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Modeling of Duty Drawback by Means of Domestic Final Consumption Subsidy

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Abstract

We suggest an approach to take the Duty Drawback regime into account in a general equilibrium frame. A change of tariffs is imitated by a virtual subsidy for domestic consumers. The approach is based on a specific shock calculation and requires neither a change of the general equilibrium model nor an adjustment of the database. As an illustrative example we analyze a tariff reduction comparing the suggested approach with a normal application. Model results show clearly that the Duty Drawback regime has a considerable influence.

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1 Introduction

Under the Duty Drawback regime (DD) all imports, which are used to produce exports are exempted from tariffs. This regime has two effects: First, the export industry gets access to inputs at world market price. Second, industries, which produce for domestic consumption, are protected against cheap imports.

In the case of a tariff reduction the DD regime plays an important role. General equilibrium models are suitable tools to analyze such policy changes. Normally, they do not distinguish between a production for domestic use and one for exports. Accordingly, they cannot depict the DD regime explicitly. So the question arises how to modify general equilibrium models in order to consider the DD regime.

Ianchovichina (2003) suggests splitting all sectors into two sub sectors. One is only producing for domestic use while the other produces export goods. The approach requires substantial changes of both model and database and is therefore costly. Especially, if the DD regime is only applied for a few sectors this approach seems not to be appropriate. Bach et al. (1996) suggest introducing subsidies for industries, which are exempted from import tariffs. Simulating a tariff reduction these subsidies are reduced. Accordingly, there are two effects in the model. First, due to the tariff reduction import prices decrease for all goods. Second, industries, which are exempted from tariffs, face a price increase due to the reduction of the mentioned subsidy. The two effects neutralize each other. Consequently, exempted industries are not affected by a tariff reduction. This approach requires an adjustment of the database while the model is not affected.

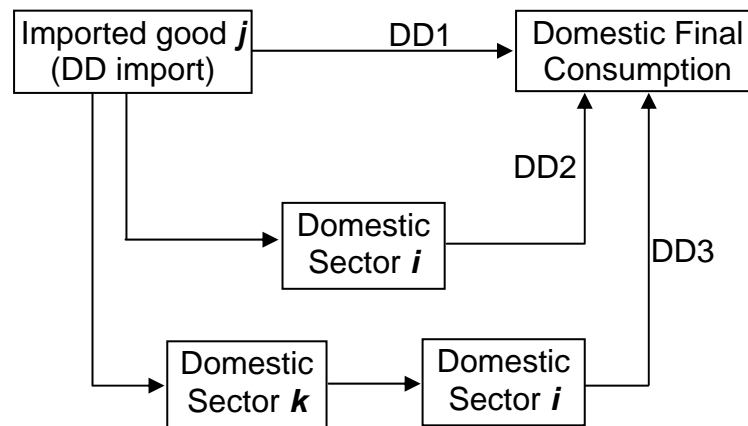
In this paper we propose a further approach, which requires neither a change of the general equilibrium model nor an adjustment of the database. Our approach is based on the assumption that the DD regime leads to a discrimination of the domestic final consumption. Latter comprises the private consumers, the government and the agent, who buys investment goods. There are two reasons why the domestic industry is not directly affected by the DD regime. First, for the production of exports, imports under the DD regime are exempted of charging with tariffs. Second, the tariffs on inputs for the domestic consumption can be shifted to the consumers. Since only domestic final consumers are affected by a tariff rate cut of DD goods, we imitate such a policy change with a virtual subsidy. Instead of changing import tariffs we introduce subsidies for the domestic final consumption. The subsidy leads to a price decrease

for the domestic final consumption and is therefore an imitation of a tariff reduction under the DD regime. Analyzing a tariff reduction, the tariff rate for commodities under the DD regime is not altered. As a consequence, the production of exported goods, which requires imported DD inputs, is not affected. The appropriate exogenous changes of the consumer subsidies are the result of a specific shock calculation, which is presented in section two of the paper. Section three includes the description of an illustrative example. The results are presented in section four, while the conclusions are drawn in the last section.

2 Shock Calculation for Imports Under DD Regime

Introducing a subsidy for DD goods of the domestic final consumption we have to consider all possibilities of consumption (Figure 1).

Figure 1: Consumption of DD Imports by the Domestic Final Consumption



Most obvious, a DD good can be directly imported, what is represented with the flow DD1. Furthermore, DD imports can also be consumed indirectly. If a DD import is used in a domestic industry in order to produce a good for the domestic final consumption, an import tariff has to be paid on this particular input (DD2). For example, Bangladesh applies the DD regime for textiles. The wearing apparel sector in Bangladesh uses imported textiles for its production. Accordingly, when private consumers buy domestic wearing apparels, the price includes also the tariff for the imported textiles. The flow DD3 in Figure 1 represents a related case, when an imported input passes two domestic industries before being consumed. Theoretically, it would be correct to continue with the corresponding flows DD4 etc. We neglect all

further possibilities, say a DD import is passing three or more domestic sectors until be delivered to the domestic final consumption.

To figure out the consumption, which has imported origin for all domestic final consumers is a precondition for the calculation of the subsidy shocks. Latter imitate tariff reductions under the duty drawback regime. The shocks depend on the level of consumption.

Although the approach can be applied for all general equilibrium models we use the coefficients of the GTAP model (Hertel, 1997). The whole code for the GEMPACK software (Harrison and Pearson, 2002) can be found in Appendix 2.

Normally, the DD regime is applied for a small group of goods. Therefore, we define the set DDTRAD, which includes all goods under the DD regime. DDTRAD is a subset of TRAD, the set of all tradable goods. Similarly, we define the set DDREG, which includes all regions with DD regime.

The following description can be divided into three steps. Before calculating the shocks (step 3) we have to define the DD imports (step 1) and the adjusted tariff rate on DD imports (step 2). A final subsection summarizes the adjustments the user is asked to do.

2.1 Step 1: Domestic Final Consumption of Imported DD Goods

We calculate value of DD1, DD2 and DD3 imports for the good j imported under the DD regime. Therefore, we distinguish three agents: The private household (DDP), which includes all private consumers, the government (DDG) and the investments or capital goods (DDI).

