TIMES Damage Extension in ANSWER-TIMES

Introduction

The purpose of this note is to briefly describe how to invoke the TIMES Damage Extension in ANSWER-TIMES.

For an explanation of the TIMES Damage Extension see:

- "TIMES Damage functions" (authors Antti Lehtila, Richard Loulou), which can be downloaded from the ETSAP website as *TIMESDamage.pdf*.

For a concrete example demonstrating Run Model using the TIMES Damage Extension, see the non-BASE scenario **DAMAGE** and the online Cases **DAMAGE-LP** and **DAMAGE-NLP** in database Example4-v661.mdb (distributed with ANSWER-TIMES version 6.6.1 and higher).

Specification of Damage Extension Data Parameters in ANSWER-TIMES

The TIMES Damage Extension involves 8 Data Parameters, as follows:

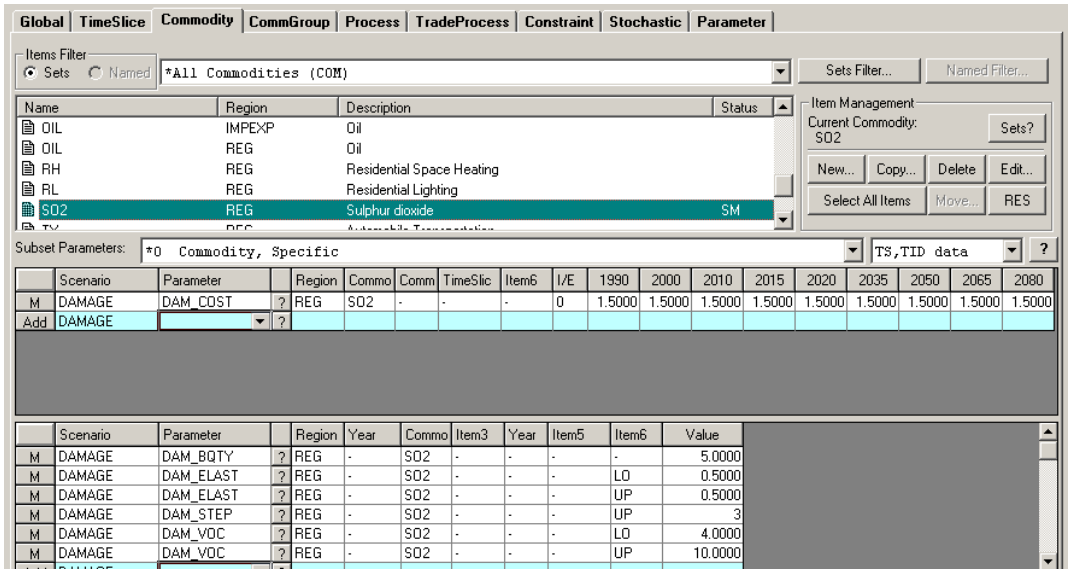
Damage Data Parameter	Description
DAM_BQTY	Base quantity of emissions
DAM_COST	Marginal damage cost of emissions
DAM_ELAST	Elasticity of damage cost
DAM_STEP	Step number for emissions up to base
DAM_TQTY	Base quantity of emissions by year (experimental)
DAM_TVOC	Variance of emissions by year (experimental)
DAM_VOC	Variance of emissions
S_DAM_COST	Marginal damage cost of emissions - stochastic

(The last of these Parameters (S_DAM_COST) is a Stochastic Parameter.)

Damage Data Parameters may be specified on either the Commodity tab, or on the Parameter tab.

