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RESEARCH PAPER

Adam Smith in a warmer world: climate change, multilateral trade and national food security

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Market efficiency is essential in a world of scarce resources, but it is a secondary concern if human survival depends on a market that can provide reliable agricultural supply. For example, the projected increase in the frequency, magnitude and severity of extreme weather events (as increasing CO_2 emissions make the world warmer) has profound implications for the reliability of the multilateral agricultural market. Market reliability is assumed to be embedded in supply and demand price transmission, although this assumption may not hold in a changing climate. This paper examines these concerns and makes recommendations to the World Trade Organization (WTO) and to leaders of national governments about rethinking the balance between interdependence on a multilateral agricultural market and national independence (not self-sufficiency) based on development of multiple food delivery systems to protect against periodic agricultural price shocks. Once established, via the WTO Doha round, a non-distorted multilateral agriculture market will become the primary global food security system, but national governments may also wish to examine a range of secondary food security systems.

Introduction

It is difficult to say, as the twenty-first century begins to unfold, what the consequences of climate change will be for the evolution of human civilization. We do know that we understand little about what will confront the human race in this and the next century. We know enough to recognize that some very basic and fundamental adjustments are required if civilization is to adapt successfully to the challenges brought on by anthropogenic (human-induced) climate change. At such a moment, it is useful to return to our roots – to those ideas and values that establish our understanding of the way the world operates – in order to review and take stock, and to determine whether our contemporary world view is sufficiently robust to support us in adapting to the challenges brought about through a changing climate.

First, this paper briefly examines those values that shape our world view, the intellectual foundations that increase or decrease the space available for human survival. The paper is concerned with global policy as it pertains to climate change, multilateral trade in agriculture and food security. In this context, the 160-member World Trade Organization (WTO) – a formal association with principles inspired by Adam Smith – plays a fundamental role in the international economy. There is a substantial link between WTO world views and the written views of Adam Smith

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expressed in his classic work, *The Wealth of Nations* (Smith, 1789).[1] As professor of moral philosophy at the University of Glasgow, Smith was concerned about promoting the 'common good' by establishing free market economics – the latter being the means and the former being the end.

Curiously, Smith lived at the very time and place where our present climate change challenges began, as the industrial revolution took off in Great Britain and then spread to Europe around 1750 (Teichgraeber, 1986). Adam Smith (1789) mentions climate on the first page of *The Wealth of Nations* and later observes that:

> The seasons most unfavourable to the crop are those of excessive drought or excessive rain … what is lost in one part of the country is in some measure compensated by what is gained in the other. (Smith, 1789, p.493)

Smith also presents an international perspective on the balance between supply and demand: 'the scarcity of any one country being more likely to be relieved by the plenty of some other' (Smith, 1789, p.506). The statement is very similar to one found in a WTO report on climate change and trade: 'If climate change leads to scarcity of certain goods and services in a country, it will nonetheless be able to obtain what it needs from countries where these goods and services continue to be available' (WTO–UNEP, 2009, p.62).

Free trade is built on the theory that supply and demand achieves equilibrium through production-side and consumption-side adjustments via supply and demand price transmission (Mundlak and Larson, 1992; Conforti, 2004). Balancing of supply and demand through price transmission is a basic economic concept, as it assures that markets meet human needs with some degree of reliability. International comparative advantage is also fundamental to our understanding of the way the world works:

> If a foreign country can supply us with a commodity cheaper then we ourselves can make it, better buy it of them with some part of the produce of our own industry. (Smith, 1789, p.424)[2]

Smith might be surprised at how the multilateral agricultural market has evolved and also dismayed that it circumvents the power of comparative advantage through government subsidies and tariffs. These forces continue to drive agricultural trade liberalization. However, in a changing climate it is not just the efficient allocation of scarce resources we seek; rather, we also seek the design of systems that deliver efficiency and reliability.[3]

'Market reliability' is to place trust or confidence in the marketplace to meet our needs. Market reliability is assumed to be embedded in supply and demand price transmission, as suppliers increase or decrease production based on signals from consumers. The agricultural market operates reliably when prices rise and fall gradually, but when prices increase substantially in a very short period of time (price spikes) (Baltzer *et al.*, 2008; Trostle, 2008), this is an indication that the market is not behaving reliably. Adam Smith did not address the 'reliability assumption' directly, but he did note that agricultural market prices experience greater variability than prices of manufactured goods because of inherent supply-side challenges in agriculture (Smith, 1789, p.58). These challenges, however, include the unpredictable nature of climate in agricultural production under 'normal conditions'. In a changing

climate, market variability and even market volatility will increase, perhaps substantially, in some years. Might Smith have re-examined his theory of the 'common good', given his scepticism about international trade in agriculture (Smith, 1789, p.426), if he had understood what awaited civilization as the world became warmer?

This paper examines the impact of a changing climate on agricultural production in the next section by identifying the potential consequences of both increases in temperature and increases in extreme weather events. This is followed by a brief discussion of research methodology, and then an examination of current and future agricultural trade policy in the context of a changing climate. This is achieved through a review of WTO Doha Development Agenda agriculture negotiations, including: (a) trade-distorting subsidies (export subsidies and domestic support) and market access (tariffs); and (b) rules regulating agricultural export prohibitions and restrictions.

Based on this review, the paper argues that the multilateral agricultural market will probably become unreliable periodically as the world becomes warmer. The paper concludes by asking what national governments can do to minimize the risk that accompanies an unreliable multilateral agricultural market. Part of the solution may be found in the development of multiple food delivery systems to protect against periodic agricultural price shocks. This would include a non-distorted multilateral agricultural market as the primary global food security system with a range of secondary food security systems operating primarily at the national level.

