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Integrated regional impact assessment of agricultural trade and domestic environmental policies

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ABSTRACT

It remains challenging to derive general findings and conclusions from either economic theory or empirical studies on the relationship between international trade and the regional environment. Consequently, we aim to analyse environmental effects of agricultural trade policies in the Austrian Marchfeld region. We apply an integrated modelling framework that accounts for heterogeneity in agricultural production and environmental outcomes. Scenario analysis is applied to assess regional impacts of different trade policy scenarios. Sensitivity analyses reveal the relative influence of model parameters on outputs. The results indicate that lower domestic tariffs have small beneficial effects on the regional environment. The regional environmental impacts highly depend on the changes in world crop prices through global trade agreements. A laissez-faire market scenario that includes the elimination of trade barriers and agri-environmental payments (AEPs) leads to substantial environmental deterioration. Hence, the alignment of AEPs with WTO trading rules remains an important issue in the trade and environment debate.
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Introduction

The relationship between agricultural trade and environment has received considerable attention in the last decades and seems to remain a disputed issue, which is often related to topics such as deforestation, biodiversity, greenhouse gas emissions, structural change, intensification or extensification of agricultural production, land abandonment or the loss of multifunctional agriculture. The linkage between the environment and international trade has already been acknowledged in the original text of the General Agreement on Tariffs and Trade (GATT, 1986; Article XX). However, the interest in the environmental effects of agricultural trade only started to gain momentum when two major trade agreements were implemented in the mid-1990s, namely the North American Free Trade Agreement (NAFTA) and the Uruguay Round Agreement on Agriculture (URAA). Environmental issues still shape negotiations in the Doha Development Agenda (DDA) (WTO, 2005), and increasing concerns about the environment – globally, nationally and regionally – show that conducting further assessments on the environmental effects of agricultural trade liberalisation remains essential (Moon, 2011).

Both, theory and empirical assessments suggest that it is difficult to anticipate in what extent agricultural trade policies might affect the regional environment and how to respond to possible side-effects. One central conclusion from the debate on trade and environment is that the effects of agricultural trade policy changes on the environment differ largely between regions and pollutants, and that the dynamic and heterogeneous effects of production should be considered in such analyses. Although previous reviews have already emphasised this conclusion (Antle et al., 1998; Jayadevappa and Chhatre, 2000; Cooper, 2005), there still is a lack of regional studies in order to add more detail to this contentious debate. We consequently argue, among others (Henseler et al., 2009), that more regional studies are needed in order to improve our knowledge on trade and environment linkages.

Our study has two major aims. First, we want to provide a brief review of the state-of-the-art literature in the agricultural trade and environment debate (next section). Second, we aim at applying a regional case study ('Regional case study' section) in order to analyse the regional impacts of agricultural trade policies on (a) land use and management choices, and regional producer surplus; and (b) environmental outcomes of agricultural production, such as total nitrogen and phosphorus emissions, topsoil organic carbon

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(SOC) content, and irrigation water use. The impact of domestic trade policy scenarios is assessed through comparative static scenario analysis. In contrast to many other empirical trade and environment studies our analysis also considers the interaction between trade policies and domestic environmental policies, i.e. agri-environmental payments (AEPs). We further scrutinise the range of impact due to global trade policy changes and AEPs in the sensitivity analysis. The regional impact analysis is conducted by employing a regional bottom-up land use optimisation model that integrates outputs from the bio-physical simulation model EPIC (Environmental Policy Integrated Climate) in order to account for the heterogeneity in agricultural production, emission and the regional environment. Our model data is validated against current participation shares in agri-environmental schemes and irrigation water use as well as to similar studies. The paper closes with a discussion and concluding remarks ('Discussion and conclusion' section).

Agricultural trade and the environment

The classical economic theory of trade and environment already shows that trade may have ambiguous effects on welfare if production and/or consumption of a traded good generates positive or negative externalities (Anderson, 1992; Antweiler et al., 2001; Krutilla, 2002), particularly at the aggregate level (Fousekis, 1998). Relaxing core assumptions of neoclassical economics shows that, not very surprisingly, the relationship between trade and environment is even more complex than the standard framework suggests. For example, a widely cited paper in the trade and environment literature by Chichilnisky (1994) shows how ill-defined property rights in transition economies can influence trading patterns with industrialised economies and well-defined property rights even with identical resource endowments. Trade between such two countries can lead to under-pricing and overexploitation of natural resources in transition economies, and thus may exacerbate environmental deterioration. Another theoretical framework by Norgaard and Jin (2008) illustrates that given the existence of transaction costs, the effect of trade on the governance of ecosystem services depends on many factors, such as the initial allocation of property rights, technological development, consumers' change in taste, and the size of the country. This leads them to the conclusion that "trade and environment will likely be complicated and politically contentious issues" (2008, p. 647) such that it remains mainly an empirical question.

