Sit down at the ballgame

How export barriers make the world less food secure

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Preface

Food prices have hit historic highs in 2007/08 and 2010/11. Several reasons have caused these peaks. Trade measures such as export restrictions have pushed up prices even more. In their Ministerial Declaration of June 2011, the G20 agriculture ministers have therefore called for reduction of barriers to international trade in agriculture.

This report describes the effects of trade measures, such as export bans and import taxes, on food prices, food security and welfare of different countries. It concludes that export bans indeed will push up prices even more and hurt (farmers in) poor food importing countries most. If trade barriers are reduced, prices will not peak as much after a negative supply shock. However, the report also points at several thorny issues related to liberalising trade. It concludes that reducing export bans is not an easy task, because it requires concerted action from all parties involved. In addition, liberalising trade will probably lead to shifts in where for instance wheat is produced, away from Asia and Africa into wheat producing areas such as US and Canada, parts of Latin America and the former Soviet Union. This may be politically unacceptable for Asian and African countries.

This report therefore contributes to the current discussion on trade measures and high food prices. The report was commissioned by the Ministry of Economics, Agriculture and Innovation. The authors gratefully acknowledge comments by the Ministry's staff on earlier drafts of the report. The contribution to the section on groundtruthing by CDI (Hans Nijhof) and Dr Tonderayi Makumire are also acknowledged.

Prof. Dr R.B.M. Huirne
Managing Director LEI

Summary

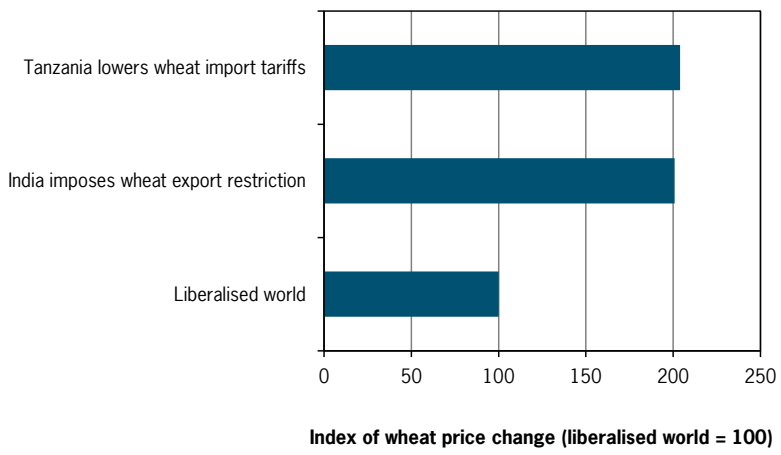
S.1 Key results

If countries - after a shortfall in wheat harvests - impose export restrictions, African countries such as Tanzania will be especially hit; export restrictions push up global wheat prices. (See Section 5.3)

Tanzania can lower its domestic wheat prices and improve wheat consumption by reducing its import tariffs. Although this policy will increase food security in wheat, it is not effective in increasing overall food security and welfare in Tanzania. (See Paragraph 5.3.3)

Tanzania and Kenya have imposed costly export restrictions. Although this policy had led to lower domestic prices, it also led to various other costs. Farmers did not only receive lowers prices, but farmers who produced a surplus lost a profitable foreign outlet. Traders lost both a profitable outlet abroad as well as investments and contacts. In addition, the policy led to a growing illegal trade (smuggling). (See Section 5.4)

Figure S.1 Price effects of three scenarios in reaction to a supply shock a)



a) In a liberalised world, a negative supply shock leads to relatively smaller price increases.

S.2 Complementary findings

Reducing import tariffs as a response to increasing import prices, can be a costly policy to pursue because it reduces trade tax revenues. As a consequence, the poorest wheat importing countries may need support to find alternative sources of government revenues. Otherwise they may run into serious problems of not being able to finance expenditures on basic needs. (See Paragraph 5.3.3)

Changes in wheat prices are not the only determinant of food security. Household income matters as well in determining the impact of shocks on food security.

In a liberalised world, where all tariffs on wheat have been abolished, world wheat prices will rise less and global welfare will be higher after a negative supply shock. Further liberalisation in future Doha rounds may therefore lead to less price volatility. (See Section 5.5)

However, in a liberalised world, wheat production is expected to shift away from Asia and Africa into wheat producing areas such as US and Canada, parts of Latin America and the former Soviet Union. This may be politically unacceptable for Asian and African countries. (See Section 5.5)

Trade measures can be compared to standing up in a crowd at a ballgame. If one person does it, she will have a better view, but her action will trigger other people to stand up as well to get a better view. To achieve that everyone 'sits down at the ballgame', a concerted and co-ordinated action is required. (See Section 5.6)

S.3 Methodology

This report was commissioned by the Ministry of Economics, Agriculture and Innovation for the BOCI project on Economic Risk Management. The high food prices of 2007/08 and 2010/11 have put food price volatility and food security high on the policy agenda. Because trade measures such as export restrictions push up prices further, the Ministry wanted a better insight into the mechanisms by which trade measures impact food prices and food security, especially in developing countries.

The request was translated into four scenarios: (See Section 4.5)

1. Base: A negative wheat supply shock in Australia (i.e. harvest loss) of 25%. Australia is a major wheat producer.

2. India reacts to higher global wheat prices by imposing export restrictions, pushing up wheat prices even more. India is a major wheat exporter.
3. Tanzania reacts to higher wheat prices by lowering import taxes. Tanzania is a net wheat importer.
4. All export and import tariffs are removed: liberalised world scenario.

A general equilibrium model (GTAP/MAGNET) was used to model different scenarios. This analysis was complemented by interviews held with major stakeholders in Tanzania and Kenya to 'groundtruth' the modelling results. (See Chapter 4)

Samenvatting

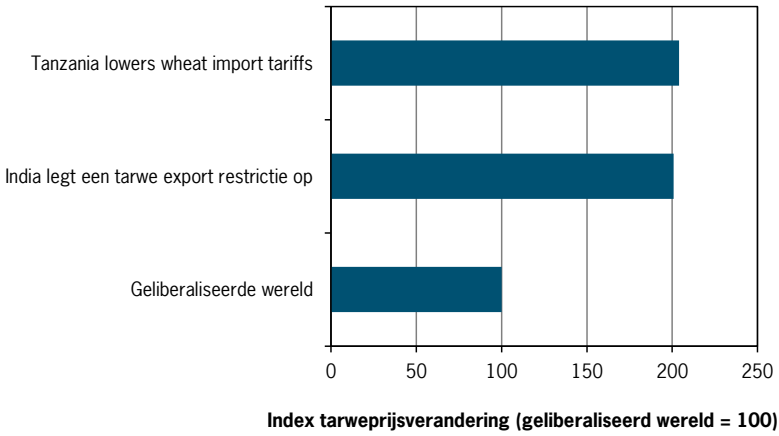
S.1 Belangrijkste uitkomsten

Als landen - na tegenvallende tarweoogsten - exportrestricties afkondigen, worden importerende Afrikaanse landen zoals Tanzania in het bijzonder geraakt; exportrestricties stuwen internationale tarweprijzen verder omhoog.

Tanzania kan binnenlandse tarweprijzen verlagen en tarweconsumptie stimuleren door importtarieven te reduceren. Hoewel door dit beleid voedselzekerheid in tarwe zal verbeteren, is het niet effectief in het verhogen van de algehele voedselzekerheid in Tanzania. Daarbij komt dat deze maatregel veel geld kost.

Tanzania en Kenia hebben allebei ook kostbare exportverboden ingevoerd. Hoewel dit beleid heeft geleid tot lagere binnenlandse prijzen, leidde het ook tot verschillende andere kosten. Boeren kregen niet alleen lagere prijzen, maar die boeren die een surplus produceerden, verloren een winstgevende buitenlandse markt. Handelaren verloren zowel een lucratieve markt in het buitenland als investeringen en contacten. Daarbij leidde het beleid tot groeiende illegale handel (smokkel).

Figuur S.1 **Prijseffecten van drie scenario's als reactie op een daling van het aanbod a)**



a) In een geliberaliseerde wereld leidt zo'n aanbodschok tot de kleinste prijsveranderingen.

S.2 Overige resultaten

Het reduceren van importtarieven als reactie op stijgende importprijzen kan een kostbaar beleid zijn, omdat belastingontvangsten afnemen. Daarom zullen de armste tarwe-importerende landen steun nodig hebben om alternatieve bronnen van overheidsinkomsten te vinden. Anders kunnen ze in serieuze problemen komen om basisbehoeften te financieren.

Veranderingen in tarweprijzen zijn niet de enige doorslaggevende factor in voedselzekerheid. Het gezinsinkomen is ook van belang in het bepalen van de effecten van plotselinge veranderingen in aanbod van tarwe op voedselzekerheid.

In een geliberaliseerde wereld, waar alle importtarieven op tarwe zijn afgeschaft, zullen tarweprijzen minder stijgen en het welvaartniveau in de wereld zal hoger zijn na een negatieve aanbodschok. Verdere liberalisatie in toekomstige Doha-rondes kunnen daarom leiden tot lagere prijsschommelingen.

Echter, in een geliberaliseerde wereld zal de productie van tarwe zich verplaatsen van Azië en Afrika naar tarwe producerende gebieden, zoals de VS en

Canada, delen van Latijns Amerika en de vroegere Sovjet Unie. Dit kan politiek onaanvaardbaar zijn voor de Aziatische en Afrikaanse landen.

Handelsmaatregelen kunnen worden vergeleken met het opstaan in het publiek tijdens een wedstrijd. Als een persoon dit doet, zal zij een beter uitzicht hebben, maar haar daad brengt anderen ertoe om ook te gaan staan om een beter uitzicht te krijgen. Om voor elkaar te krijgen dat iedereen 'bij de wedstrijd blijft zitten', zal een gezamenlijke en gecoördineerde actie nodig zijn.

S.3 Methode

Dit rapport is in opdracht van het ministerie EL&I opgesteld als onderdeel van het BOCI project 'Economisch Risico Management'. De hoge voedselprijzen van 2007/08 en 2010/11 hebben voedselprijsschommelingen en voedselzekerheid hoog op de beleidsagenda gezet. Omdat handelsmaatregelen zoals exportrestricties prijzen verder opjagen, wilde het ministerie een beter inzicht in de mechanismen die handelsmaatregelen met voedselprijzen en voedselzekerheid verbinden, vooral in ontwikkelingslanden.

Het verzoek is vertaald naar vier scenario's:

1. Basis: Een negatieve aanbodschok in tarwe van 25% in Australië (een oogstverlies). Australië is een belangrijke tarweproducent.
2. India reageert op de hogere internationale tarweprijzen door het opleggen van exportrestricties, waardoor tarweprijzen nog meer stijgen. India is een belangrijke exporteur van tarwe.
3. Tanzania reageert op de hogere tarweprijzen door importbelastingen te verlagen. Tanzania is een netto-importeur.
4. Alle exportverboden en importtarieven worden geschrapt: geliberaliseerd wereldscenario.

Een algemeen evenwichtsmodel model (GTAP/MAGNET) is gebruikt om de verschillende scenario's te modelleren. Deze analyse is aangevuld door interviews die gehouden zijn met belangrijke spelers in Tanzania en Kenya om de modelresultaten te toetsen.

1 Introduction

This report[1] has been commissioned by the Ministry of Economics, Agriculture and Innovation (EL&I) as part of a research programme on (economic) risks such as price volatility. This report examines the role of trade policy measures in perpetuating high food prices. In particular it considers what effect trade measures have on food security: to what extent it protects domestic food security but damages food security in other countries. The report also takes into account the effect on domestic farmers and farmers in other countries. We compare the results of protectionist reactions to a shock in the wheat sector to the consequences of the same shock in a fully-liberalised world. The insights provided by this study contribute to the debate on what measures policymakers can take to manage high food prices. We have limited our scope to wheat, as this is consumed throughout the world.

Various factors contribute to high prices. A peak in prices such as the one in 2007-08 as well as 2010-11 is caused by various supply and demand events that come together at the same time. World market prices are sensitive to relatively small quantity moves as only a small share of cereal production is traded internationally, compared to domestic production. World market prices serve as a signal to both importing and exporting countries about changing scarcity. Most countries aim to keep their domestic grain markets stable and may react to international price changes with trade measures. Early research into the causes of high food prices placed little importance on the role of trade events and policies. Recently there has been more emphasis placed on the role of trade policy measures. As Headey (2010) states: 'We find that trade events potentially provide an explanation for how a tightening of the world food situation rapidly turned into a full-blown crisis.'

During the food price crisis of 2007-08, many countries implemented trade measures to limit the export of foods, including export bans or taxation and cuts in import tariffs. Of 61 developing countries covered in a recent survey, 25 implemented export bans and 43 reduced import tariffs (Demeke et al., 2009). It must be noted, however, that implementing export tariffs or bans imposes restrictions on world trade, while reducing or removing import tariffs actually

[1] Also available online as a working paper at SSRN, GTAP, ETSG and MPRA websites. See e.g. http://bit.ly/jvD0KJ

opens up trade. Thus while they are in a sense opposite measures, they both lead to higher prices.

The last six months have seen continued action on global grain markets with both Russia and Ukraine restricting wheat exports in response to domestic supply shocks. These trade policy measures, akin to those of India during the high food price crisis of 2007-2008, have implications for world prices and food security for countries that rely on wheat imports.

In this introduction, we will provide some background on the high food prices in recent years. We will summarise some of the studies that have appeared on the causes and focus specifically on the role that trade measures have played. In Chapter 2 we provide the theoretical underpinnings to explain the impact of export and import taxes. A discussion of the data used is included in Chapter 3. The approach we use to model the effects of trade measures on world prices, food security and other indicators is explained in Chapter 4 along with a description of the four scenarios we develop. Chapter 5 discusses the results for the wheat market. Chapter 6 concludes.

1.1 Literature review

2008 saw many studies identifying several causes of the high food prices (see Abbott et al., 2008 for an overview). Some tried to quantify the relative importance of the various factors (e.g. Dronne et al., 2009). There has been relatively little importance given to trade events and policies in most of the research and media reports on the food crisis (Headey, 2010). Recently, however, this has changed and several studies have focused on trade policy measures (Sundaram, 2010; Karapinar and Häberli, 2010; Valdés, 2010; Anderson, 2009; Dollive, 2008; Headey, 2010; Kim, 2010; Piesse and Thirtle, 2009; DEFRA, 2010; Mitra and Josling, 2009).

Many studies have explored the impact of high food prices on vulnerable countries, for instance in Sub-Sahara Africa (Arndt et al., 2009; Cudjoe et al., 2008; Govereh, 2009; ICTSD, 2009; Jayne et al., 2008; Rapsomanikis, 2009; Rosen and Shapouri, 2008; Ulimwengu and Ramadan, 2009; Wodon and Zaman, 2010). However, only a few have focused on the impact of trade measures on poor countries (Nogués, 2008; Berman and Martin, 2010).

The studies on the high food prices have used different approaches, from more qualitative work, identifying the factors that contributed to the food price crisis, to more quantitative work. Computable General Equilibrium (CGE) modelling is used in several studies to calculate the impact of high food prices on

specific countries (Mozambique; Arndt et al., 2009; Senegal and Mali: Boccanfuso and Savard, 2009; Brazil: de Souza Ferreira Filho, 2008; Ghana: Parra and Wodon, 2008; Morocco: Diao et al., 2008) or in general (Matovu and Twimukye, 2009; Matthey, 2009).