Climate change and agricultural production

This section examines climate change, agricultural production and the science that supports our understanding of the future. Although most of the research in this area has focused on increasing levels of carbon dioxide and agricultural production, focus is also required on a field that has received far less scholarly attention: agricultural production and extreme weather events. The study of climate change is interdisciplinary with knowledge primarily organized in four areas (Crump and Downie, 2015). These four areas include causes (Solomon *et al*., 2007; IPCC, 2013); impacts (Parry *et al*., 2007; IPCC, 2014a); mitigation or reduction (Metz *et al*., 2007; IPCC, 2014b); and adaptation (Parry *et al*., 2007; IPCC, 2014a).[4]

Globally atmospheric temperature is 5°C warmer on average than during the last Ice Age (Stern, 2006). A further increase of 5°C by 2070 is within the range of possibilities (Stern, 2006; CSIRO, 2007), while the world should prepare to adapt to an average increase of at least 4°C above average temperatures in 2000 (Parry *et al.,* 2009). A world that is 9°C warmer than the last Ice Age has significant implications for agricultural production and trade.[5]

Some scholars argue that climate change is a transformational issue in the global political economy (Adger, 2010) and others argue that a dramatic restructuring of the global economy is required to deal effectively with climate change (Paterson, 2010). The conclusions of this paper tend toward the transformational. When climate change and trade are considered together, it is often in the context of a carbon or emissions trading scheme (ETS). An ETS aims to mitigate or reduce potentially harmful effects of climate change or to delay their impact. This paper, however, is concerned with climate change adaptation rather than mitigation.[6]

Climate change will have multiple impacts on agricultural production; in this paper, the effect of two distinct impacts of climate change on agricultural production

are disaggregated: (1) increasing levels of carbon dioxide (CO_2) enhance agricultural production while also increasing the mean atmospheric temperature (Parry *et al*., 2005; Solomon *et al*., 2007; IPCC, 2013); and (2) increasing temperature will increase the frequency, magnitude and severity of extreme weather events, such as heat waves, droughts, heavy precipitation, floods and cyclone activity (Trenberth, 1999; Beniston and Stephenson, 2004).

By disaggregating the impact of climate change on agricultural production, a significant omission in climate change research can be observed. Climate system, biosphere and economic models that are used to project future changes in temperature, precipitation and agricultural production associated with increased CO_2 emissions include only the first impact and not the second in their modelling. Research that examines the first impact establishes that CO_2 has a beneficial effect on plant growth by increasing the rate of net photosynthesis and improving crop water-use efficiency. Moderate temperature increases are expected to result in a relatively benign effect on world food supply as a result (Rosenzweig *et al.*, 1993; Fischer *et al.*, 1994; Rosenzweig and Parry, 1994). Those who hold this view consider the multilateral market in agriculture to be sufficiently robust to manage climate change challenges (Reilly *et al*., 1994; Randhir and Hertel, 2000; Duchin, 2005; Julia and Duchin, 2007).

> The world, for the most part, appears to be able to continue to feed itself … during the rest of this century. The explanation for this is that production in the developed countries generally benefits from climate change, compensating for declines projected for developing nations. (Parry *et al*., 2005, p.2137)

However, this conclusion takes into consideration only the first of the impacts of global warming identified above. The world may be able to produce sufficient amounts of agricultural goods to meet demand, but the question in the present study is whether we will actually be able to get product to market? This paper wonders whether the second impact – increases in the frequency, magnitude and severity of extreme weather events – may disrupt our ability to get product to market.

Twenty years of climate change research on increasing CO_2 levels has failed to develop a model that demonstrates the impact of extreme weather events on agricultural production, although the importance of benchmarking is recognized (Goodess *et al*., 2003): 'One of the biggest problems in performing analyses of extreme climate events for most of the globe is a lack of access to high-quality long-term climate data' (Easterling *et al*., 2000, p.423). For example, Goubanova and Li (2007) attempt to project extremes in temperature and precipitation to 2099 based on only 30 years of data (1970–99).

> Causal relationships between isolated [climate] events and long-term trends are difficult to establish in any statistically meaningful manner. (Beniston and Stephenson, 2004, p.3)

Furthermore, climate change impacts may be nonlinear (Francis and Hengeveld, 1998; Alley *et al*., 2003) as a small change in mean temperature can result in a large change in the frequency of extreme weather events (Mearns *et al*., 1984; Rosenzweig *et al*., 2001). Much uncertainty remains concerning how changes in extreme climate events will affect all agricultural sectors (Dessai *et al*., 2004; Easterling and Aggarwal, 2007), although it is recognized that increases in extreme weather events can adversely affect the stability of food supplies (Schmidhuber and Tubiello, 2007).

Climate science is not able to identify definitively how increasing temperature will shape the frequency, magnitude and severity of extreme weather events, although increases are expected in all three. 'Areas subject to high climate variability [e.g. midwest US, northeast Argentina, southern Africa and southeast Australia] are likely to expand, whereas the extent of short-term climate variability is likely to increase across all regions' (Schmidhuber and Tubiello, 2007, p.19704). The WTO has examined climate change and trade in a comprehensive manner. Entitled *Trade and Climate Change* (WTO–UNEP, 2009), this study charts the relationship between increasing CO_2 emissions, temperature and agricultural production, and arrives at conclusions that are consistent with the literature reviewed in the previous section, although this report does not generally move beyond a description of extreme weather event impacts. Two points from the WTO–UNEP report are especially relevant to the present study: (a) the report argues that international trade can be used to cushion climate change impacts in agriculture, but the extent that trade can play this buffering role depends on accurate price transmission between supply and demand; and (b) the report recognizes that countries which do not have comparative advantage in agriculture could be adversely affected if their exporting partners restrict such trade (WTO–UNEP, 2009, p.62).

In summary, public attention has been primarily drawn to climate change and increasing temperature, but the real issue for agricultural trade policy may be climate change and increasingly extreme weather events. The world may be able to produce sufficient amounts of agricultural goods to meet demand (into the next century) in a warmer world, but the question in the present paper is whether we will actually be able to get product to market. The primary concern in a warmer world is not market efficiency, but market efficiency and market reliability.

