# Border protection and trade modelling in CAPRI

Border protection in the context of CAPRI refers to all policy measures which impact directly on import flows, i.e. tariffs and related tariff rate quotas.

CAPRI differentiates between *specific and ad-valorem tariff*. Specific tariffs represent fixed amounts of Euro/t which are charged on imports. Ad-valorem tariff are charged as a percentage of the value of imports. It is often argued that specific tariffs are more trade distorting as they are dampening fluctuations of world market prices. However, when specific tariffs are bounded due to trade agreements such as WTO or bilateral ones, inflation will devaluate them over time whereas ad valorem tariff adjust to inflation. The EU tariff system for agricultural product is dominated by specific tariffs.

## *The MFN tariffs and exemptions*

The WTO agreement has fixed upper bounds on tariffs, i.e. countries to adjust tariffs as long as the upper bounds are not exceeded. These upper bounds are called "Most Favourite Nation" or *MFN tariffs* for short. The terms can be understood from the history of the WTO: when a country entered the WTO, it had to make sure that any WTO member received the tariffs of the "most favourite nation". The MFN tariffs are stored as "TARS" and "TARV" for the different products, and clearly, are not differentiated by importer.

There a few exemptions from the rule that all WTO members should face the same import tariffs which are integrated in CAPRI. Firstly, the so called "general system of preferences" or "GSP" which allows lower import tariffs for Least Developed Countries. The so-called "Everything but Arms" or "EBA" agreement of the EU falls under the GSP. It allows all LDC to export duty and quota free all products to the EU, with the exemptions of armaments. The major number of LDCs is found in Sub-Saharan Africa, follows by parts of East Aria and some islands in the Pacific.

A second rather important exemption in case of the UE is the so-called EC-ACP partnership agreement. The ACP – currently 79 countries from the African, Caribbean and Pacific area – countries are mostly former colonies of the EU member states. They are benefit from preferential tariffs, and the exemption is granted as a waiver by WTO. In most cases, quota free access at reduced or zero tariff is granted.

A third important class of exemptions are free-trade areas and bi-lateral agreement towards free-trade areas. An example for a free-trade area is the EU itself. This class of exemptions is stored in CAPRI on the parameter p_doubleZero. Also the EU trade agreements with the Mediterranean are such an exemption.

The applied tariffs can be found in the tables "Trade\Import flows, price and tarirfs market model detailed" as shown below. Once can clearly see that the LDCs countries do not face any import tariffs into the EU.