The few global CGE models that are applied to the effect of trade measures on food prices and food security are all based on the Global Trade Analysis Project (GTAP) modelling framework. Woldie and Siddig (2009) provides a rather crude comparative static analysis of the impacts of an export ban on cereals in Ethiopia, which does not incorporate the occurrence of the food price crisis (culminating in food price spikes in 2008) and its causes in the first place. Yang et al.'s (2008) analysis for China is more sophisticated. They model the response to high food prices of China which comprises a series of measures late 2007 up to mid-2008, most importantly drawing down stocks, imposing levies on exports and ultimately banning exports of major grains (rice, wheat and maize) altogether. Ivanic and Martin (2008) examine the impact of increases in food prices on household incomes and poverty in nine low-incomes countries. The authors specify a small partial-equilibrium household model that captures the differing effects on net-consuming households and net-producing households. Hertel et al. (2001) examine the link between trade reform, food price volatility and poverty. Following a detailed analysis of grain price volatility, Hertel et al. consider the impact of annual supply volatility on grain price volatility under varying levels of trade intervention. The modelling approach is a Gaussian Quadrature approach and an extended GTAP model that include changes in stocks and a post-simulation household poverty analysis. The authors find that the free trade and non-managed trade scenarios[1] simultaneously offer the most stability in prices, and the most stability in poverty headcount.

[1] Managed trade refers to a situation in which the imports in three regions adjust to changes in prices (North America, Australia/New Zealand and Thailand).

2 Theory

Governments cite different justifications for implementing trade measures (Bouet and Laborde Debucquet, 2010; Mitra and Josling, 2009; Kim, 2010):

- Food security;
- Low domestic purchasing power combined with high commodity prices;
- Large gap between successive crops;
- Political reasons;
- Financing government expenditure/Public receipts;
- Terms of trade justification;
- Intermediate consumption price;
- Income redistribution;
- Stabilisation of domestic prices.

The effects of trade measures used by governments such as an export tax or an import subsidy may be explained by using a few simple figures. This will clarify what happens when these measures are modelled.

2.1 Economic impacts of an export tax

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.

Figure 2.1 **Economic impacts of export taxes in a small and a large exporting country**

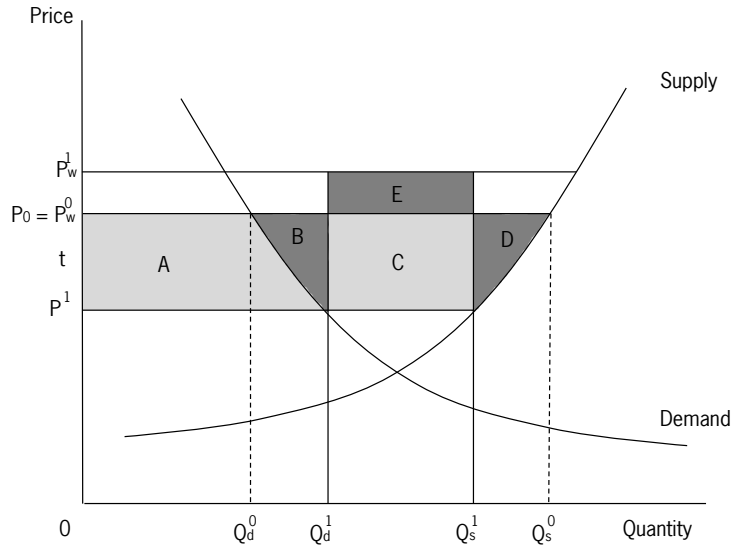


Figure 2.1 shows what happens when either a small exporter that is a price taker or a large exporter that can influence world prices imposes an *ad valorem* export tax.[1] In the case of a small country, the initial domestic price is p^0, which in an open economy is equal to the world price. At this 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

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

loss, the dead-weight loss, that can be represented by the dark grey shaded areas under B and D.[1] 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).[2]

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 2.2 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.[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_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 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 reve-

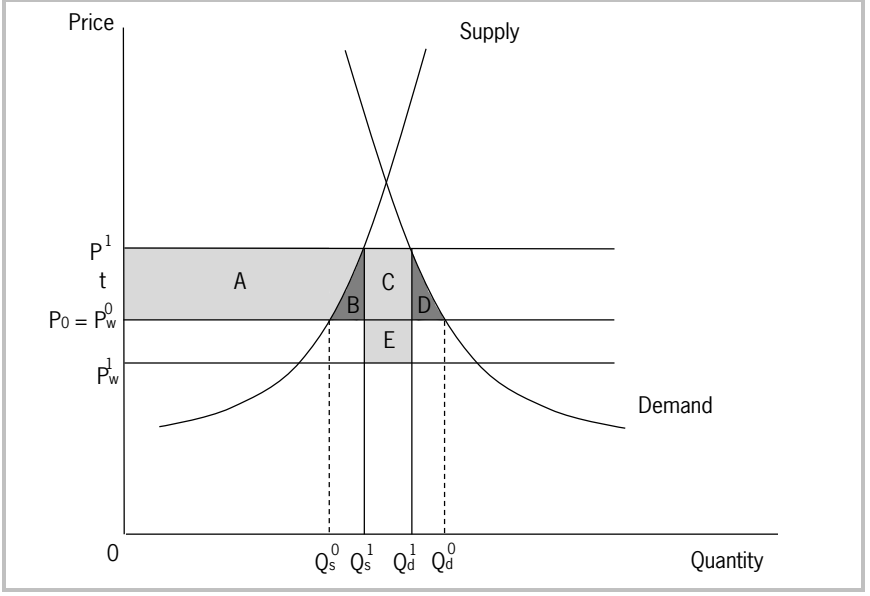
[1] Note that the size of the welfare loss depends on the slope of the demand and supply curves, the latter depicted to be elastic in that producers are assumed to respond to changes in prices. In reality, given the time it takes before a new crop is ready to be harvested, this may take some time, resulting 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.

[2] 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.

[3] 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.

nues 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).

Figure 2.2 **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 2.2, 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 the world price rises. As a result, both the small and large country will be worse off.

We have assumed throughout the analysis that a dollar's worth of the gains and losses that accrue to different actors are worth the same so that we could simply add them up to get the total net gain or 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 agrifood 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.

Note that impact of an import subsidy (starting point: no distortion) and reduction in import tariff (starting point: distortion) are not the same. Or, imposing an import tariff and introduction of an import subsidy do not have an identical opposite impact. The main difference is the size of subsidy cost (equal to s x import demand which has increased) versus the size of tariff revenue (equal to t x import demand which has fallen), which is much smaller. This is important since from standard trade theory a small country such as Tanzania is expected to lose out from an import tariff (see Krugman and Obstfeld, 1994, p. 205), so that reducing it should imply a gain.

3 Data

In this chapter we describe of the data used to calibrate the model. The model is calibrated to the GTAP database, version 7, which is a fully documented, publicly available global database containing complete bilateral trade information, transport and protection linkages among 112 regions for all 57 GTAP commodities for a single year (2004 in the case of the GTAP 7 database).[1]

The list of commodities covered in the GTAP database have been aggregated into seven categories, distinguishing the most important types of grains, i.e. rice, wheat, and other grains (including maize), other primary and processed food, manufacturing and services sectors. The resulting sectoral aggregation is shown in Table 3.1.

Table 3.1 Sectoral aggregations

Commodity/sector	Description
Pdr	Paddy rice
Wht	Wheat
Gro	Other grains (including maize)
FoodPrim	Other primary food categories
FoodProc	Processed food categories
Mnfcs	Manufacturing industry
Serv	Services

For the purpose of this study, the 112 regions in the GTAP database have been further aggregated into fifteen countries and/or regions. The regional aggregation distinguishes the most important net exporters and importers on the world markets for rice, wheat and other grains (including maize), many of which acted in view of the price hikes of 2007-2008. We have isolated the Netherlands to be able to link this study to policies of the Ministry of EL&I. Also Tanzania was isolated to analyse impacts of high grain prices and alternative policy responses for a 'typical' African country that is both a major grain importer and a small grain producer. The regional aggregation is shown in Table 3.2 and includes information on the net trading position on the rice, wheat and other grains (including maize) markets of the countries/regions distinguished, using GTAP 2004

[1] For more information see www.gtap.agecon.purdue.edu/databases/default.asp

data. Associated information on the value of worldwide exports, imports, net exports and production is included in Figures 3.1 – 3.4.

Table 3.2 Regional aggregation

Country/ Region	Description	Net trading position a)		
		Rice	Wheat	Other grains b)
NLD	The Netherlands	M	M	M
EU26	EU, excluding the Netherlands	M	E	M
USCan	United States and Canada	E	E	E
ARG	Argentina	E	E	E
LACRest	Rest of South and Central America, and Caribbean	M	M	M
MiddleEast	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
AsianRicePr	Other major Asian rice producers and exporters: Thailand, Vietnam, Pakistan	E	M	E
SEAsiaRest	Rest of South and East Asia	M	M	M
Oceania	New Zealand, Australia and Pacific Islands	E	E	E
TZA	Tanzania	M	M	E
AfriRest	Rest of Africa	M	M	M
ROW	Rest of the World (Rest of North America and Europe)	M	M	E

a) Using GTAP V7 data from 2004; b) Includes maize.
M = Net importer; E = Net exporter.

3.1 Specifics

The Netherlands and the EU26 are net importers of grains, apart from wheat, where the EU26 is a net exporter.

The United States and Canada are major producers and (net) exporters of wheat and other grains (including maize). The same is true for Argentina, the former Soviet Union and Oceania. All of the latter regions have experienced

negative wheat supply shocks in the past due to droughts and some (including Argentina and former Soviet States Ukraine, Russia and Kazakhstan) have engaged in export bans (Headey, 2010).

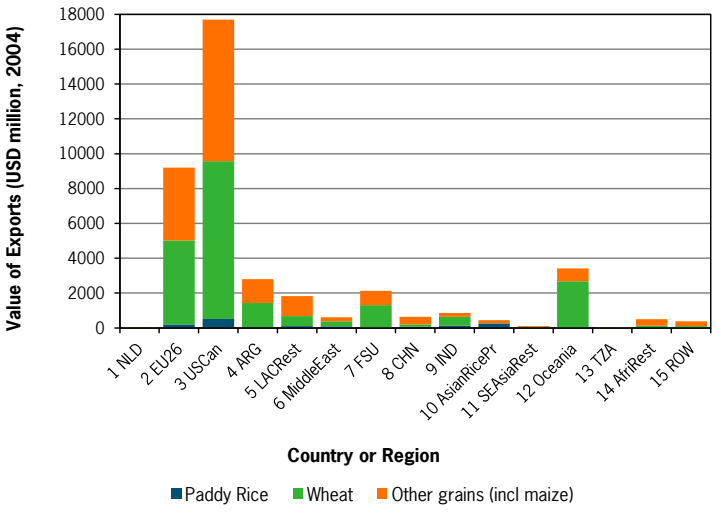
The rest of Latin America and the Caribbean, the Middle East, the rest of Africa and the rest of South-East Asia are major (net) importers of rice, and, most notably, wheat and other grains. Rice production of the latter region is relatively high, implying that most of this production is destined for the domestic market.

Both China and India are important producers and exporters of grains, but whereas India is a net exporter of all types of grain, China's demand outweighs its domestic supply of wheat resulting in a net import position on the wheat market. Both countries engaged in export restrictions in the past; India on the rice and wheat markets, China also on the maize market. Other major rice producers in Asia, including Thailand, Vietnam and Pakistan, have been grouped together in one region. Of these most notably Vietnam engaged in export restrictions on the rice market (Headey, 2010).

Tanzania, as a typical African country, is an important African producer of grains (most notably rice and other grains), but imports more rice and (especially) wheat than it exports. Several countries in Africa have been known to have lowered import tariffs so as to mitigate price spikes on the world market (e.g. Nigeria waved import tariffs on rice (Headey, 2010)). In 2008, 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).

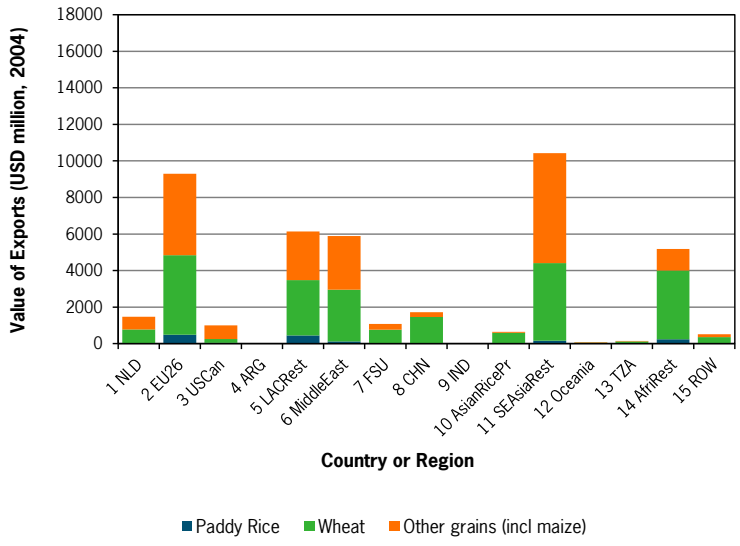
GTAP accounts for bilateral export and import taxes, which are calculated ex-post from the model by comparing values of respectively exports and imports at market and world prices. These taxes are relevant for our analysis as they are important trade policy instruments by which exports and imports, and therefore domestic, as well as world supply and prices of grains can be influenced. Export taxes are zero in the base year, apart from export taxes charged by the Netherlands and the rest of the EU. The Netherlands charges 2% on exports going to the rest of the world. The rest of the EU also levies an export tax of 2% apart from exports going to India and the rest of Africa, in which case the EU charges 1%. Import taxes for rice, wheat and other grains vary by source and destination country or region and are displayed in Table A1.1; Table A1.2 and Table A1.3.

Figure 3.1 **Total value of exports (world prices)**



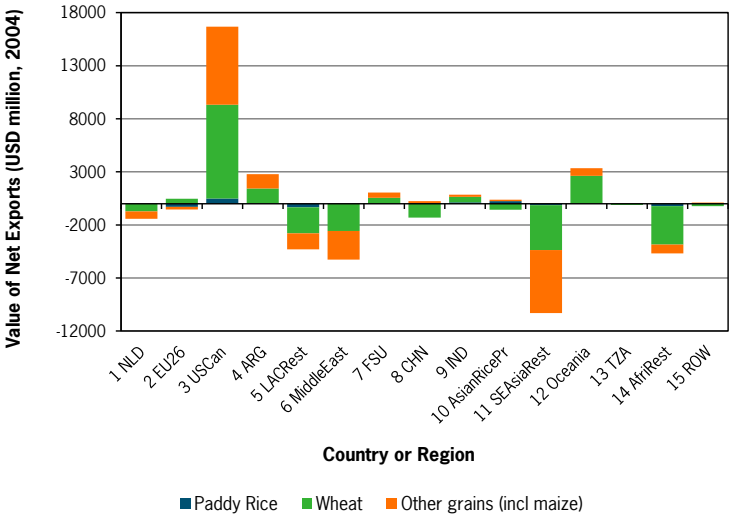
Source: GTAP7 database (2004).