Study methodology

An exploratory research design was adopted in the current study by focusing on agricultural trade policy and food security through interviews with informed policy specialists selected through a non-probable judgmental sample. Each interview respondent was assured of confidentiality as a strategy for seeking candid views. All respondents had expertise in international trade policy, agricultural policy, economics, agricultural economics or agrometeorology. Respondent technical knowledge about climate change and its potential impacts on agriculture varied.

Interviews were conducted primarily in Geneva and Rome, given the study's conceptual framework and the necessity of non-probable judgmental sampling. Rome is the global centre of agricultural policy knowledge because it is home to the Food and Agricultural Organization of the United Nations (FAO), and Geneva is the global centre of international trade policy knowledge because it is host to the World Trade Organization (WTO). In addition to the two primary organizations, interviews were also conducted with representatives of a number of other international organizations including the European Commission.

A diplomatic community of relevant experts surrounds the two primary organizations, the FAO and the WTO. Representatives of national governments were identified in Rome and Geneva on the basis of a country's degree of national agricultural independence or dependence. Agricultural independence is defined as the difference between agricultural exports and imports (positive exports). Agricultural dependence is defined as the difference between agricultural imports and exports (positive

imports). In conducting this assessment, data were obtained for 186 countries from the FAO (see Table 1). Simple analysis identified the top 20 agricultural exporters or those countries least dependent on others for agricultural goods (left side of Table 1), and the top 21 agricultural importers or those countries that are most dependent on others for agricultural goods. The 41 target countries each achieved a threshold of US$1500 million in total exports over imports or total imports over exports (i.e. the 145 countries excluded from the study were each below this US$1500 million threshold).

Interviews were conducted with ambassadors or diplomats representing 33 nations.[7] In total, 67 interviews were conducted that included 84 respondents. Of these, 31 were employed by international organizations (primarily the FAO and the WTO), and 53 were representatives of national governments through permanent missions or embassies. Of the latter group, 14 were ambassadors and 39 were diplomats. Interviews were conducted with representatives of 18 of the 35 countries (plus the European Union) that are members of the WTO special sessions of the committee on agriculture. Interviews were also conducted with 10 Cairns group members (a WTO coalition of agricultural exporting countries), and four members of the G10 (a WTO coalition of agricultural net-importing countries). Interviews were conducted in English.

There are limitations to the methodology. The 84 respondents, as a non-probable judgmental sample, are not a representative sample of diverse interests. The agricultural diplomatic community and the trade diplomatic community each include their own unique social norms that may produce a biased point of view. It is important to recognize that other informed opinions also exist (among NGOs, farmers, producer associations, etc.). The research design did not seek to incorporate diverse interests. Rather, relevant expertise, reflective of WTO and FAO views, was sought as these international organizations are instrumental in establishing global policy in trade and food security.

Agricultural trade policy and climate change

This section briefly considers the study of trade and climate change, and then examines WTO efforts to establish a non-distorted multilateral agricultural market by liberalizing trade in agriculture through the control of export subsidies, domestic support and tariffs via the WTO Doha Development Agenda negotiations. It then considers WTO policies concerning agricultural export prohibitions and restrictions, while examining a specific case that is relevant to trade policies and food security – the 2007–08 food panic. This case demonstrates that the WTO does not have a desire to curtail WTO members' right to stop exporting agricultural goods when they wish to do so. The section concludes by examining interview data that considers the relationship between initiation of agricultural export restrictions (discontinuing agricultural exports) and extreme weather events.

There is a growing literature on the intersection of trade policy and climate change (see Zhang and Assuncao, 2004; Brewer, 2010; Dong and Whalley, 2010; Keen and Kotsogiannis, 2014) with a particular interest in how such interaction impacts on competitiveness (Stern, 2006; Aldy and Pizer, 2009; Kee *et al*., 2010). As noted previously, the World Trade Organization has begun to examine climate change, but the WTO is primarily concerned with administering trade agreements and providing a forum for trade negotiations, such as the Doha Development Agenda

Table 1. Leading agricultural exporters and importers

Agricultural exporting countries	Agricultural exports (US$ million)	Agricultural imports (US$ million)	Agricultural exports>imports (US$ million)	Agricultural exporting countries	Agricultural exports (US$ million)	Agricultural imports (US$ million)	Agricultural imports>exports (US$ million)
Brazil	27,215	3598	23,617	Japan	1873	41,478	39,605
Netherlands	47,818	28,707	19,111	China	20,827	41,688	20,862
Australia	20,871	4470	16,400	United Kingdom	21,185	41,406	20,221
Argentina	15,839	886	14,953	Germany	39,240	50,822	11,582
France	46,642	34,638	12,005	Russian Federation	2197	12,363	10,166
New Zealand	10,031	1790	8241	South Korea	2135	10,616	8481
Thailand	11,926	3830	8096	Italy	24,424	31,694	7270
Denmark	13,185	7108	6077	Saudi Arabia	372	6203	5832
Canada	20,574	15,194	5380	Algeria	55	4050	3995
Malaysia	10,917	5842	5075	Mexico	9879	13,439	3559
Spain	24,294	19,798	4495	Switzerland	3269	6725	3456
Ireland	9246	4960	4286	United Arab Emirates	1404	4825	3421
Indonesia	9401	5181	4220	Portugal	2439	5800	3361
United States	63,893	59,874	4019	Sweden	3351	6648	3297
Belgium	26,304	23,042	3263	Greece	3122	5754	2632
Chile	4268	1655	2613	Norway	611	3051	2440
Côte d'Ivoire	3093	711	2382	Venezuela	210	2206	1996
India	7058	5108	1950	Bangladesh	114	1984	1870
Ukraine	3415	1691	1724	Nigeria	487	2264	1778
Colombia	3390	1859	1532	Egypt	1314	3014	1700
				Iran	1427	3055	1628

Source: *FAO Statistical Yearbook 2005–2006 (Vol. 1)*, Trade Tables C1 and C2, available from http://www.fao.org/statistics/yearbook/vol_1_1/site_en.asp?page=trade.