Review of empirical findings

Although the environmental aspect of agricultural trade liberalisation often seems to be omitted in economic studies (Zilberman, 2011), there is a steadily growing body of literature since the mid-1990s. Studies that analyse the effects at a global level usually find that trade liberalisation will lead to large production shifts from high-income (e.g. EU and USA) to middle- and low-income countries (e.g. South America, Africa, South-East Asia). While trade liberalisation increases economic efficiency, it can also lead to higher global greenhouse gas emissions (Verburg et al., 2009) and less biodiversity due to the expansion of agricultural land in tropical and sub-tropical forests (Verburg et al., 2009; Schmitz et al., 2012). A study on Ghana shows that the negative environmental effects of agricultural trade liberalisation might even outweigh the increases in economic efficiency (López, 1997). Findings for Mexico are not so clear cut, because the modelled environmental effects have been found to be positive (Beghin, 1997) as well as negative (Williams and Shumway, 2000). Furthermore, Barbier (2000) points to the importance of indirect effects, i.e. migration of unemployed workers and subsistence farmers to frontier areas, which might increase deforestation rates. Findings for high-income countries are even more ambiguous. In the USA and New Zealand, where agricultural production is reported to increase and intensify with trade liberalisation, environmental degradation (e.g. soil erosion, greenhouse gas emissions or intensive fertiliser use) may increase as well (Williams and Shumway, 2000; Cooper et al., 2005; Saunders et al., 2006). On the contrary, agricultural trade liberalisation had a positive effect on crop diversity and organic production in British Colombia, Canada due to the decline in food processing factories which made farmers switch to producing for the fresh market (Fraser, 2006). In the EU, agricultural land use is likely to become more extensive (Maltais et al., 2002; Morrissey et al., 2005; Van Meijl et al., 2006), and some land abandonment might take place in very marginal areas although intensification may still occur in agriculturally favourable areas (Renwick et al., 2013). Similar effects have also been modelled at a more regional level, for the Upper Danube basin in Germany and Austria (Henseler et al., 2009) as well as the Visp region in Switzerland (Briner et al., 2012). In the French region Neste trade liberalisation is assumed to lead to less farm income and more irrigation water use (Graveline et al., 2012). Using a multi-attribute utility theory approach and the concept of virtual land use, Würtenberger et al. (2006) estimate that further liberalisation of wheat markets in Switzerland would lead to a decline in environmental utility. Finally, an econometric study on nitrate concentration in groundwater in Austria indicates a positive correlation with (historical) coupled crop payments and market price support for sugar beet and pork (Sinabell, 2009). This suggests that agricultural production subsidies in Austria may have exacerbated environmental degradation.

Methodological approaches

The methodologies applied in the agricultural trade and environment studies are plentiful. Rather novel approaches are multi-criteria assessments (Würtenberger et al., 2006), qualitative methods (Fraser, 2006) and sustainability impact assessments (Maltais et al., 2002; Morrissey et al., 2005). Although econometric models are often applied in general trade and environment studies (usually with focus on the industry sector) they do not seem to be widespread in agriculture related studies, with a few exceptions (López, 1997; Williams and Shumway, 2000; Sinabell, 2009). A very common approach for national and global assessments is to apply general or partial equilibrium models (Beghin, 1997; López, 1997; Cooper et al., 2005; Saunders et al., 2006; Verburg et al., 2009; Schneider et al., 2011; Renwick et al., 2013). Such models are able to compute global changes in production and consumption patterns and thus commodity prices and quantities as well as trade flows and impacts. Another widely applied approach is the development of bottom-up agricultural land use models. Their application ranges from global (Havlík et al., 2011; Schmitz et al., 2012) to regional levels (Henseler et al., 2009; Briner et al., 2012; Graveline et al., 2012). While early studies only made use of vector emissions attached to production activities (Beghin, 1997), it is currently state-of-the-art to link them with bio-physical process simulation models to better represent the heterogeneous environmental impacts of agricultural production (Schneider et al., 2007, 2011; Verburg et al., 2009; Havlík et al., 2011; Schönhart et al., 2011a; Briner et al., 2012; Schmitz et al., 2012; Stürmer et al., 2013).

However, such model linkages require sufficient and good quality data to provide reliable results, which are rather available at regional scales than on continental to global scales. In particular, bio-physical process simulation models are usually driven by detailed climate, topographical, soil and crop management data, which also determine the predictive accuracy. The strength of bottom-up economic land use optimisation models relies on

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