Figure 3.2 **Total value of imports (world prices)**



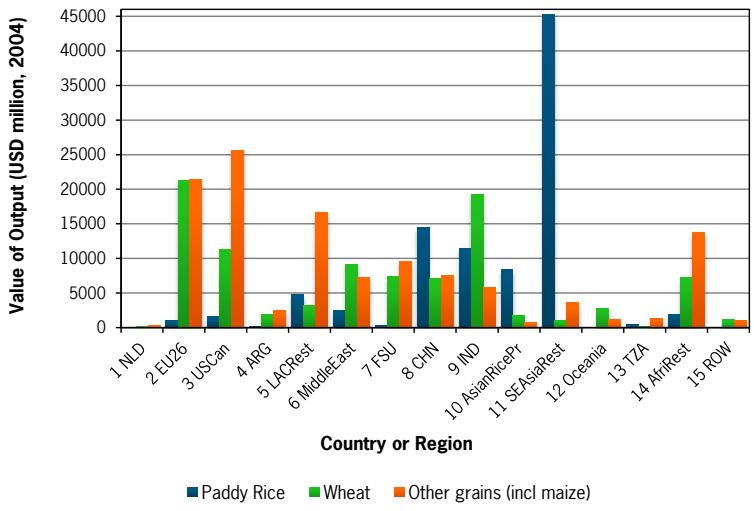
Source: GTAP7 database (2004).

Figure 3.3 Value of net exports (world prices)



Source: GTAP7 database (2004).

Figure 3.4 Worldwide production of grains (market prices)



Source: GTAP7 database (2004).

4 Methodology

4.1 Modelling approach

We employ a Computable General Equilibrium (CGE) framework to study the various impacts of higher grain prices and subsequent policy responses. This approach is most suited to analysing economic impacts, taking into account the behaviour of the various actors in the economy and how they interact in markets. The CGE approach allows for counterfactual analysis, i.e. answering 'what if' questions, and is not just restricted to 'learning from the past' like econometric studies are. A CGE model is numerically specified using consistent and balanced macroeconomic accounts data for one year, with some of the parameters (most notably elasticities) being imposed onto the model. Whilst advantageous from the point of view of data requirements, this procedure implies that statistical validation of the model is not possible. Sensitivity analysis can be used to minimise potential errors from using parameters not acquired through econometric methods.[1]

As the impacts of rising food prices and subsequent policy responses are felt throughout the world, the chosen scope of the analysis is global. The model which we use is GTAP (Global Trade Analysis Project)[2], a widely used tool for global trade analysis.

The focus is on wheat, being an important food crop throughout the world. Other grains crops such as maize and rice are also important food crops and may have different market dynamics. However, the conclusions drawn for wheat are generally applicable to maize and rice as well: trade barriers negatively affect food security.

4.2 Model description: GTAP Model[3]

The GTAP model captures the behaviour of three types of agents: households, firms and government, in each country or region of the world. Households' behaviour is captured via a 'representative regional household', which collects all income that is generated in the economy and allocates it over private household

[1] See Francois and Reinert (1997) for more information on the CGE modelling technique.
[2] www.gtap.agecon.purdue.edu/
[3] This section is based on Hertel and Tsigas (1997) and Brockmeier (1996).

and government expenditures on commodities, and savings for investment goods. Income comes from payments by firms to the regional household for the use of endowments of skilled and unskilled labour, land, capital and natural resources. The regional household also receives income from (net) taxes paid by the private household (on private consumption and income), firms (taxes on intermediate inputs and production) and the government (on its expenditures).

Firms produce commodities by employing the aforementioned endowments and using intermediate inputs from other firms so as to sell them to private households, the government and other producers. Domestically produced goods can either be sold on the domestic market or to other regions in the world. Similarly, domestic intermediate, private household and government demand for goods can be satisfied by domestic production or by imports from other regions in the world. These come with their own import and export taxes. Sourcing of imports happens at the border, after which - on the basis of the resulting composite import price - the optimal mix of import and domestic goods is derived. All accounting identities are satisfied, i.e. regional household income and expenditures are equal and for firms profits are zero.[1]

Similarly, global savings equal global investments, with the former determining the latter. Investments are computed on a global basis, via a 'global bank' which assembles savings and disburses investments, so that all savers in the model face a common price for this savings commodity. Investments only influence the pattern of production, and are not installed so as to add to the productive capacity of industries, i.e. the model is static in nature. Demand for and supply of commodities and endowments meet in the market, which clears via price adjustments.

4.3 Agents' behaviour

The behaviour of agents is captured by various functional forms. These determine to a large extent how agents respond to shocks in the model, in this case changes in wheat prices, and hence the model outcomes (i.e. consumption, production, exports, imports, prices, incomes and welfare across the various regions in the world).

[1] Note that due to the treatment of government taxes, accruing to the regional household, and government expenditures, allocated by the regional household, there is no requirement for the government budget to be balanced and no direct link between government income and outlays.

First, the preferences of the regional household are shaped via a Cobb Douglas (CD) per capita utility function, as a result of which each component of final demand maintains a roughly constant share of total regional income. Second, government behaviour follows a CD utility function, ensuring constant expenditure shares across all commodities. Third, private (household) consumption behaviour is modelled via a Constant Difference of Elasticity (CDE) function, which is a more flexible, non-homothetic function allowing for non-constant marginal budget shares, and is calibrated using data on income and price elasticities.[1] Fourth, regional investments are assumed to adjust so as to equate expected rates of return on investments across regions. The latter are modelled as an increasing function of current returns and a decreasing function of current period investment.

Fifth, production adopts a *constant returns to scale* technology with every sector producing a single output.[2] In all regions, a two-level nesting structure is adopted, with the top nest of production combining value-added and intermediates, and the lower level nests combining factor inputs and intermediate inputs into their respective aggregates. Factor inputs are treated as imperfect substitutes via a so-called Constant Elasticity of Substitution (CES) function, which is region-specific. In the agricultural sectors, the top nest and intermediate input nest also adopt a region-specific CES functional form, whereas the non-agricultural sectors adopt a more restrictive Leontief structure for these nestings, implying inputs are used in fixed proportions with no substitution between them. This production structure specification is known as GTAP-agr.

Finally, with respect to trade, the GTAP model employs the *Armington assumption* according to which domestic and imported goods are differentiated by origin. This allows for the modelling of intra-industry trade in similar commodities. The elasticity of substitution governs the extent of differentiation and is the same across uses (i.e. for government, household and intermediate input demand). The parameter values associated with private household consumption behaviour (income elasticities), producer behaviour (substitution elasticities associated with the two level nesting) and international trade (Armington elasticities) are included in Appendix 2 (Table A2.1, table A2.2, table A2.3).

As shown in Appendix 2 table A2.4, income elasticities for grains, other primary food products and processed food are positive but less than one, implying relatively inelastic demand. This conforms to reality: as income rises, we expect

[1] The parameters of the CDE function are initially selected (i.e. calibrated) to replicate a pre-specified vector of own-price and income elasticities of demand. These elasticities are generally not constant, but vary with expenditure shares and relative prices.

[2] This means that as firms grow, they do not become more or less efficient.

demand for food to increase but less than proportionally. Income elasticities for manufacturing are close to one, whereas those for services exceed one, implying relatively elastic demand. As income rises, the demand for manufacturing goods rises approximately in the same proportion, whereas the demand for (luxury) services increases by relatively more. Moreover, as expected, income elasticities are generally much higher for grains and other primary food products in developing and emerging regions and lower for processed foods compared to developed regions.

Own and cross-price elasticities of demand are not shown since they vary between pairs of commodities and are region-specific. They are, however, all negative and less than one in absolute value, implying that as the price of a commodity rises, demand for this and other commodities falls but less than proportionally. With respect to grains, own price elasticities are in between -0.01 and -0.14, whereas cross-price elasticities are generally equal to zero. Demand for grains is thus very inelastic, which is what you would expect for necessity goods.

Elasticities of substitution in production are displayed in Appendix 2 Table A2.2 All substitution elasticities are less than one, suggesting low substitution possibilities between value-added and intermediates, and within the value added and intermediates nests in the sense that as the relative price of an input rises, its relative demand falls less than proportionally.[1]

The Armington elasticities are displayed in Appendix 2, table A2.3. As shown, they all are significantly greater than one suggesting strong substitutability between domestic and imported commodities, and between imported varieties. Moreover, they are the same across regions. For example, the elasticity of substitution between domestic and imported wheat equals 4.5, and between wheat imports from different regions the substitution elasticity equals 8.9. Hence, as the relative price of domestic versus imported wheat in a particular region, say the Netherlands, goes up by 10%, the demand for imported wheat relative to domestic (i.e. Dutch) wheat goes up by 45%. We observe substitution away from relatively expensive domestic (Dutch) wheat, towards relatively cheap imported wheat. Similarly, as the relative price of two imported varieties, say Oceania versus US/Canadian wheat, goes up by 10%, in, for example, the Netherlands, the
relative demand in the Netherlands for imported wheat from US/Canadian versus Oceania goes up by 89%. We observe substitution out of the relative expen-

[1] An elasticity of substitution of x, implies that as the relative price of an input rises by 1%, its relative demand falls by x%.

sive imported variety (Oceania wheat) towards the relatively cheap variety (US/Canadian).

4.4 Model closure

Typically the number of variables in CGE models exceeds the number of equations specified. As such, the model is underdetermined as there are more unknowns than equations. The process of selecting which variables should be made exogenous is called 'model closure' and reflects the underlying beliefs about how the economy functions during the simulation period.

Macro closure
With all markets in equilibrium, firms earning zero profits and households being on their budget constraint, global investment must equal global savings. In GTAP, global savings determine global investments, i.e. the macro closure is savings driven and essentially neoclassical in nature. Instead of making the global savings-investment equation redundant, a slack variable is introduced which serves as a check onto the model (in equilibrium, the slack variable should be zero). Since the CGE model can only determine relative prices, the world index of primary factor prices is set as the numéraire of the model, against which all other prices are benchmarked.

Factor market closure
The assumptions about how the factor markets clear are particularly important as they largely determine whether the set-up of the model reflects a short or long run response to policy changes. The total supply of all endowments: land, skilled labour, unskilled labour, capital and natural resources, is fixed in the closure of the model. This is consistent with a long-run situation in which the supply of factors is determined by exogenous factors such as population growth in the case of the labour supply. Changes in the total demand for factors are therefore reflected in the model through changes in the wages rates/returns to the factors; the factor prices adjust to ensure that the total demand for factors equals the total supply available.

Whilst the total supply of factors is fixed, the use of factors by each sector is not. The sectoral use of factors can be specified in two ways: either by allowing the use of factors to respond immediately to changes in relative factor returns (fully mobile between sectors) or to specify some sluggishness in the response of factors to changes in relative factor returns.

Labour of both skill types and capital are assumed to be fully mobile across sectors whilst land and natural resources are assumed to adjust sluggishly between sectors. This assumption is consistent with a long-run situation (Narayanan et al., 2008) in which labour and capital are free to move between sectors in response to changes in relative wages and returns to capital. The movement of land and natural resources between sectors is determined by relative factor prices *and* the elasticity of transformation[1] in each region as shown in Appendix 2 table A2.4. The values for all transformation elasticities are between 0 and -1 for all regions and are therefore inelastic indicating a less than proportional adjustment in the allocation of the factor to sectors from a change in relative prices. The transformation elasticity for natural resources is set a 0.001 for all regions and the land transformation elasticity ranges between -0.25 and -0.40.[2]

4.5 Scenarios

A set of four scenarios is constructed to examine the impact of high wheat prices under protectionist and free-trade responses.

Scenario 1 represents a situation in which a negative supply shock (e.g. because of drought or floods) occurs in a major wheat producing country that reduces productivity of land in that country's wheat sector by 25%. The role of the supply shock is to simulate an increase in world wheat prices in a stylised way. We adopt a stylised approach to analyse trade responses to high food prices rather than to try to model the exact drivers of high food prices of 2007-2008. This stylised approach enables us to focus particularly on the role of trade responses in driving up prices. The supply shock occurs in Oceania (mainly Australia) such that it will have an effect on world prices. Australia is a large exporting country which has been grappling with drought (2006) and floods (2010 and 2011) recently.

In scenario 2, a large exporting country, India, that is concerned with domestic food security reacts to higher world prices by placing a tax on wheat exports to insulate domestic prices from the world market. In this scenario, the

[1] The elasticity of transformation governs how resources are combined in the production of outputs and is algebraically identical to the elasticity of substitution. Hence, an elasticity of transformation of x, implies that as the relative price of a resource rises by 1%, its relative use in production falls by x%. The elasticity of transformation is identical across sectors.

[2] Changes in the returns to land and natural resources can vary across sectors unlike capital and labour.

export tax is set at a level that maintains domestic prices at baseline levels i.e. before prices rose from the negative supply shock. In reality, India has suspended wheat exports since 2007.

Scenario 3 simulates the response of an importing country to high wheat prices. Almost all African countries are (net) importers of wheat. We have chosen Tanzania to be the focus of scenario 3 because it is a large producer as well as (net) importer of wheat, so that it has to manage interests of both wheat producers and consumers. In terms of the policy response, we assume that the latter interest dominates such that Tanzania reduces import tariffs in the face of high wheat prices. The reduction in import tariffs is just sufficient to lower domestic prices to baseline levels and counteract the effect of the negative supply shock on world prices. In reality, Tanzania did reduce 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).

Scenario 4 provides a contrasting picture in which all regions, instead of taking protectionist measures, liberalise both export taxes and import tariffs for wheat in the face of higher prices. This scenario offers a way to evaluate whether a free trade response improves food security through lower prices and increases welfare compared to the reactionary response by large exporting countries as observed during the 2007-2008 food price crisis. Scenario 3, in which an importing country reduces its import tariffs is part of Scenario 4, in which all countries remove import tariffs.

Scenarios 1-3 are introduced incrementally; the supply shock occurs in a large producing region (Oceania), then a large exporting country reacts with an export tax (India) and, finally, an importing country reacts by lowering import tariffs (Tanzania). This allows the incremental effect of each response 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 shock and responses are introduced in 2010. Since the model is calibrated to 2004 data, we have updated the model up to 2010. The underlying baseline data and assumptions are included in Appendix 2, table A2.5. The results of the comparative static analysis are discussed in the next chapter.

5 Results: The impacts of high prices in the wheat sector

The results of the negative supply shock, export tax, import tax and full liberalisation scenarios for the wheat sector are presented in this section. In each scenario, the domestic impacts and the global impacts are measured using the four effects of changes in export and import taxes identified in Bouet and Laborde (2010). These are: (1) the food security effect, (2) the anti-farmer effect, (3) the terms-of trade effect and (4) the tax income effect.[1] A detailed explanation of each effect is given in Box 5.1. As many of the effects operate in opposite direction, the overall welfare effect, which is the sum of all effects, is also reported.