(DDA). Nevertheless, by plan or by default, future trade policy needs to be sufficiently well informed to cope with the complex challenges presented by a changing climate. Current DDA negotiations convened through the WTO Special Sessions of the Committee on Agriculture may provide some insight into future trade policy opportunities and constraints. Two items are of special significance to international agricultural markets in a warmer world: (1) the current DDA agricultural agenda that is focused on trade-distorting subsidies and market access; and (2) negotiations over rules regulating agricultural export prohibitions and restrictions.

DDA agricultural agenda

In interviews, many specialists observed that a multilateral, agricultural market based on comparative advantage provides market efficiencies as this system generally produces and delivers the food required by the global community on an annual basis. One FAO interview best captured this view:

> High quality transmission between markets effectively facilitates production-side and consumption-side adjustments, and over time encourages development of agricultural production in areas where it can be conducted most effectively. (Former FAO director, Geneva)

Negotiations to conclude the DDA currently represent our best hope of establishing a non-distorted multilateral, agricultural market (*cf.* Blandford *et al.*, 2010). It is clear that a firm consensus has been established to remove agricultural export subsidies (WTO, 2008), although the DDA stand against domestic subsidies is not as firm. The DDA is considering a tiered formula to reduce overall trade-distorting domestic support (OTDS), which is a complex trade-management tool that measures a nation's total contribution to trade-distorting domestic subsidies and then establishes a cap on the total amount of domestic support for various classes of country (WTO, 2008, 2011).

> A critical aspect of the Doha round is developing the means to establish caps on trade-distorting activities. Once these protocols are adopted, it will be a matter of ratcheting down these caps in future trade negotiations. (Chinese trade minister, Geneva)

However, several interviewees observed that the current DDA proposal has too many exceptions and loopholes. Now that the WTO has developed the OTDS, this institution needs to adopt a schedule to phase out trade-distorting domestic support over the next 10 years. The global community will be prepared to adapt to climate change if export and domestic subsidies are removed. As the world becomes warmer, it is important to recognize that we are running out of time before thresholds are crossed and so we need to move as quickly as possible to lock in security offered by a multilateral agricultural market built upon comparative advantage.

The other primary WTO agricultural agenda item involves market access through the reduction or elimination of tariffs, tariff quotas and the application of special safeguard mechanisms (SSM). Developed countries will reduce their agricultural bound tariffs over five years through a detailed formula. Over a period of 10 years, developing countries will reduce their tariffs to two-thirds of the equivalent cuts of developed countries. Least-developed countries and some recently acceded WTO

members will not be required to reduce their tariffs under the draft agreement. Actual tariff reductions are also established through SSM application, which is the amount of flexibility with which developing countries are provided within the DDA with regard to reducing or eliminating tariffs (WTO, 2008).

Reducing and eliminating tariffs is also important in establishing an efficient multilateral agricultural economy. A 50% reduction in border protection will have a much larger positive impact on developing economies' exports and welfare than a 50% reduction in agricultural subsidies (Hokeman *et al*., 2004, p.175). A second study concurs, concluding that removal of market access barriers, such as tariffs explains 93% of welfare benefits with domestic support and export subsidy removal contributing 5% and 2% respectively (Anderson *et al*., 2006). Such research has been used to support how the WTO seeks to phase in the reduction of subsidies and tariffs: 'Outlawing agricultural export subsidies is the obvious first step' (Anderson and Martin, 2007, p.89). This is especially so since the DDA has succeeded in building a consensus against export subsidies. But what is the next step? Should the DDA seek substantial gains available through tariff reductions or should it concentrate on the elimination of domestic subsidies through the phased introduction of the OTDS?

In a stable climatic environment, the greatest gains should be pursued first – although it is important to recognize that exports produced with the help of domestic support could be highly disruptive to domestic agricultural markets that no longer have tariff protection. Nevertheless, projected gains far outweigh potential costs (Anderson *et al*., 2006) if the multilateral agricultural market remains stable. However, gaining such benefits could come with substantial attached costs in a world with an unstable and/or unpredictable climate as multilateral markets may be disrupted periodically. What should net-agricultural importing countries do in preparation for such events? The WTO should think carefully about the relationship between domestic support and tariffs. Tariffs should be removed, but only after domestic support is successfully eliminated. Once lost, an agricultural sector is difficult to re-establish.

> In the last 20 years, Malaysia has focused on developing its industrial sector while its agricultural sector has not received sufficient attention. To complicate matters, land that was dedicated to farming is now used for industrial or residential purposes, and those Malaysians that once worked in agricultural are no longer involved in farming. Now there is concern in Malaysia about re-establishing a viable agricultural sector. (Malaysian trade minister)

Similar observations about conversion of agricultural land into non-agricultural purposes were heard from representatives of European nations.

Over the last 40 years, there have been five spikes in world food prices (1974–76, 1980–82, 1988–90, 1995–97 and 2007–08), each of which lasted about two years. These 10 abnormal years represent 25% of the total of the period, with world food prices being stable, on trend or depressed during the remaining 30 years (Sharma and Konandreas, 2008; Trostle, 2008).

> Perhaps in the future agricultural price volatility could occur 40% or 50% of the time … with a changing climate contributing to agricultural price volatility. (FAO senior economist)

Developed and/or wealthy countries will probably be able to manage frequent price volatility, but other countries will experience significant challenges. SSM can be used as a tool to provide developing countries with sufficient flexibility to protect agricultural sectors from exports that enjoy domestic support, although DDA negotiations deadlocked over this and other issues.

Agricultural producers that benefit from domestic support could disrupt or damage agricultural systems in export markets that no longer have tariffs under the proposed DDA arrangement. Projected gains may far outweigh potential costs in this arrangement (Anderson *et al*., 2006), but this simple economic assessment does not consider the risks of losing domestic agricultural capacity in a changing climate.

In summary, the obvious solution to this concern is to implement fully OTDS, establish caps, ratchet down these caps over 10 years and then begin to reduce tariffs. Agricultural export subsidies should be removed immediately, followed by domestic support and only then followed by tariffs and tariff quotas.