## Tariff rate quotas

Tariff rate quotas (TRQs) are another exemption from the MFN tariffs. They establish a two tier tariff system. Up to the quota, a lower in-quota tariff is applied. For imports beyond the quota, the higher out-of-quota tariff is charged, which is in most cases identical to the MFN rates. When imports are at the quota, an economic rent might be observed leading to a kind of "shadow tariff". That situation is depicted below.
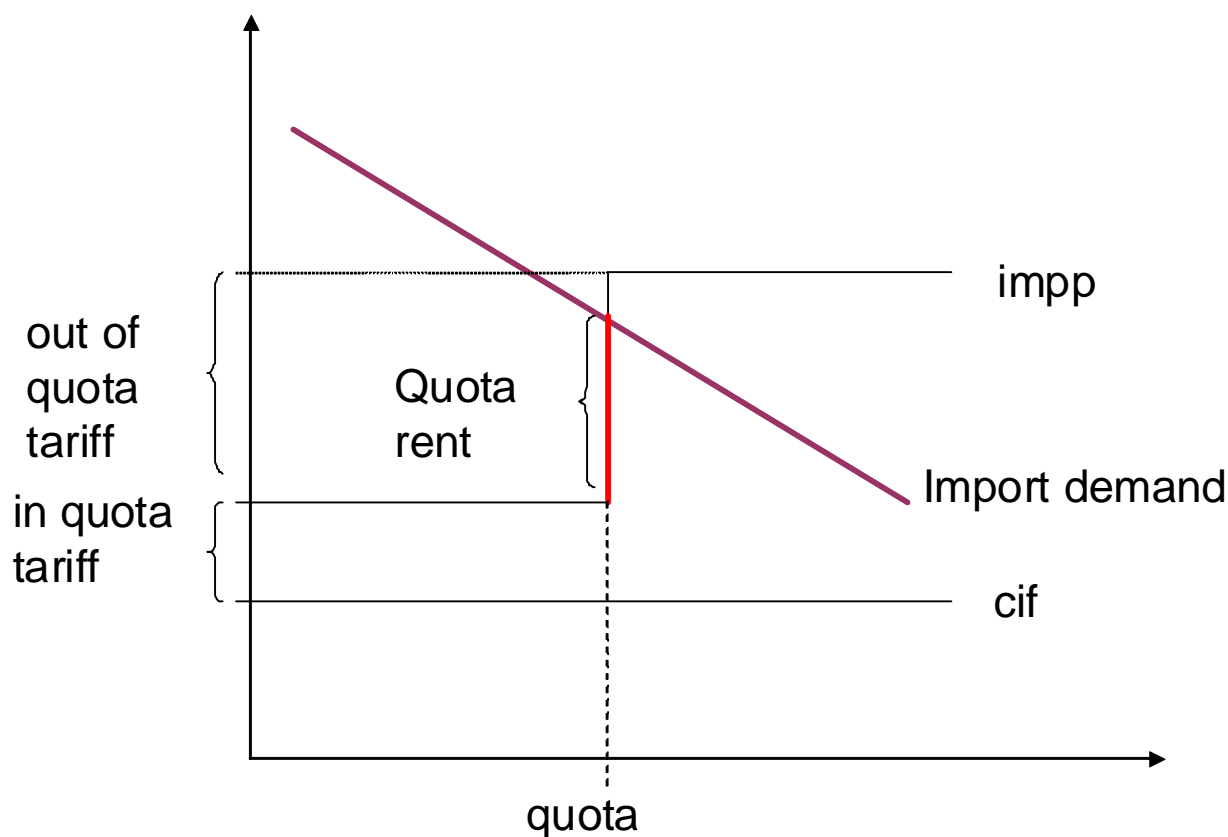
TRQs in CAPRI are not modelled based on if – else conditions which are differentiable, or based on MCP (Mixed Complimentarity Problem) formulation. Rather, a smooth approximation based on sigmoid function is used:

```
*
        v_tarSpec(RM,"RW",XXX) =E=

            p_trqGlobl(RM,XXX,"TsPref","CUR")
            + (    p_trqGlobl(RM,XXX,"TsMFN","CUR")
                  -p_trqGlobl(RM,XXX,"TsPref","CUR"))

                * sigmoid( p_trqSigmoidSlope(RM,XXX)/p_trqGlobl(RM,XXX,"TrqNT","CUR")
                        * (TrqImports(RM,XXX)- p_trqGlobl(RM,XXX,"TrqNT","CUR")*0.99));
```

The formula shows the two tariffs: the lower preferential one (the in quota tariff) and the higher MFN one (the out of quota tariff). The sigmoid function will be very close to 1 if the imports are close to the quota, so that a tariff close to the upper tier tariff will be charged. It drops quickly to 0 for small import quantities. The sigmoid function allows calibration the model to a "shadow tariff" by fixing the LHS during calibration. It is important to understand that increased (decreased) imports in the case of quota under fill lead to rapid increases (decreases) of the shadow tariff. The same mechanism does also mean that e.g. a drop in the cif prices for imports will be absorbed by a higher quota rent as long as no over quota imports occur.

Two types of TRQs stem from the so-called Uruguay round agreement which replaced the GATT by the foundation of the WTO. The general idea of the Uruguay round was to convert wherever possible existing agricultural trade barriers into MFN tariffs, which were then subject to cuts, a process called "tariffication".