Box 5.1 Different effects explained

- *The food security effect* is the effect on domestic prices and domestic consumption of wheat. In the case of rising export taxes and falling import tariffs, the food security effect is expected to be positive; indeed, the aim of these government interventions is to ensure increased domestic consumption through lower domestic prices.
- *The anti-farmer effect* is the effect on the domestic producer price and domestic production of wheat. Both higher export taxes and lower import taxes keep the domestic producer wheat price lower than the world wheat price which reduces supply.
- *The terms-of-trade effect* is the change in the ratio of export to import prices. For a large exporting country, an export tax reduces the supply to the world market, which in turn raises the world price and improves the terms of trade. Similarly, for a large importing country, an import tariff reduces the demand on the world market, which reduces the world price and improves the terms of trade, whilst a reduction of the import tariff, as simulated here, has the opposite effect.[2]

[1] Also reported in Bouet and Laborde (2010) is the effect on intermediate input prices, as an export tax on primary commodities indirectly subsidises manufacturing or processing industries further up the production chain by lowering the domestic price of inputs. An example relevant to this study is the taxation of palm oil exports by Malaysia in order to stimulate the biodiesel industry. Since biofuels are not modelled explicitly, this effect is not further looked into.

[2] In GTAP terms of trade is defined as psw/pdw for each region, i.e. price index of prices received for tradables produced in r over price index of prices paid for tradables used in r.

Box 5.1	Different effects explained (continued)

- *The tax income effect* is the change in tax receipts which result from changes in trade taxes that have an impact on real income and spending, and therefore tax receipts.[1] The introduction of an export tax may increase tax receipts,[2] which increases income and spending, which in turn increases tax receipts. Conversely, reducing import tariffs may reduce tax revenues and income and thus spending. The tax income effect is therefore likely to be positive for an export tax and negative for a reduction in import tariffs. We report the change in trade tax revenues as a proxy for the tax income effect.

The results of the scenarios reported below include changes in the overall terms of trade and trade tax revenues for all countries and/or regions included in the model (and thus include impacts of price changes on other markets), whereas the food security and anti-farmer effect are reported for the wheat market specifically. Overall food security is assessed by considering the impacts on the entire food bundle, in the context of economy-wide impacts associated with underlying changes in real incomes. Where necessary, such macroeconomic impacts are also included in the discussion of domestic and global welfare changes.

5.1 Impacts of a negative supply shock on the wheat market in Oceania

An increase in the world price of wheat is simulated by imposing a 25% reduction in the productivity of land in the wheat sector in Oceania in 2010. Oceania is one of the world's largest exporters of wheat and as such, reductions in production and exports from this region are expected to lead to increases in the world price.

5.1.1 Oceania effects

The domestic effects of the reduction in land productivity in wheat in Oceania and the resultant effects in other regions are shown in Table 5.1. As expected, the reduction in productivity has a big impact on supply and reduces output by

[1] Since this effect operates in a self-reinforcing fashion Bouet and Laborde (2010) refer to it as the multiplier effect.

[2] The magnitude of the effect depends on the price elasticity of demand; if the fall in exports outweighs the price (tax) increase, export tax revenues will fall. In the extreme case if exports fall to zero, export tax revenues are zero.

23%. The reduction in supply is accompanied by higher producer and consumer prices (which rise by approximately 4.5%). Because most of the wheat is normally exported, domestic wheat consumption is affected in only a limited way (-0.15%). The effect on the whole food bundle is considered in Box 5.2 and the economy-wide changes arising from the supply shock are considered in Box 5.3.

Table 5.1	**Effects of a negative supply shock on the wheat market in Oceania (% change)**					
	Food security effect (wheat)		**Anti-farmer effect (wheat)**		**Overall Terms-of-Trade effect**	**Tax income effect (from trade taxes)**
	Consumer Price	**Consumption**	**Producer price**	**Output**		
Oceania	4.437	-0.146	4.508	-23.32	0.009	-0.122
Netherlands	0.073	-0.001	0.038	0.377	— a)	-0.061
EU26	0.113	-0.004	0.072	0.429	—	-0.091
US and Canada	0.428	-0.004	0.434	1.883	0.006	-0.113
Argentina	0.266	-0.029	0.266	0.969	0.023	-0.104
Rest of Latin America and Caribbean	0.261	-0.028	0.157	0.668	-0.002	-0.114
Middle East	0.253	-0.028	0.113	0.701	-0.003	-0.132
Former Soviet Union	0.145	-0.019	0.146	0.443	0.001	-0.125
China	0.137	-0.02	0.133	0.561	-0.002	-0.204
India	0.092	-0.008	0.092	0.201	0.007	-0.216
Asian rice producers	1.736	-0.179	0.474	1.376	-0.004	-0.167
Rest of South East Asia	0.988	-0.043	0.624	2.625	-0.004	-0.104
Tanzania	0.461	-0.041	0.259	1.064	-0.016	-0.199
Rest of Africa	0.202	-0.025	0.084	0.637	-0.004	-0.14
Rest of the World	0.139	-0.007	0.125	0.275	—	-0.044

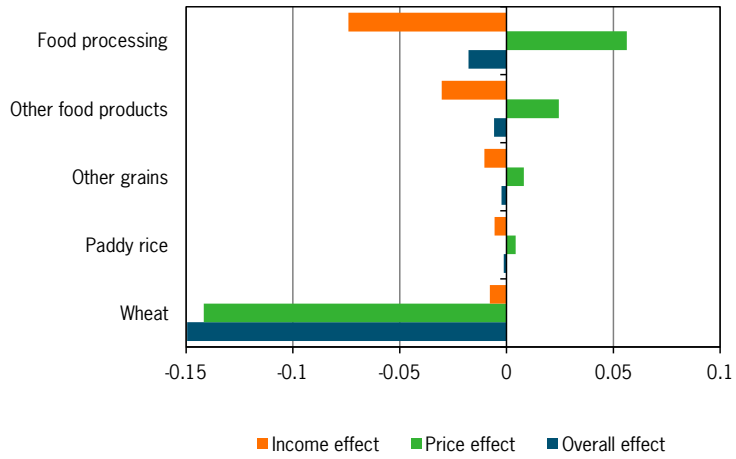
a) — = close to 0.0000.

5.1.2 Global effects

Changes within one region impact other regions through changes in trade patterns and world prices. The reduction in wheat production and exports in Oceania pushes up the world price for wheat by 0.25%[1]. This leads to higher consumer and producer prices in all regions, although the price increase differs per region. Producer prices increase only 0.04% in the Netherlands but 0.62% in the Rest of South East Asia. The higher prices induce farmers in other regions to increase production. The increase in production is greatest in the region with the highest price increase (Rest of South East Asia) and lowest in India. The production increases outside Oceania cannot prevent consumer price increases which lead to lower levels of wheat consumption in all countries. The Netherlands experiences only very little impact on wheat consumption, whilst wheat consumption among the Asian rice producers (where demand for wheat is more responsive to a change in its price) is 0.18% lower. The overall impact of the negative supply shock in Oceania is a negative effect on food security in wheat across the globe. When taking into account macro effects, it becomes clear that an increase in wheat prices not only reduces consumption of wheat, but overall food security worsens in Oceania (see Box 5.2).

[1] The model assumes that producers immediately respond to price increase. In reality there will be a lag and temporary shortage, leading to even higher prices.

Box 5.2 **Consumption effects in Oceania**



Decomposition of household consumption changes (% change)

The negative shock in the wheat sector leads to lower household consumption of all food products in Oceania.

The overall effect is a combination of the price and income effects. In the case of wheat, the higher price drives most of the reduction in household consumption. For other food products, lower prices boost consumption but this is more than offset by reductions in consumption driven by lower household incomes. This result is important as it shows that it is not only price effects that are important for food security but also how economic shocks and policies affect the income of households through factor markets. The results show that processed food and other food products are more responsive to changes in prices and household income than primary food products such as grains. The degree of responsiveness is determined by the price and income elasticities in the model.

Oceania experiences a negative farmer effect due to the fall in wheat output, whilst other regions experience a positive farmer effect because of higher wheat prices coupled with an increased wheat production elsewhere.[1] Box 5.3 explains that the production shock in Oceania has far-reaching consequences: the shock to the wheat sector brings about a slightly smaller economy with structural change away from wheat production and towards other goods.

[1] The terms of trade and tax income effects reported in Table 5.1 only become relevant in the trade response scenarios and are therefore not further elaborated on.

Box 5.3	Economy-wide effects in Oceania

Household incomes fall because the contraction of the wheat sector releases labour, land and capital for use in other sectors, causing wage rates to fall. The lower costs of labour and capital boosts non-wheat sectors but not enough to offset the contraction in the wheat sector and overall GDP falls. The components of GDP from the expenditure side also fall including government expenditures and investment, which implies a lower growth path for the economy into the future. Wheat exports fall and wheat imports rise. Exports of other goods rise slightly in line with rising domestic production. The boost to the non-wheat sectors renders Oceania more self-sufficient in non-wheat goods and imports fall slightly. Overall, the shock to the wheat sector brings about a slightly smaller economy with structural change away from wheat production and towards other goods.

5.1.3 Welfare effects

An evaluation of how the four effects work out at the country level requires the introduction of an overall welfare measure. The welfare measure included in GTAP and most commonly used in welfare analyses is Equivalent Variation (EV). The EV is a measure of how much money (USD million) should be taken from or given to consumers to be as well off as before a (policy) shock, in this case a production shock. A positive (negative) EV implies a welfare gain (loss). Table 5.2 displays the welfare effects associated with the negative supply shock in the wheat market of Oceania relative to baseline welfare levels. Most regions lose out from the higher wheat prices, apart from US and Canada, Argentina and India, the major net exporters of wheat (see Figure 3.3). The US and Canada, important wheat producers and exporters, experience the largest welfare gain in absolute terms (USD69m), whereas Oceania, struck by a harvest loss, experiences the biggest welfare loss (USD118m). The second and third biggest losers are Rest of South East Asia and the EU, big consumers of wheat, with losses of USD68m and USD24m (EU including the Netherlands) respectively. Welfare changes relative to GDP in the baseline are small (<0.1% in absolute value), but show that relative gains (losses) are highest for Argentina (Oceania). In sum, the results show that 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.

Table 5.2	Welfare effects of a negative supply shock on the wheat market in Oceania	
	Absolute change (million USD)	**Change relative to GDP in 2010 (%)**
Oceania	-117.62	-0.01438
Netherlands	-1.15	-0.00019
EU26	-22.82	-0.00018
US and Canada	86.58	0.00065
Argentina	9.44	0.00493
Rest of Latin America and Caribbean	-15.99	-0.0007
Middle East	-17.9	-0.00126
Former Soviet Union	-0.61	-0.00007
China	-12.28	-0.00047
India	4.99	0.00055
Asian rice producers	-12.55	-0.00353
Rest of South East Asia	-68.31	-0.001
Tanzania	-0.94	-0.00629
Rest of Africa	-14.56	-0.00175
Rest of the World	-1.39	-0.00018
World	-185.11	-0.00042

5.2 Impacts of an export tax response in the wheat market by India

Higher wheat prices lead to lower consumption in all countries which is of particular concern to countries with many poor citizens. India is an example of a large exporting country that is concerned about food security. Higher world wheat prices increase the domestic price for the Indian consumer by 0.092% and reduce wheat consumption by 0.008%. Whilst these changes are reported for the average consumer, the effect of the price changes 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.

India's status as a large exporting country affords it the opportunity to introduce an export ban 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 productivity shock. The incremental impact of the introduction of the export tax on India and the other regions is presented in Table 5.3.

Table 5.3	Effects of an Indian export tax on wheat					
	Food security effect (wheat) a)		Anti-farmer effect (wheat) a)		Overall Terms-of-Trade effect a)	Tax income effect (from trade taxes) b)
	Consumer price	Consumption	Producer price	Output		
India	-0.091	0.009	-0.092	-0.205	— c)	—
Netherlands	0.005	—	0.003	0.027	—	—
EU26	0.007	—	0.005	0.027	—	—
US and Canada	0.028	—	0.027	0.116	—	—
Argentina	0.026	-0.003	0.026	0.093	0.002	—
Rest of Latin America and Caribbean	0.018	-0.002	0.011	0.046	—	—
Middle East	0.025	-0.003	0.011	0.068	—	—
Former Soviet Union	0.011	-0.001	0.011	0.034	—	—
China	0.005	-0.001	0.005	0.023	—	—
Asian rice producers	0.061	-0.006	0.017	0.048	—	—
Rest of South East Asia	0.066	-0.003	0.042	0.175	—	—
Oceania	0.055	-0.002	0.055	0.097	0.001	—
Tanzania	0.415	-0.038	0.224	0.835	-0.017	—
Rest of Africa	0.013	-0.002	0.005	0.040	—	—
Rest of the World	0.010	—	0.010	0.021	—	—

a) Percentage point difference from supply shock results; b) percentage change from supply shock values; c) — = close to 0.0000.

5.2.1 India effects

The introduction of an export tax by India is expected to lower domestic wheat prices, increasing consumption but reducing wheat production. A small positive terms-of-trade effect for wheat is expected as the reduction in Indian exports reduces the supply to the world market and increases world prices. Trade tax revenues are expected to increase after the imposition of an export tax, the size of the effect depending on how trade quantities are affected.

As shown in Table 5.3, the Indian export tax on wheat offsets the increase in the consumer price brought about by the supply shock to wheat in Oceania, and wheat consumption returns to baseline levels. 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, whilst negative, are negligible due to the small size of the export tax imposed on wheat. The effectiveness of the export tax in ensuring domestic food security is considered in Box 5.4. Box 5.5 contains the economy-wide effects of the introduction of the export tax on wheat in India.

5.2.2 Global effects

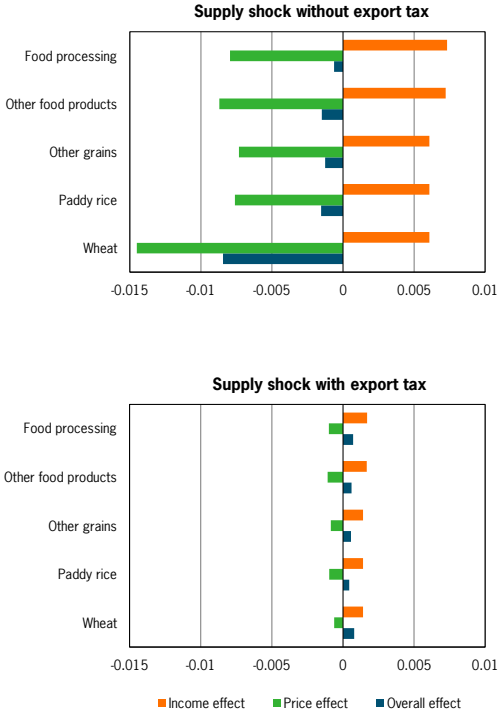
India is a large player on the world wheat market and as such it is expected that India's reaction to high wheat prices by imposing an export tax affects world prices and the domestic economies of the other regions. The effect operates via the price of wheat exports from India (which will rise), which in turn positively impacts upon the import price of wheat from India by other regions, the consumption price of wheat in other regions (a composite of domestic and import prices) and the world price for wheat (a composite of prices of traded wheat across the globe). The results in Table 5.3 indeed confirm that the imposition of an export tax on Indian wheat somewhat pushes up prices in other regions. The price of wheat exports from India rises by 1.07pp[1] as a result of the tax, yielding an increase in the world price for wheat of 0.25pp relative to the supply shock. Consumption of wheat outside India falls slightly in all regions in response to higher prices whereas output in all regions (apart from India) increases in response to higher producer prices.