Private Household (DDP)

DDP1 imports are equal to VIPM, the value of imports for the private household at market price:

$$DDP1(j,r) = VIPM(j,r) \quad \forall j \in DDTRAD$$

DDP2 measures all DD imports j , which are used in order to produce good i for the private household in region r :

$$DDP2(j,i,r) = VIFM(j,i,r) \frac{VDPM(i,r)}{VOM(i,r)} \quad \forall j \in DDTRAD$$

The imported input j for sector i $VIFM(j,i,r)$ is multiplied with the output share of sector i , which is delivered to the private household. Latter is indicated with the relation of $VDPM$ and VOM ¹. It is important to notice that the DD import j can be used in all sectors i as an input.

DDP3 is the DD import j , which is used in a domestic sector k , who's output is used in another domestic sector i . The share of sector i in sector k 's output refers to the relation between $VDFM$ ² and VOM . We have to sum up over all k sectors, which are gathered in the set $TRAD$. Again, the relation between $VDPM$ and VOM indicates the proportion, which is finally delivered to the private household¹:

$$DDP3(j,i,r) = \left[\sum_k^{TRAD} VIFM(j,k,r) \frac{VDFM(k,i,r)}{VOM(k,r)} \right] \frac{VDPM(i,r)}{VOM(i,r)} \quad \forall j \in DDTRAD$$

Government (DDG)

The three DD imports for the government are similar to those of the private household. All used coefficients are summarized in a glossary in Appendix 1.

$$DDG1(j,r) = VIGM(j,r) \quad \forall j \in DDTRAD$$

$$DDG2(j,i,r) = VIFM(j,i,r) \frac{VDGM(i,r)}{VOM(i,r)} \quad \forall j \in DDTRAD$$

$$DDG3(j,i,r) = \left[\sum_k^{TRAD} VIFM(j,k,r) \frac{VDFM(k,i,r)}{VOM(k,r)} \right] \frac{VDGM(i,r)}{VOM(i,r)} \quad \forall j \in DDTRAD$$

¹ $VDPM(i,r)$ is the value of good i , which is delivered to the domestic private household of region r at market price. $VOM(i,r)$ is the value of the total output of sector i in region r at market price.

² $VDFM(k,i,r)$ is the value of the good k , which is delivered to the domestic sector i in region r at market price.

Investments or Capital Goods (DDI)

In the GTAP model the global bank purchases investments or rather capital goods in all regions depending on the expected profitability. The investments are produced in the investment sectors. They assemble inputs from all sectors, which can be either imported or of domestic origin. The capital goods are gathered in a special set (CGDS_COMM). Normally, this set includes only one element. Nevertheless, our formulation takes also the case of several investment goods into account.

$DDI1(j,c,r)$ measures the DD good j , which is directly imported by the investment sector c in region r :

$$DDI1(j,c,r) = VIFM(j,c,r) \quad \forall j \in DDTRAD \text{ and } \forall c \in CGDS_COMM$$

$DDI2$ covers the DD import j , which is used as an input in sector i in order to produce a good for the investment sector c in region r :

$$DDI2(j,i,c,r) = VIFM(j,i,r) \frac{VDFM(i,c,r)}{VOM(i,r)} \quad \forall j \in DDTRAD \text{ and } \forall c \in CGDS_COMM$$

$VDFM(i,c,r)$ and $VOM(i,r)$ indicate the share of output i , which is delivered to the investment sector c in region r .

The third DDI import is:

$$DDI3(j,i,c,r) = \left[\sum_k^{TRAD} VIFM(j,k,r) \frac{VDFM(k,i,r)}{VOM(k,r)} \right] \frac{VDFM(i,c,r)}{VOM(i,r)} \quad \forall j \in DDTRAD \text{ and } \forall c \in CGDS_COMM$$

2.2 Step 2: Adjusted Tariff Rate for the Domestic Final Consumption

Normally, it is assumed that all users pay the same tariff rate on a specific import j . Accordingly, if the tariff revenue is divided through the total imported value, the tariff rate results. Under the DD regime it is different since only the domestic final consumption is paying tariffs³. Therefore, all tariff revenues of DD sector are assigned to domestic consumption only. An adjusted tariff rate for domestic final

³ We assume that the imports used for the production of exports includes only the CIF value, while the imports used for the private household include the CIF value as well as all tariffs.

consumption has to be calculated. As a precondition, we build the total DD imports in region r ($TOTALDD(j,r)$):

$$\begin{aligned}
 TOTALDD(j,r) = & \\
 & + DDP1(j,r) + \sum_i^{TRAD} DDP2(j,i,r) + \sum_i^{TRAD} DDP3(j,i,r) \\
 & + DDG1(j,r) + \sum_i^{TRAD} DDG2(j,i,r) + \sum_i^{TRAD} DDG3(j,i,r) \\
 & + \sum_c^{CGDS_COMM} DDI1(j,c,r) + \sum_i^{TRAD} \sum_c^{CGDS_COMM} DDI2(j,i,c,r) + \sum_i^{TRAD} \sum_c^{CGDS_COMM} DDI3(j,i,c,r)
 \end{aligned}$$

The DD2 and DD3 imports have to be summed up over all sectors because all goods may include DD imports. In addition, the DDI imports have to be added for all investment goods⁴.

Using $TOTALDD(j,r)$ we calculate the domestic final consumption specific tariff rate $ALPHA(j,r)$:

$$ALPHA(j,r) = \frac{\sum_s^{REG} MTAX(j,s,r)}{TOTALDD(j,r)} \quad \forall j \in DDTRAD$$

$MTAX(j,s,r)$ is the import tariff for good j from region s imported in region r ⁵. In order to get the total tariff revenue generated from imported good j in region r $MTAX$ has to be added over all origin region s , which are included in the set REG .

2.3 Step 3: Consumer Subsidy Shocks

The consumer subsidy shocks differ between the three agents of the domestic final consumption. Accordingly, we have to calculate shocks for private household, government and investments goods separately. All of them consume both imported as well as domestic goods. Latter may also include DD imports. We calculate shocks for both consumption possibilities. First, we look at the consumption of imported goods, which includes DD1 imports. DD2 and DD3 imports refer to the domestic consumption and are considered afterwards.

