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Evaluating the Effect of Domestic Support on International Trade: A Mercantilist Trade Restrictiveness Approach

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Evaluating the Effect of Domestic Support on International Trade: A Mercantilist Trade Restrictiveness Approach

Kirsten Urban, Martina Brockmeier and Hans G. Jensen

Abstract:

We use the Mercantilist Trade Restrictiveness Index (MTRI) to develop an extended index that measures the overall trade effects of domestic support payments in a general equilibrium framework environment. Our index is capable of analyzing the development of the trade restrictiveness of domestic support payments over time and across countries and of comparing these payments with other protection instruments. Furthermore, our index helps evaluate agricultural policy reforms that introduce changes into the composition of domestic support payments. We conduct this analysis with an extended version of the GTAP model and database using the EU as an example. Thus, we incorporate detailed EU domestic support payments taken from the OECD Producer Support Estimate (PSE) tables in the GTAP framework and reconcile PSE data with the WTO classification scheme. Although our index slightly increases from 2004 to 2007, the results indicate a decrease in trade distortion stemming from the implementation of decoupled support in the EU. The trade-equivalent protection rate determined under the index shows that domestic support payments restrict trade more than tariffs and export subsidies. Additionally, the index indicates that reducing WTO amber box domestic support payments would lead to decreased trade restrictiveness.

Keywords: domestic distortions, agricultural policies, trade restrictiveness, simulation models

JEL classification: D58, F13, F14, Q17, Q18

1 Introduction

Recent years have witnessed an ongoing debate regarding the trade-distorting effects of domestic support in agriculture. Typically, domestic support is based on a variety of different and country-specific agricultural policy instruments, which makes the impact on trade difficult to address. The importance of such payments has grown as the more detailed reduction requirements for domestic support from the Doha Round have been implemented. As a consequence,

several countries have initiated reforms of their agricultural policies to meet WTO criteria. New instruments have been developed to reduce production-distorting incentives of such payments, such as the Single Farm Payment (SFP) in the EU. Nevertheless, these new instruments, including the SFP, are controversial because payments decoupled from production may still create incentives to produce based on other coupling channels, including uncertainty, imperfect credit markets, land and labor markets, and farmers' expectations about future payments (Bhaskar and Beghin 2009). Thus, the trade-distorting effects of decoupled domestic support remain unclear.

Over the years, two prevailing sets of indicators have been developed to provide information regarding domestic support in the agricultural sector, and these indicators have become accepted worldwide. One of these indicators is the Producer Support Estimate (PSE) from the OECD, which has been calculated since 1986 and is typically accompanied by several other composite measures, such as the Percentage PSE (%PSE), the Nominal Rate of Assistance (NRA) and the Effective Rate of Assistance (ERA). The aim of the OECD in using the PSE is to quantify the effects of national distortions consistently and to establish a common basis for a policy dialogue among countries (OECD 2010). Beginning from the same basis as the PSE, the WTO established the Aggregate Measurement of Support (AMS) concurrently with its amber, blue, and green box subsidy classification scheme in the Agreement on Agriculture (AoA) (WTO 1994). In the Doha Round, the WTO introduced an additional criterion, the overall base level of all trade-distorting domestic support (OTDS) (WTO 2004), to compare the amount of domestic support between countries and to facilitate the negotiation of commitments to reducing domestic support.

Indicators such as the PSE can be classified as traditional weighted aggregates of price distortions and are thus not appropriate for analyzing the trade restrictiveness or economic welfare losses associated with policies (Anderson and Croser 2011). However, aggregation problems persist in quantifying domestic distortions and in other areas. Anderson and Neary (2003) point to the lack of a theoretical foundation in criticizing measures such as arithmetic or trade-weighted average tariffs, non-tariff barrier coverage ratios and measures of tariff dispersion that are frequently used to compare international trade polices over time and across countries. Nonetheless, researchers have developed several theoretically sound aggregation procedures to overcome the aggregation problems that arise from different types and variations of policies across sectors and regions. The general objective is to produce a single index that captures the overall effects of different policy instruments using a consistent theoretical aggregation method. This index should be capable of evaluating trade policies across policy measures, sectors, regions

and, in particular, over time. Initial and influential theoretical work in this area has been published by Corden (1966), Feenstra (1995) and, in particular, by Anderson and Neary (1994; 2003; 2005), who developed two theory-based indexes, the Trade Restrictiveness Index (TRI) and the Mercantilist Trade Restrictiveness Index (MTRI).

Several studies apply and further develop the concepts of the TRI and MTRI for tariff analysis in a partial or general equilibrium environment (Pelikan and Brockmeier 2008a; 2008b; Bureau and Salvatici 2005; Antimiani and Salvatici 2005; Kee et al. 2009). However, the literature on the adjustments and applications that measure the impact of domestic support payments remains scarce. The exceptions in the literature include Anderson, Bannister and Neary (1995) and Anderson and Neary (2005), who adjust their TRI concept to account for factor market distortions and thereby generate an index that consistently quantifies the effects of domestic distortions on welfare. With respect to the MTRI, Anderson and Neary (2005) provide a rough adjustment to cover domestic distortions, but there have been no applications as of yet to validate this methodology. Salvatici (2001) extends the TRI approach to evaluate the EU common agricultural policy by using an adjusted version of the GTAP model that includes modifications in the computation of equivalent variation. Also building on the TRI and MTRI, Anderson and Croser (2011), Croser and Anderson (2011), Croser et al. (2010), and Lloyd and MacLaren (2010) offer a methodological approach that is restricted to a partial equilibrium environment and estimates the relative contribution of different agricultural policy instruments to the overall trade and welfare effect. Utilizing the World Bank's distortions data set, they apply this methodology to generate time series of indexes for agricultural products that can be used to evaluate national policy development and make cross-country comparisons. One caveat regarding their approach is that the estimated indexes include neither non-product-specific domestic support payments as input subsidies not distributed at the product level nor, in particular, decoupled support. Lloyd and MacLaren (2010) contend that partial equilibrium estimates underestimate the true value of the indexes due to the neglect of general equilibrium effects. To overcome this bias, they apply semi–general equilibrium measures that account for input-output relationships.

Although research has addressed certain domestic support issues, other important questions remain unanswered. How harmful is agricultural domestic support for international trade? Are domestic subsidies even more restrictive than tariffs? Has the introduction of decoupled support, such as the EU's SFP, decreased the magnitude of this effect? Additionally, country-specific domestic support typically consists of different categories and types of payments. Conse-

quently, an evaluation tool is required that compares the trade restrictiveness of different policies according to the type and classification of support across countries and that evaluates their development over time. Furthermore, the WTO modalities paper defines commitments to reduce the OTDS and places reduction requirements on the AMS and blue box subsidies. However, most global equilibrium models evaluate the level of domestic support through the OECD PSE. Employing global equilibrium models in the analysis of domestic support reduction, as suggested in the WTO negotiations, requires the WTO amber, blue and green box support classification scheme and the PSE data to be reconciled.

Against this backdrop, our objective is to provide a theoretically based index to evaluate different domestic support payment categories and types over time and across countries that can also serve as an evaluation tool for WTO criteria. In addition, this index should enable us to compare the trade restrictiveness of domestic support, import tariffs, and other protection instruments. To the best of our knowledge, this type of index is not currently available in the literature. Thus, this research contributes to filling the gap of applied analyses measuring the trade restrictiveness of domestic distortions.

Specifically, this study extends the standard GTAP framework to incorporate detailed domestic support categories and payment types. Furthermore, we match the OECD PSE data in the underlying GTAP database with the WTO amber, blue, and green box support classification scheme to reconcile the representations of both important measures of domestic support payments and then integrate them into the GTAP model. We also respond to the question of how this extended GTAP framework can be utilized to calculate domestic support indexes. For this purpose, we build on the work of Anderson and Neary (2005) and Lloyd and MacLaren (2010) and introduce an adaptation of the MTRI that is adjusted to account for domestic distortions into the GTAP model. The methodological approach introduced in this article extends the standard computable general equilibrium (CGE) analyses of international trade liberalization and country-specific policy reforms by employing a CGE model that accurately covers domestic support payments and the corresponding trade restrictiveness using a theoretically sound index.