[1] Results are presented in differences from the results of the supply shock (which are represented in %). The difference in two percentages is known as percentage points (pp). In this case, the price of wheat exports from India rises by 0.09% in the supply shock scenario, and by a further 1.07pp in the Export Tax scenario, resulting in a combined effect of 1.16% approximately.

The effect of India imposing an export tax is a reduction in food security but a benefit to farmers globally. In India itself, the effect is opposite: an Indian export tax yields a benefit for consumers but a cost to producers domestically. To this end, India's reaction can be seen as 'exporting price instability' by taking protectionist measures.

When we look at the effects of India's policy on a small importing country such as Tanzania, it is clear from the results presented in Table 5.3 that Tanzania's food security in wheat is negatively affected. The consumer price in Tanzania is 0.461% higher after the supply shock but rises by a further 0.415pp after India introduces the export tax. The latter price rise leads to a 0.038pp lower consumption of wheat. The terms of trade also worsen by 0.017pp. The food security and terms-of-trade effects are negative for Tanzania (the tax income effect is slightly positive, but negligible), but because Tanzania is also a producer (and exporter) of wheat, Tanzanian farmers respond to the higher producer price by increasing output by 0.835pp.

Box 5.4 Does the export tax improve food security in India?



Decomposition of household consumption changes before and after the export tax (% change).

Introducing an export tax to stabilise domestic wheat prices has the desired effect on household food consumption. Household consumption of all food goods is higher when the export tax is introduced than when the supply shock occurs without the protection of domestic prices. The increase in consumption can be attributed to the fact that household incomes rise by more than the prices of goods when the export tax is in place. Before the introduction of the export tax, the rise in incomes was not enough to compensate for rising prices in the economy and real household consumption of food products fell. By this measure, the introduction of an export tax on wheat to stabilise domestic prices has the desired effect of ensuring food security for the average household in India. It is clear from this comparison why India would introduce an export tax to protect domestic food security in the context of higher world prices.

Box 5.5	Economy-wide effects in India

The negative supply shock in Oceania increases the world price of wheat which brings about an expansion in the Indian wheat sector. The increased demand for resources by the wheat sector increases the returns to land, labour and capital which in turn raise household incomes, albeit by less than food prices. The introduction of the export tax also brings about a small amount of structural change with contracting wheat and manufacturing sectors and expansions in other sectors. On balance, factors returns increase causing household incomes to rise by more than the change in the price level.

The introduction of an export tax on wheat in India improves not only the impact of the supply shock on food security but also the economy as a whole. In the absence of the export tax, the Indian economy is smaller in real terms whereas with the export tax, real GDP is higher. Investment is higher with the export tax although government expenditure is slightly lower. The supply shock in Oceania moves resources in India into the wheat sector at the expense of other sectors. This is reflected in an increase in wheat exports and a fall in almost all other exports. Under the export tax, this trend is reversed and exports of wheat are lower (compared to the supply shock) and exports of all other products are higher. The supply shock alone reduces imports of wheat and processed food due to higher levels of domestic production and imports of all other goods increase. The introduction of the export tax renders India is less import dependent in all goods compared to the economy after the supply shock alone as the boost to the wheat sector does not occur and domestic production of other goods (except manufacturing) increases.

5.2.3 Welfare effects

The incremental impact of the introduction of the Indian export tax on wheat on welfare across regions is presented in Table 5.4. The general pattern is that the major net exporters of wheat (see Figure 3.3) gain, whereas net importers lose out from India's trade measures. Specifically, India, which imposes the export tax, US and Canada, and Oceania, big wheat producers and exporters, experience the greatest welfare gains, whereas Rest of Latin America and Caribbean, EU26 and the Middle East 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. For Tanzania, the high wheat price combined with an Indian export tax, reduces welfare with USD1.88m. By comparison, the Netherlands contributed USD3.75m to rural development in

Tanzania annually from 1987-2002 (IOB 2004). This shows that high food prices combined with trade measures can have a detrimental effect on poor countries.

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 (see Section 6.4). Although the world may be slightly better off, the results also show that India's export tax has a negative effect on poor countries such as Tanzania.

Table 5.4 Welfare effects of an Indian export tax on wheat

EV	Absolute change (million USD) a)	Change relative to GDP in 2010 (%) a)
India	6.44	0.00071
Netherlands	-0.03	— b)
EU26	-1.04	-0.00001
US and Canada	5.63	0.00004
Argentina	0.88	0.00046
Rest of Latin America and Caribbean	-1.14	-0.00005
Middle East	-1.01	-0.00007
Former Soviet Union	0.01	—
China	-0.41	-0.00002
Asian rice producers	-0.14	-0.00004
Rest of South East Asia	-0.98	-0.00001
Oceania	1.99	0.00024
Tanzania	-0.94	-0.00629
Rest of Africa	-0.79	-0.00010
Rest of the World	-0.08	-0.00001
World	8.39	0.00002

a) In differences from supply shock result; b) — = close to 0.0000.

5.3 Impacts of an import tax response in the wheat market by Tanzania

If food security is a key priority, developing countries such as Tanzania may respond to export taxes in large exporting countries by reducing import tariffs to protect domestic prices, despite the boost to the wheat sector from higher

producer prices. In the import tax 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 baseline level.

The reduction in the price of imports and the accompanying increase in demand for imports would increase the world price in the case of a large country; worsening its terms of trade. However, the import response here is implemented for a country which does not have a large enough share of total imports to affect the world price. Tanzanian imports of wheat representing only 0.5% of global imports, i.e. Tanzania is a 'small country' in terms of wheat imports. Trade tax revenues are expected to decrease after the reduction of import tariffs but the size of the effect depends on how trade quantities are affected.

Table 5.5	**Effects of lowering Tanzanian import tariffs on wheat**					
	Food security effect (wheat) a)		**Anti-farmer effect (wheat) a)**		**Overall Terms-of-Trade effect a)**	**Tax income effect (from trade taxes) b)**
	Consumer Price	**Consumption**	**Producer price**	**Output**		
Tanzania	-0.887	0.069	-0.483	-1.734	-0.009	-0.004
Netherlands	—.c)	—	—	0.001	—	—
EU26	—	—	—	—	—	—
US and Canada	0.001		0.001	0.003	—	—
Argentina	0.002		0.002	0.009	—	—
Rest of Latin America and Caribbean	0.001	—	—	0.001	—	—
Middle East	0.001			0.002	—	—
Former Soviet Union	—	—	—	0.001	—	—
China	—	—	—	0.001	—	—
India	—	—	—	—	—	—

a) percentage point difference from export tax results; b) percentage change from export tax values; c) — = close to 0.0000.

Table 5.5	Effects of lowering Tanzanian import tariffs on wheat (continued)					
	Food security effect (wheat) a)		Anti-farmer effect (wheat) a)		Overall Terms-of-Trade effect a)	Tax income effect (from trade taxes) b)
	Consumer Price	Consumption	Producer price	Output		
Asian rice producers	0.001	—	—	0.001	—	—
Rest of South East Asia	0.001	—	0.001	0.004	—	—
Oceania	0.002	—	0.002	0.003	—	—
Rest of Africa	—	—	—	—	—	—
Rest of the World	—	—	—	—	—	—

a) percentage point difference from export tax results; b) percentage change from export tax values; c) — = close to 0.0000.

5.3.1 Tanzania effects

The incremental effects of Tanzania lowering its import tariffs on wheat are shown in Table 5.5. The reduction in import tariffs by Tanzania is effective in lowering the consumer price by 0.887pp which boosts consumption of wheat by 0.069pp but this comes at a cost to farmers. Farmers lower production by 1.734pp in the face of falling producer prices which fall by 0.483pp.[1] The reduction in import tariffs is relatively effective as it almost returns consumption to the baseline level. In addition to the negative effect on output, the reduction in the import tariff slightly worsens Tanzania's terms of trade and trade tax revenues. The economy-wide effects are discussed in Box 5.6. The impact of the supply shock, India's export tax policy and Tanzania's import tax policy on food security of the whole food bundle is shown in Box 5.7.

[1] Since Tanzania's lowering of import tariffs on wheat slightly decreases the supply of wheat to the world market, India has to increase export taxes by 0.018pp more, which slightly affects the results.

Box 5.6 Economy-wide effects of an import tax imposed by Tanzania

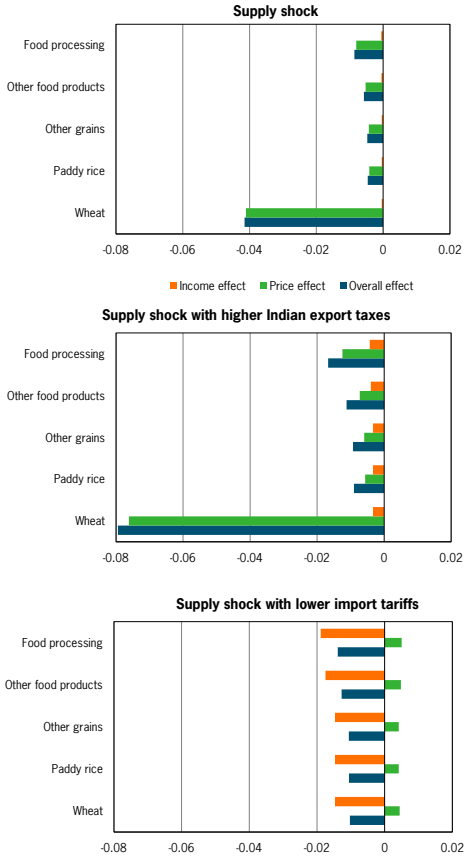
The supply shock to the wheat market has a negative effect on the Tanzanian economy which is further worsened by India's export tax response. Household consumption, government expenditures and investment are lower in both scenarios. Wheat imports actually increase after the supply shock and export tax due to the expansion of the wheat sector that uses a high proportion of wheat as an intermediate input. Imports of other goods except rice (in the supply shock scenario) and processed food fall. Exports increase for all goods except processed food (and wheat after the export tax). The supply shock in Oceania and the introduction of the Indian export tax both boost the Tanzanian wheat sector but the contraction of other sectors is such that the demand and therefore returns to factors fall slightly, lowering household consumption.

Lowering the import tariff on wheat offsets the negative effect of the Indian export tax but still yields a smaller real economy with lower household and government expenditures and investment. Exports and wheat imports are higher and all other imports are lower.

Box 5.7 Food security in Tanzania

Consumption of all food products is lower after the supply shock in Oceania with the reduction in consumption driven mainly by higher prices. The introduction of the Indian export tax leads to great reductions in food consumption in which both higher prices and lower incomes play a role, with the former dominating.

The lowering of the import tariff on wheat leads to higher wheat consumption than in the previous two scenarios but does not completely eradicate the negative effect of the supply shock. Moreover, although the household consumption of wheat is reduced by less, the consumption of other food products is reduced more than in the previous scenarios suggesting that lowering the import tariff worsens food security across the food bundle. The lower import tariff on wheat lowers prices and increases consumption but this price effect is outweighed by the negative effect on household income that reduces consumption of all food products.



5.3.2 Global effects

As Tanzania is a relatively small importer of wheat, a change in its import tariffs has a limited global effect, yielding a negligible increase in the world price for wheat of only 0.004pp relative to the export tax scenario. As a result, most countries are unaffected by the change in Tanzanian import tariffs.

5.3.3 Welfare effects

The incremental effects of Tanzania lowering its import tariffs on wheat on welfare across regions are presented in Table 5.6. Effects are small, but as before, US and Canada, and India experience the largest welfare gains in absolute values, and gains are highest for Argentina in relative terms. Tanzania is worse off from lowering import tariffs (welfare loss of USD0.32m) and experiences the highest welfare loss in absolute and relative terms across the globe. These results reveal that the positive food security effect is insufficient to compensate for the negative farmer, tax income and terms-of-trade effects in Tanzania.

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.

Table 5.6	Welfare effects of lowering Tanzanian import tariffs on wheat	
EV	**Absolute change (million USD) a)**	**Change relative to GDP in 2010 (%) a)**
Tanzania	-0.32	-0.00214
Netherlands	0.01	—
EU26	0.07	—
US and Canada	0.14	—
Argentina	0.07	0.00004
Rest of Latin America and Caribbean	-0.04	—
Middle East	-0.02	—
Former Soviet Union	—	—
China	-0.01	—
India	0.13	0.00001
Asian rice producers	-0.02	-0.00001
Rest of South East Asia	-0.06	—
Oceania	0.06	0.00001
Rest of Africa	-0.02	—
Rest of the World	—	—
World	-0.01	—

a) In differences from export tax results — close to 0.0000.

5.4 Groundtruthing the results: views from Tanzania and Kenya

Interviews were carried out in Tanzania and Kenya with the aim of getting the views of the main players in the maize market on the table.

5.4.1 Tanzania

To stabilise cereal availability and prices, the government of Tanzania enforced a cereal export ban in January 2008; although unofficially exports continued. In a further effort to limit the price increases Tanzania imposed an export ban on all staple crops (maize, sorghum, cassava, beans, wheat, potatoes and rice). Maize imports became exempt from import duties in March 2008 to increase cereal availability. By the end of 2008, the Government announced that it would make maize flour available at a subsidised price (TZS50 per kilo[1]). In January

[1] In 2008 €1 was around TZS2,325. TZS50 is therefore a little over 2 cents per kg.

2009, the government stopped issuing food export permits. Import taxes were abolished for several staple crops, including rice and wheat (Meijerink et al. (2009)). The export ban lasted for three years. During the 2010 election the ban was temporarily suspended in response to calls from farmers and traders to end the ban. In 2010, the government implemented fixed prices for maize at TZS340-360 per kg[1] (interviews in 2010).

Maize is the most important staple crop in Tanzania and maize exports continue to be subject to occasional export bans. The government allows exports of maize only when all regions of the country can be declared food secure. In practice, however, there is almost always a problem of food security in some part of the country, particularly in the semi-arid central region. Thus, in practice, maize exports are banned on an almost continual basis (Minot, 2010). The stakeholders pointed out that often food security problems in Tanzania are usually not linked to (un)availability of staple crops due to failed harvests, but to affordability. The poor are often unable to buy sufficient amounts of food. This is especially true when prices rise. Therefore, the safety net programmes that make food available at subsidised prices in a targeted way to the poorest were judged to be an effective way to achieve food security. However, subsidies are a heavy strain on a government that is already short of funding, especially when it abolished import tariffs, as Tanzania has done.

The occasional maize export bans are a topic of debate within Tanzania. Some researchers have suggested that removing restrictions on the external trade of maize would help Tanzanian producers gain from the trade with other countries that face shortages; thereby boosting the domestic production of maize. Others have argued that lifting the export ban would mainly help producers situated along the border of the country, but would hurt consumers in urban and maize-deficit regions through the increased price. Policy-makers tend to believe that the cost to urban consumers exceeds the benefit to rural producers (Kilima, Chung, Kenkel and Mbiha, 2008).

