



*Introducing Liquid Biofuels into the GTAP Data Base\**

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## **1. Introduction**

Production of liquid biofuels has rapidly increased around the world in recent years. Biofuel production, by its nature, can affect the economy and environment of many countries in different ways. Global Computable General Equilibrium (CGE) analysis is an appropriate approach to study the widespread socio-economic and environmental impacts of bioenergy production. An appropriate benchmark data base including an independent biofuel sector is essential to develop a CGE model for this purpose.

This paper represents the first effort aimed at formally introducing liquid biofuels sectors into the version 6 of the GTAP data base (Dimaranan, 2007). It builds on the International Energy Agency (IEA) data base, plant-level, biofuel processing models, and the *SplitCom* program developed by Horridge (2005) to introduce three biofuel sectors into the GTAP data base.

This research develops four data bases. In the first database we introduce three new commodities into the GTAP data base. These commodities are: 1) ethanol from coarse grains (mainly corn); 2) ethanol from sugarcane; 3) and biodiesel from oilseeds. In developing the first data base we assume “no intermediate use” for biofuels. In addition, we assume biofuel production “does not generate byproducts”. The first data base is labeled GTAP-BIO. In the second data base we remove the “no intermediate use” assumption and we assume a portion of ethanol-1 is used by p\_c industry as an additive to gasoline. This has the advantage of permitting users to model the demand for additives differently from the demand for ethanol as an energy substitute. The second data base is built on the GTAP-BIO and is given the name, GTAP-BIOA. Finally, in the third and fourth data bases we remove the “no byproduct assumption” by introducing Distillers Dried Grains with Solubles (DDGS) as a byproduct of ethanol-1 production process and

biodiesel byproduct (BDBP), soy and rapeseed meals, into the data base. The last two data bases are built on GTAP-BIOA and are given names GTAP-BIOB and GTAP\_BIOC.

In what follows we explain the rationale for our approach and steps that we took to generate these data bases.

## **2. Background and general information**

Liquid biomass fuels can be produced from two major resources: food/feed crops and cellulosic material (USDA and DOE, 2005 and DOE, 2005)<sup>1</sup>. Currently, the biofuels industry relies mainly on food/feed crops such as corn, soybeans, rapeseed, and sugarcane. Technologies for deriving biofuels from crops are well developed, and their use has been expanded substantially in the past two decades. In 2001, the major producers of biomass fuels from food/feed crops were the U.S., Brazil, and the European Union. They mainly produce ethanol from corn and sugarcane, and biodiesel from rapeseed (or Canola) and soybeans. In recent years, Indonesia, Malaysia, and some other countries have started to produce palm oil based biodiesel as well. While producing biofuels from food/feed crops is well established, producing biofuels from cellulosic materials is not yet commercially viable and only tiny amounts are being produced. For this reason we only consider producing liquid biofuels from food/feed crops.

Ethanol and biodiesel are the two main types of liquid biofuels which have been produced from food/feed stocks. Since production processes, as well as the uses of these products differ, we introduce them into the GTAP data base as different commodities. Ethanol can be produced from different types of feedstocks. The most common feedstocks are starchy crops (mainly corn) and sugarcane. While final products from these feedstocks are homogeneous, since their production processes are different we defined two types of ethanol products: ethanol from starchy crops and ethanol from sugarcane<sup>2</sup>. Therefore, we introduced the following three new commodities into the

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<sup>1</sup> Biofuels also can be produced from manure, fats, greases, and MSW. We do not consider these products in this database work.

<sup>2</sup> If the users wish, they can utilize the GTAP-Agg program to merge eth1 and eth2 and generate only one ethanol product.

GTAP data base:

- i) Ethanol from starchy crops, called Ethanol-1 (eth1)
- ii) Ethanol from sugarcane, called Ethanol-2 (eth2)
- iii) Biodiesel from oils seeds, called Biodiesel (biod)

We develop the new data base, GTAP-BIO, based on two assumptions. We assume “no intermediate use” for biofuel products and “no byproduct from biofuel production processes”. Then we relax these assumptions to generate three additional new data bases, GTAP-BIOA, GTAP-BIOB, and GTAP-BIOC. In developing GTAP-BIOA we assume a portion of ethanol-1 is used in p\_c as an additive to gasoline. We made this assumption because US, the main producer of ethanol-1, uses ethanol mainly as an additive to gasoline.

