

Endogenous Technology Learning (ETL) under ANSWER-MARKAL

The purpose of this note is to briefly describe the extensions made to ANSWER to handle the Endogenous Technology Learning (ETL) formulation, and to indicate how to set up and run ETL MARKAL from within ANSWER.

For more details regarding ETL MARKAL, see the ETSAP RMARKAL Information Note ETLPARAM.DOC.

Extensions to ANSWER for ETL MARKAL

- ANSWER database tables were modified as follows:

tblModelVariants :- The possibility of having an ETL (Endogenous Technology Learning) option was added. Since ETL may be combined with either of the Elastic Demand variants, and/or with the Stochastic variant (but not with the Stochastic Risk variant), and/or with the multi-region MARKAL variant, many other model variants were also added to *tblModelVariants*.

tblParamData :- Six new data parameters were added - see the table 'ETL Data Parameters' below.

ETL Data Parameters

Parameter	Description	UnitNum	UnitDen	Default	GAMSArgs
ETL-CUMCAP0	Initial cum. capacity (starting point on learning curve)	TCAP	-		CCAP0(TCH)
ETL-CUMCAPMAX	Maximum cum. capacity (ending point on learning curve)	TCAP	-		CCAPM(TCH)
ETL-INDIC	Indicates technology for which learning curve is specified	-	-	1	NTEG(TCH)
ETL-INVCOST0	Investment cost corresp. to starting point on learning curve	MONY	TCAP		SC0(TCH)
ETL-NUMSEG	Number of segments for cumulative cost curve	-	-		SEG(TCH)
ETL-PROGRATIO	Progress ratio	-	-		PRAT(TCH)

tblParamResults, tblGAMStoANSWER :- No new results parameters were added. Results specifically related to ETL in the ETL MARKAL run are available in the <casename>.ETL file.

- The RMARKAL GAMS code required the following modifications — specifically on account of the Endogenous Technology Learning variant — to make it ANSWER-compatible:
 - in MMINIT.ANS, declaration of Parameter NTEG(TCH), used as an indicator that ETL data associated with technology TCH is to be used in an ETL run;
 - in ANS2GAMS.ANS, Set TEG(TCH) is defined as those TCH for which Parameter NTEG(TCH) = 1; and
 - in MMINCLUD.INC, the declaration of Parameter HPRAT(TEG) is changed to HPRAT(TCH) to avoid a GAMS compilation error.
- ANSWER's new template-based approach to the creation of the <casename>.GEN file ensures that when the user chooses any model variant involving 'ETL', the following line is automatically generated in the <casename>.GEN file:

\$SET ETL 'YES'

Working with ETL MARKAL in ANSWER

- Use ANSWER's ETL data parameters to define ETL technical coefficients associated with each technology (conversion/demand/process) for which you wish ETL to be specified. Note that only those ETL coefficients associated with a technology where the ANSWER parameter ETL-INDIC is specified, and is = 1, will be used in an ETL MARKAL run. (ETL coefficients associated with technologies where the ETL-INDIC parameter is either not specified, or is ≠ 1, will be ignored.)
- When running the model, use the Model Variant combobox on ANSWER's Run Model form to choose the appropriate ETL model variant.
- When the mixed integer programming ETL MARKAL run is finished, the Case results may be imported into ANSWER in the standard way. In addition, results specifically related to ETL in the run are available in the <casename>.ETL file.