⁴ In the standard version of GTAP there is just one element in the set $CGDS_COMM$.

⁵ We assume that the tariffs or rather the tariff revenues in the GTAP database are correct.

Shocks for Imports (DD1)

All DD1 imports are transferred into a consumption subsidy on imports. The subsidies amount the differences between the agent and the market price and can be expressed with a relation of two coefficients. The counter indicates the value at agents price and includes the subsidy. In contrast, the denominator is the value at market price and does not include the subsidy. The coefficients for private household (TPM), government (TGM) and investment sector (TFM) are⁶:

$$TPM(j, r) = \frac{VIPA(j, r)}{VIPM(j, r)} \quad \forall j \in DDTRAD$$

$$TGM(j, r) = \frac{VIGA(j, r)}{VIGM(j, r)} \quad \forall j \in DDTRAD$$

$$TFM(j, c, r) = \frac{VIFA(j, c, r)}{VIFM(j, c, r)} \quad \forall j \in DDTRAD \text{ and } \forall c \in CGDS_COMM$$

If a tariff reduction for DD imports takes place, we simulate a price decrease of direct imported DD goods. Looking at the coefficient TPM, we have to subtract a subsidy from VIPA. Given a tariff reduction of X percent, TPM_N, the value of TPM after the simulation becomes:

$$TPM_N(j, r) = \frac{VIPA(j, r) - \frac{X}{100} * ALPHA(j, r) * DD1(j, r)}{VIPM(j, r)} \quad \forall j \in DDTRAD$$

TPM_N has a value below 1, since the numerator decreases. The percentage change from TPM towards TPM_N can be expressed as percentage change, which is denoted by small letters (tpm):

$$tpm(j, r) = \frac{[TPM_N(j, r) - TPM(j, r)]}{TPM(j, r)} * 100 \quad \forall j \in DDTRAD$$

tpm is the shock of the consumer subsidy for imports and is used in the model simulation.

The shocks for government and investment sector are calculated similarly. The referring formulations can be found in Appendix 2.

⁶ In contrast to market values values at agents price include the agent specific tax or subsidy. For example, it holds: $VIPA = VIPM + \text{Private Household Subsidy}$

Shock for Domestic Goods (DD2 and DD3)

Since domestic goods may include DD imports we calculate shocks for all of them according to the DD2 and DD3 imports. They are translated into consumer specific subsidies on domestic goods. The shock calculation is similar to the tariffs on direct imported goods. The coefficients for private household (TPD), government (TGD) and investment sector (TFD) are⁷:

$$TPD(i, r) = \frac{VDPA(i, r)}{VDPM(i, r)} \quad \forall i \in TRAD$$

$$TGD(i, r) = \frac{VDGA(i, r)}{VDGM(i, r)} \quad \forall i \in TRAD$$

$$TFD(i, c, r) = \frac{VDFA(i, c, r)}{VDFM(i, c, r)} \quad \forall i \in TRAD \text{ and } \forall c \in CGDS_COMM$$

After a tariff reduction of X percent the coefficient for the private household TPD_N results:

$$TPD_N(i, r) = \frac{VDPA(i, r) - \frac{X}{100} * \sum_j^{DDTRAD} [ALPHA(j, r) * (DD2(j, i, r) + DD3(j, i, r))]}{VDPM(i, r)} \quad \forall i \in TRAD$$

The delivery of sector i to the private household may include different inputs j, which are imported under the DD regime. Therefore, the tariff rate ALPHA has to be multiplied with the DD2 and DD3 imports and summed up over all goods under the DD regime. The calculation of the shock tpd is similar to those of tpm. Appendix 2 includes also the shock calculation for the government (tgm) and the investment sector (tfm).

All three steps have to be done before the model simulation starts. During the simulation the shocks (tpm, tgm, tfm, tpd, tgd and tfd) are used as exogenous inputs.

⁷ VDPA is the value of domestic goods for the private household at agents price, while VDPM indicates the corresponding value at market price.

2.4 Summery for Users

To apply the suggested approach the user needs to carry out three things:

- First, all goods under the DD regime build the set DDTRAD. In addition, the countries or regions, which apply the DD regime has to be defined in the set DDREG. Both sets need to be added to the GTAP parameter file.
- Second, it is necessary to define the level of the tariff cut. Latter is denoted as X (previous subsection). Its definition is in the tab-file (Appendix 2).
- Finally, the tab-file has to be run with a corresponding cmf-file in order to calculate all shock. The cmf-file is in Appendix 3.

3 Scenario and Data

Bangladesh applies the DD regime for two commodities textile and wearing apparel⁸. Accordingly, if imported textiles or wearing apparels are employed to produce exports, they are released from tariffs.

As an illustration of the suggested approach we simulate twice a unilateral import tariff reduction of 50 percent for two Bangladeshi sectors textile and wearing apparel. First, we apply a normal tariff reduction (“Normal”), which means we cut the tariffs in halve. In a second attempt we apply the shock calculation as described in section two (“WithDD”).

We use the standard version of the general equilibrium model of the Global Trade Analysis Project (GTAP; Hertel, 1997). It is a static comparative multi-sector and multi-region model.

The version 5.3 of the GTAP database is employed, which refers to the year 1997 (Dimaranan and McDougall, 2002). For the analysis we aggregate the database into two regions (Bangladesh and the Rest of the World) and 12 sectors. The sector “Rice” includes the production of paddy rice as well as the rice processing industry. All non-

⁸ In reality, several programs with slightly different incentives are applied. Two of the most important incentives in Bangladesh are DD facility and Bonded Warehouse Facility (BWF). Under the DD, the exporters are refunded not only the duties paid on the imported inputs but also the value added tax paid on domestic inputs used in the production of the exports. The BWF is even more profitable for exporters. Under this system a firm can delay the payments of duties until they are ready to consume raw materials imported earlier and if theses raw materials are used for producing export goods then they are not required to pay the duty. It implies that the firms do not require capital to finance import tariffs.

rice grains are in the sector “Grains”, while the plant based fibers build the sector “Fibers”. All other agricultural activities are included into the sector “rAGR”. The sector “Food” covers the whole food processing without processed rice. The textile related sectors are “Textiles”, “Wearing Apparel” and “Leather Products”. Forestry, fishing and extraction activities are in the sector “Extract”. The manufacturing is split into a labor intensive (“LiMANF”) and capital-intensive (“CiMANF”) sector. All services are included in the last sector.

