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1. Introduction

As it is known, the Common Agricultural Policy (CAP) is still based on border measures and direct income transfers aimed at modifying returns to productive factors. One commonly used measure gauging the effects of border policies is the effective protection rate (ERP).

The ERP seeks to capture in a single figure support to productive factors resulting from a complex tariff structure. By including the price-distorting effects on intermediate inputs as well as on output, EPR provides a measure of the "net" effect of border policies.

This is particularly relevant for developing countries, since their exports face tariffs that are generally higher on processed agricultural products than on primary commodities. Tariff escalation - which refers to the wedge between the tariff on a processed commodity and the one on the corresponding primary commodity – is discussed in the present round within the World Trade Organisation (WTO) as one of the major obstacles to the establishment of processing industries, and to the diversification of agricultural exports.

However, according to Anderson (1998) "Effective protection is the ranch house of trade policy construction – ugly but apparently too useful to disappear". In order to avoid the critiques that have been brought to the index originally conceived by Corden (1971), Anderson defined a Distributional Effective Rate of Protection (DERP) for each sector j: the idea is to find the uniform tariff on all distorted goods affecting profits in j, which is equivalent to that of the initial tariff structure.

This work aims at computing the effective protection for the EU agrifood sector using the DERP. Section 2 presents the analytical foundation of the DERP, and compares the new index with the traditional one. Section 3 discusses the method followed for the calculation of the DERP. This has been based on the Global trade Analysis Project (GTAP) model. Section 4 discusses the empirical results both in terms of the new and the traditional index. Section 5 reports concluding remarks.

2. The effective protection

The tariff wedge approach is the simplest measure of tariff escalation, and it is easy to operate since it relies on generally available data. However, this method has several limitations: nominal tariffs wedges do not fully represent the protection level caused by the tariff structure, and do not provide information about the impact of tariffs on the value added of processed products; secondly, since tariff wedges do not take into account the value added, they cannot be compared across commodities. Finally, the concept of tariff wedges can hardly be applied to production functions with multiple input and/or multiple output (J. Lindland, 1997).

These limitations can be overcome trough the effective rate of protection, which focuses the attention on gross outputs, taking account of the role of intermediate inputs. If we are interested in a sector's total use of primary resources, gross output appears to be the appropriate concept to work with. Similarly to the measurement of net output protection, gross output protection can be defined as the proportional increase in the price of a sector's gross output relative to free trade. Since the economy's total value of gross output priced at value added per unit equals the total value of net output (valued at equilibrium prices), an appropriate price for gross output seems to be the *value-added per unit*. Accordingly, the effective rate of protection of industry i (E_i) measures the increase in industry's value added per unit of output under protection (V_i') as a percentage of the free trade value added per unit (V_i):

$$(1)\quad E_i = \frac{V_i' - V_i}{V_i}.$$

Although we have identified value-added per unit as a price of gross output, and have defined the ERP as the proportional divergence of this price from its free trade level, Ethier (1977) showed that the link between nominal rates and net outputs is not always equal to the link between effective rates and gross output. Moreover, a key assumption of the basic effective protection model is fixed coefficient or separability in the production function. If there is any substitutability between primary factors and intermediates, the computation of effective rates is biased (Anderson and Naya, 1969). If the value of intermediate inputs is close to the value of output when these values in domestic prices are converted into free trade prices, the effective rates approaches positive infinity, and then switch to negative infinity. Negative value added can be explained by inefficient inputs use in highly protected industries, but it is also likely to be the consequence of the fixed coefficient assumption. If the assumption of fixed physical input coefficients does not hold, free trade input-output coefficients must be inferred from the observed distorted coefficients. This is the approach followed by Bureau and Kalaitzandonakes (1995).

In terms of the possibility for the ERP to be a good predictors of gross outputs change, effective protection is a partial equilibrium index, that measures the impact of protection on the ability of sectors to compete with other industries in factors markets. In general equilibrium, though, the prices of primary (non-produced) factors are endogenous, and the prices of (internationally) nontraded goods may change as well. The fundamental theoretical critique moved to the effective protection concept stems largely from concerns about drawing general equilibrium inferences from a partial equilibrium measure (Ethier, 1971, 1977; Bhagwati and Srinivasan, 1973; Davis, 1998). Even if the fixed coefficient assumption is met, as a matter of fact, ranking effective rates may not allow ranking percentage output changes: a non-prohibitive import tariff or export tax in partial equilibrium, for example, might become prohibitive in general equilibrium (Anderson, 1970).

