

# Instructions for Code to Create IMPLAN-based Regional Social Accounting Matrices with Detailed Land Use Data

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# 1 Introduction

This document describes the structure and use of a series of programs used to modify and balance any regional 2008 IMPLAN Social Account Matrix (SAM) to include detailed land-use data. The program also separates IMPLAN's proprietors income account into the more intuitive factors of production of labor and capital. Import duties are also separated from IMPLAN's aggregated indirect business taxes (IBT). IMPLAN's IBT account is also modified for the wholesale and retail trade sectors to reflect more accurate tax allocation.

## 1.1 Requirements

Users are required to have a working copy of GAMS. As provided, the code is designed to run on a UNIX-like machine (e.g., Linux or Mac OS X), however Windows users should be able to easily use this code by appropriately modifying file paths (which must be modified by all users anyway) to employ Windows-style backslashes and partition/drive letters (e.g., "C:\data\" rather than "/home/user1/data/"). As provided, the SAM balancing code (`entropy.gms`) makes use of the PATH solver, for which users must provide their own license. Alternatively, we believe that this code would run with very little modification under the default mixed complementarity solver provided with all GAMS installations (MILES). Users must provide their own IMPLAN 2008 data. No IMPLAN data of any kind is provided or redistributed with this software.

## 1.2 Included files

The software provided here is comprised of the following programs and files and follows the flow shown in figure 1:<sup>1</sup>

`sambuild1.gms` imports 27 `dat` files and a `gms` file from IMPLAN that contain the information for each SAM transaction,<sup>2</sup> merges the trade information from the satellite matrices to the SAM, modifies negative transfers between government and households, includes a simple balancing procedure, and produces a `gdx` output file called `unbalsam.gdx`. For the most part, this program can be easily modified by following the instructions contained in section 3 of this document.

`entropy.gms` takes the `unbalsam.gdx` file, runs it through the cross entropy (CE) SAM estimation technique made available by Robinson and El-Said (2000),<sup>3</sup> and produces the `balsam.gdx` file as an output file.<sup>4</sup> This program should not be modified by any user, except perhaps to employ a mixed complementarity solver other than PATH.

`sambuild2.gms` takes the `balsam.gdx` as an input file, separates proprietor's income into labor and capital, includes land rents per Major Land Resource Area (MLRA), modifies the IBT account, aggregates all IMPLAN sectors and maps code to abbreviations, and produces the `dsam.gdx` file as an output file ready to be used for an Input Output (IO) or Computable General Equilibrium (CGE) model. If the user wishes to modify this program it is highly advised to read Monge (2012).

`LAND.gdx` contains detailed land use data compiled from primarily from USDA sources.

`PROPRIETORS.gdx` contains data from the Bureau of Labor Statistics and the Bureau of Economic Analysis on the number of wage and salary employees and proprietors by activity and by state.

`TAX.gdx` contains U.S. import duty rates.

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<sup>1</sup>The `sambuild1.gms` and `sambuild2.gms` programs are roughly based on original code `aggreg.gms` and `check.gms` made available by Holland, Stodick, and Devadoss (2010).

<sup>2</sup>The first 18 `dat` files comprise what is known as the basic matrix and the other 9 comprise the satellite sub-matrices. The only `gms` file imported from IMPLAN contains a very detailed matrix of the transactions between economic actors.

<sup>3</sup>The CE estimation technique is explained in more detail in Golan, Judge, and Robinson (1994) and Robinson, Cattaneo, and El-Said (2001).

<sup>4</sup>The version included and described in this document has been modified to conform to the structure of a mixed complementarity problem and be solved by the PATH solver.

It is recommended to save the three `gms` files and three `gdx` files in the same directory. The 27 `dat` files and the `gms` file coming from IMPLAN can be saved in a different directory. If different sectorial and regional aggregations are desired, the 27 `dat` files and `gms` file for each aggregation can be saved in different directories.

## 2 IMPLAN

The analyst can specify any desired regional aggregation even including the 48 states included in the contiguous U.S. by following MIG, Inc. (2012b). The analyst can use almost any sectorial aggregation level in IMPLAN since the SAM building procedure is general enough to accommodate most of the original IMPLAN activities and commodities by following MIG, Inc. (2012a). However, there are a few important exceptions of which the user should be aware.