The export ban had several effects. The main effect was that domestic prices dropped, as was intended. This indeed benefitted (urban) consumers, but hurt traders and farmers. Two main problems related to the export ban were identified by the stakeholders interviewed in 2010. First, during those years in which the export ban was imposed, several areas in Tanzania (especially the South) produced good harvests, which could not be sold. Without an export ban, the oversupply could be sold across the borders. The government (through the National Food Reserve Agency (NFRA)) bought up maize but only to a limited ex-

[1] Around 15 cents per kg.

tent due to financial constraints. For instance, the Lukwa region produced 700,000 tonnes, but the government could only buy 60,000 tonnes. The second problem is that the infrastructure for storage and transport is underdeveloped. This means that the oversupply of one region cannot be stored well or transported to areas within Tanzania that have shortages (for instance from the Southern highlands to the Central region).

In addition, the (illegal) cross-border trade with Kenya, Malawi and Zambia still continued (e.g. at night). This type of trade raises the costs of trade. When the government imposes an export ban unexpectedly, there are other costs - traders may have loans from a bank, contracts with buyers, all of which become at risk when they cannot deliver due to an export ban. Some stakeholders mentioned that traders are shifting to other crops because of the maize (and cereal) export bans, such as beans, fruits, timber. Farmers are less flexible: they consume part of the maize, and shifting to other crops requires funds to invest, which they often do not have.

5.4.2 Kenya

Although a newspaper headline[1] of 21 May 2011 read 'Tanzania exports ban heralds rise in East African maize prices', the stakeholders interviewed in 2010 seemed to agree that the export ban by Tanzania did not have a significant impact on Kenya. The two different viewpoints show two different aspects of maize trade. First, most of the imports (maize) from Tanzania are reported to take place through the informal market, involving small scale traders and brokers. Second, Kenya relies on South Africa and the USA for maize imports and these are important official suppliers of maize.

Dr. Adrian Mukhebi of the Kenya Agricultural Commodity Exchange Limited (KACE) explained in the newspaper article: 'The action by Tanzania cuts off supplies to our market and the immediate impact will be an imbalance in demand and supply. Prices will climb on this effect. Maize trade in the region is mainly driven by informal cross-border imports and exports - meaning that the decision by Tanzania to block its borders will affect the flow of the commodity.'

Kenya has responded to high (maize) prices with several measures:

1. Maize export ban;
2. Duty waiver on maize imports;
3. Additional imports of maize by the government for milling, which are sold directly to consumers;

[1] *The Citizen*, 21 May 2011, available on http://bit.ly/illw0R

4. Release of national strategic maize reserves to millers at a subsides price;
5. Implementing fixed maize producer prices and barring the private sector from buying maize from farmers;
6. Removal of duties on agricultural inputs (fertiliser and seeds);
7. Free input schemes (seed and fertilisers).

We will discuss the effects of the first four measures.

The maize export ban was ineffective because maize still found its way out of Kenya to neighbouring countries like South Sudan where the high prices were quite lucrative for traders. It also meant commodity brokers and traders lost business as they had done to many of their operations illegally.

The duty waiver on maize was the most significant measure imposed by the Government. The private sector in Kenya took advantage of the favourable trade conditions to import significant quantities of maize, mainly from South Africa and the USA. In total about 14m bags of maize were imported into the country. The duty waiver also helped lower maize domestic consumer prices, helping to stabilise food prices. By far this was the most effective measure adopted by the Kenyan Government and tangible benefits were felt by consumers. In the short-term, the influx of foreign maize into the country had no immediate adverse impact on smallholder farmers in the country as the majority had been affected by drought and had no surplus for sale. However, cheap imported maize could have led to (unfair) competition with domestic farmers.

Aware that the release of strategic grain stocks to millers was falling short, the Government imported maize through the National Cereals and Produce Board (NCPB) for milling and direct distribution to consumers, by-passing the normal market channels. The approach was however expensive for the Government and distribution was costly. The programme was discontinued after only 3-4 months because the Government could not afford the milling costs.

The NCPB handles strategic grain reserves in the country and its mandate includes procurement and management of stocks, famine relief and distribution as well as intervention on the market (both consumer and producer prices). In response to the shortage of maize on the market and the high food prices, the Government ordered the NCPB to release most of its stock onto the market. Of the 5m bags in stock at the time, only 1.6m bags were retained. The maize was sold to millers at a subsidised price with the aim that the millers would in turn sell to retailers at below market prices leading to lower consumer prices. Unfortunately this did not work out as planned, as the millers were neither licenced, regulated, nor properly registered. The majority of them sold maize to retailers at market prices while some diverted maize for sale in southern Sudan (by-

passing the maize export ban). The real beneficiaries from this policy were the millers themselves, as well as brokers and traders. Where retailers received cheap maize from some millers, there were no monitoring mechanisms from the Government to ensure that consumers enjoyed lower prices. This measure thus was the most flawed of all the measures and only managed to fuel corruption whilst at the same time exposing the country to high grain prices as the NCPB had no strategic stocks.

The government also tried to fix maize producer prices by barring the private sector from buying maize from farmers. Unfortunately, the Government (through the NCPB) was cash strapped and could not buy maize from smallholder farmers at the set high prices. Those who supplied their maize to NCPB faced payment problems. This acted as a disincentive for smallholder farmers and some of them shifted to more profitable crops. Large-scale traders who were involved in the maize chain also lost trust in the businesses and diversified to other commodities. In addition, this measure fuelled illegal maize exports as farmers and traders tried to evade the restrictive trade environment and seek new and better markets.

5.4.3 Conclusion

The stakeholders in Tanzania concluded that the export ban was inefficient. In short, although the export ban did lower prices, it entailed several other high costs. Farmers not only faced lower prices, but those who produced a surplus lost a profitable outlet. Also traders lost out by losing a lucrative market as well as investments and contacts. Adding to this the illegal trade that arose, they conclude that an export ban is not the most efficient or effective of instruments. Improving the trade network and infrastructure, coupled with safety net programmes for the poorest are probably much more successful in achieving food security.

The stakeholders in Kenya concluded that the measures that promoted private sector participation in the maize value chain were the ones that were mostly effective and helped stabilise food prices. Government regulation on producer prices has stifled trade and involvement of the private sector on the local market and in the long-term this will adversely affect the maize value chain and local production in the country. These conclusions resonate with those from Tanzanian stakeholders. Direct involvement in trade (rather than putting in place policies that promoted private sector participation) was seen as a grey area that needs to be addressed in future. Together with donors, the Government could provide short term measures to mitigate the adverse impact of high food prices by

offering safety nets and emergency responses to the poorest members of the community, but with the need to ensure there are no market distortions that might hamper recovery and long-term gains.

5.5 Comparison with full trade liberalisation of the wheat market

Large exporting countries have the option of increasing export taxes in the face of higher world prices. An alternative option is for all countries to fully liberalise trade and remove all import and export taxes, with the argument that by removing all obstacles to trade, resources will move where they are most needed thus mitigating the impact of higher world prices. We are interested in analysing what would happen when grain prices suddenly rise in a world in which trade was fully liberalised. The effects on food (wheat) security, on wheat farmers, on terms of trade and the tax income effect are considered in turn. The results are presented in graphical form in percentage point changes from the supply shock results.

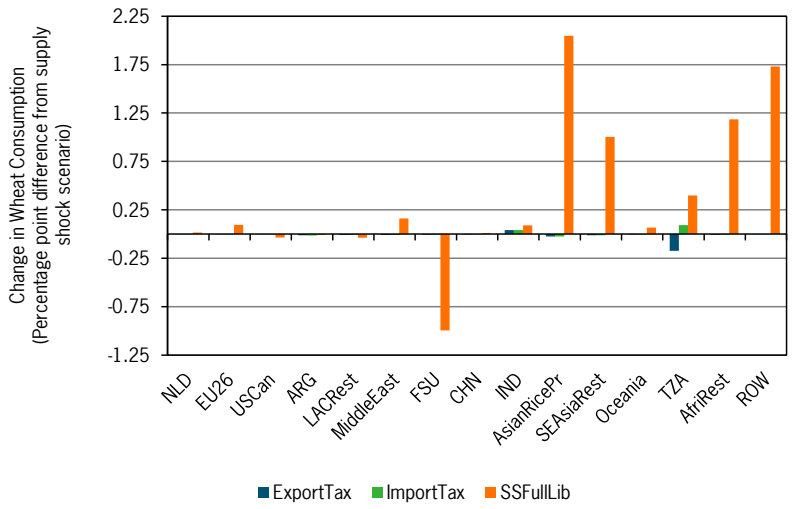
A comparison of the impact of the alternative trade policy options on wheat consumption is shown in Figure 5.1. The results clearly show that in a fully liberalised world, a shock in the wheat market has a significant impact on food consumption and that the magnitude of effects are many times that of the export and import tax responses by India and Tanzania. In a fully liberalised world, Oceania, Africa and all of Asia, have a much higher consumption of wheat compared to the effects of the same shock in a non-liberalised world. After the supply shock, the world price for wheat rises by only 0.126pp, compared to 0.253pp (0.257pp) in a world where India (and Tanzania) respond.

Only the former Soviet Union experiences a large reduction in wheat consumption. This 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 (for former Soviet Union over 30%). When wheat tariffs are fully liberalised, former Soviet Union (including Russia) benefits from increased wheat exports into the EU, and generally benefits from cheaper wheat imports. The resulting reorientation in final demands towards traded wheat goes at a cost of the domestic wheat market, as the increased demand stemming from the increased export revenues drives up domestic wheat prices. As a result overall household consumption of wheat falls.[1] Essentially, the former Soviet Union experiences a Dutch Disease from booming wheat exports.

[1] Household consumption of wheat consists of demand for imported wheat, which rises, and domestic wheat, which falls.

Of particular note is the fact that wheat consumption in India is higher in a fully liberalised wheat market than when it introduces an export tax to ensure food security. Consumption in Tanzania is also higher under a fully liberalised wheat market. This suggests that prices increases in a fully liberalised world are less harmful in terms of food security, under the condition that all countries participate, i.e. all countries have to sit down at the ballgame.

Figure 5.1 **Effect of higher prices on wheat consumption in a liberalised and non-liberalised world**



NB:

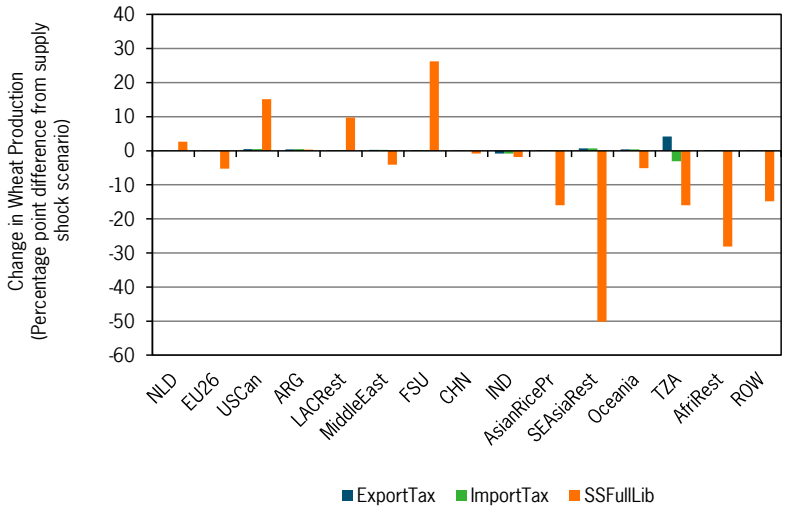
TX	scenario in which India imposes an export tax on wheat in response to the negative wheat supply shock in Oceania.
TX +TM	scenario in which not only India imposes an export tax, but also Tanzania reduces its import tariffs on wheat in response to the negative wheat supply shock in Oceania.
Full lib	scenario where, instead, all countries reduce export taxes and import tariffs on wheat in response to a negative wheat supply shock in Oceania, i.e. full liberalisation of the wheat market.

A comparison of the effect of full liberalisation on wheat production with the effects of other measures is shown in Figure 5.2. Again, full liberalisation of the wheat market has large effects compared to nationally implemented policies. Full liberalisation implies large shifts in the global production of wheat. Production shifts away from Asia and Africa into US and Canada, Rest of Latin America and Caribbean and former Soviet Union. The Dutch wheat sector also benefits, experiencing a production rise of 1.5pp. This is significantly more than the

0.01pp increase in wheat production when India and Tanzania take measures on their own, and in contrast to wheat production losses for the rest of the EU of 5.4pp. While wheat consumption in Africa and Asia is higher in a fully liberalised world, wheat production in these regions falls, so that they become more dependent on wheat imports.

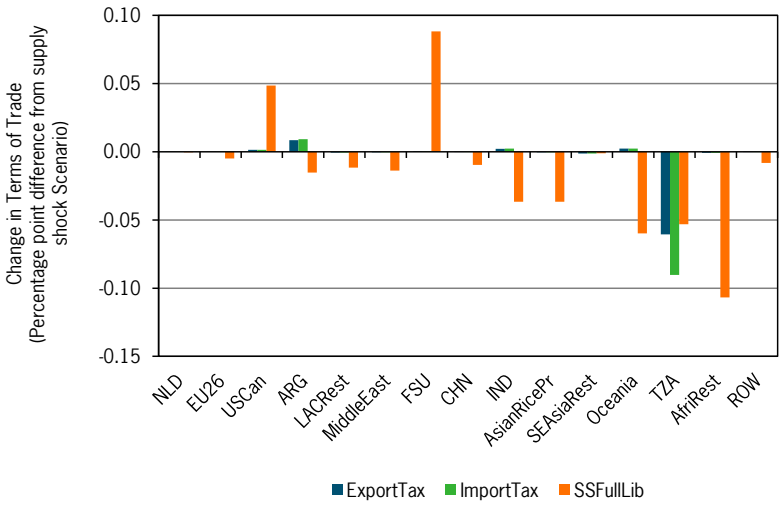
While wheat consumption in Africa and Asia is higher in a fully liberalised world, wheat production in these regions falls, so that they become more dependent on wheat imports.

Figure 5.2 **Effect of higher prices on wheat production in a liberalised and non-liberalised world**



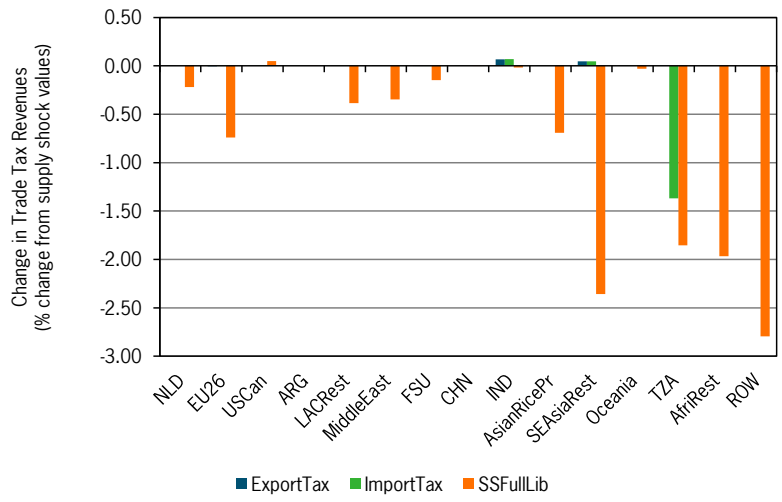
The terms-of-trade effects for all policy responses are small, as shown in Figure 5.3. Countries that reduce their production of wheat typically experience a worsening of the terms of trade whereas US and Canada, and former Soviet Union experience an improvement in their terms of trade.