This article is organized as follows. In section 2, we explain how we adapted the MTRI to measure the tariff equivalent of domestic support payments, which is followed by a description of the extended GTAP modeling framework in section 3. Section 4 introduces the experiment design and simulation results. The closing section discusses our findings, offers political conclusions, and suggests directions for future research.

2 Existing indicators of domestic distortions for the EU

The EU agricultural sector is heavily subsidized. The starting point of the common agricultural policy (CAP) of the EU consisted of policy instruments, such as intervention prices and output subsidies, that primarily created production incentives. Such policies enhanced EU agricultural production on the domestic market, led to oversupplies on the world market, and replaced imports. The EU substantially modified the CAP to address its impact and to meet WTO criteria. In general, these reforms induced reductions in market price supports and output subsidies, and increased decoupled subsidies, such as the SFP.

Figure 1 shows the development of the CAP using OECD PSE data. The PSE consists of market price support (MPS) and budgetary transfers that are subdivided into single commodity transfer (SCT) payments, group commodity transfer (GCT) payments, all commodity transfer (ACT) payments, and other transfers to producers (OTP) payments that comprise the SFP. The graph displays only slight variations of domestic support payments in the 1986-2012 period, whereas it clearly depicts a change in the composition of the PSE.

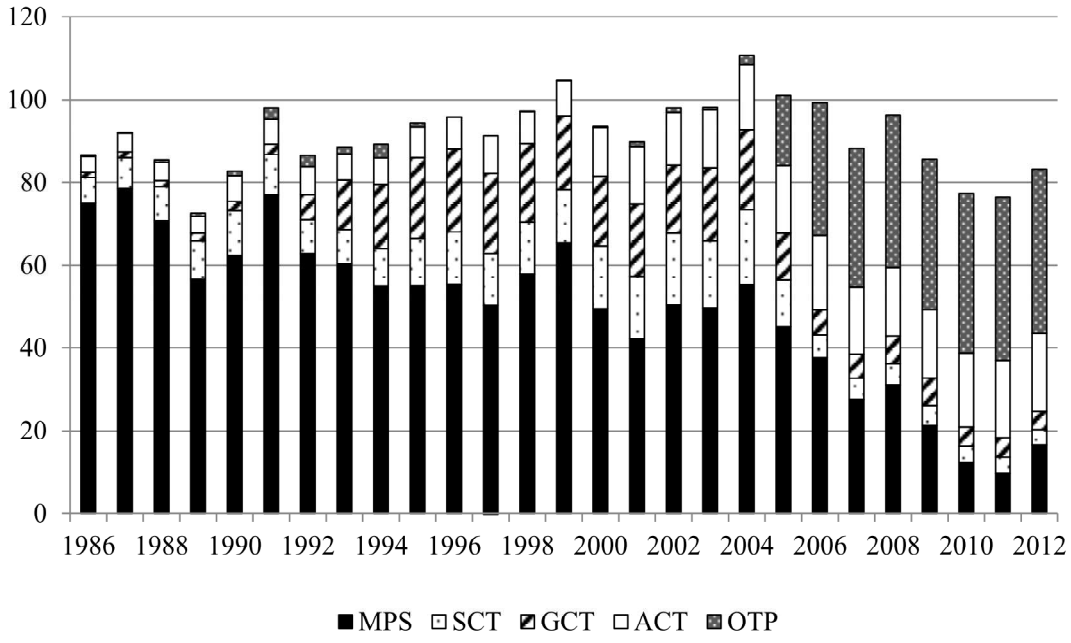

Figure 1. Development of the PSE composition of the EU (in € million)

Source: Authors' elaboration based on OECD PSE database (OECD 2014)

The MPS share of the PSE decreases from more than 90% in 1986 to less than 20% in 2012. The share of budgetary transfers rises accordingly. Furthermore, the composition of budgetary transfers reveals the changes induced by CAP reforms. Figure 1 presents the increase in product-specific (SCT) and group-specific (GCT) domestic support, introduced in 1992 with the McSharry reform, which remains coupled to production. The EU initiated the first attempt toward decoupled support with the Agenda 2000 reform, which is shown in the larger shares of support allocated to all primary agricultural commodities (ACT) in figure 1. In 2005, the EU introduced the SFP (OTP), which was declared to be decoupled from production. The graph highlights that decoupled support has increased considerably since 2005, whereas coupled support has obviously diminished.

The PSE payments are further subdivided according to subsidy types, such as output, input use, land, labor, and capital. Table 1 decomposes the PSE budgetary transfers of the EU25 into payment categories and types for the years 2004 and 2007 to identify the development of these categories and types. The first column in the years 2004 and 2007 present the values for each category (SCT, GCT, ACT, OTP), which are further subdivided into values for each payment type. The second column shows the shares of each category of the total PSE and the shares of each payment type of the corresponding category. The last column of table 1 depicts changes from 2004 to 2007. The total value of PSE budgetary transfers rises by 7% from 2004 to 2007. Furthermore, table 1 emphasizes the significant increase in OTP, which accounts for only € 1,455 million in 2004 but rises to € 31,382 million in 2007. As a result, 53% of the PSE budgetary transfers are classified as decoupled from production.

Additionally, coupled support in the form of product- and group-specific support (SCT, GCT) clearly decreases to values that are less than one-third of their 2004 values, whereas the less-coupled non-product-specific category ACT increases by approximately 9%.

In addition, table 1 depicts considerable changes in the allocation of payments within each category. The composition of SCT shows a move toward payments based on land and away from payments based on output and input use. By contrast, the structure of GCT moves toward subsidies allocated according to input and labor use, whereas ACT shifts toward subsidies allocated according to labor and capital use. Both categories show reduced payments based on land. These changes reflect an increase in production incentives through GCT and ACT payments and a decrease in production effects due to SCT payments.

Table 1. Composition of the EU25's PSE in 2004 and 2007 Excluding MPS (in € million)

	2004		2007		change
Budgetary transfer	**€**	**% share of PSE category**	**€**	**% share of PSE category**	**%**
SCT	**18,012**	**33**	**4,632**	**8**	**-74**
Output	243	1	2	0	-99
Input	5,542	31	922	20	-83
Land	2,061	11	1,173	25	-43
Labor	-	-	-	-	-
Capital	10,167	56	2,534	55	-75
GCT	**19,331**	**35**	**5,529**	**9**	**-71**
Output	-	-	-	-	-
Input	1,304	7	1,190	22	-9
Land	17,479	90	3,633	66	-79
Labor	67	0	768	14	1,046
Capital	482	2	-	-	-100
ACT	**15,785**	**29**	**17,131**	**29**	**9**
Output	-	-	-	-	-
Input	4,553	29	4,627	27	2
Land	7,732	49	6,812	40	-12
Labor	237	2	481	3	103
Capital	3,263	21	5,212	30	60
OTP / SFP	**1,455**	**3**	**31,382**	**53**	**2,057**
PSE excl. MPS	**54,583**		**58,674**		**7**

Source: OECD PSE tables 2004, 2007(OECD 2014) and own calculations

Note: Here we allocated the PSE classification of policy instruments according payment types (output, input, land, labor, and capital) that are used in GTAP.

The WTO scheme classifies subsidies coupled to production as AMS support (AoA Article 6.2) consisting of MPS and non-exempted direct payments (amber box support) or direct payments meeting the criteria of AoA Article 6.5 (blue box support), depending on the extent to which they create production incentives. Decoupled support and other direct payments given to

agricultural producers as defined in AoA Annex 2, paras. 5 and 6 are categorized as green box support because they are only minimally trade distorting. Figure 2 shows the development of domestic support classified according to the WTO scheme from the 1999/2000 – 2009/2010 marketing years. This graph highlights the reduction of trade-distorting amber and blue box support, and the rise of only minimally trade-distorting green box support. Thus, it reflects the movement from market price support schemes to decoupled support schemes. Hence, domestic support categorized according to this WTO scheme shows the same changes that can be seen in the PSE data from the OECD. Josling and Mittenzwei (2013) provide a reconstruction of WTO notification tables using the PSE categories and support types.