The first type of TRQs emerging from the Uruguay round is called a "minimum access" quota. These were introduced when the MFN rates were prohibitive to ensure that at least 5% of domestic consumption could be covered by imports. How these quotas are distributed to the different import partners differs from country to country. In CAPRI, they are assumed to be open for all importers (parameter *p_trqGlobl*).

If existing preferences before the Uruguay allowed for a market share of imports higher exceeding 5%, and the tariffication led to prohibitive tariffs, so called "current access" quotas were granted to avoid a situation where imports would fall after an agreement targeting tariff reductions. These types of preferences are typically stored as a bi-lateral quota (*p_trqBilat*). The reader should not that importers are allowed in CAPRI to deliver in global quotas ocne the bi-lateral ones are filled.

The TRQ quotas, related import quantities and tariffs can be analyzed with a summary table (Trade / Detail tariff information, averages ..)



| | Global Quota [1000t] | Bilateral Quotas [1000t] | Imports (under global quotas) [1000t] | Imports (under bilateral quotas) [1000t] | Ad val. MFN [%] | Ad val. applied [%] | Spec. MFN [Euro/t] | Spec. applied [Euro/t] | Quota rents (under global quotas) [Mio Euro] | Quota rents (under bilateral quotas) [Mio Euro] | Free on Board (f.o.b.) [Euro/t] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Cereals | 6181.23 | 663.00 | 7702.50 | 638.06 | 5.50 | 0.00 | 92.78 | 0.07 | 2.01 | | 139.71 |
| Oilseeds | | | 19024.35 | | ∞ | | | | | | 181.72 |
| Other arable field crops | | 282.00 | 3604.24 | 284.91 | 8.00 | 0.56 | | | | 3.20 | 129.26 |
| Vegetables and Permanent crops | | 780.09 | 21973.45 | 819.44 | 6.38 | 0.79 | 171.02 | 7.46 | | 46.81 | 985.29 |
| Meat | 441.79 | 284.70 | 1106.93 | 325.74 | 9.47 | 0.19 | 1540.19 | 17.24 | 502.65 | 340.95 | 2451.54 |
| Other Animal products | 135.22 | | 175.39 | | 2.57 | 0.00 | 693.98 | 0.73 | 0.05 | | 1521.34 |
| Dairy products | 223.56 | 79.85 | 683.29 | 76.18 | 5.77 | 0.04 | 1222.84 | 8.65 | 94.20 | 98.54 | 1405.03 |
| Oils | 5.62 | 57.00 | 9878.94 | 149.57 | 4.29 | 1.16 | 35.08 | 13.35 | | 38.05 | 964.33 |
| Oil cakes | | | 25959.42 | | ∞ | | | | | | 164.13 |
| Secondary products | 216.09 | 2339.80 | 977.48 | 3108.43 | ∞ | | 310.87 | 18.75 | 1.39 | 353.47 | 372.30 |
| Cereals | 6181.23 | 663.00 | 7702.50 | 638.06 | 5.50 | 0.00 | 92.78 | 0.07 | 2.01 | | 139.71 |
| Wheat | 2496.91 | 663.00 | 2379.28 | 638.06 | 12.80 | 0.00 | 118.21 | 0.00 | 0.61 | | 143.01 |
| Rye and meslin | | | 1594.83 | | ∞ | | 93.00 | 2.21 | | | 112.77 |

## *Special import regimes*

The EU claims to make apply generally the WTO bound rates, i.e. to use the maximum level of border protection possible. An important exemption is the so-called "flexible levy" system for cereals. It modulates the specific tariffs of cereals depending on CIF prices and the administrative prices for cereals. That mechanism is integrated into CAPRI (equations DiffLevies1_, DiffLevies_).

```
*
*    MAX(0,Min. Border price - CIF)
*
   DiffLevies1(RM,RM1,XXX) =E=

         -ncpcm( -(  DATA(RM,"MinBordP",XXX,"CUR")
                   -(v_marketPrice(RM1,XXX)*p_exchgRateChangeFactor(RM,RM1)+v_transpCost(RM,RM1,XXX))),0,1.E-2);
..
```

And:

```
*
*    MIN( DiffLevies1 =  MAX(0, Min. Border price - CIF), Bound Rate resp. tariff under TRQ)
*
         DiffLevies(RM,RM1,XXX) =E= ncpcm(DiffLevies1(RM,RM1,XXX),v_tarSpec(RM,RM1,XXX),1.E-2);
     T
```

Were *ncpcm* is a smooth approximation of the *min* operator. Even more complex, but in essence similar, is the import regime for specific fruits and vegetables.