Export prohibitions and restrictions

Although not a primary agenda item, DDA negotiations have also considered agricultural export prohibitions and restrictions. Historically, international trade negotiations have spent little time on this topic.

> The WTO is not really concerned about export restrictions. (FAO director)

> The WTO has only focused on low agricultural prices, high tariffs and high subsidies. (WTO counsellor)

> The WTO has no role in regulating export restrictions, as no country wants to give up their right to stop exporting agricultural goods. (Indian trade official)

On the other hand, WTO net-agricultural importing countries, such as the G10, express concern about the unrestricted right of exporters to stop agricultural exports.

> The G10 is very concerned that the WTO [special sessions] agricultural committee is basically uninterested in regulating agricultural export restrictions. (Swiss minister)

> It is unfair that the WTO imposes obligations on importing countries but not exporting countries. (Korean diplomat)

> Japan will be forced through the DDA to become even more dependent on imported food. The free market destroys Japanese farming and then exporters refuse to sell. It's not fair. (Japanese trade official)

GATT Article XI 2(a) (1947/1994) establishes WTO member rights to limit agricultural exports by allowing 'Export prohibitions or restrictions temporarily applied to prevent or relieve critical shortages of foodstuffs or other products essential to the exporting contracting party'. The Uruguay Round Agreement on Agriculture (AoA) Article 12 (1994), entitled Disciplines on Export Prohibitions and Restrictions, later elaborated on this right. It specifies that WTO members deciding to institute export prohibitions and restrictions shall give due consideration to their effect on importing members' food security, and specifies that 'before any Member institutes an export

prohibition or restriction, it shall give notice in writing, as far in advance as practicable, to the Committee on Agriculture'. Article 12 also instructs that exporters 'shall consult, upon request, with any other Member having a substantial interest as an importer … [and] shall provide, upon request, such a Member with necessary information'.

The 2007–08 food panic put export prohibitions and restrictions back on the negotiation table.[8] The Swiss and the Japanese (leading G10 members) submitted a proposal to establish notification and consultation processes via a transparent system.[9] The DDA Agricultural Committee considered this proposal and essentially rejected it, although the chair of the committee did include relevant language in the December 2008 version of the WTO revised draft modalities for agriculture (2008). The chair's proposed change establishes 12–18 month time limits for export prohibitions and restrictions (where no limit is found in GATT Article XI or AoA Article 12).

However, we observe in the 2007–08 food panic that social disorder can develop quickly once nations begin to prohibit agricultural exports (Trostle, 2008). In a worst case, climate change scenario, social disorder and famine could emerge in agricultural importing countries long before the proposed time limits are reached. The changes proposed in December 2008 also modify when notice must be given. AoA Article 12 requires notification before instituting prohibitions or restrictions, but proposed changes allow notification up to 90 days after export prohibitions and restrictions enter into force. The difference is significant as a food panic may be averted when relevant information is provided as early as possible.

The reaction of the DDA Agricultural Committee to the 2007–08 food panic does make a clear point. WTO members do not desire to discipline export prohibitions and restrictions. This is significant from one perspective as it demonstrates that policies for export restrictions and prohibitions are not currently a viable tool for climate change adaptation. From another perspective, however, export prohibitions and restrictions are actually a false food security tool. Even if trade disciplines were much stronger (e.g. clearly forbidding agricultural export prohibitions and restrictions), such policies would be ineffective or unenforceable.

> Nations will not follow WTO rules if things become desperate as national security will take precedence. (European Union head of delegation)

> In case of a massive upheaval, I doubt WTO rules will prevent many governments doing what they think is necessary. Legal cover could also be provided by GATT Articles XX [general exceptions] or XXI [security exceptions]. (Email from WTO counsellor, September 2009)

> Countries considering export restrictions need to feed their own people first and then export agricultural goods if they are able. Such countries should not be blind to the problems of their neighbours. (Bangladeshi trade official)

In many interviews, discussion was steered toward the question of increasingly extreme weather events triggering national governments to establish agricultural export restrictions. No respondent thought this question lacked relevance or validity. Of 23 interviews in which this question was considered, four respondents said they did not know or could not address the question. Five shifted the topic and avoided answering the question. The remaining 14 respondents, including four WTO policy specialists, answered the question directly and said they thought it likely that an

increase in extreme weather events would trigger many national governments to establish agricultural export restrictions. These responses are meaningful and deserve to be considered by national governments and relevant international organizations.

In summary, establishing a non-distorted multilateral agricultural market requires the removal of export subsidies, domestic support and tariffs. There is global consensus that export subsidies should be removed immediately. Economists recognize that the greatest welfare gains will come from abandoning tariffs and argue that tariffs should be reduced and/or removed as soon as possible, while domestic support can be removed gradually. However, this paper argues that nations without agricultural factor endowments and without agricultural tariff protection will probably experience agricultural production disruption through the import of agricultural goods that have gained competitive advantage through domestic support. In this policy environment, some countries will lose the capability to produce agricultural goods, which could result in the loss of their agricultural sector – an agricultural sector these nations may wish to maintain if agricultural exporting countries decide, *en masse* (as in 2007–08), to stop exporting agricultural goods. Finally, many policy specialists associated directly or indirectly with the WTO thought that an increase in extreme weather events could trigger many national governments to establish agricultural export restrictions and cease exporting agricultural goods.

National food security

The following section outlines a scenario involving climate change and the initiation of a global food auction – similar to the auction that occurred in 2007–08. This scenario invites national governmental leaders, especially leaders of developing and least-developed countries, to consider the balance between dependence on the multilateral agricultural market and national independence in agriculture (not self-sufficiency). This section proposes that national governments establish or strengthen a regulatory framework that supports agricultural infrastructure projects from production to market. A number of national-based agricultural programmes are outlined that could support or contribute to national agricultural independence.