The development of the concept of effective protection may be seen as an attempt to define a 'price' system as a pure production concept - expressed in terms of nominal prices and input coefficient - making enough assumptions so that demand might be ignored, and imposing technological restrictions in order to obtain a simple measure. Nowadays, however, the development of Computable General Equilibrium models implies that the ERP can be computed as a general equilibrium index summarising all the model information (Stevens, 1996). Moreover, gross output is also relevant for income distribution, since the income of an industry-specific factor will be related to the overall level of activity of that industry, rather than the to production for final use. In this perspective, Anderson suggested an interesting new definition of the index: the *distributional effective rate of protection* (DERP), based on "the uniform tariff (on distorted goods) which is equivalent to the actual differentiated tariff structure in its effects on the rents to residual claimants in sector j".

Following Anderson, let v denote the fixed supply of non produced factors which are mobile between sectors at price w, while let k denote the vector of sector specific factors, and let p is the domestic price vector. It is important to notice that the vector k is a convention, not necessarily associated with any measurable factor, which accounts for diminishing returns, and thus positive profits ($\Pi = \sum_j \pi_j$) which go to residual claimants.

The sum of payments to all factors is equal to gross domestic product function g, defined as

(2) $g(p,v,k) = \min_w \{w'v + \Pi(p,w,k)\}$.

Drawing on the properties of the gross domestic product function we know that:

g_p = the vector of general equilibrium net (final) supply function;

g_v = the vector of competitive factor prices for intersectorally mobile factors;

g_k = the vector of the sector specific competitive factors returns.

The effective rate of protection E^j of sector j in general equilibrium is defined as the uniform tariff which exert on the return to specific factor j an effect which is equivalent to the initial tariff structure. That is

(3) $E^j = 1/D^j - 1$, where

(4) $D^j(p^1; p^0, v, k) \rightarrow D \left| g_k^j(p^1/D, v, k) = g_k^j(p^0, v, k), \right.$

The function, D is the distance function applied in tariff distorted price space. Accordingly, D^j is the uniform output price deflator which maintains profits in j constant. Since D is equal to the inverse of a uniform tariff factor, E^j is equal to the uniform tariff on distorted goods, which has the same effect on the profits of sector j as the initial tariff vector. In a special case, that of partial equilibrium with fixed coefficients of production, the formula implied by the new definition is identical to the usual effective rate of protection formula; with variable coefficients but still in partial equilibrium, the formula is a simple variant of the usual formula (Anderson, 1998).

Sector specific factor income changes are a product of two elements: the level of protection given to the sector (and this is what the old effective protection concept tried to measure) and the rate at which the level of protection is translated into sector-specific factor's income. Differences in income changes across sectors arise from the differences in both elements of the product, and the new concept gives a precise measure of the "level" of protection in this context. In other words, the main difference refers to the concepts of effective protection and tariff escalation: these two concepts, even if correlated, are different because the former refers "only" to the tariffs, while the latter takes into account the structure of production. The traditional ERP captures only the tariff escalation, while the new index tries to compute all the effects on the production function arising from the tariff structure (Anderson, 1998).

3. GTAP model and the DERP

In this work we use the GTAP applied general equilibrium model (Hertel, 1997), which is a multi-region model built on a complete set of economic accounts and detailed inter-industry linkages for each of the economies represented. The model represents the global economy, including bilateral trade flows based on Armington hypothesis, and a global bank linking total savings to total investment. In each region, there is a representative agent who maximizes its own utility. Private demand is based on a Constant Difference of Elasticity functional form, while supply is based on a "production tree": at the bottom of the inverted tree are the individual inputs demanded by the firm which purchase on one side, primary factors (with a Constant Elasticity of Substitution) and, on the other side, intermediate inputs (both domestic and foreign produced, with a Constant Elasticity of Substitution). Firms choose their optimal mix of primary factors (intermediate inputs) independently of the price of intermediate inputs (primary factors). Since the level of output is also irrelevant, due to the constant returns to scale assumption, the only argument in the firms' conditional demand equation for components of value-added (of the costs due to intermediate input) is the relative prices of the primary factors (the intermediate inputs). By assuming this type of separability, the elasticity of substitution between any individual primary factor, on the one hand, and intermediate inputs, on the other, is equal. The GTAP production system, moreover, distinguishes sectors by their intensities in five primary production factors: land (agricultural sectors only) and natural resources (extractive sectors only), which are sluggish, and unskilled labor, skilled labor and capital, which are mobile across productive sectors.