4 Results

Although we are looking twice at the same policy change, the effects in the model are quite different.

In the version “Normal” the imports of textiles and wearing apparel become cheaper. Accordingly, the wearing apparel production faces a cost reduction of more than 2 percent (Table 1). This in turn facilitates exports. The exported quantity increases by 23 percent (Table 2). Since the main part of the wearing apparel production is exported, an output increase of 19 percent (Table 3) results. The demand for factors increase. Accordingly, factor prices rise (Table 1).

Table 1: Price Changes in Percent for Bangladesh

	Normal	WithDD
Land	0.2	-0.4
Labor	1.5	-0.6
Capital	1.6	-0.5
Rice	1.2	-0.5
Grains	0.9	-0.4
Fibers	0.8	-0.8
rAGR	1.0	-0.4
Food	1.1	-0.4
Textiles	-0.5	-0.5
Wearing Apparel	-2.4	-0.4
Leather Products	1.0	-0.4
Extract	1.4	-0.5
LiMANF	1.1	-0.4
CiMANF	1.3	-0.5
Services	1.4	-0.5

In the “WithDD” version only the private household faces cheaper imports. The imported quantities of textiles and wearing apparel increase, while the private

household is consuming less domestic products. As a further consequence demand for factors decrease and a reduction of factor prices results (Table 1). Accordingly, production costs of all sectors are decreasing, which in turn leads to a general increase of exports (Table 2).

Table 2: Quantity Changes in Percent of Bangladeshi Exports and Imports

	Exports		Imports	
	Normal	WithDD	Normal	WithDD
Rice	-5.0	2.1	2.7	-1.1
Grains	-3.5	1.5	0.3	-0.1
Fibers	-2.9	3.3	-0.2	-4.2
rAGR	-4.2	1.8	2.2	-0.9
Food	-4.7	1.9	2.0	-0.7
Textiles	2.0	2.0	24.9	10.8
Wearing Apparel	22.7	3.2	49.1	29.0
Leather Products	-8.4	3.6	4.1	-1.0
Extract	-7.1	2.7	2.1	-0.7
LiMANF	-6.1	2.3	2.0	-0.7
CiMANF	-6.9	2.7	1.3	-0.5
Services	-5.1	2.0	2.8	-1.0

Table 3: Output Change in Percent for Bangladesh

	Normal	WithDD
Rice	0.0	0.1
Grains	-1.5	0.6
Fibers	-2.0	-1.8
rAGR	-0.3	0.2
Food	-0.8	0.4
Textiles	-1.6	-3.0
Wearing Apparel	19.4	2.6
Leather Products	-6.4	2.8
Extract	-0.2	0.2
LiMANF	-1.4	0.6
CiMANF	-2.2	1.0
Services	0.0	0.1

5 Conclusions

We suggest an approach to take the Duty Drawback (DD) regime into account in a general equilibrium frame. Since only the domestic final consumption is affected by the DD regime we introduce virtual subsidies for domestic final consumers instead of a tariff change. Therefore, a specific shock calculation is applied. The approach requires neither a change of the general equilibrium model nor an adjustment of the database.

As an illustration of the approach we simulate twice a unilateral tariff reduction for Bangladesh using both the normal procedure and our suggested approach. The effects in the model as well as model results are different and emphasize the importance to take the DD regime explicitly into consideration. In particular, model results for goods, which are mainly used in export-oriented industries, depend strongly on the applied depiction of the DD regime.

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Appendix 1: Glossary

Table 4: Glossary of used Coefficients

Coefficient	Explanation
ALPHA(j,r)	Tariff rate for domestic final consumption for DD good j in region r
MTAX(j,s,r)	Import tariff for good j from region s imported in region r
TOTALDD(j,r)	Value of good j which is imported under DD regime for domestic final consumption in region r at market price
VDFA(k,i,r)	Value of the good k which is delivered to the domestic sector i in region r at agent price
VDFM(k,i,r)	Value of the good k which is delivered to the domestic sector i in region r at market price
VDGA(i,r)	Value of domestic good i, which is delivered to the government of region r at agent price
VDGM(i,r)	Value of domestic good i, which is delivered to the government of region r at market price
VDPA(i,r)	Value of good i, which is delivered to the domestic private household of region r at agent price
VDPM(i,r)	Value of good i, which is delivered to the domestic private household of region r at market price
VIFA(j,i,r)	Imported input j for sector i in region r at agent price
VIFM(j,i,r)	Imported input j for sector i in region r at market price
VIGA(j,r)	Imported input j for the government in region r at agent price
VIGM(j,r)	Imported input j for the government in region r at market price
VIPA(j,r)	Value of imported good j demanded by the private household in region r at agent price
VIPM(j,r)	Value of imported good j demanded by the private household in region r at market price
VOM(i,r)	Value of the total output of sector i in region r at market price.