Multilateral markets and national governments

An increase in the frequency, magnitude and severity of extreme weather events could trigger WTO members to institute agricultural export restrictions through GATT Article XI (1947/1994). A WTO–UNEP (2009, p.62) report observes that 'matters will only deteriorate if its partners restrict trade to safeguard their own [agricultural] supplies'. Such decisions, made independently by the leaders of multiple agricultural exporting nations, could contribute to a breakdown of the multilateral agricultural market for months and contribute to social disorder in affected countries.

Thirty years ago, Amartya Sen (1981, p.158) concluded that 'severe famine conditions can develop for reasons that are not directly connected with food production at all'. Over time, such price shocks may occur periodically as the world becomes warmer.

Imagine a period in the near future when Australia and India must endure extended droughts, Central America and Southeast Asia are consumed by recurring cyclones, parts of China and North America are drenched in torrential rains, and Africa, Europe and the Middle East are afflicted with severe heat waves. Imagine that all these climatic events play out around the same time, in a single year or over

several years. This is not an unrealistic scenario. Cities, communities and seasonal harvests will be destroyed and many people may die. Nevertheless, suppose there is still sufficient food to feed all or most of the global community if multilateral trade in agriculture continues to operate as designed. How will the leaders of national governments behave in this scenario? The future is difficult to predict, but reasonable possibilities can be identified by drawing on historical precedent. Although the food panic of 2007–08 had very little to do with climate change, it may serve as an instructive example of government behaviour when national leaders perceive a crisis.

Under such conditions, it is expected that certain net agricultural importers, such as Japan, Korea, Norway, Switzerland and wealthy oil-producing countries from the Middle East, will drive global agricultural prices even higher as they compete for any agricultural goods that are available for export. These countries are relatively insensitive to price changes because of their wealth. For example, massive price jumps occurred in commodities in the 2007–08 food panic once countries began to limit or restrict agricultural exports (Baltzer *et al*., 2008; Trostle, 2008). In this scenario, least-developed countries may survive only through official development assistance (ODA) and resilience. Developing countries without significant factor endowments in agriculture will be unable to compete in this recurring global food auction and securing ODA is harder for them than for least-developed countries. The governments of such countries should be concerned.

Rethinking the balance between interdependence on an efficient but unstable multilateral agriculture market and national independence in agriculture will be critical in preparing for a changing climate. Dependency on a highly efficient but unreliable multilateral market is misguided, as is national self-sufficiency. There is no one-size-fits-all solution to the problem of finding the balance between interdependence and independence in agriculture.

Having food or having an entitlement to food is key. Having direct control over food or policies and programmes that deliver food is one form of entitlement (Sen, 1981), and such entitlement is more effectively realized at the national level than the multilateral level. Both multilateral and national approaches are essential.

So far this paper has examined only multilateral approaches *via* the WTO. The next section considers national approaches to food security through a policy that seeks to develop multiple food delivery systems.

Rethinking the national agricultural system

National governments should actively support the efficient and effective functioning of the agricultural system within their borders. National governments should establish a regulatory framework that supports domestic agricultural market liberalization and supports investment in agricultural infrastructure to develop production systems that achieve, or come close to achieving, international comparative advantage. A robust national agricultural research and development (R&D) programme aimed at agricultural infrastructure systems will contribute to national resilience in a warmer world.

Officials interviewed at the UN World Food Program highlighted the importance of infrastructure projects that support agriculture from production to market. Establishing and maintaining water reserves, irrigation schemes, electricity systems, storage facilities and transportation to markets require significant expenditure. Governments should establish an agricultural infrastructure budget and/or develop a strategy to secure such funds through ODA as one part of a national food security policy. Many respondents argued

that national governments have lost sight of the importance of supporting agricultural infrastructure and that there is now an urgent need to re-focus on this vital concern. The G8 have acted by seeking to mobilize US$20 billion for sustainable agricultural development and emergency food aid, but this was over five years ago.[10] Such commitment must be maintained. In addition, the relevance of a number of secondary food security systems should be considered at the national level country-by-country.

Agricultural supplier relations. National governments will also want to look carefully at policies concerning the nature and quality of exporter–importer agricultural relations. Japanese, Singaporean and Swiss respondents (each agricultural net-importing countries) elaborated on the importance of maintaining long-term agricultural supplier relations in assuring food security – the Japanese with Australian exporters, the Singaporeans with Thai exporters, and the Swiss with Canadian exporters. For example, the Swiss could not source wheat from European suppliers after World War II and went to the Canadians for wheat. Today, the Swiss continue to purchase wheat from the Canadians although they could now grow all their own wheat if they wished. The Swiss do not grow their own wheat because they consider their 60-year relationship with the Canadians to be a form of food security. Historical relations between nations have a special quality that supports stability and hence reliability, although this is not the only supplier strategy.

> The risks of insufficient agricultural imports are minimized through a national policy that maintains a diversity of food suppliers, although if exports dry up then this ultimately will not protect a nation either. (US minister-counsellor)

> Governments can encourage agricultural importers to diversify in terms of sourcing so that a nation is not dependent on too few exporters for a particular staple food. (Singaporean trade negotiator)

An ideal national food security policy will combine the two approaches: a diverse number of agricultural suppliers maintained over the long term. In a warmer world, it will be prudent to establish long-term agricultural relations in diverse geographic areas just in case a changing climate reduces production in specific areas.

Foreign direct investment. Wealthy countries without adequate agricultural factorendowments (such as the Middle East) or with high population and inefficient agricultural sectors (such as Japan and Korea) may explore the possibility of foreign direct investment (FDI) in agriculture. For example, note the sudden and substantial increase in agricultural FDI following the 2007–08 food panic (Haralambous *et al*., 2009). FDI in agriculture is currently occurring in Africa and Asia, primarily government to government, private sector to government, and private sector to private sector (von Braun and Meinzen-Dick, 2009). An Indonesian diplomat interviewed spoke positively about a recent Saudi Arabia public–private proposal to secure 50,000 hectares of land to grow rice and corn in eastern Indonesia for the Middle East market.