Table 1 - Aggregation used in the GTAP model

Regions	***Sectors***	***Endowments***
Eu	Paddyrice	Labour, skilled and unskilled aggregated (mobile)
Row	Cereals	Land (sluggsih, with elasticity of trasformation=-1)
	Oilseed	NatRes (sluggsih, with elasticity of trasformation=-1)
	Raw milk	Capital (sluggsih, with elasticity of trasformation=-10)
	Vegetables and fruits	
	Livestock products	
	Dairy	
	Processed rice	
	Sugar	
	Vegetables oil and fats	
	Otpf (other primary and food	
	Textile	
	Motorveich	
	Mnfcs	
	Svces	

The baseline of latest available version of the GTAP database (version 5) is 1997. Version 5 includes up to a maximum of 66 regions and 57 sectors (Dimaranan and McDougall, 2002). Given our focus on the EU, all the other countries were aggregated into a "rest of the world" (ROW) region. On the other hand, we maintained a relatively high level of product detail, including 5 aggregate farm sectors and 6 aggregate processed food sectors, while the rest of the economy is represented with 4 sectors (table 1).

The 1997 database was updated by shocking a set of known variables – GDP, the labor force, total factor productivity and population – and by implementing the Agenda 2000 reform. The sources of information for the exogenous variables are reported in Table 2.

Table 2

variable	**source**
GDP	International Monetary Fund
labor force	FAO - Faostat database
total factor productivity	Hertel and Martin (2000)
population	UN projections

Agenda 2000 was modeled following the experiment described in Conforti, De Filippis, Salvatici (2002). Direct payments are represented as *ad valorem* subsidies to factor use, i.e. as a subsidization of land in the case of cereals and oilseeds, and as a subsidization of capital in the case of livestock.

Table 3 - Implementation of the Agenda 2000 to obtain the 2003 database

measure	**shock**	**Sources of calculation**
introduction of a slaughtering (coupled) bovine premium	increase in the output subsidy for the livestock sector	ratio of expenditure to the value of production in AGLINK; weight of bovine on total livestock from Van Tongeren and Van Meijl (2000)
increase in the semi-decoupled premium for bovines	increase in subsidy to capital for the livestock sector	44% decrease in the premium; weight of bovine on total livestock from Van Tongeren and Van Meijl (2000)
increase in direct payment for cereals	increase in the subsidy to land in the cereal sector	+ 16%, from 54 to 63 Euro/ton
decrease in intervention price for cereals	decrease in the ratio of domestic to import price and in related export subsidies	change in market price after change in the intervention price as in Van Tongeren and Van Meijl (2000); import price as 1.55 times intervention price
decrease in direct payment for oilseeds	decrease in the subsidy to land in the oilseed sector	-33% from 94 to 63 Euro/ton
increase in milk quotas	increase in raw milk output	2.4%

In reality, direct payments per hectare (per head) are reduced if the cultivated land (the herd size) exceeds the maximum threshold. In order to represent this financial stabilizer, a mechanism was

added to the standard model by which the expenditure for direct payments to cereals, oilseeds and livestock is fixed, and the unit subsidy adjusts to changes in production. Moreover, since direct payments are fixed in nominal terms, payments were reduced by 2% per year.

Changes in intervention prices are modeled as changes in the ratio of domestic to import prices, while milk production quotas are introduced by fixing the output at the quota level and allowing the production tax to adjust. Finally, land set-aside provisions are not represented, since Agenda 2000 did not change the rate of the year 1997. The shocks implemented in the case of Agenda 2000 are summarized in Table 3

As seen in the previous section, the definition of the DERP requires the "small country" assumption. As it was mentioned, in the GTAP model foreign trade is described according to an Armington specification, which implies endogenous world prices. If the vector p is a function of the tariff vector $\boldsymbol{t}$, equation (4) becomes:

(5) $D^j(p^1;p^0,v,k) \rightarrow D\left|g_k^j\left[p^1(\boldsymbol{t}^1/D),v,k\right]=g_k^j(p^0,v,k),\right.$

This extension is already suggested in the original work by Anderson (1998), though it was not implemented in his analysis of US agriculture effective protection.