In developing GTAP-BIOB we add the DDGS into the data base as a major byproduct for ethanol 1 production process. The major byproduct of producing ethanol 2 is the biomass remaining after sugarcane stalks are crushed to extract their juice. This byproduct is usually used as a source of energy in the ethanol 2 production process and hence it is not considered a byproduct here. Finally, in developing GTAP-BIOC, we add BDBP into the data base as a major byproduct of biodiesel production process.

The version 6 of GTAP data base covers 87 countries and 57 commodities that represent the world economy in 2001. The new data bases are built based on this database. To develop GTAP-BIO Data Base we followed three steps. In the first step we estimated values of produced biofuel products across the world in 2001 based on the IEA data base. In this step we determined the bilateral trade for these products as well. In the second step we determined sectors which should be split in biofuel producing countries. In this step we also used plant-level biofuel processing models to split costs between the original and new sectors. Finally, in the last step, we used the *SplitCom* program to generate GTAP-BIO.

Since *SplitCom* can split only one sector in each run, we first introduced eth1 then we used the results of the first run to introduce eth2, and finally we used the results of the second run to add biod into the data base. For each of these commodities we have

developed a TAB file (GEMPACK based program) which updates the userwgt.har file<sup>3</sup> of the *SplitCom* according to the provided data in steps 1 and 2 for that commodity.

In the remainder of this report we first explain these three steps in more details. Then we remove “no intermediate use” and “no byproduct” assumptions to generate GTAP-BIOA, GTAP-BIOB, and GTAP-BIOC Data Bases.

### 3. Steps to develop GTAP-BIO

#### 3.1. Step one; Production and trade of biofuels in 2001

According to the IEA data base, only a few countries produced liquid biofuel in measurable quantities in 2001 (Table 1). This table shows that the US and Brazil are major producers of biofuel. According to Table 1, more than 90 percent of the world’s liquid biofuel were produced by these two countries in 2001.

**Table 1. Biofuel production across the world in 2000-4 (figures are in KTOE)**

<b>Country</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
Austria	17	<b>19</b>	20	20	22
Canada	94	<b>94</b>	94	94	94
Czech Republic	61	<b>63</b>	94	103	74
Denmark	0	<b>22</b>	36	40	58
France	352	<b>350</b>	374	405	451
Germany	222	<b>315</b>	494	731	1011
Italy	0	<b>0</b>	0	0	212
Korea	0	<b>0</b>	1	1	4
Poland	0	<b>0</b>	0	29	14
Slovak Republic	0	<b>38</b>	3	2	12
Spain	54	<b>54</b>	127	175	207
Sweden	0	<b>0</b>	0	0	52
Switzerland	0	<b>0</b>	0	0	2
United States	2887	<b>3046</b>	3968	5608	6930
Brazil	6211	<b>6516</b>	6788	7829	8022
Cuba	53	<b>52</b>	53	53	42
Paraguay	1	<b>1</b>	1	1	0
<b>Total</b>	<b>9953</b>	<b>10570</b>	<b>12052</b>	<b>15090</b>	<b>17211</b>

Since the IEA data base does not provide production of liquid biofuels by type (e.g., ethanol vs. biodiesel), we used indirect information (e.g. capacity of biodiesel

<sup>3</sup> This file includes weights for splitting the sectors.

production) to determine production values of new commodities. We first split the IEA production data between ethanol and biodiesel according to IEA reports<sup>4</sup> for 2001. Then we split production of ethanol between eth1 and eth2 according to the common method of ethanol production in each country. Finally, we convert quantities to dollar values using the US average price of ethanol in 2001<sup>5</sup>. Results are shown in table 2. Note that Brazil, the world's largest producer of liquid biofuels in 2001, produces ethanol from sugar-cane only (eth2). On the other hand, US production is nearly all eth1 (from maize). Biodiesel is more important in the EU. For further expansion of biofuel production in the future we added small non-zero numbers for production of eth1, eth2, and biod for non-producing biofuel countries in the split processes. In particular, we added small amounts of palm oil based biodiesel production and consumption into the Malaysia and Indonesia input-output tables<sup>6</sup>. These two countries currently produce considerable amount of palm oil based biodiesel, but they had no biodiesel production at the commercial level in 2001.

