



Research paper

Attaining food and environmental security in an era of globalization

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ABSTRACT

Attaining the twin goals of food and environmental security in the coming decades poses a significant sustainability challenge. This paper examines the food and environmental security implications of a range of policies affecting the global food economy and terrestrial ecosystems, first in the context of historically segmented markets, and secondly in a hypothetical future world of fully integrated crop commodity markets. We begin by revisiting history, considering how food production and global land use would have evolved over the period: 1961–2006 in the presence of greater market integration. We find that there would have been greater disparities in regional crop output growth, with regions experiencing higher productivity growth tending to expand more rapidly under this counterfactual experiment. Going forward, greater market integration can be expected to reshape the way we think about future food and environmental security. In the presence of continued market segmentation, strong population growth, accompanied by robust overall income projections, results in exceptionally high demand growth, rising prices and increased non-farm undernutrition in Sub-Saharan Africa (SSA) by 2050. On the other hand, if markets are fully integrated, relative rates of productivity growth become key to the regional composition of world crop output and agricultural production and cropland grow much more slowly in SSA. We explore the implications of four policy initiatives aimed at improving food security and environmental outcomes, including enhanced on-farm productivity and reductions in post-harvest losses in SSA, reductions in food waste in the wealthy economies, and a global terrestrial carbon policy. We also evaluate the potential impacts of climate change under these two trade regimes. Our results suggest that, in some cases, the food and terrestrial implications will be radically different in a more integrated global economy.

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1. Introduction

Attaining both food and environmental security in the coming decades poses a significant challenge (Davis et al., 2016; Suweis et al., 2015). On the one hand, providing affordable food and energy to consumers suggests a strategy of cropland expansion, as the world seeks to feed more than 9 billion people in 2050. Indeed some of the Integrated Assessment Models project sizable cropland expansion over the coming decades (Schmitz et al., 2014) – particularly under scenarios incorporating bioenergy into climate mitigation policy (Rose et al., 2012; Wise et al., 2009). On the other hand, preservation of biodiversity and forest carbon stocks mitigates against such expansion. Improving agricultural

productivity on existing croplands is therefore often advocated as an important option for meeting food security objectives in an environmentally sustainable way (Burney et al., 2010).

However, in the presence of smoothly functioning international trade, isolated improvements in productivity can result in rapid expansion of cropland, with attendant degradation of natural resources (Angelsen and Kaimowitz, 2001; Lambin and Meyfroidt, 2011). These potential environmental risks notwithstanding, international economic integration has been shown to offer significant food security benefits in the context of extreme weather events (Burgess and Donaldson, 2010; Verma et al., 2012), provided governments avoid the imposition of export restrictions (Puma et al., 2015). Economic integration can also enhance food security in the context of long run changes in agricultural productivity due to climate change (Reilly et al., 1994; Baldos and Hertel, 2015). So is globalization good or bad for food security and the terrestrial ecosystem? More to the point, given that greater economic integration is viewed by many as inevitable, how are such market developments likely to alter our view of the

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challenges facing the global food system? We explore these questions in the context of historical events as well as prospective policy interventions in the food and terrestrial ecosystems, including improvements in agricultural technology, reductions in post-harvest losses and food waste, as well as climate change mitigation policies.

The history of agricultural markets has been one of episodes of globalization, followed by periods of protectionism and isolation (Johnson, 1973). During times of war there is great interest in ensuring food self-sufficiency, thereby leading to restrictions on imports to stimulate domestic production. Yet another important driver of agricultural protection is the political-economic power of agricultural interest groups. As Hayami and Ruttan (1985) and Anderson et al. (2013) demonstrate, as countries move from subsistence farming and low income levels, to commercial agriculture and higher per capita incomes, government policies directed at the farm sector shift from net taxation to net support of agriculture. The logic is that, at low levels of economic development, the farm sector comprises millions of relatively poor, rural producers, with little political influence. It is hard for them to organize, and, even if they were able to do so, their share of overall employment and GDP is so large as to preclude the feasibility of significant income support for such a large segment of the population. Indeed, with underdeveloped institutions and small manufacturing sectors, agricultural commodities are one of the few tangible items which can be effectively taxed in the world's poorest countries.