1. As will be explained below, land rent payments are specified for certain agricultural activities (IMPLAN codes 1, 2, 7, 8, 9, 10, 11, 12 and 16); hence, the original disaggregation level obtained from IMPLAN should be followed for these activities;
2. The agricultural activities for which no land rent payments have been specified (IMPLAN codes 3, 4, 5, 6, 13, 14, 15, 17, 18 and 19) can be aggregated or left at their original IMPLAN disaggregation level and will demand land through the intermediate real estate commodity (IMPLAN code 3360);
3. All of the retail-related activities (IMPLAN codes 320 to 331) should be aggregated into one retail activity with the IMPLAN code 320 for the activity and 3320 for the commodity;
4. The wholesale activity should be left alone and the IMPLAN codes 319 and 3319 should be kept for the activity and commodity, respectively.

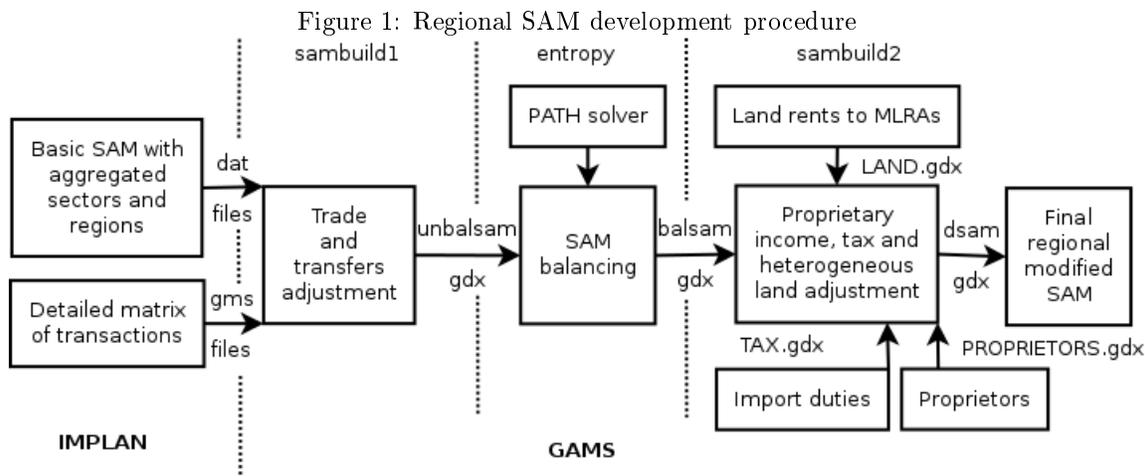
To export the 27 `dat` files and the `gms` single file, read and follow the directions listed in MIG, Inc. (1998) and MIG, Inc. (2012c).

## 3 sambuild1.gms

### 3.1 Sets and parameters

The folder where the 27 `dat` files created by IMPLAN are located is specified by the global variable `PATH`. The appropriate directory location is specified after the `$SETGLOBAL PATH` command.

Then the set `REGION` is helpful to identify the regional aggregation contained in all of the subsequent `gdx` files. Any identifier for the region can be specified between the forward slashes.



The global variable `NATIONAL` is used to specify the scope of the aggregation for subsequent coding. If the regional aggregation includes all the 48 contiguous states in the U.S., then specify `YES` after the `$SETGLOBAL NATIONAL` command in cap letters. If the regional aggregation includes less than 48, then specify `NO`.

The following set `Y` includes all of the codes for the 440 `IMPLAN` activities and commodities. It should not be modified unless the original disaggregation from `IMPLAN` increases to more than 440 activities and commodities.

The set `STATES` contains the FIPS code of the 48 states included in the contiguous U.S. This set should also not be modified.

The set `AGG` is a modifiable subset of the set `STATES` and specifies the regional aggregation to be used. *The user must modify this set to correspond to the imported regional IMPLAN SAM.* In other words, only the FIPS codes of the states that were included in the `IMPLAN SAM` should be specified here.

The modifiable set `K` represents the rows and columns of the `SAM` that will be modified. It includes the codes of the aggregated activities and commodities, the institutions, factors of production, and trade accounts imported from `IMPLAN` as well as all the codes of the Major Land Resource Areas (MLRAs). *The user must modify this set to correspond to imported regional IMPLAN SAM, meaning that the same number of IMPLAN codes for economic agents included in the imported SAM should be included here.* The codes of the MLRAs should not be modified since this list includes the MLRAs present in the 48 states.