# Import and market prices in CAPRI

The import prices can be found in the table "Trade / Tariff and transport costs, averages over importers w/o intra block trade". The latter is important for EU27, as otherwise, the duty and quota free imports inside the EU are taken into account. The table shows the basic elements determining import prices according to the equation in the market model:

```
*
* ---- import price relation to producer price
*     (attention: ExpSub and Tariff may be endogenous variables)
*
 ImpP_(RM,RM1,XXX) $ (DATAI(RM,RM1,XXX,"CUR") or SAMEAS(RM,RM1)) ..

    ImpP(RM,RM1,XXX)    =E=
*
    ( (v_marketPrice(RM1,XXX) * p_exchgRateChangeFactor(RM,RM1)

*
*      --- export subsidies
*
    - ExpSub(RM1,XXX)  $ ( (DATA(RM1,"PADM",XXX,"CUR") gt eps) and (DATA(RM1,"FEOE_max",XXX,"CUR") GT eps)
                         and (NOT p_doubleZero(RM,RM1,XXX,"CUR")) and (NOT SAMEAS(RM,RM1))))
*
*      --- transport costs
*
    + v_transpCost(RM,RM1,XXX) )
*
*      --- add valorem tariff
*
      * ( 1. + 0.01*v_tarAdVal(RM,RM1,XXX) $ ( (NOT p_doubleZero(RM,RM1,XXX,"CUR")) and (NOT SAMEAS(RM,RM1))))
*
*      --- specific tariffs
*
      + (
*              --- fixed according to tariff schedule or endogenous under TRQ
               v_tarSpec(RM,RM1,XXX) $ (DATA(RM,"MinBordP",XXX,"CUR") LE eps)

*              --- or flexible levy in case of minimum border prices
             + DiffLevies(RM,RM1,XXX)  $ (DATA(RM,"MinBordP",XXX,"CUR") GT eps)

      ) $ ( (NOT p_doubleZero(RM,RM1,XXX,"CUR")) and (NOT SAMEAS(RM,RM1)));
```

- **Free on board price** – these are equivalent to market prices time exchange rates minus possible export subsidies. Both the export subsidies and the market prices are endogenous variables

- **Per unit transport costs** – these are fixed and given

- **(Applied) ad valorem tariffs** – as discussed above, they are endogenous in the case of bi-lateral or global TRQs

- **(Applied) specific tariffs resp. flexible levies** – as discussed above, they are endogenous in the case of bi-lateral or global TRQs or in case of minimum import price regimes



## *From import prices to import quantities*

CAPRI does not apply the "rule of one price" for products of different origin. Rather, the so-called "Armington assumption" is applied which accounts for differences in product composition and quality between origins. Imports can occur even if the import price is above the market price, and a country might be at the same an importer and exporter. Domestically produced and the imported products are assumed to imperfect substitutes, and the same is true for imports of different origins. That assumption can be easily defended by considering that market balances and import flows in CAPRI are based on FAO statistics measured in "primary product equivalents". Imports of pork meat account hence also for sausages, ham etc.. The Armington assumption is also applied in most Computable Equilibrium models.