Figure 5.3 **Effect of higher prices on terms of trade in a liberalised and non-liberalised world**



The effects on trade tax revenues for all policy responses are shown in Figure 5.4. Unsurprisingly, trade tax revenues mostly go down in case of full liberalisation of the wheat market, most notably for Africa, Asia (excluding India and China), the Rest of the World Region (including rest of North America and Europe) and the EU, where tax revenues from traded wheat are relatively important. These losses have to be considered in the light of welfare gains for consumers (facing lower prices) and gains in allocative efficiency (wheat being produced at lowest cost). This result shows that fully liberalising markets will be politically difficult, as countries that largely depend on import tax revenues have an important reason not to liberalise their market.

Figure 5.4 **Effect of higher prices on trade tax revenues in a liberalised and non-liberalised world**



The welfare effects of all policy responses relative to the supply shock in absolute and relative terms are shown in Figure 5.5 and 5.6 respectively. Absolute welfare gains (and losses) of full wheat trade liberalisation exceed that of the unilateral responses to the wheat supply shock many times. Overall, the world is many times better off in absolute terms compared to the unilateral responses. Rest of South East Asia, US and Canada, EU26, the FSU and Rest of World gain, whereas the Rest of Latin America and Caribbean, Oceania, China and Rest of Africa are the biggest losers. In relative terms, the FSU, Rest of World and Rest of South East Asia are best off, whereas Oceania, Africa and Asian rice producers are worst off. Both India and Tanzania would have been better off in terms of overall welfare if all countries had liberalised their trade in wheat.

Figure 5.5 **Effect of a supply shock and higher wheat prices on welfare in a liberalised and non-liberalised world**

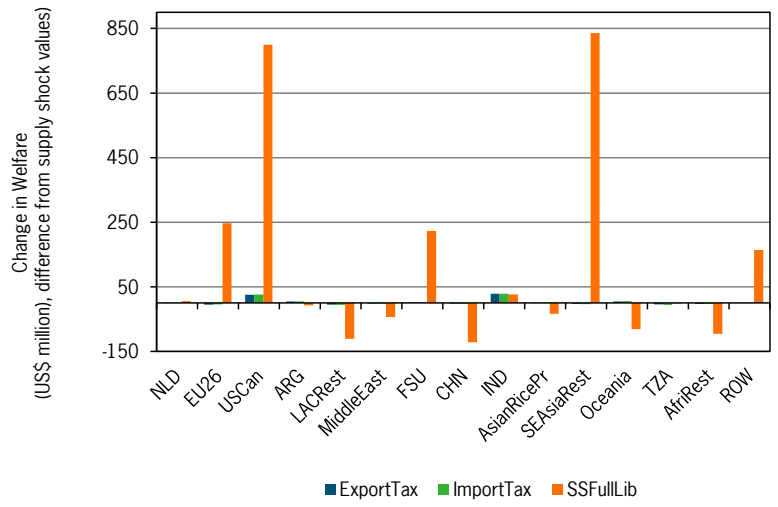
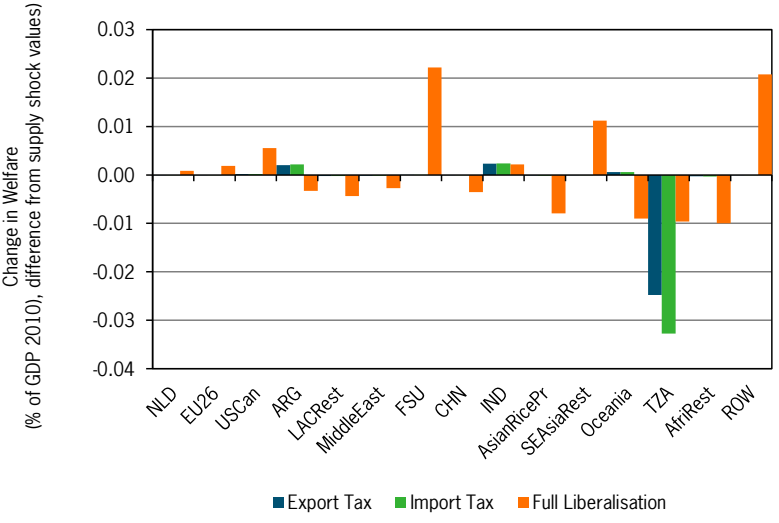


Figure 5.6 **Effect of a supply shock and higher wheat prices on welfare relative to GDP in a liberalised and non-liberalised world**



5.6 Discussion

This study focused on wheat markets. Although many results will apply to other major grains, such as rice and maize, these markets may have different dynamics and therefore some country or region specific outcomes may differ.

We used a stylised analysis: one shock in one market (Oceania, wheat) and one response by one net exporter (India) and by one net importer (Tanzania), using a model. In reality, the world is more complex, as are the events that are occurring (multiple shocks, multiple responses). Although some events may cancel each other out, the events of the past years seem to be reinforcing each other. For instance, in 2010, drought and subsequent fires in Russia and Ukraine coincided with floods in Pakistan and Indonesia and severe drought in parts of South America. This was followed by severe floods in Australia at the end of 2010. This means that there are often several supply shocks, as well as several countries imposing export bans and reducing import tariffs.

The results obtained from the three scenarios (supply shock in Oceania, trade ban in India and import subsidies in Tanzania) may not seem very big. The supply shock in Oceania 'only' increases world wheat prices by 0.25%. However, when we take into account that a supply shock in one country usually coincides with other supply shocks elsewhere, we can imagine that such events combined will have a significant impact on world wheat markets. We did not simulate different supply shocks in this research, but this may be a line of further research. Especially in the context of global climate change in which more extreme weather patterns are expected, this may be useful.

Our measure of food (wheat) security is rather coarse. It measures the total amount of wheat consumed in a country of region. The household in the model is representative of all households in economy, i.e. average household, whereas impacts may differ quite a lot across poor versus rich households and rural versus urban households. A more detailed study could take into account the impacts across different types of households and get a better grip on what effect a supply shock and related trade measures have on vulnerable people.

Another route to obtaining more meaningful insights could be to calculate nutrition impacts. The ultimate concern of food security is that of sufficient nutrient intake (especially for poorest). As prices rise, households may spend more on cheaper, calorie-rich staples and less on foods rich in protein and vitamins, such as meat, fish, dairy, fruit and vegetables, reducing the quality of their

diet, and increasing rates of malnutrition and micronutrient deficiencies. This may have adverse health consequences.[1]

Our analysis shows that liberalising trade is effective in reducing the effects of supply shortfalls on price rises as well as food security. Wheat prices rise only half as much in a liberalised world after a major supply shock in e.g. Oceania. Absolute welfare gains (and losses) of full wheat trade liberalisation well exceed that of the unilateral responses to the wheat supply shock. Interestingly, wheat consumption in India and Tanzania, the two countries in our study that imposed trade measures, would be *higher* in a liberalised world where neither of them would impose any measure.

However, full liberalisation of the wheat market will not benefit all regions. Full liberalisation implies large shifts in the global production of wheat. Production shifts away from Asia and Africa into US and Canada, Rest of Latin America and Caribbean and former Soviet Union. While wheat *consumption* in Africa and Asia is higher in a fully liberalised world, wheat *production* in these regions falls. 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. The idea of food sovereignty is that people have the right to define their own food, agriculture, livestock and fisheries systems, in contrast to having food largely subject to international market forces.[2] Being dependent on the world market may make a country more vulnerable to changes in the world market that may affect food security.

In this line of reasoning, high export tariffs combined with tightness on the world markets are said to have had a wider negative effect by reducing the faith in the multilateral trading system. Demeke et al. (2009, p. 24) point out that many countries that previously put their faith in the world market as a reliable source of food supply have shifted their position since the food price crisis by:

- Insulating domestic prices from world prices (exporting countries) by imposing protectionist measures such as export taxes or outright bans;
- Moving from a food security based strategy to a food self-sufficiency based strategy;
- Bypassing 'normal' international trade processes, either by acquiring land abroad for securing food and fodder procurement or by engaging in trade agreements at the regional level;
- Showing distrust towards the private sector (via price controls, anti-hoarding laws, government intervention in output and input markets).

[1] See, for example, Wiggins and Levy (2008) and Lock et al. (2009).

[2] See for instance www.foodsovereignty.org/

Thus, paradoxically, the export restrictions have led to a reduced enthusiasm for (further liberalising) the world market. At the same time, however, the export restrictions were matched by calls to ban such trade measures in the WTO: Switzerland and Japan submitted this at the WTO, but also the High Level Task Force on the Global Food Crisis, a combination of various UN and other multilateral organisations (e.g. World Bank and IMF) have called for minimising use of export restriction[1] to meet food security needs of vulnerable populations.

Export bans, restrictions or taxation are technically legal under the WTO rules; there are only a few weak restraining provisions. Two WTO agreements (GATT and AoA[2]) deal with this issue.

Although Paragraph 1 of GATT Article XI states that there can be no prohibitions or restrictions on exports other than through duties and taxes, Paragraph 2(a) makes an important exception to this general rule, by stating that Paragraph 1 shall not apply to 'export prohibitions or restrictions temporarily applied to prevent or relieve critical shortages of foodstuffs or other products essential to the exporting contracting party'. Article 12 of The Agreement on Agriculture (AoA) refers to this GATT Paragraph 2(a). Because the terms 'critical shortage' and 'temporary' are, however, not defined anywhere, this leaves open much room for discussion.

AoA Article 12 does require that countries imposing export bans should take into 'consideration to the effects of such prohibition or restriction on importing Members' food security', and provide 'information as the nature and the duration of such measures'. However, 12.2 makes an exception for Developing Country Members: 'unless the measure is taken by a developing country Member which is a net-food exporter of the specific foodstuff concerned'.

In addition, there are no bounds for export taxes; countries could implement very high taxes effectively resulting in an export ban. In contrast, there are bounds for import taxes. This issue of asymmetry as well as the issue of reducing export taxes is being debated in the WTO.[3] In the last framework (August 2004) it is stated that 'disciplines are to be strengthened, but the details to be negotiated'. The framework also includes differential export taxes under 'Issues of interest but not agreed'. Because there is resistance from several WTO

[1] See the Comprehensive Framework for Action, available at http://bit.ly/e74aFo

[2] The General Agreement on Tariffs and Trade (GATT) and the Agreement on Agriculture (AoA). The AoA was established because agricultural goods were not integrated into GATT. However, the AoA represents an important improvement towards increased liberalisation of the trade rules in the agricultural sector.

[3] See the WTO for more information on the discussions: http://bit.ly/i9qSA6

members (in particular developing countries) on a stronger discipline, it is unlikely that this issue will be resolved under the Doha Round.

With respect to the reduction of import tariffs, WTO rules are relatively permissive to such policies that are directed towards supporting consumers. This is understandable as lowering import tariffs reduces market distortions, is trade-enhancing and does not impinge on the export interests of trading partners (Konandreas, 2010). In addition, the scope of this policy response is limited because applied tariffs for most food commodities are generally already in the low range (10%-20%).

The WTO rules currently in place reflect the trade concerns in agriculture of an era of cheap food and oversupply. The concern of governments then was low producer prices. Many felt compelled to put in place policies to cushion the adverse effect of such depressed prices on domestic production. (Konandreas, 2010). However, the fundamentals of world food markets have changed, making it necessary to change the multilateral rules to address trade issues that may arise in periods when food prices are high.

The EU has stated that it will continue to promote an open trade policy and working towards an early conclusion of the Doha Development Agenda (DDA). The EU feels that there are significant potential gains for developing countries from the Doha Round in terms of new market opportunities, which would help generate additional export income, stimulate agricultural production and facilitate access to foodstuffs, thereby alleviating the current food price hikes. The EU also believes that the issue of the negative impact of export restrictions should be raised at relevant forthcoming meetings of the WTO and in other relevant international fora (European Commission, 2008).

Although our analysis shows that export restrictions are damaging to world food security, constraining or even forbidding the use of export restrictions is probably not feasible. However, clarification and sharpening of the rules in the WTO is warranted. Making explicit the trade-offs of using export measures and a regular discussion of the situation in the markets will help restore trust in the multilateral trading system, which, in the end is so crucial for many food insecure countries.

6 Conclusions

Trade measures can be compared to standing up in a crowd at a ballgame. If one person stands up he will have a better view, but his action will trigger other people to stand up as well to get a better view. When global wheat prices rise, it makes sense for a large exporter to impose trade measures (e.g. increased export taxes) that stabilise prices because it has a positive effect on domestic food security. In this case, a net importer can react by lowering import tariffs to achieve the same aim. Countries that do not implement trade measures (increasing export or lowering import tariffs) face higher world wheat prices as well as lower welfare as a result of such unilateral policy actions. In a sense, domestic food insecurity is exported to the rest of the world.

The results show that changes in wheat prices are not the only determinant of food security. Household income matters as well in determining the impact of shocks on food security. Household incomes are affected by changes in the economy through changes in wage rates as well as capital returns.

Large exporters that protect domestic consumers from high global wheat prices do so at a cost: domestic farmers face lower producer prices. Net importing countries that lower import tariffs will see a reduction in their trade tax revenues. Trade tax revenues can be an important source of income. When trade tax revenues fall, the poorest wheat importing countries may need support to find alternative sources of government revenues. Otherwise they may run into serious problems of not being able to finance expenditures on basic needs.

Liberalisation of international markets may be a solution. Our analysis shows that a wheat supply shock occurring in a world where all nations have liberalised, leads India and Tanzania to be more food secure in wheat and to experience an improvement in welfare, compared to if these countries were to take unilateral trade measures. Globally, more wheat is produced at lower cost, as a result of which world wheat prices rise less and world food security in wheat improves. in such a scenario, global welfare is higher.

Impacts across regions are, however, highly uneven. Specifically, when all countries liberalise, production is expected to shift away from Asia and Africa into US and Canada, Rest of Latin America and Caribbean and former Soviet Union, whereas wheat consumption in the Africa and Asian regions is expected to rise. Thus the Africa and Asian regions have become more food secure, but less food sovereign and less food self-sufficient. This may be unacceptable in

political terms. A clear concern in this respect is the volatility of world food prices and the associated risk for domestic food security that comes with being more import dependent. In addition, trade tax revenues mostly fall in a fully liberalised world, which may again be politically undesirable, especially in developing countries that largely depend on import tax revenues as a source of income.

To achieve that no country imposes export bans or that 'everyone sits at the wheat market ballgame', a concerted and co-ordinated action is required. Such concerted action in avoiding export bans will need to be done at the WTO forum trough clarification and sharpening of the rules in the WTO. Making explicit the trade-offs of using export measures and a regular discussion of the situation in the markets will help restore trust in the multilateral trading system, which, in the end is so crucial for many food insecure countries.