Over time, as countries become wealthier, and their manufacturing and service sectors grow, wages rise, farms consolidate, agriculture becomes more capital intensive and the number of farmers inevitably declines. This improves the opportunities for political mobilization. Also, with farming accounting for a smaller share of GDP and economy-wide employment, richer countries, with well-developed industrial and service sectors, and strong government institutions, can now draw on a broad-based tax system to subsidize the shrinking farm sector as has been the case most recently in China (Gale, 2013). So it is hardly surprising that the rich countries of the world tend to subsidize agriculture (Anderson, 2009).

From the point of view of world markets, a critical question is how this support is provided to the farm sector. Up until the Uruguay Round Agreement of the World Trade Organization (WTO) it was very common to intervene at the border with quotas and export subsidies, preventing smooth adjustments in trade in response to changing supply and demand conditions (Martin and Winters, 1997). This wreaked havoc in world markets, and contributed to substantial differences between domestic and world prices. Subsequently, there were important efforts to decouple producer support from production and consumption decisions – particularly in the European Union (Swinnen, 2010). This has improved the functioning of global markets, although many barriers to agricultural trade remain (Anderson, 2009) and these have proven to be stumbling blocks on the path to a new WTO agreement. The current Doha Development Round of WTO talks was initiated in 2001, yet still has not been successfully concluded.

Frustration with the lack of progress in multilateral trade negotiations gave rise to an explosion of bilateral and regional trade agreements. Indeed, since the year 2000, more than 200 bilateral trade agreements have been reported to the WTO (WTO Regional Trade Agreements, 2016). One of the most important developments over the past few decades has been the enlargement of the EU to 28 countries, along with associated reforms to the EU's Common Agricultural Policy (CAP). This resulted in the elimination of its export subsidies and the conversion of much of the producer support into “decoupled” payments which less trade-distorting

(European Commission, 2012). The EU has also established free trade agreements with many of its trading partners, as have the US, Japan and many other large economies. Nonetheless, more than half of the tariff cuts between 2001 and 2013 were the result of unilateral trade reforms as countries have sought to become part of the ‘global value chains’ now coming to dominate the modern food economy (Bureau et al., 2016). In order to effectively participate in such value chains, economies must reduce the cost of goods passing across national borders. Development of these value chains has been further facilitated by major investments in physical and logistical infrastructure, including increasing use of electronic customs clearance (Arvis et al., 2012).

Globalization not only influences commodity markets, it also affects the flow of knowledge, capital and labor between countries and between the farm and non-farm sectors. In the wake of the post-2007 commodity price boom, there was a sharp increase in interest by foreign investors in farmland – particularly in Africa (Deininger and Byerlee, 2010). This was dubbed the ‘land grab’ by many commentators, and, although the number of investments actually consummated was far less than preliminary commitments indicated, this wave of interest demonstrated the great potential for global capital flowing into the agricultural sector. While many saw this as a threat to native communities and the environment (Margulis et al., 2013), others saw this as a chance to bring in new technologies and infrastructure, thereby modernizing the farm sector and boosting productivity in some of the least developed parts of the global food system (World Bank, 2009). Closer integration of farmers into national and international capital markets is expected to make producers more responsive to market conditions – allowing for rapid expansion in the face of high commodity prices – which, as we will see below, also has important implications for food security and environmental outcomes.

In this paper, we explore the frequently posited hypothesis that globalization is bad for food and environmental security. We do so by exploiting a historically validated, global economic modeling framework which allows for analysis of the impacts of five pressing issues in food and environmental security. These are first examined under the assumption that food markets will perform in the future as they have in the past – namely with segmentation between national and global markets. We then turn to a counterfactual representation in which full market integration is assumed. By contrasting the impacts of these five scenarios under market segmentation vs. full integration, we are able to evaluate how globalization can alter the consequences of policy interventions aimed at improving food and environmental security.

2. Materials and methods

2.1. A model for analysis of globalization

In order to understand the historical interplay between globalization, on the one hand, and food and environmental security on the other, it is necessary to utilize a global economic model of agriculture, food and the environment. Here we draw on the partial equilibrium model of agricultural trade nick-named SIMPLE (A Simplified International Model of crop Prices Land use and the Environment) (Baldos and Hertel, 2013; Hertel and Baldos, 2016). As its name suggests, this has been designed around the principle that a model should be no more complex than is absolutely necessary to understand the basic forces governing the global supply and demand for crops, cropland and food prices. The model disaggregates the world economy into fifteen regions, each producing an aggregate crop commodity using a variable combination of land and nonland inputs (Fig. A1 in Supplementary material). Substitution of non-land inputs (e.g., fertilizers, farm

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