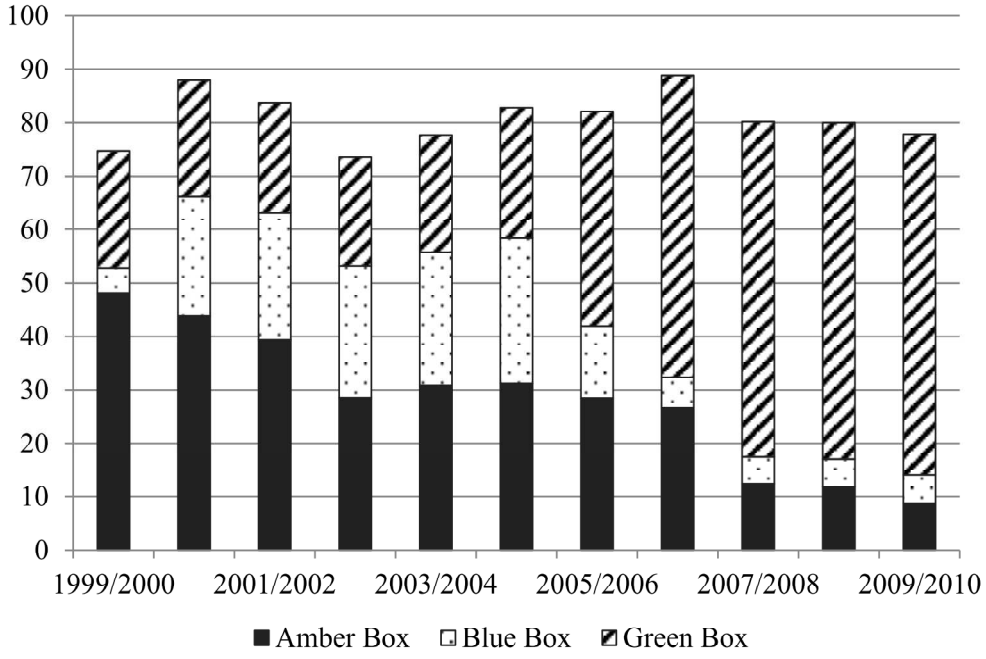

Figure 2. Development of EU domestic support according to the WTO classification scheme (in € million)

Source: Authors' elaboration based on WTO notification tables for domestic support (WTO ; WTO 2014)

In addition, Josling and Mittenzwei (2013) analyze and discuss the production requirement and the related trade-distorting effects of green box support and conclude that the PSE database is not only suited to rebuild but also to improve the policy details of the WTO notification tables. Many support programs that fulfill the WTO requirements defined in Article 6 and Annex 2 of the AoA imply that there is a need for production. Josling and Mittenzwei (2013), in particular, stress the benefit of utilizing both databases regarding the extent to which green box

payments require production that is provided by the PSE. Furthermore, they emphasize that the two datasets, the OECD PSE tables and the WTO classification scheme, can be regarded as complementary resources and use OECD PSE data to build pre-notification tables to overcome the delay in countries' submission of notification tables.

The PSE and the WTO classification scheme are both important measures that monitor changes in the composition of countries' agricultural policy instruments and are thus both well suited to evaluate such changes. Nevertheless, neither the PSE nor the WTO classification scheme enable a quantification of the impact on trade or a comparison with other trade-distorting policy instruments, such as tariffs or export subsidies.

3 Mercantilist Trade Restrictiveness Index of domestic support payments

The MTRI developed by Anderson and Neary (2003; 2005) is a theoretically based index that measures import volume-equivalent protection, which is defined as the uniform tariff τ^{μ} that results in the same import volume $M(p^0, b^0)$ at world prices π of tariff-restricted imports, such as the initial sector-specific tariffs when domestic prices equal p and the economies' exogenous income b:

$$(1) \qquad \tau^{\mu}\left(p^0, b^0\right) : M\left[(1+\tau^{\mu})\pi, b^0\right] = M\left(p^0, b^0\right)$$

Following Anderson and Neary (2005), the import volume is given by world market prices times net import demand. The exogenous balance-of-payments surplus is assumed to be the same during both periods. Anderson and Neary (2005) considered a small open economy that produces and consumes $n+1$ commodities that are traded at exogenous prices with the rest of the world. All agents within this economy face the same domestic prices, which differ from world prices due to the country's trade policies.

This characteristic of accounting for protection in terms of import equivalences enables the MTRI to be an appropriate starting point for the development of our index, which measures the distortive effects of domestic support payments.

In figure 3, we use a small country to illustrate an application of the MTRI approach to domestic support. We assume that this net-importing country provides a product-specific output subsidy, that the market is not protected by tariffs in the initial situation, and that there are no consumer subsidies. Abolishing the output subsidy shifts the auxiliary supply curve S_0 back to

the actual supply curve S_1 and decreases the agent's price from p^0 to π, which is accompanied by a reduction in the quantity supplied from q_s^0 to q^π. The world market price for this product is not affected. The import demand quantity given by $q_d^0 - q_s^0$ rises to $q_d^0 - q_s^\pi$.

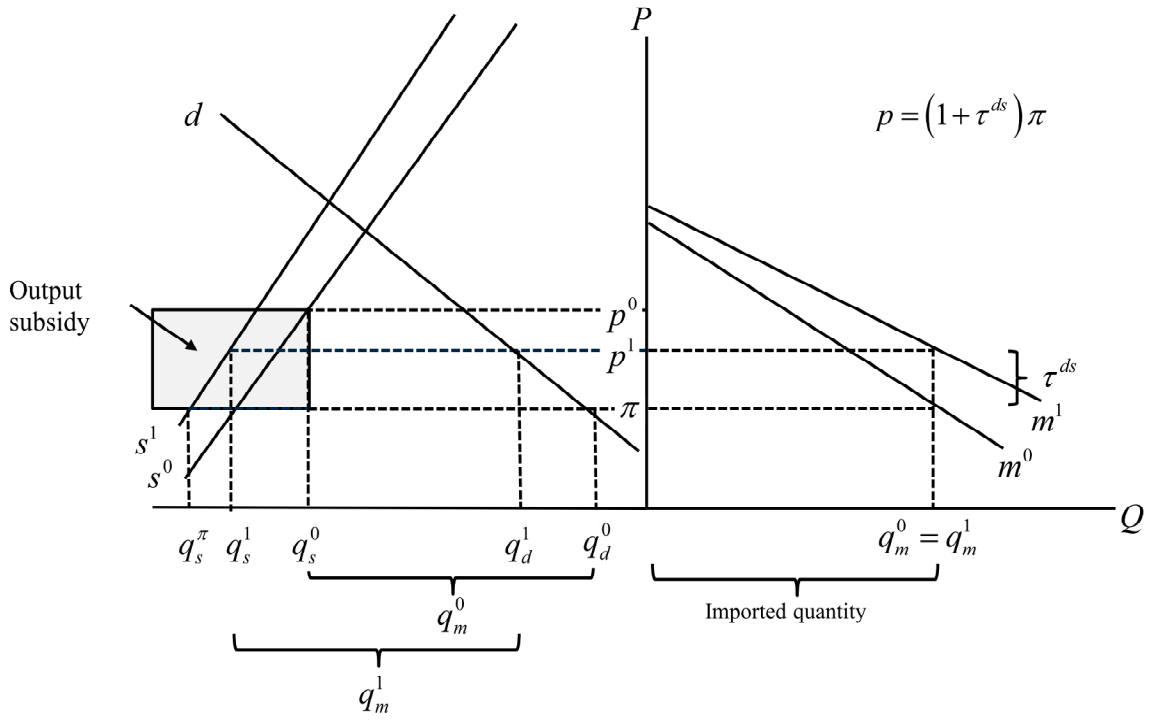

Figure 3. Implication of a removal of output subsidies - small country case

Source: Authors' elaboration

Note: The initial situation with an output subsidy in place is indicated with superscript 0 whereas the new situation after the removal of the output subsidy and the uniform protection rate is indicated with superscript 1.

Following the MTRI concept, the removal of an output subsidy subject to a constant import volume leads to the new market price, p^1, by implementing a uniform tariff, τ^{ds}. Both producers and consumers are faced with new market price $p^1 = \left(1+\tau^{ds}\right)\pi$, which leads to a decrease in quantity supplied, q_s^1, and demanded, q_d^1. Because the world market price remains unchanged due to the small country assumption, the new import volume given by $\left(q_d^1 - q_s^1\right)\pi$ equals the initial import volume given by $\left(q_d^0 - q_s^0\right)\pi$.

In the multi-good case, the implemented tariff, τ^{ds}, reflects the uniform tariff that keeps the total import volume of the aggregated commodities constant, as all domestic support payments are removed.