The two-dimensional and modifiable set `IMPLAN` is a mapping set between the aggregated accounts (set `K`) and the original `IMPLAN` disaggregation (set `Y`).

The modifiable set `Z` includes the abbreviations used to easily identify the accounts in set `K`. It is recommended to specify a character that differentiates activities and commodities. For example, the capital letter `A` is used at the beginning of every activity and `C` at the beginning of every commodity.

The two-dimensional and modifiable set `MAP` is a one-to-one mapping set between the `IMPLAN` codes of the aggregated accounts included in set `K` and the abbreviations included in set `Z`.

The following group of sets are modifiable subsets of the general set `K` and separates activities (`AK`), commodities (`CK`), value added (`FK`), institutions (`IK`), taxes (`TAXK`), trade regions (`TK`), and row and column totals (`TOTAL`).

The two-dimensional and modifiable set `ACTCOM` is a one-to-one mapping set representing the diagonal section of the “use” and “make” sub-matrices. Although `IMPLAN` does not follow a diagonal structure for the previously mentioned two sub-matrices, this mapping will be useful to model import duties on a commodity basis rather than an activity basis.

The two-dimensional parameter `SAM` will fill in the rows and columns, defined by the set `K` and its alias `KK`, with the data contained in the imported `dat` files from `IMPLAN`. The `PATH` variable specified earlier becomes useful here when repeating the location of the 18 `dat` files. The location of the files is specified in quotes after the `$INCLUDE` command. As any other variable macro, the `PATH` variable is specified in between percent (%) characters. The following three characters identify the position of the sub-matrix to be imported in the `SAM` following the convention used in MIG, Inc. (1998).

The following parameters will import the 9 `dat` files that comprise the satellite sub-matrices. The two-dimensional parameters `FEXPORT` and `DEXPORT` represent the exports coming from foreign and domestic (within the U.S.) regions, respectively. The two-dimensional parameters `FIMPORT` and `DIMPORT` represent the imports going from foreign and domestic (within the U.S.) regions, respectively. The last parameter, `EMPLOY`, imports the employment estimates per activity from `IMPLAN`.

The parameter `TRANSACTION` includes all the detailed transactions imported from `IMPLAN` in the `gms` file. This file is obtained from `IMPLAN` by choosing the option “Industry detail SAM files - GAMS single file” once the sectorial and regional aggregations have been performed. This parameter will be useful when separating import duties and modifying the `IBT` account for the wholesale and retail trade activities.

## 3.2 Adjusting commodity trade

The section under the `ADJUSTING COMMODITY TRADE` title contains code that will merge the trade information from the satellite matrices to the `SAM`. The satellite matrices obtained from `IMPLAN` represent

trade as transactions between activities and commodities from outside regions (rest of the U.S. and the world). However, by following IO and CGE conventions, trade needs to be represented in the SAM as transactions between commodities and outside regions. Hence, the transactions in the satellite matrices will be added to the “make” and “use” sub-matrices and new accounts will be created for traded commodities.

### 3.3 Adjusting government and household transfers

The section under the `ADJUSTING GOVERNMENT AND HOUSEHOLD TRANSFERS` title contains code to modify the negative transfers between government and households. There are some negative payments coming from low-income households to the government. These will be reflected in the SAM as positive transfers from the government to low-income households. There are also negative government transfers to the high-income households. These will be reflected in the SAM as taxes paid to the government.

### 3.4 Simple balancing procedure

The section under the `SAM BALANCE PROCEDURE` title contains code for a simple balancing procedure based on the differences between row and column sums. This simple balancing procedure was created to avoid any large and unreasonable changes when the SAM is passed through the CE balancing procedure. The essential idea is to get a balanced SAM by reducing the difference between the row and column sums for any account. By using the trade, labor and IBT accounts, this simple balancing procedure assigns the small differences to “residual accounts” such as the investment and state government non-education accounts.

From the previous simple balancing procedures, three parameters are created (`DIFF`, `DIFF_CHK` and `SAM_CHK`) to easily check if the SAM has been balanced. These three parameters will be displayed in the `1st` file after running the `gms` program. By subtracting the summation of the row totals from the summation of the column totals, the `SAM_CHK` parameter is estimated and provides a rough balancing indicator. If it is significantly higher than zero, the `DIFF_CHK` parameter should be checked. The `DIFF_CHK` parameter is the summation of the absolute values of the differences between the column and row totals for every account. Being a more refined balancing measurement, if it is higher than zero then every individual difference should be checked. The `DIFF` parameter shows a list of all the differences between row and column sums for all the accounts.

