU, the FSU, Rest of the World and India gain, whereas other regions lose out. Relative to GDP, Oceania, Africa and Asian Rice Producers are worst off. As anticipated, a fully liberalised wheat market fully transmits the negative supply shock, whereas with protectionist measures in place the negative supply shock would be felt less by Oceania. For Africa (and Asian Rice Producers) the result implies that the benefits for food security do not outweigh the losses in production, terms-of-trade and trade tax revenues, suggesting that they would need some time (and support) to adjust in case of wheat market liberalisation.

Some remarks regarding the results are justified. Firstly, the relatively small impacts of the first three scenarios is inherent to the scenario design as they incorporate (a) a relatively small supply shock (25% reduction in productivity of land used in the wheat sector in Oceania), (b) single country responses (of India and Tanzania employing trade measures) and (c) the

[12] The large reduction in FSU's wheat consumption can be explained by the fact that Russia is not a member of the WTO and faces relatively high tariffs on wheat exports in the EU. Due to the abolishment of all tariffs on wheat, FSU benefits from increased wheat exports into the EU. The resulting boom in wheat exports leads to Dutch Disease effects of rising domestic wheat prices and a fall in wheat consumption.

results are shown for the long run situation, whereas agricultural production is less responsive in the short run, leading to higher prices. In reality, a negative supply shock in one region usually coincides with negative supply shocks in other regions (as they are often climate-related). Similarly, trade policy actions of one country often spur reactions by other countries elsewhere in the world. Such combined events are likely to have a more significant impact on the world market for wheat. Martin and Anderson (2010) liken trade measures in world food markets to standing up in a crowd at a ballgame. If one person stands up, she will have a better view, but her action will trigger other people to stand up as well, giving her the same view as if she had remained seated. Secondly, we assume that in response to the adverse supply shock, India and Tanzania employ trade measures that fully offset the associated wheat price rise. In reality, countries may not go that far (for small importing countries like Tanzania there are obvious fiscal constraints). Incorporating a broader set of shocks and policy responses would not only necessitate making assumptions on what shocks to implement where and what trade policy reactions to implement and by whom, it would also complicate the analysis of domestic and global effects. Bouët and Laborde Debucquet (2010) employ scenarios that represent the extreme case of all net wheat exporting countries employing export taxes and all net wheat importing countries employing tariff reductions so as to keep the real domestic price of wheat constant, following a positive demand shock that causes the world price for wheat to rise (increase in the demand for wheat by oil exporting countries). Whereas the magnitude of effects is bigger in their analysis, the direction of effects is the same. Our analysis provides more detail at the country level in terms of the sources of welfare changes and thus complements their analysis.

7. Conclusions

We employed a world trade CGE model to analyse the impacts of trade policy responses to rising world food prices through a series of stylised experiments in the world market for wheat. The major findings of our analysis are as follows. Firstly, when global food prices rise, it is rational for large net exporting countries to implement export taxes because – despite a negative impact on farmers – it has a positive effect on food security, terms- of-trade and, potentially, trade tax revenues so that overall welfare is likely to improve. Secondly, by doing so large exporting countries in essence 'export price instability' to the rest of the world causing world food prices to rise further. This is to the detriment of net importing countries, who lose in terms of food security, terms-of-trade and overall welfare, despite a positive impact on farmers. Thirdly, net food importing countries have limited means to react, as they are constrained by fiscal limits to reduce tariffs or subsidise imports and, in case of large countries, associated negative terms-of-trade effects. Adding up the negative impact of reducing import tariffs on domestic farmers, such measures are likely to result in welfare losses for net importing countries, even though food security in food items targeted by the reductions in import tariffs may improve. Such negative impacts are especially problematic for poor countries in Africa, and they may need additional sources of financing for basic needs. Fourthly, our analysis suggests that liberalising agricultural trade mitigates food price volatility and contributes to food security. Liberalisation leads to higher levels of production and consumption of food at lower cost, and higher levels of global welfare. However, impacts across regions are highly uneven, with benefits accruing to

regions that have a comparative advantage in food production (major food producers and exporters) at a cost of regions that are at a comparative disadvantage. Notably, with respect to wheat, we find that production shifts away from Asia and Africa so that they become more dependent on wheat imports. This undermines their food sovereignty in wheat and aims to be self-sufficient, making them more vulnerable to changes in the world market. Combined with the, often drastic, losses in trade tax revenues this will make full liberalisation of agri-food markets politically difficult to implement. If it were to happen, net importers, especially poor countries in Africa, would need some time (and support) to adjust. Finally, our analyses shows that changes in food prices are not the only determinant of food security. The effect of trade policy on household income is shown to matter as well, through the effect of economy wide changes on factor returns.

Policy recommendations are as follows. Our analysis suggests that further WTO-led liberalisation of agricultural markets via a completion of the Doha round is advisable from the perspective of food security and mitigating price volatility. The implied structural changes in the world economy, and accompanying weakening of food sovereignty and self-sufficiency for certain regions, makes some regions more vulnerable to changes in the world economy. This necessitates good safeguard mechanisms. Moreover, as import tariff barriers are lowered, poor net importing countries, notably in Africa, that have limited financial resources need time and support to adjust. In order to diminish the use of trade policy measures in response to rising world food prices, concerted action preferably at the WTO forum is required. Referring to the analogy of the behaviour in world food markets to that observed during a ballgame: individually it does not pay off to sit down, only a concerted effort to remain seated will maintain a good view for all and avoid the cost of standing. Whilst the WTO is stringent on the use of import tariffs, export measures such as taxes are allowed, and are unlikely to be abolished in the face of, albeit temporary, benefits to large exporters. Making explicit the impacts and trade-offs of using export measures and the retaliatory and counter-retaliatory actions that are triggered by them, should provide an incentive to clarify and sharpen the rules regarding export measures in the WTO. An on-going discussion of the situation in markets should further help restore trust in the multilateral trading system, which, in the end is so crucial for many food insecure countries.

Further research should focus on (1) extending our analysis to other grain markets (most importantly rice and maize) and (2) improving the measure of food (wheat) security, distinguishing different types of households (e.g. poor versus rich, rural versus urban, farmers versus rural labourers, large scale farmers versus smallholders) and what it implies for nutrient intake so as to be able to identify potential nutrient and health impacts.

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