We adapt the theoretical concept of Anderson and Neary (2005) to domestic support by quantifying the trade-distortive effect of these subsidies. As shown in figure 3, the idea of applying the MTRI as a measure of the distortions of domestic support is to remove domestic subsidies and quantify a uniform protection rate that keeps trade volume constant. To evaluate the trade-restrictiveness of domestic support payments with the help of a theoretically sound index, we must consider the effect on both import demand and export supply. Furthermore, consumers and producers receive domestic support payments such that the net import demand function $m\left(p^p, p^c\right)$ is determined as a function of producer p^p and consumer prices p^c (Anderson and Neary 2005).

$$(2) \quad m\left(p^p, p^c\right) = d\left(p^c\right) - s\left(p^p\right)$$

Assuming that there are no other trade policies in place, the distorted domestic producer price is given for commodity i by $p_i^p = \left(1+\tau_i^p\right)\pi_i$, where τ_i^p is the rate of producer distortions. However, the distorted domestic consumer price is given by $p_i^c = \left(1+\tau_i^c\right)\pi_i$, where τ_i^c is the rate of consumer distortions.[1] If $\tau_i^p = \tau_i^c = 0$, there are no distortions.

The aggregated vector of net imports is given by $M\left(p^p, p^c\right)$:

$$(3) \quad M\left(p^p, p^c\right) = \pi m\left(p^p, p^c\right)$$

Thus, the MTRI for domestic support payments (MTRI-DS) τ^{ds} is determined through the following identity:

[11] Assuming initial import tariffs in place, e.g., the producer price is given by $p_i^p = \left(1+\tau_i^p\right)\left(1+\tau_i\right)\pi_i$ and the consumer price is given by $p_i^c = \left(1+\tau_i^c\right)\left(1+\tau_i\right)\pi_i$, which would affect the height of the uniform protection rate.

(4) $$\tau^{ds}\left(p^{p},p^{c}\right):M\left[\left(1+\tau^{ds}\right)\pi,\left(1+\tau^{ds}\right)\pi\right]=M\left[\left(1+\tau^{p}\right)\pi,\left(1+\tau^{c}\right)\pi\right]=M\left(p^{p},p^{c}\right)$$

Following Lloyd and MacLaren (2010), equation (5) represents the change in the value of imports from the free-trade situation for a small country.

(5) $$\Delta M=(\pi)'\Delta m\left(p^{p},p^{c}\right)=(\pi)'\Delta d\left(p^{p},p^{c}\right)-(\pi)'\Delta s\left(p^{p},p^{c}\right)$$

Accordingly, the MTRI-DS, τ^{ds}, is implicitly given by equations (6) and (7), where we equate this change with the situation with a uniform protection rate. Hence, the MTRI-DS quantifies the homogeneous protection rate that results in the same change in the import value as the initial consumer and producer distortions.

(6) $$(\pi)'\Delta m\left(p^{p},p^{c}\right)=(\pi)'\Delta m\left[\left(1+\tau^{p}\right)\pi,\left(1+\tau^{c}\right)\pi\right]=(\pi)'\Delta m\left[\left(1+\tau^{ds}\right)\pi,\left(1+\tau^{ds}\right)\pi\right]$$

In general, because the rate of producer distortion differs from the rate of consumer distortions, it is important to distinguish between consumer and producer distortions. Nevertheless, assuming $\tau^{c}=\tau^{p}$ and linear import demand functions implying constant slopes of the demand and supply curves, equations (6) and (7) can be solved for τ^{ds} to obtain the general equilibrium form of the MTRI-DS, based on Lloyd and MacLaren (2010), with commodity $i=1,....,n$ and commodity $j=1,....,n$, where $i\neq j$ are complements/substitutes reflecting cross-price effects.

(7)
$$\begin{aligned}&(\pi_i\ \pi_j)\begin{bmatrix}\frac{\partial d_i}{\partial p_i} & \frac{\partial d_i}{\partial p_j}\\ \frac{\partial d_j}{\partial p_i} & \frac{\partial d_j}{\partial p_j}\end{bmatrix}\begin{pmatrix}\pi_u\tau^{ds}\\ \pi_j\tau^{ds}\end{pmatrix}-(\pi_i\ \pi_j)\begin{bmatrix}\frac{\partial s_i}{\partial p_i} & \frac{\partial s_i}{\partial p_j}\\ \frac{\partial s_j}{\partial p_i} & \frac{\partial s_j}{\partial p_j}\end{bmatrix}\begin{pmatrix}\pi_u\tau^{ds}\\ \pi_j\tau^{ds}\end{pmatrix}\\ &=(\pi_i\ \pi_j)\begin{bmatrix}\frac{\partial d_i}{\partial p_i} & \frac{\partial d_i}{\partial p_j}\\ \frac{\partial d_j}{\partial p_i} & \frac{\partial d_j}{\partial p_j}\end{bmatrix}\begin{pmatrix}\pi_i\tau_i^{c}\\ \pi_j\tau_j^{c}\end{pmatrix}-(\pi_i\ \pi_j)\begin{bmatrix}\frac{\partial s_i}{\partial p_i} & \frac{\partial s_i}{\partial p_j}\\ \frac{\partial s_j}{\partial p_i} & \frac{\partial s_j}{\partial p_j}\end{bmatrix}\begin{pmatrix}\pi_i\tau_i^{p}\\ \pi_j\tau_j^{p}\end{pmatrix}\end{aligned}$$

The MTRI-DS accounts for cross-price effects on both consumption and production sides and considers both producer and consumer distortion rates. Equation (8) shows the general equilibrium solution of the MTRI-DS.

$$(8) \qquad \tau^{ds} = \left(\sum_i \sum_j \tau_j^c w_{ij} \right)(a) + \left(\sum_i \sum_j \tau_j^p v_{ij} \right)(b)$$

The consumer distortion rate, w_{ij}, and the producer distortion rate, v_{ij}, are expressed by the equations (9) and (10) separating own- and cross-price effects.

$$(9) \qquad \mathrm{w_{ij}} = \pi_i \pi_j (\partial \mathrm{d_i} / \partial \mathrm{p_j}) \Big/ \sum_i \sum_j \pi_i \pi_j (\partial \mathrm{d_i} / \partial \mathrm{p_j})$$

$$(10) \qquad \mathrm{v_{ij}} = \pi_i \pi_j (\partial \mathrm{s_i} / \partial \mathrm{p_j}) \Big/ \sum_i \sum_j \pi_i \pi_j (\partial \mathrm{s_i} / \partial \mathrm{p_j})$$

Equation (8) divides the total import responses into two shares: consumption responses denoted by a and production responses denoted by b (equations (11) and (12)). These shares weight the total production and consumption effects that are given in parentheses in equation (8). All weights sum to unity.

$$(11) \qquad a = \sum_i \sum_j \pi_i \pi_j \left(\partial d_i / \partial p_j \right) \Big/ \sum_i \sum_j \pi_i \pi_j \left(\partial m_i / \partial p_j \right)$$

$$(12) \qquad b = -\sum_i \sum_j \pi_i \pi_j \left(\partial s_i / \partial p_j \right) \Big/ \sum_i \sum_j \pi_i \pi_j \left(\partial m_i / \partial p_j \right)$$

In this article, we apply a CGE model to determine the MTRI for domestic support provided to agricultural producers. Deviating from the small country approach introduced above, the CGE approach allows us to account for effects on world market prices and considers diverging consumer and producer distortion rates.

4 Extended GTAP modeling framework

The analysis in this article is based upon an extended version of the standard GTAP model and updated versions of the underlying GTAP database Version 8.1 that are well documented in Hertel (1997) and Narayanan et al. (2012). Following Urban et al. (2014), we update the

domestic support payments in the GTAP database to consider the structure of these payments.[2] The application of a complex updating procedure with a modified version of the Altertax program (Malcolm 1998) enables us to integrate the PSE data according to the SCT, ACT, GCT, and OTP categories and the payment types, i.e., output, input, land, labor and capital. The various agricultural policy instruments are mirrored in the GTAP model in the form of the five price wedges affecting the transactions of producers at agents' and market prices for output, intermediate inputs, land, capital, and labor, respectively. We implement additional policy instruments to subdivide each of these price wedges according to the four PSE categories to achieve a detailed representation of domestic support in the underlying value flows and the corresponding price-linkage equations. The SCT payments are linked to a specific product, whereas ACT and GCT payments are given to a group of commodities and are therefore allocated with a homogenous rate across the commodities belonging to these product groups. OTP payments are not linked to production. Hence, they are distributed at a homogeneous rate across primary agricultural commodities according to land utilization (Urban et al. 2014), which reflects effectively fully decoupled payments (Cahill 1997).