The model we use departs from the standard GTAP in two main respects. Firstly, in order to compute the DERP, we introduce a new variable *tr(i)* defined as the power of a uniform (that is, product-generic as well as source-generic) *ad valorem* import tariff. Secondly, capital is moved from the set of mobile factors to the sluggish one. This allows us to set exogenously factor used by the sector for which we are computing the index, while for the rest of the economy capital is still mobile, since we set its elasticity of transformation parameter at a high level. In other words, this allows us to leave the capital factor mobile across sectors, like it is in the real economy, however it enables us to fix it in a specific sector in order to compute the index.

In order to compute the uniform tariff equivalent of the actual protection levels, the policy experiment requires the elimination of all existing tariffs and export subsidies. In this free-trade scenario, the new variable (*tr*) is swapped with the capital endowment available to firms in the sector under consideration. In other words, we ask the model to compute the uniform tariff that would eliminate any incentives to reallocate the "fixed factor" to or from the sector for which we are computing the index.

Finally, we compare the DERP with the traditional measure of effective protection. The latter is computed according to the methodology suggested in Hertel (1997), based on a composite measure of import and export protection.

4 Experiment and results

The computation of the DERP for the EU trade policies in 2003 takes into account the implementation of the Agenda 2000 reform of the CAP. Results for the main agricultural commodities, food products and non-primary sectors are presented in Table 4. The cell entries are the nominal tariff rates (as reported in the GTAP database), the ERP, and the DERP. The ERP is the usual index, computed according to the methodology suggested by Hertel (1997), while the DERP is the uniform tariff equivalent which holds constant the amount of capital employed in the sector denoted by the row heading.

The first four sectors are agricultural commodities. According to the ERP, paddy rice and cereals are the most protected agricultural sectors; the DERP shows the same ranking, even if with different values. For cereals, while according to the ERP the protection is 56,1%, the DERP it is lower (49,9%). Note that for both indexes oilseed sector appear to be taxed even if for DERP the value is higher then ERP.

The following five sectors are food products, though livestock products, dairy, and sugar include also the corresponding agricultural commodities. According to the ERP the most protected are sugar (411,1%) and livestock products, while, according to the DERP, processed rice is the most protected, with more then 170%, followed by dairy (134,9%). For dairy and processed rice, it was not possible to compute the ERP because of the GTAP model, computing the variables, the value added in free trade become negative.

Table 4 - Levels of protection in several agriculture sectors of EU by nominal rates, ERP and DERP

	Nominal rate	*ERP*	*DERP*
Paddyrice	64,9	245,3	110,2
Cereals	22,1	56,1	49,9
Oilseed	0,0	-1,6	-5,7
Vegetables and fruits	14,5	17,1	21,4
Livestock products	41,2	266,4	69,1
Dairy	87,7	-	134,9
Processed rice	87,4	-	170,3
Sugar	77,5	411,1	100,4
Vegetables oil and fats	11,4	22,1	17,7
Textile	8,3	8,2	-2,8
Motorveich	7,8	10,2	-1,6

The last two sectors are textile and motor vehicles. According to the old concept (ERP), both receive positive effective protection, while according to the new one (DERP), effective protection is negative.

5 **Concluding remarks**

This paper attempted to measure the effective protection granted to the EU agrifood sector after the implementation of Agenda 2000. In order to do that, we used a new index of effective protection, obtained by applying index number and duality theory. The DERP, proposed by Anderson (1998), is defined as the uniform tariff which has the same impact on the profit of the sector as the actual tariff structure. We computed the index with a global CGE model, the GTAP, by removing the "small country" assumption underlying the original application by Anderson to the US agriculture.

Despite our results are still preliminary and should be used with caution, they show that the old and new concepts of effective protection give rather different pictures of the pattern of protection afforded to sectors of the actual tariff structure. The ERP and the DERP are not correlated like it is in the work by Anderson, further, the absolute values, and in any case also the signs, differ significantly, consequently the DERP leads to a reconsideration of the ranking of effective protection across different sectors.

It will be interesting in the future to use the DERP to rank the protection in a set of industries and see how it changes with different protection structures (border policies) and with different support structures (domestic policies). Secondly, the index considered in this paper is concerned with distribution rather than output changes. However, it would be interesting to follow the indication by Anderson that the same approach could be used to construct output effective rates of protection, based on the uniform tariff on all distorted sectors which produces the same level of sectoral output as does the initial differentiated tariff structure.

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