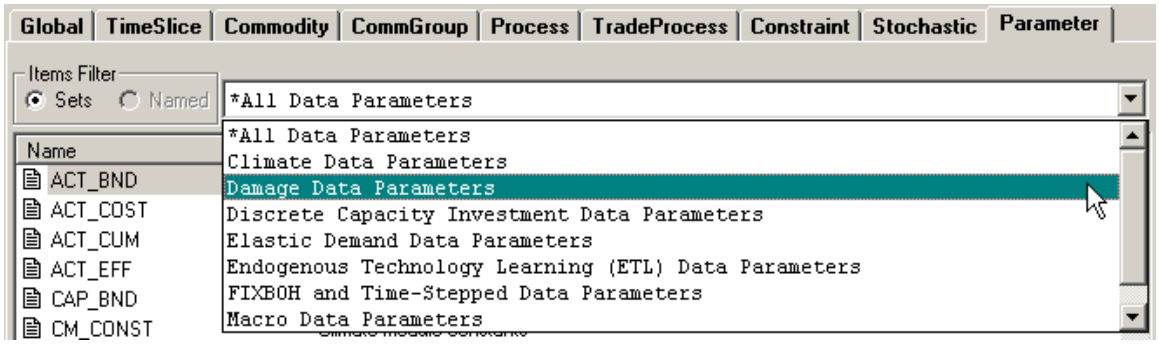
Commodity Tab
On the Commodity tab, specify that Damage applies to a particular Commodity by selecting that Commodity and using the AddRow in the TS or TID spread to add the above parameters as applicable.

- For the demonstration database Example4-v661.mdb, if you make the non-BASE scenario **DAMAGE** the editable scenario, move to the Commodity tab and select commodity SO2 (Sulphur dioxide), you will see that the Damage Parameters DAM_COST, DAM_BQTY, DAM_ELAST, DAM_STEP, DAM_VOC have already been specified for commodity SO2. See the screen snapshot on the following page.

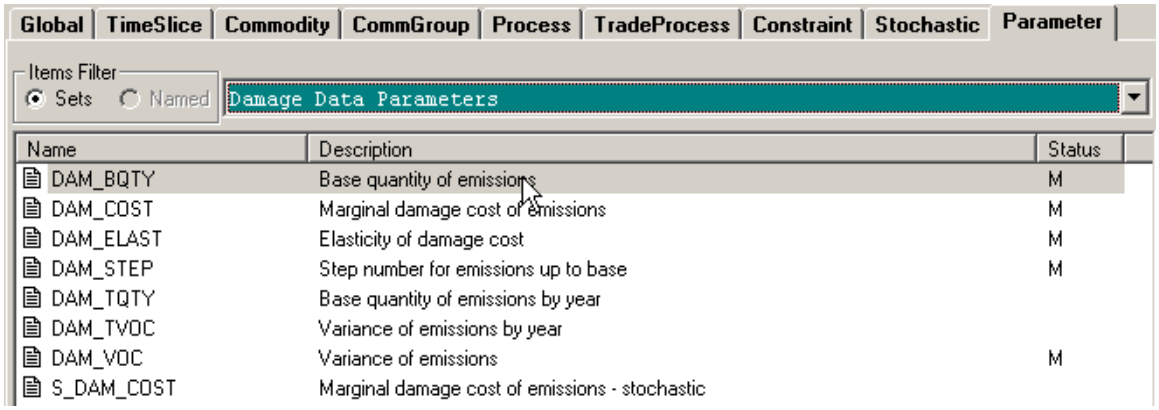


Parameter Tab

The Parameter tab offers the convenience of being able to see all instances of Damage Data Parameters in the database (for the currently selected scenarios) and also provides a convenient way of adding these parameters for multiple Commodities. On the Parameter tab, drop down the long combobox, and select the Damage Data Parameters setting:



This provides the convenience of displaying just those Data Parameters that are specific to the TIMES Damage Extension:

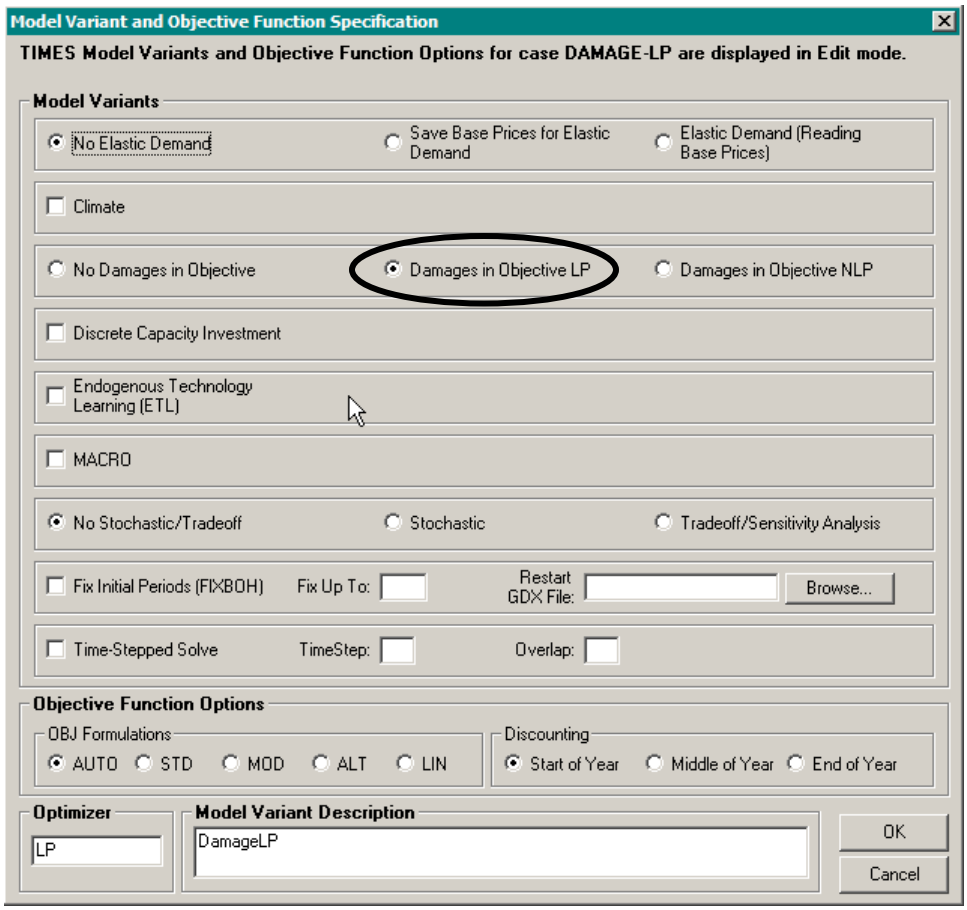


Now use the AddRow facility to specify Damage Data Parameter instances as needed.

Specifying a Damage Extension Model Run in ANSWER-TIMES

To specify in ANSWER-TIMES that a TIMES model run uses the Damage Extension, click on the Specify Model Variant... button on the Run Model form, and then select either the "Damages in Objective LP" option button, or the "Damages in Objective NLP" option button, according to whether you wish to use the LP or NLP approach to Damages.

- For Run **DAMAGE-LP** as the current run on the Run Model form, the "Damages in Objective LP" option button is selected, indicating that the LP approach to Damages has been selected:



- Click on the [OK] button on the Model Variant Specification form to return to the Run Model form, and click on the [OK] button of the Run Model form to carry out Run Model using the LP Damage Extension.

- ANSWER-TIMES then ensures that the control variable **DAMAGE** is set to **LP** in the GEN file that controls the TIMES GAMS model run, by inserting:

  $SET DAMAGE 'LP'

  This can be seen by opening the file DAMAGE-LP.GEN with a text editor.

- Similar considerations apply for **DAMAGE-NLP** as the current run on the Run Model form, where clicking on the 

button will show that the "Damages in Objective NLP" option button is selected, indicating that the NLP approach to Damages has been selected. See in particular Note 2 below.

Assorted Notes regarding the Damage Extension

1. In ANSWER-TIMES, the default setting for the control variable **DAMAGE** is **NO** (**$SET DAMAGE 'NO'** will appear in the GEN file) corresponding to the default selection of the "No Damages in Objective" option button.

2. If the "Damages in Objective NLP" option button is selected, then ANSWER-TIMES ensures that the control variable **DAMAGE** is set to **NLP** in the GEN file that controls the TIMES GAMS model run, by inserting:

$SET DAMAGE 'NLP'

Note that a NLP (Non Linear Programming) optimizer is needed to carry out a model run that adopts an NLP approach to Damages.

3. The TIMES Damage LP Extension is available in conjunction with most of the other TIMES Model Extensions.

4. Use of the TIMES Damage NLP Extension with Extensions such as ETL or Lumpy Investment that require Mixed Integer Programming (MIP) is problematic, since the resulting mathematical program involves both NLP and MIP and as such tends to be extremely difficult to solve.