The introduction of additional policy instruments enables the relocation of domestic support payments in the updated database according to the WTO classification scheme. To achieve this, we subdivide each of the newly integrated domestic support price wedges in the GTAP model into amber, blue and green box supports, which results in a complex structure of domestic support payments in the GTAP model and database that represents both important measures of domestic support payments, the PSE concept and the WTO classification scheme.

Modeling the MTRI for domestic support payments builds on an approach developed by Antimiani and Salvatici (2005) and Pelikan and Brockmeier (2008a). This approach introduces new variables that measure the imported quantity of all commodities by source and destination and define the newly implemented quantity variables as exogenous in the model to calculate the endogenously adjusted uniform tariff equivalent.

The GTAP model represents trade through bilateral trade matrices based on the Armington assumption (Armington 1969). The elasticity of substitution therefor determines the similarity of commodities from different countries to allow all products to be differentiated by country of

[2] Market price support is implicitly included in the GTAP model via border measures. To avoid double counting, we only incorporated PSE budgetary payments into the GTAP database and model.

origin. The import demand is modeled in GTAP using a two-stage nested CES functional form (Hertel 1997). Consequently, a country both imports and exports in the same sector.

To capture the trade-distorting effect of domestic support payments, we must keep track of the effect on both import and export flows. Considering this, we introduce the new policy variable "MTRI-DS" in both the market price and export price equations. Adapting the approach of Antimiani and Salvatici (2005) and Pelikan and Brockmeier (2008a), we capture domestic support by introducing new variables to quantify the trade volume of commodities by source and destination by determining the value of net imports in the model. Similar to their approach, we define trade volume variables as exogenous such that the adjusting uniform protection rate takes the changes on both the import and export sides into account, while we remove domestic support subsidies.

In contrast to the simplified formal approach based on the small country assumption (compare section 3), the general equilibrium environment of the GTAP model allows us to account for the effects of removing domestic support on world market prices.

5 Experiment design

The GTAP database Version 8.1 includes bilateral trade and protection matrices and additional data from the OECD PSE tables and links 57 sectors in 129 regions in the year 2007. This database is aggregated to the EU and to the Rest of the World and to 22 sectors (compare tables A1 and A2 in the appendix). The highly aggregated regional setting is chosen to avoid aggregation effects that might lead to a bias in the analysis. The aggregate of the EU consists of 25 EU member states. However, Bulgaria and Romania joined the EU in 2007. Therefore, we have excluded both from the EU aggregate to allow consistent comparison of the regional aggregation and the PSE tables of the EU in the years 2004 and 2007.

Decoupled payments are controversially discussed in the literature. Important issues include capitalization of direct payments in land rents as well as various coupling channels through which a farmer's production decision might be influenced (Bhaskar and Beghin 2009; Goodwin and Mishra 2005; Key and Roberts 2009; Latruffe and Le Mouel 2009). However, the extent to which this incentive occurs remains unclear, and we thus choose to follow Urban et al. (2014) in our analysis.

We create a set of deviating GTAP databases to enable our evaluation of domestic support development (table 2). Therefore, we implement domestic support payments originating from

OECD PSE tables for 2004 and 2007 (OECD 2014) in the GTAP database (version 8.1, base year, 2007). In so doing, we vary the assumptions regarding the degree of decoupling of the SFP. The first (PSE04-SFPland100) and second (PSE07-SFPland100) database represent a full capitalization of the SFP in land rents, whereby the SFP is allocated with a homogeneous rate across primary agricultural commodities to land. In the first database (PSE04-SFPland100), we integrate the levels of domestic support from the PSE tables of 2004 into Version 8.1, base year 2007, of the GTAP database.

Table 2: Database Setting

		Name of the database			
		PSE04-SFPland100	**PSE07-SFPland100**	**PSE07-SFPland90**	**PSE07-SFPland80**
Baseyear PSE table	2004	X			
	2007		X	X	X
SFP allocation	Land	100%	100%	Land usage + 90% of labor, capital usage	Land usage + 80% of labor, capital usage
	Labor, capital			10% of factor usage	20% of factor usage
Effect on production	Fully decoupled	X	X		
	Partially decoupled			X	X

Source: Authors' elaboration

This procedure allows us to compare domestic support over different years but does not create a bias through deviating parameters in different base years, such as changing trade protection data would, for example. For the third database (PSE07-SFPland90), we assume that the SFP is not fully capitalized in land rents but nonetheless creates production incentives through other coupling channels. Here, we begin from an allocation of the SFP according to

factor usage and shift 90% of the SFP initially distributed to labor and capital onto land. This seems appropriate because Goodwin and Mishra (2005), for example, state that the effect of other coupling channels is rather modest. In the fourth database (PSE07-SFPland80), we account for a lower degree of decoupling, as in PSE07_SFPland90, and shift only 80% to land.

We use the four databases as starting points to run the scenarios summarized in table 3. The database PSE07-SFPland100 is applied to first run a simulation that completely removes domestic support payments given to primary agricultural commodities. This scenario serves as a benchmark to evaluate the effectiveness of the extended MTRI at capturing the effects and restrictiveness of domestic support payments. Second, three scenarios (table 3) are simulated to either eliminate domestic support, import tariffs or export subsidies and to determine the uniform equivalent protection rate. The remaining three databases are used to determine the MTRI-DS, applying scenario DS–UPR

Table 3. Overview of Applied Scenarios

		Name of scenario		
		DS-UPR	**TMS-UPR**	**TXS-UPR**
Abolishment of:	Domestic support payments	X		
	Import tariffs		X	
	Export subsidies			X
UPR included in:	Market price equation	X	X	
	Export price equation	X		X
UPR:	Swapped with net-imports	X	X	X

Source: Authors' elaboration

Note: UPR stands for uniform protection rate

Finally, to validate the concept of the MTRI-DS, in particular the effects of domestic support payments on downstream sectors of the value chain, we calculate the MTRI-DS not only for a specific sector but also for aggregated primary and downstream sectors. In so doing, we analyze how different commodity aggregations affect the index number and the allocation effects in the

EU due to removal of subsidies. We begin with eliminating domestic support payments given to all primary agricultural commodities, while we determine the uniform protection equivalent first for primary agricultural commodities and second for all food commodities to account for effects along the value chain.

6 Results

Abolishing EU domestic support payments causes the well-known effect of a decrease in output and exports, while imports and the world market price increase (compare table A3 in the appendix). Although the trade-distorting effect of EU domestic support is obvious, we are not able to identify the overall level of trade restrictiveness of these policy instruments used for domestic support. Therefore, we describe in the following subsections the results of our applied MTRI-DS in the GTAP model.

6.1 MTRI-DS compared with border measures

We utilize the three scenarios (DS-UPR, TMS-UPR und TXS-UPR) described in table 3 to assess this issue. Following the defined scenarios, we compare the results of completely removing domestic support, import tariffs, or export subsidies for primary agricultural commodities utilizing database PSE07-SFPland100 in table 4. In the first column of the table, we present the uniform equivalent protection for removing domestic subsidies and the decomposition of the overall change in the MTRI-DS by primary agricultural commodities. The second and third columns show the uniform protection rate and the decomposition for the removal of import tariffs and exports subsidies, respectively.

Three points are notable. First, the MTRI-DS equals a uniform protection rate of 3.66, compared with 2.98 for import tariffs and only 0.29 for export subsidies, which indicates that domestic support payments are more trade restrictive than are import tariffs and export subsidies. Second, the decomposition reveals that the MTRI-DS is mainly driven by removing domestic support payments given to other crops, followed by fruits and vegetables; however, with respect to removing import tariffs, the fruits and vegetables sector contributes the most to the MTRI-DS.

Third, table 4 clearly shows that import tariffs are more trade restrictive in arable crops than domestic support payments, whereas domestic support payments are more trade distorting in the oilseeds and other crops sectors. Domestic support payments and import tariffs show almost

the same level of trade restrictiveness only in the fruits and vegetables sector. Thus, the impact on trade caused by the applied protection instruments varies significantly between sectors.