**Table 2. Biofuel production by type in 2001 (figures are in \$US millions)**

<b>Countries</b>	<b>Ethanol-1</b>	<b>Ethanol-2</b>	<b>Biodiesel</b>	<b>Total</b>
Austria	0	0	15.59	15.59
Canada	77.11	0	0	77.11
Czech Republic	51.68	0	0	51.68
Denmark	18.05	0	0	18.05
France	57.42	0	229.69	287.11
Germany	0	0	258.4	258.4
Slovak Republic	31.17	0	0	31.17
Spain	38.98	0	5.32	44.3
United States	2486.42	0	12.24	2498.67
Brazil	0	5345.15	0	5345.15
Cuba	0	42.66	0	42.66
Paraguay	0	0.82	0	0.82
Total	2760.83	5388.63	521.24	8670.71

<sup>4</sup> IEA (2004) provides data on biodiesel production capacity across the world.

<sup>5</sup> The US average price of ethanol in 2001 was \$1.48. See <http://www.neo.ne.gov/statshtml/66.html>.

<sup>6</sup> The Malaysian input-output table, used in GTAP database version 6, does not properly reflect the palm oil industry of this country. We made some changes in the input-output table of this country. For details see Appendix B

The IEA data base provides total exports and imports of liquid biofuel for each country. We used these figures and other available data<sup>7</sup> to determine bilateral trade in ethanol products in our benchmark year, 2001. In this process we assumed that countries buy/sell biofuel from/to the nearest location. Ethanol trade patterns are depicted in table 3.

**Table 3. Ethanol trade in 2001 (figures are in KTOE)**

Exporting and Importing Regions		Importing Countries					
		USA	Canada	Czech	Denmark	Slovak	France
Exporting Countries	Canada	10	0	0	0	0	0
	Czech	0	0	0	0	2	1
	Denmark				3	0	19
	Slovak	0	0	2	0	0	0
	Brazil	78	97	6	0	0	17

In the case of biodiesel, given the limited amount of production in 2001, we assumed that it was entirely for domestic use for US and EU. The largest bilateral flows are for Brazilian exports to USA and Canada. Data on sales and trade are saved in three data files. These files are explained in section 3.3.

### **3.2. Step two; Sectors to be split and biofuels plant level models**

We reviewed the existing input-output tables of the main producers of biofuels to determine sectors we have to split. After reviewing these tables and considering all possibilities, we decided to follow the splitting rule below to introduce these new products into the GTAP data base:

- Ethanol-1 is split from the food processing (ofd) sector,
- Ethanol-2 is split from the chemicals rubber and plastics (crp) sector,
- Biodiesel is split from the vegetable and oilseeds (vol) sector.

For the sales-splitting procedure we took the corresponding biofuel values from sales values and directed towards households purchases for all types of biofuels.

<sup>7</sup> Such as international trade data of ethyl alcohol (HTS codes 22011060 and 22072000).

For the production side of the splitting procedure we used three plant-level models. For ethanol-1 we followed Tiffany and Eidman (2003). For ethanol-2 we combined available information in USDA (2006), Geller (1985) and OECD (2006). Finally, for biodiesel we used Haas et al. (2005). We used these studies to determine the cost components of producing new commodities. Table 4 depicts these cost structures.

**Table 4. Production Costs for biofuel products**

<b>Main Costs</b>	<b>Ethanol-1*</b>	<b>Ethanol-2</b>	<b>Biodiesel</b>
Feedstock**	39.34	26.00	81.00
Chemicals	7.87	2.10	7.10
Energy	12.38	4.50	2.00
Other	2.60	5.00	1.00
Labor	2.89	15.50	3.00
Capital	34.92	46.90	5.90
Total	100.00	100.00	100.00

\* For details see Appendix A.

\*\* Corn, sugarcane, and processed oilseeds for Ethanol-1, Ethanol-2 and biodiesel, respectively.

Note that the cost of feedstock is between one-quarter and one-third for ethanol, whereas it is much higher in the case of biodiesel. We also assumed that all inputs are produced domestically, except for the feedstock used in the biodiesel industry. Biodiesel is produced mainly by the EU members. Since these countries import a portion of their oilseed consumption, we divided feedstock used in biodiesel production between the domestic and imported sources. Data on the cost structures of new commodities are saved in three different data files. These files are explained in section 3.3

### **3.3. Step Three; Using the *SplitCom* program**

We used the *SplitCom* program to introduce new commodities into the GTAP data base. For each new commodity we have developed a TAB file which updates the userwgt.har file of the *SplitCom* according to the data provided in steps 1 and 2 for that commodity. Note that all files used in this step are saved in a zipped folder which is attached to this report. The content of this folder are explained in Appendix C of this report. The splitting procedure is explained in what follows.