Many respondents in Rome and Geneva expressed views on FDI in agriculture, though it is clear that with this development comes controversy. On the one hand, many policy specialists saw the positive benefits of this development:

> There is no problem at all with one nation securing land in another nation to produce crops to be consumed by the FDI country. Multiplier effects would be apparent, including technology transfer and infrastructure development in the host country. (Former FAO director)

> FDI in agriculture represents a strategic resource for the countries conducting such business. (United States minister-counsellor)

> The Saudis have invested in agricultural production in Ethiopia and it appears to be a win–win situation. The Saudis very much want a stable food supply and this project provides it, while Ethiopia receives agricultural knowhow, technology and capital. However, FDI in agriculture can be a form of colonialism if it is not managed properly. (South African ambassador)

> It makes perfect sense to engage in agricultural FDI programmes on food security grounds but it looks like colonialism and so it will not be acceptable to some. (Norwegian ambassador)

> If agricultural FDI operates as an exclusive buyer–seller arrangement it is an unhealthy business model. FDI in agriculture is fine as long as the produce is sold on the open market. (WTO counsellor)

> FDI in agriculture is something that the private sector should be involved in and not a government. (South Korean minister counsellor)

It is clear that international FDI rules need to be further developed in agriculture and there were discussions on this topic at the G8 2009 summit at L'Aquila in Italy, although a firm position was not achieved. Once more, if specific FDI rules are developed then technical assistance should be offered to developing countries to help them negotiate agricultural FDI agreement as such arrangements could, in principle, provide benefits to both sides (Evans, 2009). Agricultural FDI agreements could contribute to national food security for developed and wealthy countries seeking these opportunities and developing and least-developed countries that might attract such investment if international rules were to promote outcomes that serve the fundamental interests of each side.

National food reserves. A national programme to establish and/or maintain food reserves is also part of the national policy mix, although such programmes come with challenges. Public stockpiles are costly to maintain and involve difficult management issues, such as uncertainty about the quantity of stocks required and the amount to release at any stage (Ivanic and Martin, 2008). Such challenges may be too great:

> Governments used to keep food reserves, but it became too costly and so they have been getting out of that operation. A food reserve serves as a hedge against increasing agricultural prices on the global market. (Former FAO director)

> It is important for nations to keep up to nine months' food in reserve to get through one growing season. It is not necessary to feed the entire population, but food reserves will need to be established for some portion of the population. (WTO counsellor)

The critical question is not if a national food reserve should be operated, but rather who should operate it. Should food reserves be operated directly by the government, or should the government require the private sector to manage a viable food reserve system that would allow passing on the costs of food storage and food rotation to consumers? The Singapore government, for example, has turned over significant responsibility for managing the national food reserve to the private sector:

> Major importers, such as the National Trades Union Congress FairPrice Co-operative, are required to contribute a defined amount of rice to the national stockpile. (Singaporean ambassador)

More research is needed into the question of public or private management of a national food reserve as there will be certain advantages and disadvantages to each approach. For example, if the private sector is the best place to manage food reserves, then what kind of governmental policy framework is most useful? What private players in the food supply system are best prepared to manage a national food reserve in a country that is an agricultural exporter (e.g. production, wholesaler, retail) or an importer (e.g. importer, wholesaler, retail)? In linking a national reserve to a regional reserve, will a public or private national food reserve more effectively integrate into a regional reserve?

Regional food reserves

> Food security not only means having sufficient food for your own people. If your neighbours do not have food, then this also becomes your problem. (Ukrainian trade negotiator)

Although unsuccessful, the Association of Southeast Asian Nations (ASEAN) has sought to address this specific problem by adopting the agreement on the ASEAN Food Security Reserve and more recently ASEAN+3 (including China, Japan and Korea) established the East Asia Emergency Rice Reserve with a secretariat in Bangkok. Unfortunately, EAERR rice reserves were too small to offer support during the 2007–08 global food panic.

An American trade diplomat and a former senior FAO official separately outlined the economic challenges of operating a regional food reserve. When food reserves are withdrawn, it reduces global demand for food and results in a lowering of the global price of the commodity being withdrawn. If a regional food reserve has a mix of members, then motives for operating the reserve will differ – especially among exporters and importers. For example, exporters will benefit from high global prices because they have product to sell at this high price, and importers will not benefit from this high price because they must buy at inflated prices. Regional food reserves offer important economies of scale by sharing costs and risk, although it is difficult to operate regional reserves for these reasons. Clear and transparent rules on when and how a member can draw down regional reserves is the only solution, although it will be difficult to achieve a regional agreement that can establish policies that support such rules. National governments are advised to establish and maintain national food reserves until regional associations can establish clear and transparent policies and rules. International agriculture and trade research centres should study this complex problem in detail.

Table 2. Climate change adaptation: multiple food delivery systems

Primary food security system
A non-distorted multilateral agricultural market grounded in comparative advantage by removing export subsidies first and then domestic subsidies, followed by tariffs
Secondary food security systems
National agricultural system: develop and maintain domestic agricultural system by various means, including investment in agricultural infrastructure to achieve comparative advantage when possible (once the WTO Doha Development Agenda negotiations reach a successful conclusion)
Supplier relations: agricultural importers maintain geographically diverse group of long-term suppliers
FDI: foreign direct investment for countries with inadequate agricultural factor endowments and/or inefficient agricultural sectors
National food reserves: public or private sectors food reserves?
Regional food reserves: national food reserves as part of regional strategy
Consumption side adjustments: national strategy encourages less consumption

Consumption-side adjustments. It is also useful to consider the consumption side of food security.

> There are 7.5 million Swiss and the average Swiss citizen consumes 3400 kilocalories per day, which results in the Swiss importing 40% of the food they consume to meet this demand. However, if the nation could bring this amount down to a per person average of 2400 kilocalories per day, then that would result in the Swiss only importing 20% of the food that they consume. Reducing national consumption provides food security and national health benefits. (Swiss Minister)

Table 2 provides a list of food delivery systems that can contribute to a national food security policy that supports climate change adaptation.