Table 4. Comparison of the MTRI-DS with other Border Measures

	Removal of: Domestic support	Import tariffs	Export subsidies
MTRI-DS / UPR for primary agricultural commodities	**3.66**	**2.98**	**0.29**
Decomposition of results:			
All crops:			
Arable crops	0.56	0.75	0.00
Oilseeds	0.13	0.00	0.00
Other crops	2.42	0.50	0.00
Fruits and vegetables	1.68	1.62	0.11
Livestock:			
Ruminants	-0.66	0.04	0.18
Non-ruminants	-0.46	0.07	0.00

Source: Authors' calculation

Note: GTAP Version 8.1 adapted to PSE07-SFPland100 as described in table 2. Compare table A 4 to A 5 in the appendix for the effect of the elasticity of substitution and the underlying protection data on the MTRI of domestic distortion. For the representation of the results, we aggregated the primary agricultural sectors as shown in the table. The arable crops aggregate comprises paddy rise, wheat, cereal grains as corn, barley, rye, oats, sugar cane and sugar beet, and plant-based fibers. The Oilseed sector includes oil seed and oleaginous fruits, soybeans and copra. Aggregated other crops considers other crops as live plants, cut flowers, beverage and spice crops, tobacco, seeds, protein crops as clover, lupines, and alfalfa, fodder and forage products. The fruits and vegetables sector contains vegetables, fruits, nuts, potatoes, cassava, and truffles. The ruminants sector includes cattle, sheep, goats, horses, and raw milk and wool whereas the non-ruminants sector consists of other animal products as swine, poultry, other live animals, and eggs.

6.2 Development of the MTRI-DS

How does implementing decoupled support affect the results? In table 5, we compare the effects of the deviating GTAP databases (columns 1 to 4) regarding distribution of the SFP for base year 2007 (compare table 2). Furthermore, table 5 decomposes the results according to the effects of payment categories, payment types, different sectors, and the WTO classification scheme on the uniform protection equivalent.

Table 5. Development of the MTRI-DS for Agricultural Commodities and its Components

	PSE04-SFP-land100	PSE07-SFP-land100	PSE07-SFP-land90	PSE07-SFP-land80
1. MTRI-DS	**3.42**	**3.66**	**4.64**	**5.62**
2. Payment category:				
Single commodity transfer (SCT)	2.38	0.75	0.76	0.76
Group commodity transfer GCT)	-0.65	0.30	0.30	0.30
All commodity transfer (ACT)	1.68	2.59	2.60	2.61
Other transfer to producers (OTP /SFP)	0.00	0.02	0.99	1.95
3. Payment type:				
Output	1.73	0.39	0.39	0.39
Input	0.74	0.70	0.70	0.69
Land	-0.72	0.28	0.28	0.28
Labor	0.10	0.18	0.95	1.72
Capital	1.58	2.11	2.32	2.54
4. Primary agricultural commodities:				
Arable crops	-0.70	0.56	0.74	0.93
Oilseeds	0.94	0.13	0.23	0.23
Other crops	1.96	2.42	2.79	3.15
Fruits and vegetables	0.98	1.68	1.96	2.25
Ruminants	0.26	-0.66	-0.61	-0.55
Non-ruminants	-0.02	-0.46	-0.42	-0.38
5. WTO box classification:				
Amber box	2.31	0.79	0.78	0.78
Blue box	-0.60	0.26	0.26	0.26
Green Box	1.71	2.61	3.59	4.57

Source: Authors' calculations

Note: GTAP version 8.1, base year 2007.

The MTRI-DS shows a slight increase of 7% from 3.42 in 2004 to 3.66 in 2007 based on growth of the total PSE from 54.583 to 58.674 Mio. € (compare table 1). However, a decrease in MTRI-DS from 2004 to 2007 would be expected to reflect the higher share of decoupled

support in 2007 because the CAP introduced the SFP in 2005, accounting for 53% (3%) of domestic support payments in 2007 (2004).

As anticipated, the decrease in the degree of decoupling (columns 2 to 4) leads to a rise in the MTRI-DS. The integration of the SFP as effectively fully decoupled payments into the model results in the smallest uniform protection rate, whereas databases considering the SFP as only partially decoupled show a MTRI-DS that is increasing from database PSE07-SFPland90 to PSE07-SFPland80, which corresponds to an increasing degree of coupling. Thus, the MTRI-DS reflects the impact on trade restrictiveness of deviating underlying assumptions about the SFP.

The second and third part of table 5 presents the MTRI-DS differentiated into categories and types of support. This depiction indicates that the SFP has no effect on the MTRI-DS when payments are modeled with a homogeneous rate across commodities allocated to land.

This decomposition shows that SCT and ACT payments govern the uniform equivalent protection rate. SCT comprises product-specific subsidies and therefore obviously affects production decisions. The effect of the SCT on the MTRI-DS declines from 2.38 (2004) to 0.75 (2007) because of the reduction in SCT payments from 18.012 to 4.632 Mio. €. The change in composition of the SCT away from subsidies based on output or input use strengthens this effect (compare table 1).

6.3 Impact of the payment category and payment type on the MTRI-DS

The composition of ACT payments explains the impact on the MTRI-DS. In 2004, only 49% of ACT payments are allocated to land. Payments to land are expected to have the least effect on production, particularly when distributed at a homogeneous rate across all primary agricultural commodities. Furthermore, the contribution of ACT payments to the MTRI-DS rises from 1.68 (2004) to 2.59 (2007) due to reduced payments allocated to land in favor of payments distributed to labor and capital.

In contrast to ACT, GCT is provided in the form of group-specific subsidies; hence, GCT may create higher production incentives. Table 5 displays contrasting effects on the MTRI-DS in 2004 compared with 2007. In 2004, contribution to the MTRI-DS is negative, whereas it is positive in 2007, although the share of GCT payments shrinks considerably. In 2004, 90% of GCT payments are provided as subsidies based on land. Additionally, the homogeneous distribution across groups of commodities harms all commodities equally and does not boost factor

re-allocation. Consequently, reducing those payments affects production decisions less than SCT and ACT payments affect such decisions. Furthermore, GCT subsidies based on land substantially decrease in 2007 whereas the distribution to labor clearly increases, which explains the reverse effect (0.3) on the MTRI-DS.

Payment types affect the MTRI-DS differently. Output subsidies apparently create production incentives shown by the highest contribution to the MTRI-DS in 2004 (1.73). The substantial removal of output subsidies until 2007 explains the reduced contribution in 2007. The determined effect for intermediate inputs is almost the same in 2004 as in 2007. According to the PSE tables, product-specific input subsidies are reduced considerably, followed by moderate decreases of input subsidies in the GCT category and only a slight reduction in the ACT category. However, the contribution of intermediate inputs to the overall MTRI-DS diminishes only slightly. Payments given to capital largely decrease, whereas the effect on the MTRI-DS increases. These results support the conclusion that payment types other than land have become more important.

6.4 Decomposition of the MTRI-DS according to sectoral contributions

The fourth part of table 5 shows a decomposition of the overall change in the MTRI-DS according to sectoral contribution. Clearly, the other crops sector has the greatest effect on the MTRI-DS. Its importance even increases from 2004 to 2007 due to a rise in domestic support payments involving growth of capital- and labor-based payments that exceed the decreases in output subsidies. However, the sector for fruits and vegetables also reveals a significant effect on the MTRI-DS that increases considerably from 0.98 to 1.68. Domestic support in this sector is three times as high in 2007 as in 2004, which explains the increase, particularly because payments based on output, capital, and labor rise. The effects of the arable crop sector also grow, although the total amount of subsidies declines from € 30.245 million to € 19.794 million.[3] However, in 2004, the decomposition reports a negative number for arable crops. A negative contribution to the MTRI-DS implies that an import subsidy, export tax or a combination of these policy instruments is required to keep the volume of net imports constant. In 2004, 96% of the subsidies for arable crops are allocated based on land and only 0.1% are output

[3] Table 1 shows the aggregated PSE values according to payment categories and types. Sector-specific PSE values are not presented in this article.

subsidies. Furthermore, no more than 8% are product-specific subsidies. Removing these subsidies would imply a decrease in the value of exports that is less than the increase in the value of imports. Consequently, an import subsidy, an export tax or a combination of these policy instruments is required to keep net trade volume constant. In 2007, the share of payments allocated based on land clearly decreased, thereby necessitating an import tariff, an export subsidy or a combination of these policy instruments to fix the net trade volume by inducing a positive MTRI-DS.