Appendix 2: Model Code in GEMPACK (DDshocks.tab)

```

!-----!
! DDshocks.TAB FILE                                     !
! Shocks for DD Imports for domestic final demand      !
!-----!

!-----!
! SETS                                                  !
!-----!

FILE GTAPSETS # File with set specification #;

SET REG # Regions in the model #
      MAXIMUM SIZE 10 READ ELEMENTS FROM FILE gtapsets HEADER "H1";

SET DDREG # Regions which apply the DD regime #
      MAXIMUM SIZE 10 READ ELEMENTS FROM FILE gtapsets HEADER "DDRE";

Subset DDREG is subset of REG;

SET TRAD_COMM # TRADED COMMODITIES #
      MAXIMUM SIZE 10 READ ELEMENTS FROM FILE gtapsets HEADER "H2";

SET DDTRAD # DD Imports #
      MAXIMUM SIZE 10 READ ELEMENTS FROM FILE gtapsets HEADER "DDGO";

Subset DDTRAD is subset of TRAD_COMM;

SET ENDW_COMM # ENDOWMENT COMMODITIES #
      MAXIMUM SIZE 5 READ ELEMENTS FROM FILE gtapsets HEADER "H6";

SET CGDS_COMM # CAPITAL GOODS Commodities #
      MAXIMUM SIZE 1 READ ELEMENTS FROM FILE gtapsets HEADER "H9";

SET ENDWC_COMM # Capital Endowment Commodity # (capital) ;

SET PROD_COMM # PRODUCED COMMODITIES # = TRAD_COMM UNION CGDS_COMM ;

SET DEMD_COMM # DEMANDED COMMODITIES # = ENDW_COMM UNION TRAD_COMM ;

SET NSAV_COMM # NON-SAVINGS COMMODITIES # = DEMD_COMM UNION CGDS_COMM ;

SUBSET PROD_COMM IS SUBSET OF NSAV_COMM ;

SUBSET ENDWC_COMM IS SUBSET OF NSAV_COMM;

Set MARG_COMM # margin commodities #
      Maximum size 10 read elements from file GTAPSETS header "MARG";

Subset MARG_COMM is subset of TRAD_COMM;

Set NMRG_COMM # non-margin commodities # = TRAD_COMM - MARG_COMM;

!-----!
! FILES                                                  !
!-----!

FILE GTAPDATA # The file containing all base data. # ;

FILE (NEW,TEXT) TPM_shock # The file with shocks for tpm #;
FILE (NEW,TEXT) TPD_shock # The file with shocks for tpd #;

FILE (NEW,TEXT) TGM_shock # The file with shocks for tgm #;
FILE (NEW,TEXT) TGD_shock # The file with shocks for tgd #;

FILE (NEW,TEXT) TFM_I_shock # The file with shocks for tfm #;
FILE (NEW,TEXT) TFD_I_shock # The file with shocks for tfd #;

!-----!
! COEFFICIENTS                                          !
!-----!

```

```

COEFFICIENT (all,i,ENDW_COMM)(all,r,REG)          EVOA(i,r)
! value of commodity i output in region r. ! ;

COEFFICIENT (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)  EVFA(i,j,r)
! producer expenditure on i by industry j,
! in region r, valued at agent's prices ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)  VIFA(i,j,r)
! purchases of imported i r for use in j
! in region r ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)  VDFA(i,j,r)
! purchases of domestic i r for use in j
! in region r ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)          VIPA(i,r)
! private household expenditure on imported i ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)          VDPA(i,r)
! private household expenditure on domestic i in r ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)          VIGA(i,r)
! government household expenditure on imported i ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)          VDGA(i,r)
! government household expenditure on domestic
! i in r ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)      VXMD(i,r,s)
! exports of commodity i from region r to
! destination s valued at market prices
! (tradeables only) ! ;

COEFFICIENT (all,i,MARG_COMM)(all,r,REG)          VST(i,r)
! exports of commodity i from region r for
! international transportation valued at market prices
! (tradeables only) ! ;

COEFFICIENT (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)  VFM(i,j,r)
! producer expenditure on i by industry j,
! in region r, valued at market prices ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)  VIFM(i,j,r)
! purchases of imports i for use in j in region r ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)  VDFM(i,j,r)
! purchases of domestic i r for use in j in region r ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)          VIPM(i,r)
! private household expenditure on i in r ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)          VDPM(i,r)
! private household expenditure on domestic i in r ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)          VIGM(i,r)
! gov't household expenditure on i in r ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)          VDGM(i,r)
! government household expenditure on domestic i in r ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)      VIMS(i,r,s)
! imports of commodity i from region r to s, valued
! at domestic market prices ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)      VXWD(i,r,s)
! exports of commodity i from region r to
! destination s valued fob (tradeables only) ! ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)      VIWS(i,r,s)
! imports of commodity i from region r to s, valued
! cif (tradeables only) ! ;

!-----!
! Reading basedata                                     !
!-----!

```

```

READ (all,i,ENDW_COMM)(all,r,REG)                                EVOA(i,r)
    FROM FILE GTAPDATA HEADER "EVOA" ;

READ (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)              EVFA(i,j,r)
    FROM FILE GTAPDATA HEADER "EVFA" ;

READ (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)              VIFA(i,j,r)
    FROM FILE GTAPDATA HEADER "VIFA" ;

READ (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)              VDFA(i,j,r)
    FROM FILE GTAPDATA HEADER "VDFA" ;

READ (all,i,TRAD_COMM)(all,r,REG)                                VIPA(i,r)
    FROM FILE GTAPDATA HEADER "VIPA" ;

READ (all,i,TRAD_COMM)(all,r,REG)                                VDPA(i,r)
    FROM FILE GTAPDATA HEADER "VDPA" ;

READ (all,i,TRAD_COMM)(all,r,REG)                                VIGA(i,r)
    FROM FILE GTAPDATA HEADER "VIGA" ;

READ (all,i,TRAD_COMM)(all,r,REG)                                VDGA(i,r)
    FROM FILE GTAPDATA HEADER "VDGA" ;

READ (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)                    VXMD(i,r,s)
    FROM FILE GTAPDATA HEADER "VXMD" ;

READ (all,i,MARG_COMM)(all,r,REG)                                VST(i,r)
    FROM FILE GTAPDATA HEADER "VST" ;

READ (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)              VFM(i,j,r)
    FROM FILE GTAPDATA HEADER "VFM" ;

READ (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)              VIFM(i,j,r)
    FROM FILE GTAPDATA HEADER "VIFM" ;

READ (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,r,REG)              VD FM(i,j,r)
    FROM FILE GTAPDATA HEADER "VD FM" ;

READ (all,i,TRAD_COMM)(all,r,REG)                                VIPM(i,r)
    FROM FILE GTAPDATA HEADER "VIPM" ;

READ (all,i,TRAD_COMM)(all,r,REG)                                VDPM(i,r)
    FROM FILE GTAPDATA HEADER "VDPM" ;

READ (all,i,TRAD_COMM)(all,r,REG)                                VIGM(i,r)
    FROM FILE GTAPDATA HEADER "VIGM" ;

READ (all,i,TRAD_COMM)(all,r,REG)                                VDGM(i,r)
    FROM FILE GTAPDATA HEADER "VDGM" ;

READ (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)                    VIMS(i,r,s)
    FROM FILE GTAPDATA HEADER "VIMS" ;

READ (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)                    VXWD(i,r,s)
    FROM FILE GTAPDATA HEADER "VXWD" ;

READ (all,i,TRAD_COMM)(all,r,REG)(all,s,REG)                    VIWS(i,r,s)
    FROM FILE GTAPDATA HEADER "VIWS" ;

!-----!
! DERIVATIVES OF THE BASE DATA                                     !
!-----!

ZERODIVIDE (ZERO_BY_ZERO) DEFAULT 0 ;
ZERODIVIDE (NONZERO_BY_ZERO) DEFAULT 0 ;

COEFFICIENT (all,i,DEMD_COMM)(all,j,PROD_COMM)(all,r,REG)      VFA(i,j,r)
    ! producer expenditure on i by industry j,
    ! in region r, valued at agent's prices ! ;

FORMULA (all,i,ENDW_COMM)(all,j,PROD_COMM)(all,r,REG)
    VFA(i,j,r) = EVFA(i,j,r) ;

FORMULA (all,i,TRAD_COMM)(all,j,PROD_COMM)(all,s,REG)
    VFA(i,j,s) = VDFA(i,j,s) + VIFA(i,j,s) ;