### 3.5 Exporting the SAM

The last couple of sets, `ALLACCTS` and `ACCTS`, differentiate between the set that contains all the SAM accounts plus column totals and the set that contains only the SAM accounts not the totals, respectively. These two sets will be useful in the CE balancing procedure.

The last command line `EXECUTE_UNLOAD` creates the `unbalsam.gdx` file including all of the sets and parameters specified afterwards separated by commas. The `unbalsam.gdx` file will be created in the working directory where the `sambuild1.gms` program is located.

## 4 entropy.gms

As previously mentioned, this program was obtained from Robinson and El-Said (2000). *It is highly advised not to modify the code in this section before reading Golan, Judge, and Robinson (1994) and Robinson, Cattaneo, and El-Said (2001).* This manual will only describe the function of the sets and parameters created in `sambuild1.gms` and imported to this program. Some of the parameters created to check the balancing results will also be described. The code for the CE procedure is explained in detail in Robinson, Cattaneo, and El-Said (2001).

## 4.1 Sets and parameters

The set `i` and subset `ii` are the equivalents of the `ALLACCTS` and `ACCTS` sets created in `sambuild1.gms`, respectively. All of the sets, subsets and parameters exported from `sambuild1.gms` are created first in order to import them to `entropy.gms`. The only parameter that will be used in this program coming from `sambuild1.gms` will be the `SAM` parameter. The rest will not be used and are imported to subsequently be exported to `sambuild2.gms`.

The code between `$GDXIN` and `$GDXOUT` serve to import the `unbalsam.gdx` file and to load the `SAM` parameter, the `ALLACCTS` set (now `i`), the `ACCTS` set (now `ii`), and the rest of the sets and parameters.

The set `TK` is created and explicitly defined here since the `IMPLAN` SAM for a national aggregation does not include the account for the trade with the rest of the U.S. (`IMPLAN` code 28001). Hence, by not including this account, the subsequent use of the `SAM` in an `IO` or `CGE` model would result in compilation errors. This set will subsequently be exported to `sambuild2.gms`.

## 4.2 SAM balancing check

At the end of the code, after the `SOLVE` statement, some parameters are created to check the results of the CE balancing procedure. The most important ones are: `NBALSAM` being the new balanced SAM containing the modified flows from the CE procedure, `origsam` being the positive unbalanced SAM, `difference` being the absolute difference between the original sam and final sam, and `percent` being the percent change of the new balanced SAM from the original one.

The last group of parameters are the same as the ones used in section 3.4, these being `sam_chk`, `diff_chk` and `rowcoldiff` (which is the equivalent of `DIFF`). All of the previous parameters will be shown in the `lst` file after running the program.

## 4.3 Exporting the SAM

The last command line `EXECUTE_UNLOAD` creates the `balsam.gdx` file including all of the sets and parameters specified afterwards separated by commas. The `balsam.gdx` file will be created in the working directory where the `entropy.gms` program is located.

# 5 sambuild2.gms

## 5.1 Sets and parameters

The first `SETS` command recreates all of the sets, first created in `sambuild1.gms`, to import the `balsam.gdx` file. The parameters `SAM`, `EMPLOY` and `TRANSACTION` are also recreated here to import the `balsam.gdx` file.

The commands between `$GDXIN` and `$GDXOUT` serve to import the `balsam.gdx` file with all of its sets and parameters. The only parameter that changes name is the `SAM` parameter to `NBALSAM`.

The following couple of command lines revert the column and row totals to zero to avoid miscalculations in the following procedures.

## 5.2 Separating capital and labor returns from proprietary income

The section under the `SEPARATING CAPITAL AND LABOR RETURNS FROM PROPRIETARY INCOME` title contains code to modify the “proprietary income” `IMPLAN` account into its labor and capital components. The two “employee compensation” and “other property type income” `IMPLAN` value-added accounts are converted into the new “capital” and “labor” accounts. By using the number of proprietors contained in the `PROPRIETORS.gdx` file, a competitive wage is estimated for proprietors based on the wage received by employees. With the competitive wage, the capital and labor shares of proprietary income are estimated and added to the new capital and labor accounts.<sup>5</sup> *It is highly advised not to modify the code in this*

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<sup>5</sup>The only exception is the logging industry (`IMPLAN` code 16) where all the proprietary income is assigned to the capital account. This was done in order to have enough capital to accommodate the land rent payments to forestland later on.