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Appendix 1

Import tariffs

Table A1.1 **Import tariffs on rice by source and destination (%)**

From / To	NLD	EU26	US Can	ARG	LAC Rest	Middle East	FSU	CHN	IND	Asian RicePr	SEAsia Rest	Oceania	TZA	Afri Rest	ROW
NLD	0	0	0	0	0	0.2	10	0	80	0	0	0	0	0	3
EU26	0	0	3.5	10.4	11.2	6.6	10	0	0	52	0	0	7.5	14.3	6.9
USCan	52.6	54.8	0	10	9	29.9	8.3	0	80	51.9	343.4	0	23.9	10.2	7
ARG	0	81.6	0	0	0	3.3	0	0	0	0	0	0	0	0	0
LACRest	72.4	71.1	0.5	0	1.2	0.9	0	0	0	0	43.1	0	0	4.9	8.7
MiddleEast	23.4	19.7	3.2	0	0.5	7.9	1.6	0	67.8	0	259.5	0	5.5	0.5	6.3
FSU	0	37.9	2.2	0	0	31.5	0.1	0	0	0	339.4	0	0	0	0
CHN	0	22	0	0	10.3	4.7	16.8	0	0	20	427.2	0	24.7	10	1.5
IND	59	58.8	4	0	0	0.3	0	0	0	0	144.5	0	0	2	3.3
AsianRicePr	63.5	71.1	3.8	0	20.6	10.7	8.5	0	0	9.4	318.6	0	24.9	11.2	9.1
SEAsiaRest	3.6	17.5	1.8	0	0	1.7	0	9.4	57.9	17.9	65.1	0.1	0.6	3.1	1.4
Oceania	0	50.8	0	0	0	5.8	0	0	0	0	411.3	0	0	0.1	26.7
TZA	0	0	0	0	0	0	0	0	0	0	0	0	0	10.4	0
AfriRest	0.2	2.1	0	0	0	2.7	0	0	0	0	0	0	9.6	1.9	0
ROW	0	50.6	5.1	0	24.9	2	0	0	0	0	0	0	0	9.9	8.7

Source: GTAP7 database (2004).

Table A1.2	Import tariffs on wheat by source and destination (%)														
From / To	**NLD**	**EU26**	**US Can**	**ARG**	**LAC Rest**	**Middle East**	**FSU**	**CHN**	**IND**	**Asian RicePr**	**SEAsia Rest**	**Oceania**	**TZA**	**Afri Rest**	**ROW**
NLD	0	0	0	0	0	25	0	0	0	0	20.8	0	0	15	11.6
EU26	0	0.9	0.6	2.5	1.1	7.4	5.6	0	0	0.4	8.2	0	4.5	15.2	85.3
USCan	14.7	17.5	0	2.9	4.9	2.2	10.7	0	0	24.8	43.4	0	5	11.9	61.1
ARG	29.5	28.1	2.6	0	0.3	3.8	17.7	0	0	0	1.8	0	5	15.9	16.9
LACRest	0.1	23.4	0	0	0.3	4.6	4.3	0	0	0	0.3	0	0	26	65.4
MiddleEast	0.5	5.5	1.3	0	0.5	1.4	1.3	0	0	15.9	0.9	0	5	6	47.3
FSU	32	31.4	2.7	0	0	5.7	2.3	0	0	24.8	5.4	0	0	49.5	29.5
CHN	0	0	2.5	0	0	3.2	0	0	0	4.4	10.4	0	0	9.5	170.6
IND	0	7.2	3.2	0	0	1.9	0	0	0	3.2	2.9	0	5	13.1	0
AsianRicePr	0	0	0	0	0	2.1	0	0	0	0	12.4	0	0	5	0
SEAsiaRest	6.6	7.6	3.2	2.2	14	4.5	1.3	31.4	8.2	0.2	3.1	0	0	9	43.6
Oceania	26.8	5.9	0.8	5.7	7	3.8	0	0	0	17.1	19.3	0.3	5	10.2	120.3
TZA	0	0	0	0	0	2.5	0	0	0	0	0	0	0	0	0
AfriRest	0	0	0	0	0	0.9	0	0	0	0	0.1	0	1.9	2.3	0
ROW	0	1.6	0.1	0	0	24.2	1.9	0	0	0.6	0	0	0	18.1	4.6

Source: GTAP7 database (2004).

Table A1.3	Import tariffs on other grains (incl. maize) by source and destination (%)														
From / To	**NLD**	**EU26**	**US Can**	**ARG**	**LAC Rest**	**Middle East**	**FSU**	**CHN**	**IND**	**Asian RicePr**	**SEAsia Rest**	**Oceania**	**TZA**	**Afri Rest**	**ROW**
NLD	0	0	0	0	3.8	40.8	4.6	0	0	24.2	4.6	0	0	21	49
EU26	0	1	0.1	1.1	5.8	43.5	5.5	0.8	6.8	23.9	13.5	0	21	19	37
USCan	17	13.3	0	1.1	10	32.1	4.7	1.5	50	8.8	24.8	0	16	26	27.3
ARG	24	27.3	0.2	0	5.5	25.4	12	0	60	37.2	0.8	0	25	21	119
LACRest	22	23.2	0	0	1.8	4.1	1	0	0	0.1	4.3	0	0	39	24.3
MiddleEast	14	35.5	0.2	0	0.5	3.1	1.6	0	0	4.3	0.6	0	21	26	14.6
FSU	34	57.2	0.7	0	0	14.2	0.9	0	0	0	12.8	0	10	26	23.1
CHN	28	30.8	0.6	4.8	4.8	3.6	5	0	0	25.2	12.9	0	0	22	44.9
IND	31	18.9	0.8	0	3.3	4.8	0	0.2	0	9.9	8.9	0	21	31	0
AsianRicePr	30	29.7	0.3	0	5.7	0.4	12	58	0	3.2	1.8	0	13	11	89.9
SEAsiaRest	73	2.3	0.3	0.2	1.1	0.8	0.1	0.8	0.3	31	3.4	0	25	32	5.5
Oceania	33	25.5	0.3	4.5	9	0.3	0	1.5	8.5	10.7	80.2	0.6	0	5.6	88.3
TZA	0	0	0	0	0	0	0	0	79	0	0	0	0	30	0
AfriRest	8.4	2.1	0	0	4.1	2.4	1.1	0	0	23.1	3.4	0	12	11	5.1
ROW	0.5	0.9	0	0	0	130.3	3.3	0	0	0	0.1	0	0	16	12.6

Source: GTAP7 database (2004).

Appendix 2

Substitution and income elasticity parameters used in the model

The tables below include the parameter values used in the estimation of the CDE private household demand function, the nested CES production function, the nested CES Armington demand function for imported and domestic goods, and the modelling of the sluggishness of land and natural resources.

Table A2.1 **Income elasticities of demand**

	NLD	EU26	US Can	ARG	LAC Rest	Middle East	FSU	CHN	IND	Asian RicePr	SEAsia Rest	Oceania	TZA	Afri Rest	ROW
Pdr	0.02	0.03	0.02	0.33	0.28	0.55	0.47	0.6	0.61	0.46	0.57	0.07	0.68	0.63	0.06
Wht	0.02	0.09	0.02	0.33	0.35	0.38	0.47	0.6	0.61	0.62	0.21	0.09	0.68	0.51	0.15
Gro	0.02	0.24	0.01	0.33	0.34	0.45	0.51	0.6	0.61	0.56	0.46	0.13	0.68	0.6	0.07
FoodPrim	0.24	0.26	0.39	0.41	0.52	0.56	0.64	0.74	0.72	0.84	0.48	0.36	0.81	0.7	0.5
FoodProc	0.89	0.89	0.92	0.69	0.72	0.72	0.76	0.75	0.73	0.74	0.84	0.89	0.88	0.79	0.88
Mnfcs	1	0.99	0.99	0.92	0.96	0.99	1	0.95	1.09	0.99	1	0.99	1.25	1.04	1
Serv	1.03	1.04	1.01	1.09	1.1	1.16	1.14	1.14	1.24	1.15	1.04	1.03	1.37	1.21	1.04

Source: GTAP-AGR.

Table A2.2	Elasticities of substitution in production														
Topnest (substitution between value added and intermediate aggregates)															
ELTOP	**NLD**	**EU26**	**US Can**	**ARG**	**LAC Rest**	**Middle East**	**FSU**	**CHN**	**IND**	**Asian RicePr**	**SEAsia Rest**	**Oceania**	**TZA**	**Afri Rest**	**ROW**
Pdr	0.90	0.90	0.80	0.50	0.50	0.50	0.90	0.50	0.50	0.50	0.44	0.90	0.50	0.50	0.90
Wht	0.90	0.90	0.84	0.50	0.50	0.69	0.90	0.50	0.50	0.50	0.44	0.90	0.50	0.50	0.90
Gro	0.90	0.90	0.81	0.50	0.50	0.61	0.90	0.50	0.50	0.50	0.48	0.90	0.50	0.50	0.90
FoodPrim	0.89	0.85	0.78	0.50	0.47	0.63	0.87	0.44	0.48	0.44	0.35	0.81	0.46	0.46	0.75
FoodProc	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mnfcs	–	–	–	–	–	–	–	–	–	–	–	0.01	–	0.01	–
Serv	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CGDS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Value added nest (substitution between land, natural resources, skilled labour, unskilled labour and capital)															
ELVA	**NLD**	**EU26**	**US Can**	**ARG**	**LAC Rest**	**Middle East**	**FSU**	**CHN**	**IND**	**Asian RicePr**	**SEAsia Rest**	**Oceania**	**TZA**	**Afri Rest**	**ROW**
Pdr	0.40	0.40	0.30	0.50	0.50	0.50	0.40	0.50	0.50	0.50	0.38	0.10	0.50	0.50	0.37
Wht	0.40	0.40	0.23	0.50	0.50	0.45	0.40	0.50	0.50	0.50	0.37	0.10	0.50	0.50	0.40
Gro	0.40	0.40	0.29	0.50	0.50	0.47	0.40	0.50	0.50	0.50	0.48	0.10	0.50	0.50	0.40
FoodPrim	0.40	0.39	0.28	0.50	0.48	0.44	0.39	0.47	0.48	0.47	0.35	0.11	0.47	0.48	0.37
FoodProc	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12	1.12
Mnfcs	1.17	1.21	1.17	0.91	1.05	0.52	0.68	1.11	1.00	1.11	1.20	0.96	0.55	0.62	0.92
Serv	1.30	1.34	1.36	1.37	1.35	1.37	1.43	1.39	1.42	1.42	1.38	1.38	1.48	1.40	1.37

Table A2.2	Elasticities of substitution in production (continued)														
ELVA	**NLD**	**EU26**	**US Can**	**ARG**	**LAC Rest**	**Middle East**	**FSU**	**CHN**	**IND**	**Asian RicePr**	**SEAsia Rest**	**Oceania**	**TZA**	**Afri Rest**	**ROW**
CGDS	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Intermediates nest (substitution between intermediate inputs used (PDR, Wht, Gro, FoodPrim, FoodProc, Mnfcs, Serv)															
ELPURCH	**NLD**	**EU26**	**US Can**	**ARG**	**LAC Rest**	**Middle East**	**FSU**	**CHN**	**IND**	**Asian RicePr**	**SEAsia Rest**	**Oceania**	**TZA**	**Afri Rest**	**ROW**
Pdr	0.50	0.50	0.15	0.15	0.15	0.16	0.50	0.15	0.15	0.15	0.25	0.10	0.15	0.15	0.32
Wht	0.50	0.50	0.13	0.15	0.15	0.31	0.50	0.15	0.15	0.15	0.24	0.10	0.15	0.15	0.50
Gro	0.50	0.50	0.15	0.15	0.15	0.25	0.50	0.15	0.15	0.15	0.20	0.10	0.15	0.15	0.49
FoodPrim	0.49	0.47	0.14	0.15	0.14	0.27	0.49	0.13	0.15	0.13	0.21	0.09	0.14	0.13	0.40
FoodProc	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mnfcs	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Serv	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
CGDS	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

Source: GTAP-AGR.

Note: CGDS stands for the investment good, which is also produced using intermediate and factor inputs; – zero.

Table A2.3	Armington elasticities of substitution in trade	
Substitution between	**Imported and domestic variety**	**Imports from different regions**
Pdr	5.1	10.1
Wht	4.5	8.9
Gro	1.3	2.6
FoodPrim	2.2	4.4
FoodProc	2.5	5.0
Mnfcs	3.6	7.7
Serv	1.9	3.8
Source: GTAP-AGR.		

Table A2.4	Elasticities of transformation for sluggish factors by region	
	Land	**Natural resources**
NLD	-0.250	-0.001
EU26	-0.250	-0.001
USCan	-0.400	-0.001
ARG	-0.400	-0.001
LACRest	-0.400	-0.001
MiddleEast	-0.337	-0.001
FSU	-0.250	-0.001
CHN	-0.400	-0.001
IND	-0.400	-0.001
AsianRicePr	-0.400	-0.001
SEAsiaRest	-0.336	-0.001
Oceania	-0.400	-0.001
TZA	-0.400	-0.001
AfriRest	-0.400	-0.001
ROW	-0.250	-0.001
Source: GTAP-AGR.		

Baseline Updating: Data and Assumptions

Using USDA's ERS data on annual GDP and population growth[1] the model has been updated to 2010. In doing so it is assumed that skilled and unskilled labour endowments grow in line with the population and that capital grows in line

[1] See www.ers.usda.gov/Data/Macroeconomics/

with GDP. All other endowments are assumed to remain unchanged. The resulting growth paths of GDP and population (and so capital and labour endowments) are shown in the table below.

Table A2.5	Baseline growth in GDP and population (2004-2010)	
% Change in	**GDP**	**Population**
NLD	6.7	2.8
EU26	4.0	0.7
USCan	8.6	5.8
ARG	38.3	6.7
LACRest	18.8	8.1
MiddleEast	26.3	12.0
FSU	25.0	-0.9
CHN	73.8	3.8
IND	55.2	9.2
AsianRicePr	26.2	8.3
SEAsiaRest	6.5	6.8
Oceania	12.1	8.7
TZA	40.1	13.3
AfriRest	27.2	14.8
ROW	9.6	1.5

Appendix 3

List of stakeholders

List of stakeholders interviewed in Kenya

Organisation	Contact person
Kenya Agriculture Commodity Exchange	Dr Adrian Mukhebi, Managing Director
East Africa Grain Counil	Mr Nsanya Ndanshau, Executive Director
Ministry of Agriculture	Mrs Ann Onyango, Director of Policy and Planning
Ministry of Special Programmes	Permanent Secretary
National Cereals and Produce Board	Mr Evans Wasike, Public Relations Officer
Ministry of Finance	Permanent Secretary
Regional Strategic and Knowledge Support System (ReSAKSS) is an International Food Policy Research (IFPRI) Programme housed with the International Livestock Research Institute (ILRI)	Dr Joseph Karugia, Programme Coordinator

List of stakeholders interviewed in Tanzania

Organisation	Contact person
World Food Programme	Mr Juvinal Kisanga
MNMA	Mr Moses Ayoub Kusiluka
Rural Urban Development Initiatives	Mr Abel Lyimo
East African Grain Council	Mr George Mboje
National Food Reserve Agency (NFRA)	Representative for NFRA
National Food Security dept. MoA	Representative for MoA
Mohammed Enterprises Tanzania Ltd (METL) - Dar es Salaam	Mr Billu

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