### 3.3.1. In creation of Ethanol-1

- i. The original GTAP data base and its associated files (*basedata.har*, *default.prn*, and *sets.har*) were copied into the input folder of the *SplitCom* program.
- ii. In a primary action, the *SplitCom* was used to split ofd into eth1 and ofdn with simple weights of 50% for eth1 and 50% for ofdn. The purpose of this action was to build the new data base with required files and sets for further actions<sup>8</sup>.
- iii. The 50%:50% weights were replaced with 0% for eth1 and 100% for ofdn. The program was executed with these weights. The purpose of this action was to make the program ready to take our desired weights.
- iv. To make the program ready for accepting our weights, four new headers of *TWGT*, *RWGT*, *CWGT*, and *XWGT* were added to the *userwgt.har* file<sup>9</sup>.
- v. A TAB file named *ethanol1.tab* was used to update the headers of the *userwgt.har* file according to the obtained data in the step 1 and 2. This TAB file is prepared to read data from a file named *eth1data.har* and calculate new weights to split ofd between eth1 and ofdn. The *eth1data.har* file has several headers and contains data on sales, costs, self uses, and trade of ethanol-1. These files are available in the attached zip file.
- vi. The *SplitCom* was used with the updated *userwgt.har* file to get the final split.

### 3.3.2. In creation of Ethanol-2

The data base including eth1 (generated in section 3.3.1) and its associated files were copied into the input folder of a fresh *SplitCom* program folder. Then we followed actions (i) through (vi) as describe in 3.3.1 to split crp into eth2 and crpn. For action (v) we used a TAB file named *ethanol2.tab* to read data from a file named *eth2data.har* and calculate new weights to split crp between eth2 and

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<sup>8</sup> The *SplitCom* generates a file named *userwgt.har* with these primary weights in its first run for a new split process. This file can be found in the input directory after the first run for a new split.

<sup>9</sup> These headers can be found in a file named *nuweight.har* in the work folder of the *SplitCom*. These headers are originally designed to introduce the user weights for sales, costs, self uses and trade data into the *SplitCom*.

ofdn. The *eth2data.har* file has several headers and contains data on sales, costs, self uses, and trade of ethanol-2. These files are available in the attached zip file.

### **3.3.3. In creation of Biodiesel**

The data base including eth1 and eth2 (generated in section 3.3.2) and its associated files were used to add biodiesel into the data base. Here, we first made some minor adjustments in the data base for Malaysia. During the work on the data base we recognized that the input-output table of this country does not properly reflect its palm oil industry. So, before moving forward for adding biodiesel we fixed the problem by some adjustments in the data base for this country, for details see Appendix B. The Adjusted data base and its associated files were copied into the input folder of a fresh *SplitCom* program. Then we followed actions (i) through (vi) as described earlier to split vol into biod and voln. For action (v) we used a TAB file named *biodiesel.tab* to read data from a file named *bioddata.har* and calculate new weights to split vol between biod and voln. The *bioddata.har* file has several headers and contains data on sales, costs, self uses, and trade of biodiesel. These files are available in the attached zip file.

## **4. Development of GTAP-BIOA**

A major portion of corn ethanol produced in the US has been introduced to substitute for the use of MTBE (methyl tertiary-butyl ether) in gasoline production process. We develop GTAP-BIOA to cover the use of ethanol-1 in p\_c industry as an additive to gasoline. According to our assessment about 75% of ethanol production in the US is used as an additive to gasoline in 2001. In preparing GTAP-BIO we were assumed that households are buyers of ethanol-1. Here, we transfer 75% of their consumption of ethanol-1 to the p\_c sector as an intermediate input. To do this transformation we manipulate the GTAP-BIO Data Base using a TAB file named *additive.tab* to generate the GTAP-BIOA Data Base. This data base is provided in the attached zip file. Note that since ofd (the original source of eth1) does not sell its product to p\_c sector, we made suitable manipulations to make the transformation possible. Interested users can see the *additive.tab* file for details.