```

```

COEFFICIENT (all,i,NSAV_COMM)(all,r,REG)                                VOA(i,r)
! value of commodity i output in region r. ! ;

FORMULA (all,i,ENDW_COMM)(all,r,REG) VOA(i,r) = EVOA(i,r);

FORMULA (all,i,PROD_COMM)(all,r,REG)
VOA(i,r) = sum(j,DEMD_COMM, VFA(j,i,r));

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                                VDM(i,r)
! domestic sales of commodity i in region r
! valued at market prices (tradeables only) ! ;

FORMULA (all,i,TRAD_COMM)(all,r,REG)
VDM(i,r) = VDPM(i,r) + VDGM(i,r)
+ sum(j,PROD_COMM, VDFM(i,j,r)) ;
Coefficient (all,i,NSAV_COMM)(all,r,REG)
VOM(i,r) # value of commodity i output in region r at market prices #;
Formula (all,i,ENDW_COMM)(all,r,REG)
VOM(i,r) = sum(j,PROD_COMM, VFM(i,j,r));
Formula (all,i,MARG_COMM)(all,r,REG)
VOM(i,r) = VDM(i,r) + sum(s,REG, VXMD(i,r,s)) + VST(i,r);
Formula (all,i,NMRG_COMM)(all,r,REG)
VOM(i,r) = VDM(i,r) + sum(s,REG, VXMD(i,r,s)) ;
Formula (all,h,CGDS_COMM)(all,r,REG)
VOM(h,r) = VOA(h,r);

! _____!
! Shock calculation in order to respect the DD regime !
! _____!

! j      = imported DD good !
! i,k    = Sector, which use a DD import for its production !
! c      = Investment/ Capital Goods Sector !
! _____!
!_STEP 1_ _____!

!-PRIVATE HOUSEHOLD-----!
COEFFICIENT (all,j,TRAD_COMM)(all,r,REG)                                DDP1(j,r)
#First COEFFICIENT Private Household#;
Formula (all,j,TRAD_COMM)(all,r,REG) DDP1(j,r) = 0;
Formula (all,j,DDTRAD)(all,r,DDREG)
DDP1(j,r) = VIPM(j,r);

COEFFICIENT (all,j,TRAD_COMM)(all,i,TRAD_COMM)(all,r,REG)            DDP2(j,i,r)
#Second COEFFICIENT Private Household#;
Formula (all,j,TRAD_COMM)(all,i,TRAD_COMM)(all,r,REG)
DDP2(j,i,r) = 0;
Formula (all,j,DDTRAD)(all,i,TRAD_COMM)(all,r,DDREG)
DDP2(j,i,r) = VIFM(j,i,r)*[VDPM(i,r)/VOM(i,r)] ;

COEFFICIENT (all,j,TRAD_COMM)(all,i,TRAD_COMM)(all,r,REG)            DDP3(j,i,r)
#Third COEFFICIENT Private Household#;
Formula (all,j,TRAD_COMM)(all,i,TRAD_COMM)(all,r,REG)
DDP3(j,i,r) = 0;
Formula (all,j,DDTRAD)(all,i,TRAD_COMM)(all,r,DDREG)
DDP3(j,i,r) = sum(k,TRAD_COMM, VIFM(j,k,r)*[VDFM(k,i,r)/VOM(k,r)])
*[VDPM(i,r)/VOM(i,r)] ;

!-GOVERNMENT-----!
COEFFICIENT (all,j,TRAD_COMM)(all,r,REG)                                DDG1(j,r)
#First COEFFICIENT Government#;
Formula (all,j,TRAD_COMM)(all,r,REG)
DDG1(j,r) = 0;
Formula (all,j,DDTRAD)(all,r,DDREG)
DDG1(j,r) = VIGM(j,r);

COEFFICIENT (all,j,TRAD_COMM)(all,i,TRAD_COMM)(all,r,REG)            DDG2(j,i,r)
#Second COEFFICIENT Government#;
Formula (all,j,TRAD_COMM)(all,i,TRAD_COMM)(all,r,REG)
DDG2(j,i,r) = 0;
Formula (all,j,DDTRAD)(all,i,TRAD_COMM)(all,r,DDREG)
DDG2(j,i,r) = VIFM(j,i,r)*[VDGM(i,r)/VOM(i,r)] ;

COEFFICIENT (all,j,TRAD_COMM)(all,i,TRAD_COMM)(all,r,REG)            DDG3(j,i,r)