Most important is the role of social and organizational evolution in conceiving and developing national agricultural strategy for a warmer world. First, non-market or quasi-market solutions are likely when markets experience friction (Williamson, 1973). Second, successful, political-economic systems have evolved flexible institutional structures that can survive the shocks and changes that are a part of successful evolution (North, 1994).

Conclusion

> There must be a trade-off between efficiency and stability in agriculture. (Former FAO director)

This paper has examined the challenges that may appear through a changing climate and has sought to balance the desire for efficiency with the need for reliability in multilateral agricultural markets. It appears that supply and demand price transmission cannot assure multilateral market reliability because national leaders are likely to prohibit or restrict agricultural exports in a perceived crisis.

The WTO Doha Development Agenda (DDA) must succeed in establishing a highly efficient multilateral agricultural market. Export subsidies must be removed

immediately, followed by domestic subsidies and then followed by tariffs and tariff quotas. Furthermore, all national governments must establish a regulatory framework that maintains domestic agricultural market liberalization and supports investment in agricultural infrastructure to develop production systems that achieve, or come close to achieving, international comparative advantage.

International organizations and national governments would be wise to re-examine the balance between interdependence in multilateral agricultural markets and national independence. Depending on a single agricultural system, such as the multilateral agricultural market or national self-sufficiency, is each an imprudent policy in a warmer world.[11] Although a non-distorted, multilateral agricultural market will be the primary food security system, secondary or back-up systems (managed at the national level) are required. This paper has outlined a range of secondary systems. It is important to recognize that some countries are more vulnerable than others, as not all confront the same risks and not all need to implement the same measures. For example, nations identified as at risk and that can strengthen their national agricultural systems to compete within the multilateral market would be well advised to begin doing so immediately. But how will a nation's agricultural factor endowments evolve as the world becomes increasingly warm?

A changing climate will certainly create future winners and losers. How can future agricultural factor endowments be identified and utilized to prepare for future climate patterns? Such questions require interdisciplinary study at a national and regional level. It will be useful to identify categories or types of risk in this research.

A changing climate compels us to engage in serious debate about balancing desire for economic efficiency with need for national and human security. In essence, market efficiency is essential in a world of scarce resources, but of secondary concern if human survival depends on market reliability. National governments, and the international organizations they create, will ignore this basic principle at their peril.

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Notes

1. *An Inquiry into the Nature and Causes of the Wealth of Nations* was first published in 1776, although this paper refers to the fifth and final edition, published in 1789.
2. David Ricardo's classic study *On the Principles of Political Economy and Taxation* (third edition, 1821) is credited with establishing comparative advantage as an essential economic concept, although Ricardo gives credit to Smith for his inspiration.
3. These neoclassical 'textbook' propositions are rejected by many scholars within and outside economics, including the efficiency of markets and comparative advantage. The WTO, the FAO and other international organizations that control global trade and food security policy generally adopt these propositions.
4. Some scientists argue that climate change is an unpreventable natural phenomenon rather than a result of human activity, and thus mitigation activity is misguided. However, even these scientists recognize the importance of adaptation (see letter signed by 103 scientists and presented to the UN Secretary-General at the Bali UN Climate Conference in 2007, available from http://www.nationalpost.com/story-printer.html?id=164002). Regardless of the scientific debate, world leaders accept climate change as a reality (e.g. the G20 *Leaders' Communiqué* at the Brisbane summit, 15–16 November 2014, available from http://g20watch.edu.au/sites/default/files/pictures/brisbane_g20_leaders_summit_communique.pdf; the UN Climate Change Conference 2009, available from http://en.cop15.dk/; and the G8 Leaders' Statement 2008, available from http://www.mofa.go.jp/policy/economy/summit/2008/). Global policy will be built on an evolving belief that it is safer to assume climate change is occurring than to assume it is not, which is an application of the precautionary principle.
5. Climate change science is greatly influenced by the Intergovernmental Panel on Climate Change (IPCC), a UN body that conducts analysis of the scientific literature and makes recommendations in their assessment reports, most recently published in 2013–14 (see IPCC, 2013, 2014a, 2014b).
6. There is a substantial literature on emission trading schemes and trade. For an overview of climate change mitigation and trade see Hufbauer *et al*. (2009) and of climate change mitigation, agriculture and trade see Blandford and Josling (2009).
7. Argentina, Australia, Bangladesh, Brazil, Canada, Chile, China, Egypt, France, Germany, Greece, India, Indonesia, Iran, Ireland, Japan, Malaysia, Mexico, The Netherlands, New Zealand, Norway, The Russian Federation, Singapore, South Africa, South Korea, Spain, Switzerland, Thailand, Ukraine, the United Arab Emirates, the United Kingdom, the United States and Venezuela.
8. In 2007–08, dramatic commodity price increases triggered a record number of national export restrictions as governments moved to preserve supplies for domestic consumption, which led to even greater price increases (Evans, 2009). The FAO surveyed 77 countries worldwide in early 2008 to identify agricultural trading behaviour during this food panic. One-quarter of the surveyed governments imposed export restrictions, such as export bans or embargoes, export taxes and/or export quotas (FAO, 2008). Fifteen countries capped or halted wheat exports, 14 countries limited or banned rice exports, and at least 12 countries limited corn exports (Mitra and Josling, 2009). For example, Argentina, Brazil, Egypt, India and Indonesia, among other nations, prohibited exports. China, Kazakhstan, Russia and the Ukraine, among other nations, imposed export taxes or ceilings on agricultural commodities.
9. WTO Job(08)/34, Proposal on export prohibitions and restrictions, submitted to the WTO committee on agricultural special session by Japan and Switzerland (30 April 2008).
10. *G8 Joint Statement on Global Food Security* (2009), available from http://www.g8italia2009.it/G8/Home/G8-G8_Layout_locale-1199882116809_Atti.htm.
11. This study has examined climate change, multilateral trade and food security. Many other global challenges exist, including energy security, water scarcity, competition for land and a global population expected to rise to 9.2 billion by 2050 (see Evans, 2009).

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