In order to model substitution in between imports, and between imports and domestic sales, a Constant Elasticity of Substitution (CES) function is used so that import shares react to price changes. The code snippet below shows the equation in the code (Shares2_). The relation

between the trade flows *v_tradeFlows* from specific country and the trade flow of a numeraire country depends on the relation between import price of that country and the numeraire country, the substitution elasticity *p_rhoArm2* and a so-called share parameter *dp*. The latter is used to calibrate the model against a given vector of import prices and flows.

```
*
    (v_tradeFlows(RM,RM2,XXX)+1.E-6)
*
*         --- biggest import streams as comparison point
*
          =E=  (SUM(RM1 $ (RM1.pos EQ p_arm2Num(RM,XXX)), (v_tradeFlows(RM,RM1,XXX)+1.E-6)
*
                  * (
                        dp(RM,RM2,XXX)/dp(RM,RM1,XXX)
                      * (ImpP(RM,RM1,XXX)+1.E-3)/(ImpP(RM,RM2,XXX)+1.E-3)

                    )**(1/(1+p_rhoArm2(RM,XXX))))) $ (dp.l(RM,RM2,XXX) GT 1.E-12)
..
```

In a similar fashion, domestic sales and total imports shares are driven by their respective prices. A first overview on these gives the table "Price market model". The market price is the price charged for domestic sales, whereas the "price Armington 2" is the average price of import evaluates based on their shares and prices. The "Armington 1" price is the average price from domestic sales and imports. Another important point is the difference between consumer prices and the "Armington 1" price. For agricultural raw product, prices with the exemption of consumer prices relate to raw products, where final consumer of wheat face the price of wheat based products (bread, pizza, cakes …). The huge difference between the two explains in parts the dampened reaction of human consumption to changes in market and import prices. The reader might also note that the relative differences between consumer and raw product prices differ considerably between product groups.

| Table | Region | Years | | View type |
|---|---|---|---|---|
| Prices market model | European Union 27 | 2020 | | Table |

| | Producer price [Euro /t] | Market price [Euro /t] | Price Armington 2 [Euro /t] | Price Armington 1 [Euro /t] | Consumer price [Euro /t] | Processing margin [Euro /t] |
|---|---|---|---|---|---|---|
| Cereals | 138.84 | 139.77 | 185.89 | 142.04 | 2515.50 | |
| Oilseeds | 220.07 | 224.22 | 237.53 | 230.23 | 919.03 | 95.61 |
| Other arable field crops | 133.14 | 128.80 | 182.10 | 132.78 | 846.37 | |
| Vegetables and Permanent crops | 637.00 | 1077.90 | 826.58 | 1036.62 | 2267.17 | |
| Meat | 2264.23 | 2452.58 | 3243.52 | 2484.07 | 6069.79 | |
| Other Animal products | 1449.01 | 1520.76 | 2387.68 | 1575.50 | 3845.87 | |
| Dairy products | 1377.57 | 1394.66 | 2673.28 | 1422.15 | 1911.81 | 250.65 |
| Oils | 1372.94 | 1383.65 | 722.61 | 1061.94 | 4804.47 | |
| Oil cakes | 182.83 | 167.71 | 248.53 | 209.90 | 212.63 | |
| Secondary products | 531.42 | 376.67 | 532.76 | 435.89 | 5759.24 | |
| Cereals | 138.84 | 139.77 | 185.89 | 142.04 | 2515.50 | |
| Wheat | 133.99 | 142.60 | 188.43 | 144.18 | 2502.60 | |
| Rye and meslin | 109.16 | 113.90 | 155.75 | 122.46 | 2241.24 | |
| Barley | 109.49 | 114.36 | 147.20 | 114.75 | 2641.68 | |
| Oats | 116.93 | 120.64 | 158.42 | 121.31 | 2940.52 | |
| Grain maize | 181.19 | 158.00 | 180.32 | 159.81 | 2699.16 | |
| Other cereals | 125.70 | 164.18 | 267.21 | 176.50 | 1833.78 | |

The "Armington 1" price (average of imports and domestic sales) drives:

- Feed demand

- Processing demand (along with the producer prices for the outputs)

- The consumer price, which drive food demand

It will thus determine demand quantities in the market, and therefore, indirectly, also the exported and imported quantities. The relation between the "Armington 2" and the "Market price" will determine the shares of demand covered by domestic sales and by imports, the weighted average of the two prices is the "Armington 1" price.