## 5. Development of GTAP-BIOB and GTAP-BIOC

The biofuel industry produces considerable amounts of valuable byproducts such as DDGS, soy meal, and rapeseed meal. Revenues from selling these by products can play a major role in the profitability of the biofuel industry. In addition, byproducts are major inputs for other industries, in particular livestock. In preparing GTAP-BIO and GTAP-BIOA, we were assumed that the biofuel industry does not have any byproduct. Here, we relax this assumption to introduce DDGS and BDBP to the data base. To develop the third data bases, GTAP-BIOB, we determined the volume of DDGS produced in each country according to the ethanol production in each country. Then, we assessed the monetary value of DDGS produced in each country according to the price of DDGS in the US in 2001. We determined the trade pattern of this commodity according to the available trade data bases as well. The production and trade data on DDGS is saved in a HAR data file named *ddgs.har*. Finally, we used a TAB file, named *ddgs.tab*, to modify the sale pattern and the cost structure of the eth1 industry according to the production and the trade data on the DDGS. We followed the same process to generate the last data base, GTAP-BIOC, as well. The production and trade data on BDBP is saved in a HAR data file named *bdbp.har*. We also used a TAB file named *bdbp.tab* to generate the data base. The last two data bases are not available for public uses. Interested users can follow our approach to introduce biofuel byproducts according to their needs.

## 6. Summary and Evaluation

This research has detailed an effort to disaggregate liquid biofuels in GTAP data base. However, this work has several limitations. First, we assumed the three basic biofuel production technologies are the same for all countries, with minor exceptions. We assumed that biofuels can be produced from corn, sugarcane, and oil seeds such as soybeans and rapeseeds and we ignored biofuels produced from other sources such as palm oil. Furthermore, we relied on imperfect biofuel production and trade information. These deficiencies can be removed with more research and improved data.

In this research we introduced two types of ethanol products: Ethanol based on sugar cane and ethanol based on maize and other starchy crops. Treating these as separate

products permits us to distinguish the two production processes. However, it also means that the resulting products will have separate market clearing conditions in the standard GTAP model. If the user wishes to make them (nearly) perfect substitutes, then a very high elasticity of substitution in use must be introduced into the subsequent model. An alternative is to simply aggregate the two sectors into one.

Finally, there is a question of data consistency. We have observed that there are some significant inconsistencies between independent data sources on ethanol production and trade. In addition, existing input-output tables in the GTAP data base are not very consistent in their treatment of the flow of inputs to the biofuel sectors and uses of these products. These problems are to be expected in the case of a set of newly emerging activities. We hope that these inconsistencies will be reduced over time.

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### Appendix A: Cost Shares for Producing Ethanol-1

This appendix explains cost shares for ethanol-1 presented in table 4 with more details. As mentioned earlier we followed Tiffany and Eidman (2003) to determine cost shares for ethanol-1. They provide a method to estimate costs of and revenues from each gallon of corn ethanol. Using this method we estimated costs of producing each gallon of ethanol based on the average prices of corn and other inputs in 2001. We also calculated revenues from each gallon of ethanol using prices of ethanol and DDGS in 2001. Results are shown in table A-1.

A-1. Costs and revenues per gallon of ethanol in 2001  
(Including revenues from DDGS)

Revenues		Costs	
Price of Ethanol	\$1.48	Feedstock (Corn)	\$0.68
DDGS Revenues	<u>\$0.25</u>	Chemicals	\$0.14
Total Revenue	\$1.73	Energy	\$0.21
		Other Costs	\$0.05
		Labor	\$0.05
		Capital*	<u>\$0.60</u>
		Total	\$1.73

\*Capital includes interests, profits, and depreciation

Since DDGS is a byproduct from ethanol production and there is no place for byproducts in the GTAP data base we used revenues from DDGS to mitigate production costs of ethanol. We distributed revenues from DDGS among cost items proportionally. Results are shown in table A-2.

A-2. Costs of and revenues per gallon of ethanol (excluding revenues from DDGS)

Revenues		Costs	
Price of Ethanol	\$1.48	Feedstock (Corn)	\$0.58
DDGS Revenues	<u>\$0.00</u>	Chemicals	\$0.12
Total Revenue	\$1.48	Energy	\$0.18
		Other Costs	\$0.04
		Labor	\$0.04
		Capital*	<u>\$0.52</u>
		Total	\$1.48

\*Capital includes interests, profits, and depreciation.