```

```

#Third COEFFICIENT Government#;
Formula (all,j,TRAD_COMM)(all,i,TRAD_COMM)(all,r,REG)
    DDG3(j,i,r)= 0;
Formula (all,j,DDTRAD)(all,i,TRAD_COMM)(all,r,DDREG)
    DDG3(j,i,r) = sum(k,TRAD_COMM, VIFM(j,k,r)*[VDFM(k,i,r)/VOM(k,r)]
        *[VDGM(i,r)/VOM(i,r)] ;

!-INVESTMENTS/CAPITAL-GOODS-----!
COEFFICIENT (all,j,TRAD_COMM)(all,c,CGDS_COMM)(all,r,REG)          DDI1(j,c,r)
#First COEFFICIENT Capital Goods (Investment) #;
Formula (all,j,TRAD_COMM)(all,c,CGDS_COMM)(all,r,REG)
    DDI1(j,c,r) = 0;
Formula (all,j,DDTRAD)(all,c,CGDS_COMM)(all,r,DDREG)
    DDI1(j,c,r) = VIFM(j,c,r);

COEFFICIENT (all,j,TRAD_COMM)(all,i,TRAD_COMM)(all,c,CGDS_COMM)(all,r,REG)
    DDI2(j,i,c,r)
#Second COEFFICIENT Capital Goods (Investment) #;
Formula (all,j,TRAD_COMM)(all,i,TRAD_COMM)(all,c,CGDS_COMM)(all,r,REG)
    DDI2(j,i,c,r) = 0;
Formula (all,j,DDTRAD)(all,i,TRAD_COMM)(all,c,CGDS_COMM)(all,r,DDREG)
    DDI2(j,i,c,r)= VIFM(j,i,r)*[VDFM(i,c,r)/VOM(i,r)] ;

COEFFICIENT
(all,j,TRAD_COMM)(all,i,TRAD_COMM)(all,c,CGDS_COMM)(all,r,REG)
    DDI3(j,i,c,r)
#Third COEFFICIENT Capital Goods (Investment) #;
Formula (all,j,TRAD_COMM)(all,i,TRAD_COMM)(all,c,CGDS_COMM)(all,r,REG)
    DDI3(j,i,c,r)= 0;
Formula (all,j,DDTRAD)(all,i,TRAD_COMM)(all,c,CGDS_COMM)(all,r,DDREG)
    DDI3(j,i,c,r)= sum(k,TRAD_COMM, VIFM(j,k,r)*{VDFM(k,i,r)/VOM(k,r)})
        *(VDFM(i,c,r)/VOM(i,r)) ;

!_____!
!_STEP 2_____!

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)          TARIFF(i,r)
#Total Tariff of imported good i#;
Formula (all,i,TRAD_COMM)(all,r,REG)
    TARIFF(i,r)= sum(s,REG, VIMS(i,s,r) - VIWS(i,s,r));

COEFFICIENT (all,j,TRAD_COMM)(all,r,REG)          TOTALDD(j,r)
#Sum of DD COEFFICIENTs of imported good j#;
Formula (all,j,TRAD_COMM)(all,r,REG) TOTALDD(j,r) =
    !Private Household!
    DDP1(j,r)
    + sum[i,TRAD_COMM, DDP2(j,i,r)]
    + sum[i,TRAD_COMM, DDP3(j,i,r)]

    !Government!
    + DDG1(j,r)
    + sum[i,TRAD_COMM, DDG2(j,i,r)]
    + sum[i,TRAD_COMM, DDG3(j,i,r)]

    !Capital Goods!
    + sum[c,CGDS_COMM, DDI1(j,c,r)]
    + sum[i,TRAD_COMM,sum(c,CGDS_COMM, DDI2(j,i,c,r))]
    + sum[i,TRAD_COMM,sum(c,CGDS_COMM, DDI3(j,i,c,r))] ;

COEFFICIENT (all,j,TRAD_COMM)(all,r,REG)          ALPHA(j,r)
#Tariff Rate of private Household for good j#;
Formula (all,j,TRAD_COMM)(all,r,REG)
    ALPHA(j,r) = 0;

Formula (all,j,DDTRAD)(all,r,DDREG)
    ALPHA(j,r) = TARIFF(j,r)/TOTALDD(j,r);

!_____!
!_STEP 3_____!

COEFFICIENT (all,j,TRAD_COMM)(all,r,REG)          REDUCTION(j,r)
#Reduction of Tariff Rate for DD Good j in Region r#;
Formula (all,j,TRAD_COMM)(all,r,REG)
    REDUCTION(j,r) = 0.5;