Table 1: Acreage and crops demanding cropland

IMPLAN Code	Aggregated Activity	Crops included	Total acreage
1	Aolsd	Canola, flaxseed, soybean, sunflower, mustard, safflower, rapeseed and sesame	77,289,801
2	Agran	Corn for grain and silage, barley, dry edible beans, oats, rice, rye, sorghum grain and silage, wheat, dry edible peas, cowpeas, lentils, buckwheat, popcorn and wild rice	155,771,190
7	Atobc	Tobacco	317,232
8	Acott	Upland and pima cotton	7,473,539
9	Asugr	Sugarbeets and sugar cane	1,861,035
10	Aocrp	Hay, peanuts, alfalfa, birdsfoot, crimson clover, red clover, white clover, lespedeza, vetch, bahia grass, bentgrass, bermuda grass, blue grass, bromegrass, fescue, orchardgrass, ryegrass, sudangrass, timothy, wheatgrass, guar, hops and mint oil	49,235,752

section before reading Monge (2012). By reading Monge (2012) the analyst will get a better idea of the procedure followed.

### 5.3 Including land rents

The section under the INCLUDING LAND RENTS title contains code to include land rent payments for crop, pasture and timberland at the MLRA level. This section imports the total land rent payments, contained in the LAND.gdx file, to every MLRA per state and activity in millions of U.S. dollars. *It is also highly advised not to modify the code in this section before reading Monge (2012)*. It is worth mentioning that the subset AGR(K) is critical to the inclusion of land rents to the SAM. This set includes the following agricultural activities competing for crop, pasture and timberland:

- oilseed farming (IMPLAN code 1),
- grain farming (IMPLAN code 2),
- tobacco farming (IMPLAN code 7),
- cotton farming (IMPLAN code 8),
- sugarcane and sugar beet farming (IMPLAN code 9),
- all other crop farming (IMPLAN code 10),
- cattle ranching and farming (IMPLAN code 11),
- dairy cattle and milk production (IMPLAN code 12), and
- commercial logging (IMPLAN code 16).

Cropland is demanded by the first six previously listed agricultural activities including the crops listed in table 1. Pastureland is demanded by cattle ranching and farming (11) and dairy cattle and milk production (12). Timberland is demanded by commercial logging (16). *It is highly advised to keep this disaggregation level and codes for the previously listed agricultural activities since the program is not built for their aggregation.*

Following the criteria presented in Graham (1994), land demanded by activities producing high-value agricultural crops such as vegetable and melon farming (3), fruit farming (4), tree nut farming (5), greenhouse, nursery and floriculture (6), poultry farming (13) and all other animal ranching (14)<sup>6</sup> were excluded from the competition for crop, pasture and timberland. Although the demand for land from these activities will still be included in the SAM, it will not be included as a factor of production but as the intermediate demand for the real estate commodity (IMPLAN code 3360).

## 5.4 Tax adjustments

### 5.4.1 Import duties adjustments

The section under the TAX ADJUSTMENTS title contains the code that modifies the IBT account. First, the import duties are extracted from the IBT account of the wholesale trade activity. Following conventional SAM structures, these duties should be reflected as payments from the commodity accounts (column) to an import tax account (row). Hence, the total amount of import duties (IMPLAN code 15018) is obtained from the TRANSACTION parameter, created in `sambuild1.gms`, as the payments from the IBT account (IMPLAN code 8001) to the federal government non-defense (IMPLAN code 11001). Import duties were obtained from GTAP and will be helpful to obtain the shares of the total amount of import duties for every commodity. The GTAP import duties are contained in the `TAX.gdx` file for every commodity imported into the U.S. *As previously mentioned, it is highly advised not to aggregate the wholesale trade activity into another group and identify it with the activity code 319 and commodity code 3319.*

### 5.4.2 Adjusting the retail indirect business taxes

The subsection under the ADJUSTING THE RETAIL AND WHOLESALE INDIRECT BUSINESS TAXES title contains the code to modify the IBT account for the retail and wholesale trade activities. According to Dixon and Maureen (2001) and Giesecke (2009), taxes are recorded in the column of the industry collecting them, not the institutions producing the commodities on which the taxes are levied. Hence, most taxes appear on the output of the retail and wholesale activities. The IBTs paid by the retail and wholesale activities need to be redistributed to the activities and institutions consuming the commodities on which the taxes are levied. Hence, the reduction in the payments from the retail and wholesale activities to the IBT account will be added to the payments from the activities and institutions, using the wholesale and retail activities, to the IBT account. The total amount of sales taxes (IMPLAN code 15020) is obtained from the TRANSACTION parameter, created in `sambuild1.gms`, as the payments from the IBT account (IMPLAN code 8001) to the federal government non-defense (IMPLAN code 11001).