By contrast, the contribution of oilseeds decreases from 0.94 in 2004 to only 0.13 in 2007 due to a decrease of domestic support of -50%; in particular, product-specific subsidies allocated on output are lowered. Additionally, the livestock sectors, in particular, show reduced trade restrictiveness. In 2007, both the ruminants and non-ruminants sectors even display a negative contribution to the uniform protection rate. The results for the sector of cattle, goats, sheep and horses demonstrate that this sector is highly subsidized. In 2004, 82% of domestic support is distributed-product specific, of which 98% is allocated based on capital. This result supports our assumption that this sector is highly trade restrictive. Nevertheless, removing domestic support leads to a decrease in export values that exceeds the increase in import values, which yields a negative MTRI-DS and implies the need for an import subsidy, an export tax or a combination of these policy instruments to maintain an unchanged net import volume. We observe such a discrepancy because the import volume of the downstream sectors, such as meat products, substantially increased.

6.5 Aggregation effects on the MTRI-DS

Table 6 emphasizes the impact of sectoral aggregation on the MTRI-DS. The first column shows the effects explained in the previous sections, whereas the second column illustrates the uniform protection rate that is necessary to keep the net import volume of all food commodities constant to account for forward linkages. This net import equivalent clearly varies depending on the aggregation. The deviations are induced by changes in the downstream sectors because the removal of domestic support leads to higher input prices. In so doing, eliminating subsidies given to the livestock sector results in reduced output, higher market prices and, consequently, decreased exports and increased imports.

Thus, downstream sectors, such as meat products, are faced with higher input prices that cause market prices for meat products to rise and results in increased meat imports and reductions in the livestock inputs used in the meat industry. Consequently, a simulation that also retains the import volume of the forward-linked sectors yields an MTRI-DS for livestock that is positive; therefore, the trade restrictiveness of subsidies given to livestock producers is notable.

Table 6. Impact of the Sectoral Aggregation on the MTRI-DS in 2007

	Primary agricultural commodities	**Food commodities**
MTRI-DS	**3.66**	**1.97**
Decomposition of results:		
All crops:		
Arable crops	0.56	0.04
Oilseeds	0.13	0.46
Other crops	2.42	0.64
Fruits and vegetables	1.68	0.33
Livestock:		
Ruminants	-0.66	0.40
Non-ruminants	-0.46	0.11

Source: Authors' calculation

Note: GTAP Version 8.1 adapted to PSE07-SFPland100 as described in Table 2.

6.6 Decomposition of the MTRI-DS according to the WTO classification scheme

The last part of table 5 shows the results of the reconciliation of PSE data with the WTO classification scheme. Here, the achievement of the CAP reform in lowering the trade-distortive effects of domestic support is evident. In our representation, the amber box comprises only non-exempt direct payments. The highly trade-distortive amber box support decreases substantially from 2004 to 2007, which is reflected in a decline of the contribution to the MTRI-DS from 2.31 to 0.79. Furthermore, the EU cut payments classified as blue box support. However, in table 5 the contribution of blue box support to the overall MTRI-DS changes from -0.6 to 0.26. The effect of the removal of domestic support on forward linkages as described for the livestock

and meat sector in the previous paragraph explains this result. The trade-distortive effect of green box support increases from 1.71 to 2.61. Our application of the MTRI-DS reveals that payments assigned to the green box other than the SFP have a clear effect on trade. In 2004, the green box includes 32% of the PSE budgetary transfers, of which 9% are SFP, whereas in 2007, the green box increases to 84% of the PSE budgetary transfers and 66% of these are now SFP. Non-SFP green box support based on the PSE increased by more than 6% from 2004 to 2007. Green box payments other than SFP are modeled in GTAP by their PSE category, and the PSE concept distinguishes policy instruments according to their production requirement. ACT contains most of the non-SFP green box payments. Only half of these payments are distributed to land whereas the other half is provided as mainly capital, labor and input subsidies. They attract more capital, labor and intermediate inputs to be employed in the agricultural sector and are trade distorting, as a consequence. The rise from 2004 to 2007 can therefore be traced back to substantial growth of green box payments allocated to output, capital, and labor.

7 Discussion and conclusion

The objective of this article is to provide a theoretically sound index that enables the evaluation of the trade restrictiveness of domestic support payments and the application of this index in a CGE framework. Specifically, we build on the work of Anderson and Neary (2005) to derive an index based on their MTRI. We name our index MTRI-DS and implement it in the GTAP framework. The adopted model is an extended version of the GTAP framework that considers domestic support payments in detail and includes a reconciled representation of two important measures of domestic support payments: the PSE concept and the WTO classification scheme. We employ this framework to determine the tariff equivalent of EU domestic support payments while accounting for the general equilibrium effects, including all intersectoral linkages and interdependencies with world markets.

This tariff equivalent of domestic support payments is appropriate for comparing different protection policies, such as import tariffs, export subsidies, and domestic support payments. The simulation results reveal that domestic support payments in the EU (3.66) are more trade restrictive than import tariffs (2.98) or export subsidies (0.29). Hence, our new MTRI-DS allows a rating of the trade-distortive effect of different protection instruments based on quantitative results. Furthermore, the resulting uniform protection rate demonstrates the development of domestic support payments in the EU over time, including the effect of the implementation

of decoupled support. Our MTRI-DS tracks changes in the composition of CAP policy instruments and is therefore suited to assess the effect of policy reforms. Additionally, our MTRI-DS allows evaluation of policy reforms with respect to their contribution to meeting WTO requirements. In other words, the MTRI-DS helps to assess the effect of countries' policy reforms over time, indicating a movement toward less-distortive policy instruments, and is therefore suited to support trade negotiations. Finally, the MTRI-DS figures are meaningful for comparisons across countries.

Our MTRI is thus useful for policy analysis in which the relevancies of different policy instruments are considered and compared, such as in simulations to analyze WTO negotiations, which requires a comparison of the trade restrictiveness of domestic support payments, other protection instruments for market access, and export subsidies.

Although this index already operates as an effective tool for analyzing domestic support payments, it also provides a springboard for further research. The PSE concept classifies domestic support payments according to production requirements and thus results in a higher trade-distortive effect than does green box support under the WTO framework. Our current method of incorporating non-SFP green box payments based on the PSE into the GTAP model is clearly trade distorting and might, as a result, overestimate the effect on trade. De Gorter, Ingko and Nash (2004), however, refer to the definition of trade-distorting measures in the AoA, noting that not all policy instruments are appropriately categorized by their production requirements, which leads to underemphasized green box support. Consequently, delving deeper into the definition and quantification of trade-distorting measures would help to reveal whether our representation of non-SFP green box support correctly reproduces the non-SFP green box in terms of distortions.

Second, aggregation bias can change the results and might, therefore, cause an over- or underestimation of the trade restrictiveness of domestic support payments. In fact, in our analysis, we detect such an aggregation bias. The results clearly demonstrate that the MTRI-DS is affected by the inclusion of forward-linked sectors. Therefore, focusing future research on analyzing the effect of sectoral aggregation on the MTRI-DS would lead to improvements in the validation of results.

In the CGE application, we shift the focus toward producer subsidies, ignoring the potential implications of changes in consumer subsidies, although we theoretically derive the MTRI-DS from the import volume function, depending on consumer and producer prices. This derivation is based on the theoretical approach of Anderson and Neary (2005) and Lloyd and MacLaren

(2010). The reason to exclude consumer subsidies is the modeling of households as one representative household in the GTAP model, which makes the model inappropriate for analyzing the effects of consumer support. This exclusion provides another interesting avenue for future research, as embedding consumer subsidies into the analysis would afford the model more applicability.

The focus of the MTRI approach and subsequently our MTRI-DS is on foreign trade, whereas the implications for welfare and other effects within a country are not covered. Eliminating domestic support reduces government spending whereas introducing the uniform tariff rate creates additional tax revenue in our application. Thus, this forces the question of how much this increase in government income affects production, consumption, and welfare. Elaborating a comparison of our MTRI-DS and the TRI of domestic distortion (Anderson and Neary, 2005) following the GTAP application of Salvatici (2001) for the EU would therefore complete the assessment of the impact of domestic support payments.