```

```

!-DD Goods for Private Household-----!
COEFFICIENT (all,j,TRAD_COMM)(all,r,REG)                                TPM(j,r)
#Coefficient for Imports of private household#;
Formula (all,j,TRAD_COMM)(all,r,REG)
    TPM(j,r) = VIPA(j,r)/VIPM(j,r);

COEFFICIENT (all,j,TRAD_COMM)(all,r,REG)                                TPM_N(j,r)
#Value of TPM after the simulation#;
Formula (all,j,TRAD_COMM)(all,r,REG)
    TPM_N(j,r) = [VIPA(j,r) - REDUCTION(j,r)*ALPHA(j,r)*DDP1(j,r)]
    /VIPM(j,r);

COEFFICIENT (all,j,TRAD_COMM)(all,r,REG)                                tpmSHOCK(j,r)
#tpm Shock#;
Formula (all,j,TRAD_COMM)(all,r,REG)
    tpmSHOCK(j,r) = [TPM_N(j,r)-TPM(j,r)]/TPM(j,r)*100 ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                                TPD(i,r)
#Coefficient for Domestics of private household#;
Formula (all,i,TRAD_COMM)(all,r,REG)
    TPD(i,r) = VDPA(i,r)/VDPM(i,r);

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                                TPD_N(i,r);
Formula (all,i,TRAD_COMM)(all,r,REG)
    TPD_N(i,r) = [VDPA(i,r)- sum{j,DDTRAD, REDUCTION(j,r)*ALPHA(j,r)*
    [DDP2(j,i,r)+DDP3(j,i,r)]}]/VDPM(i,r);

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                                tpdSHOCK(i,r)
#tpd Shock#;
Formula (all,i,TRAD_COMM)(all,r,REG)
    tpdSHOCK(i,r) = [TPD_N(i,r)-TPD(i,r)]/TPD(i,r)*100 ;

!-DD Goods for Government-----!
COEFFICIENT (all,j,TRAD_COMM)(all,r,REG)                                TGM(j,r)
#Coefficient for Imports of Government#;
Formula (all,j,TRAD_COMM)(all,r,REG)
    TGM(j,r) = VIGA(j,r)/VIGM(j,r);

COEFFICIENT (all,j,TRAD_COMM)(all,r,REG)                                TGM_N(j,r);
Formula (all,j,TRAD_COMM)(all,r,REG)
    TGM_N(j,r) = [VIGA(j,r)-REDUCTION(j,r)*ALPHA(j,r)*DDG1(j,r)]
    /VIPM(j,r);

COEFFICIENT (all,j,TRAD_COMM)(all,r,REG)                                tgmSHOCK(j,r)
#tgm Shock#;
Formula (all,j,TRAD_COMM)(all,r,REG)
    tgmSHOCK(j,r) = [TGM_N(j,r)-TGM(j,r)]/TGM(j,r)*100 ;

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                                TGD(i,r)
#Coefficient for Domestics of Government#;
Formula (all,i,TRAD_COMM)(all,r,REG)
    TGD(i,r) = VDGA(i,r)/VDGM(i,r);

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                                TGD_N(i,r)
#Value of TPD after the simulation#;
Formula (all,i,TRAD_COMM)(all,r,REG)
    TGD_N(i,r) = [VDGA(i,r)- sum{j,DDTRAD, REDUCTION(j,r)*ALPHA(j,r)*
    [DDG2(j,i,r)+DDG3(j,i,r)]}]/VDGM(i,r);

COEFFICIENT (all,i,TRAD_COMM)(all,r,REG)                                tgdSHOCK(i,r)
#tpd Shock#;
Formula (all,i,TRAD_COMM)(all,r,REG)
    tgdSHOCK(i,r) = [TGD_N(i,r)-TGD(i,r)]/TGD(i,r)*100 ;

!-DD Inputs for Capital Goods (Investments)-----!
COEFFICIENT (all,j,TRAD_COMM)(all,c,CGDS_COMM)(all,r,REG)            TFM(j,c,r)
#Coefficient for Imports for Capital Goods (Investments) #;
Formula (all,j,TRAD_COMM)(all,c,CGDS_COMM)(all,r,REG)
    TFM(j,c,r) = VIFA(j,c,r)/VIFM(j,c,r);

COEFFICIENT (all,j,TRAD_COMM)(all,c,CGDS_COMM)(all,r,REG)            TFM_N(j,c,r);
Formula (all,j,TRAD_COMM)(all,c,CGDS_COMM)(all,r,REG)
    TFM_N(j,c,r) = [VIFA(j,c,r)-REDUCTION(j,r)*ALPHA(j,r)*DDI1(j,c,r)]
    /VIFM(j,c,r);

COEFFICIENT (all,j,TRAD_COMM)(all,c,PROD_COMM)(all,r,REG)            tfmSHOCK(j,c,r)
#tfm Shock#;

```

```

Formula (all,j,TRAD_COMM)(all,c,TRAD_COMM)(all,r,REG)
    tfmSHOCK(j,c,r) = 0;
Formula (all,j,TRAD_COMM)(all,c,CGDS_COMM)(all,r,REG)
    tfmSHOCK(j,c,r) = [TFM_N(j,c,r)-TFM(j,c,r)]/TFM(j,c,r)*100 ;

COEFFICIENT (all,i,TRAD_COMM)(all,c,CGDS_COMM)(all,r,REG)      TFD(i,c,r)
#Coefficient for Imports for Capital Goods (Investments) #;
Formula (all,i,TRAD_COMM)(all,c,CGDS_COMM)(all,r,REG)
    TFD(i,c,r) = VDFA(i,c,r)/VDFM(i,c,r);

COEFFICIENT (all,i,TRAD_COMM)(all,c,CGDS_COMM)(all,r,REG)      TFD_N(i,c,r);
Formula (all,i,TRAD_COMM)(all,c,CGDS_COMM)(all,r,REG)
    TFD_N(i,c,r) = [VDFA(i,c,r)- sum{j,DDTRAD, REDUCTION(j,r)*ALPHA(j,r)*
        [DDI2(j,i,c,r)+DDI3(j,i,c,r)]}] /VDFM(i,c,r);

COEFFICIENT (all,i,TRAD_COMM)(all,c,PROD_COMM)(all,r,REG)      tfdSHOCK(i,c,r)
#tfd Shock#;
Formula (all,i,TRAD_COMM)(all,c,TRAD_COMM)(all,r,REG)
    tfdSHOCK(i,c,r) = 0;
Formula (all,i,TRAD_COMM)(all,c,CGDS_COMM)(all,r,REG)
    tfdSHOCK(i,c,r) = [TFD_N(i,c,r)-TFD(i,c,r)]/TFD(i,c,r)*100 ;

!-----!
WRITE tpmSHOCK TO FILE TPM_shock ;
WRITE tpdSHOCK TO FILE TPD_shock ;

WRITE tgmSHOCK TO FILE TGM_shock ;
WRITE tgdSHOCK TO FILE TGD_shock ;

WRITE tfmSHOCK TO FILE TFM_I_shock ;
WRITE tfdSHOCK TO FILE TFD_I_shock ;

!_____!
!_End of TABLO File DDshocks.TAB_____!

```

Appendix 3: Cmf File for GEMPACK (ShocksDD.cmf)

```

Auxiliary files = DDshocks;
File gtapdata = ..\data\basedata.har ;
File gtapsets = ..\data\sets2.har;

FILE TPM_shock = ..\shocks\TPM_shock.shk;
FILE TPD_shock = ..\shocks\TPD_shock.shk;

FILE TGM_shock = ..\shocks\TGM_shock.shk;
FILE TGD_shock = ..\shocks\TGD_shock.shk;

FILE TFM_I_shock = ..\shocks\TFM_I_shock.shk;
FILE TFD_I_shock = ..\shocks\TFD_I_shock.shk;

dws = yes ;

```