The subsection under the ADJUSTING RETAIL TAXES title contains the code to modify the IBT account for the aggregated retail trade activity. According to Dixon and Maureen (2001), retail taxes accounted for approximately 28% of the total sales taxes paid by different activities and institutions in 1992. Hence, by multiplying total sales taxes by 28% total retail taxes would be estimated and subtracted from the retail trade payment to the IBT account. The analyst can easily change the assumed 28% by changing the percentage multiplied by `TOTSALETAX` to obtain `TOTRETAILTAX` in the code. *As previously mentioned, it is highly advised to aggregate the retail-related activities (IMPLAN codes 320 to 331) into one retail activity with the code 320 and its respective commodity with the code 3320.*

### 5.4.3 Adjusting the wholesale indirect business taxes

The subsection under the ADJUSTING WHOLESALE TAXES title contains the code to modify the IBT account for the disaggregated wholesale trade activity. The IBTs paid by the wholesale trade activity have been used to distribute import duties among imported commodities and will be used to distribute the portion of sales taxes among consuming entities (activities and institutions). Since total import duties have already been extracted from the IBT payments by the wholesale trade activity, the rest of the IBT payments will be used to redistribute sales taxes among consuming entities. *As previously mentioned, it is highly*

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<sup>6</sup>The poultry sector was excluded due to its low pastureland demand. The sector for the rest of the animal production was also excluded since it includes animal families whose pastureland demand is negligible and, hence, no recorded demand figures exist.

*advised not to aggregate the wholesale trade activity (IMPLAN code 319) into other activities and to assign it the activity code 319 and its respective commodity code 3319.*

## 5.5 Assembling the modified IMPLAN SAM

The section under the `ASSEMBLING THE EXTENDED SAM` title contains the code that will map the IMPLAN codes to the abbreviations included in set Z and created in `sambuild1.gms`. First the column totals are reverted to zero and re-estimated to avoid including any residual number from the previous code. Next, the subsets of the set Z are created to accommodate activities (AZ), commodities (CZ), factors of production (FZ), institutions (IZ), trade (TZ), MLRAs (MLRAZ), agricultural activities competing for land (AGRZ), household and enterprises (HOUSENTZ) and import duties (TAXZ). Afterwards, the elements of the subsets are defined by mapping the elements of the subsets AK, CK, FK, IK, TK, MLRA, AGR, HOUSENT and TAXK to the elements of the set Z and conditioning the column totals to be different than zero (NE 0). The subset TOTALZ is also created and assigned its respective element from set Z.

The parameters that will contain the data with the new abbreviations are created afterwards. NSAM will contain the new modified and extended SAM with the abbreviations instead of IMPLAN codes. LABOR will contain the employment data per aggregated activity. ACREAGE and ACRERENT will contain the number of acres and rents per acre per MLRA per aggregated activity, respectively.

The subsequent code defines the elements of the new NSAM with the abbreviations by mapping the elements of the previous SAM with the IMPLAN codes for every sub-matrix included. The first subsection defines the elements of the sub-matrices including commodity and factor supply and demand as well as institutional transfers. The second subsection defines the elements of the trade sub-matrices with the rest of the world. The third subsection defines the elements of the trade sub-matrices with the rest of the U.S. The last subsections define the elements of the ACREAGE and ACRERENT parameters.

## 5.6 SAM balancing check

The section under the `SAM BALANCING AND ADJUSTMENT` title contains code to check if the SAM is balanced well enough to be used in IO or CGE models. The parameters are the same as the ones used in section 3.4, these being SAM\_CHK, DIFF\_CHK and DIFF. All of the previous parameters will be shown in the `1st` file after running the program.

## 5.7 Exporting the SAM

The last command line `EXECUTE_UNLOAD` creates the `dsam.gdx` file including all of the sets and parameters specified afterwards separated by commas. The `dsam.gdx` file will be created in the working directory where the `sambuild2.gms` program is located.

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