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9 Appendix

Table A 1. Regional Aggregation of the GTAP Database

Countries and Regions	Abbreviation
1 EU:	**EU25**
Austria, Belgium, Denmark, Finland, France, Germany, Ireland, United Kingdom, Greece, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, Czech Republic, Cyprus, Hungary, Malta, Poland, Slovakia, Slovenia, Estonia, Latvia, Lithuania	
2 Rest of the World:	**ROW**
United States, Canada, Japan, Australia, New Zealand, Bulgaria, Romania, Switzerland, Norway, Rest of EFTA, Albania, Croatia, China, India, Brazil, Argentina, Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela, Panama, Rest of South America, Rest of Oceania, Rest of Caribbean, Mauritius, Zimbabwe, Botswana, South Africa, Hong Kong, Korea, Rest of East Asia, Indonesia, Malaysia, Philippines, Singapore, Thailand, Viet Nam, Pakistan, Sri Lanka, Mexico, Costa Rica, Guatemala, Nicaragua, Rest of Central America, Belarus, Rest of Eastern Europe, Kyrgyzstan, Armenia, Georgia, Turkey, Rest of Western Asia, Egypt, Morocco, Tunisia, Rest of North Africa, Rest of South African CU, Cambodia, Lao People's Democratic Republic, Myanmar, Rest of Southeast Asia, Bangladesh, Rest of South Asia, Nigeria, Senegal, Rest of Western Africa, Rest of Central Africa, Rest of South Central Africa, Ethiopia, Madagascar, Malawi, Mozambique, Tanzania, Uganda, Zambia, Other Eastern Africa, Taiwan, Rest of North America, Russian Federation, Rest of Europe, Kazakhstan, Rest of FSU, Azerbaijan, Iran Islamic Republic, Ukraine, Mongolia, Nepal, Honduras, El Salvador, Bahrein, Israel, Kuwait, Oman, Qatar, Saudi Arabia, United Arab. Emirates, Benin, Burkina Faso, Cameroon, Cote d'Ivoire, Ghana, Togo, Kenia, Rwanda, Namibia	

Source: Authors' elaboration

Table A 2 Sectoral Aggregation of the GTAP Database

Sectors		Abbreviation
1	Paddy rice	pdr
2	Wheat	wht
3	Cereal grains nec	gro
4	Vegetables, fruits, nuts	v_f
5	Oilseeds	osd
6	Sugar cane, sugar beet	c_b
7	Plant-based fibres	pfb
8	Crops nec	ocr
9	Cattle, sheep, goats, horses	ctl
10	Animal products nec	oap
11	Raw milk	rmk
12	Wool, silk worm cocoons	wol
13	Meat: cattle, sheep, goats, hoarses	cmt
14	Meat products nec	omt
15	Vegetable oils and fats	vol
16	Dairy products	mil
17	Processed rice	pcr
18	Sugar	sgr
19	Other food	ofd
20	Beverages and tobacco products	b_t
21	Manufacturing: Coal, oil, gas, petroleum, coal products, Forestry, fishing, minerals, Textiles, wearing apparel, leather products, wood products, paper products, publishing, chemical, rubber, plastic prods, mineral products nec, ferrous metals, metals nec, metal products, motor vehicles and parts, transport equipment, electronic equipment, machinery and equipment, manufactures nec	Mnfc
22	Services: Water, construction, trade, transport nec, sea transport, air transport, communication, financial services nec, insurance, business services nec, recreation and other services, PubAdmin/Defence/Health/Educat, dwellings	Services

Source: Authors' elaboration

Table A 3. Effects of an Elimination of Domestic Support Payments in the EU

	Output	EU imports	EU exports	Domestic prices	World market prices
pdr	-21.85	52.37	-64.78	12.53	0.71
wht	-3.68	24.15	-21.11	3.70	1.24
gro	-1.82	5.25	-6.52	3.40	0.85
v_f	-2.16	5.73	-6.64	2.91	0.77
osd	-3.71	4.80	-9.58	2.95	0.84
c_b	-0.15	3.79	-3.90	1.41	0.56
pfb	-20.35	26.20	-51.35	17.25	0.91
ocr	-2.40	8.77	-10.29	2.74	1.35
ctl	-4.21	38.30	-29.04	10.92	2.31
oap	-1.58	4.31	-5.21	2.98	0.84
rmk	-0.70	5.39	-19.10	3.48	1.14
wol	-16.90	2.65	-18.90	2.16	0.43
cmt	-4.81	22.74	-22.55	4.18	0.94
omt	-1.58	10.82	-9.74	1.73	0.78
vol	-2.43	3.63	-5.80	1.36	0.47
mil	-0.67	4.27	-3.70	0.96	0.59
pcr	-1.99	5.50	-7.12	2.09	0.46
sgr	-0.21	-0.20	0.00	0.29	0.28
ofd	-0.49	0.73	-0.99	0.57	0.35
b_t	-0.22	0.31	-0.39	0.45	0.31
Mnfc	0.20	-0.33	0.47	0.07	0.13
Services	0.04	-0.22	0.28	0.06	0.13

Source: Authors' calculation

Table A 4. Effect of the Initial Protection on the Results of the MTRI-DS

Protection	reduced by		default	increased by	
	100%	50%		50%	100%
Primary agricultural commodities	**3.51**	**3.59**	**3.66**	**3.71**	**3.73**
All crops:					
Arable crops	0.72	0.64	0.56	0.47	0.37
Oilseeds	0.06	0.09	0.13	0.16	0.20
Other crops	2.17	2.30	2.42	2.53	2.63
Fruits and vegetables	1.68	1.68	1.68	1.67	1.65
Lifestock:					
Ruminants	-0.66	-0.66	-0.66	-0.66	-0.66
Non-ruminants	-0.46	-0.47	-0.46	-0.46	-0.46

Source: Authors' calculation

Note: GTAP Version 8.1, base year 2007, PSE 2007, SFP allocated 100% to land. In addition, the validation of results requires an analysis of the implications of changes in the underlying border protection, because of the modeling of the MTRI-DS. We implement the MTRI-DS in the price linkage equations for exports and imports. In the price linkage equation for imports (13) the market price is determined.

$$(13) \qquad p_m = (1+\tau_i)(1+\tau^{ds})\, p_{cif}$$

The multiplication of the specific tariff rate $(1+\tau_i)$ with the uniform protection rate $(1+\tau^{ds})$ might lead to an effect of the initial tariff rate on the MTRI-DS. Hence, we conduct a second sensitivity analysis where import tariffs and export subsidies are decreased (increased) for all traded commodities by 50% and 100% to validate the impact of varying initial protection data. This analysis reveals that the impact on results is rather modest.

Table A 5. Effect of the Elasticity of Substitution on the Results of the MTRI-DS

Elasticity of substitution	Reduced by 50%	default	Increased by 50%	esubm = esubd
Primary agricultural commodities	**3.70**	**3.66**	**3.54**	**3.70**
All crops:				
Arable crops	0.55	0.56	0.53	0.47
Oilseeds	0.24	0.13	0.05	0.25
Other crops	2.55	2.42	2.35	2.58
Fruits and vegetables	1.64	1.68	1.71	1.55
Lifestock:				
Ruminants	-0.71	-0.66	-0.66	-0.68
Non-ruminants	-0.56	-0.46	-0.44	-0.47

Source: Authors' calculation

Note: GTAP Version 8.1, base year 2007, PSE 2007, SFP allocated 100% to land. Applying the concept of the MTRI-DS in a CGE framework, we are concerned about the Armington assumption. Therefore, we conduct a sensitivity analysis to assess the effect of the elasticity of substitution on the MTRI-DS. We distinguish between two cases in this sensitivity analysis. First, the nested case, where the elasticity of substitution among sources of imports (ESUBM) is equal to two times the elasticity of substitution between domestic and imported goods (ESUBD), which is the default option in the standard GTAP model. We increase (decrease) the elasticity of substitution for 50% in this nested structure. Second, we assume a non-nested case, where ESUBM is equal to ESUBD (Francois and Reinert 1997). The results confirm minor impact for most of the commodities, although the direction varies between sectors. Oilseeds are much more sensible than other commodities.