## **Appendix B: Corrections in the Malaysian Input-Output Table**

Indonesia and Malaysia produce considerable amounts of palm oil and palm kernel oil. The main agricultural inputs used to produce these products are palm fruit and its kernel. According to the GTAP classifications, palm oil and palm kernel oil should be classified under the code vol and the palm fruit and its kernel should be classified under the code osd.

The GTAP data base indicates that in Indonesia, about 18% of the intermediate inputs used (domestic and imported) by the vol industry is obtained from the osd industry. The corresponding figure for Malaysia is about 1% which is exceptionally small. On the other hand, the data base shows that the use of vol by vol in Malaysia is exceptionally high (75% of inputs used) compared to the corresponding figure for Indonesia (52%). These figures indicate that the intermediate inputs used by the vol industry of Malaysia are not appropriately recorded in its input-output table. The same conclusion can be made for the distribution of the value added of the vol industry among the primary inputs of land, labor and capital in this country.

Given the existing deficiencies in the input-output table of Malaysia we made some modifications in this table according to the Indonesia input-output table. The major modifications are:

- The value of osd used by the vol industry is fixed.
- Given the above change, the value of the osd production is fixed to maintain the table in balance. For this purpose, a portion of value added of vol is transferred to osd.
- The transferred valued added is distributed across the primary inputs of land, capital, and labor according to the distribution of value added of the osd industry of Indonesia.

A TAB file, named “*EditMalaysia*” is used for the above modifications. This file is available in the attached zip file.

## Appendix C: Contents of the zipped folder

The zip file contains two main folders named: GTAP-BIO and GTAP-BIOA the Contents of these folders are:

### 1. GTAP-BIO

This folder contains the following folders:

#### 1.1. eth1

This folder contains two folders: “*updating\_userwgt*” and “*split*”. The first folder contains:

- *eth1data.har*: including data on ethanol-1
- *ethanol1.tab*: A TAB file to calculate and update the 0:1 *userwgt.har* file for ethanol-1
- *ethanol1.cmf*: a CMF file to support the above TAB file
- *userwgt.har*: contain 0:1 weights for eth1 and ofdn
- *userwgt1.har*: contain updated weights for eth1 and ofdn

The second folder, i.e. “*split*”, contains two folders: “input” and “output”. The input folder contains original data base and its associated files, including a copy of file *userwgt1.har* renamed *userwgt.har*. The output folder contains the extended data base including eth1 and ofdn.

#### 1.2. eth2

This folder contains two folders: “*updating\_userwgt*” and “*split*”. The first folder contains:

- *eth2data.har*: including data on ethanol-2
- *ethanol2.tab*: A TAB file to calculate and update the 0:1 *userwgt.har* file for ethanol-2
- *ethanol2.cmf*: a CMF file to support the above TAB file
- *userwgt.har*: contain 0:1 weights for eth2 and crpn
- *userwgt1.har*: contain updated weights for eth2 and crpn

The second folder, i.e. “*split*”, contains two folders: “input” and “output”. The input folder contains the extended data base including eth1 and its associated files, including a copy of file *userwgt1.har* renamed *userwgt.har*. The second folder contains the extended data base including eth2 and crpn.

### **1.3. biod**

This folder contains two folders: “*updating\_userwgt*” and “*split*”.

The first folder contains:

- *bioddata.har*: including data on biodiesel
- *biodiesel.tab*: A TAB file to calculate and update the 0:1 *userwgt.har* file for biodiesel
- *biodiesel.cmf*: a CMF file to support the above TAB file
- *userwgt.har*: contain 0:1 weights for biod and voln
- *userwgt1.har*: contain updated weights for biod and voln

The second folder, i.e. “*split*” contains two folders: “input” and “output”. The input folder contains the extended data base including eth2 (including the modification process for Malaysia) and its associated files, including a copy of file *userwgt1.har* renamed *userwgt.har*. The output folder contains the extended data base including biod and voln. This is the GTAP-BIO Data Base.

## **2. GTAP-BIOA**

This folder contains a TAB file named *additive.tab* which is used to transfer a portion of ethanol 1 to the p\_c sector as an intermediate input in gasoline production. The *basedata.har* in this folder is a copy of the *basedata1.har* generated 1.3 above and the *basedata1.har* is the GTAP-BIOA Data Base.